



**SWP 7/98 SPINNING YOUR WHEELS OR WINNING THE  
RACE: KNOWLEDGE, RESOURCES AND  
ADVANTAGE IN FORMULA ONE RACING**

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This inductive study takes advantage of a unique archival data base on Formula One racing. The accumulation of resources and knowledge are compared for three cases, representing the only instances of sustained competitive advantage. Enfolding data with existing theory leads to a model that integrates knowledge absorption and application processes.

**Key words: resources, knowledge, competitive advantage**

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*A new theory of the firm, better still, a new theory of competitive advantage creation and maintenance would be of enormous value to the practice of management.” (Schendel, 1996: 2)*

Schendel underlines that the creation and maintenance of competitive advantage is still very much the question of the day for both academics and practitioners of strategy. The emergence of the resource based view has lead many strategy scholars to shift emphasis away from the notion that advantage is created by market structure and positioning, and to move toward an explanation which considers internal resources or assets as the source of the economic rents and competitive advantage (Wernerfeldt, 1984; Barney 1991). In addition to the role of industry structure in determining potential profitability (McGahan & Porter, 1997), the resource-based view (RBV) has now become mainstream strategy thinking.

The re-focusing of the field brought about by the RBV has spawned further theoretical development. In particular, the role of knowledge in strategy can be viewed as an ‘outgrowth’ of the resource based view (Grant, 1996). According to this perspective, knowledge is an intangible resource which is most likely to take the form of an asset stock (intellectual capital) or resource flow (R&D investment). Alternatively, it can be argued that the role of knowledge in competitive advantage can never be fully understood through a resource based lens. Spender’s (1996) thesis is that the knowledge-based view of the firm is a more general statement of the principles underlying competitive advantage.

The purpose of this paper is to move toward a theory of competitive advantage that integrates the knowledge- and resource-based views. This involves developing a set of measures that differentiates between the effects of resources and knowledge on competitive advantage. Then, using an inductive research design, we explore patterns in the relationships among these variables. Data comes from 33 years of archive on the Formula One industry and three specific case studies, representing the only instances of sustained competitive advantage in the industry's history.

The results of our analysis lead to several observations and conclusions. First, the data underscores the fact that the knowledge needed by a firm often grows outside it. Valuable new technologies, management expertise, and intellectual capital may become available in the industry, but firm-level advantage depends on knowing the *potential* value of such resources (appraisal) as well as on knowing how to apply them. At the "industry"<sup>1</sup> or field-level of analysis, this means that competitive advantage moves between firms as individual actors and organisations react to shifts in industry factors (Amit & Shoemaker, 1993). Reactions to such shifts spring first from firm knowledge-absorption processes (research and appraisal) and second from firm knowledge-application processes (development and co-ordination). The role of individual firms in both creating and responding to such shifts is consistent with a

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<sup>1</sup> Although we use the term "industry" throughout the paper, this should not be taken as a reference to specific IO boundaries. Instead, we intend the word more as a place-holder for Spender's less familiar (and for our tastes, too general) phrase (i.e. activity system). "Industry" has a more specific connotation that is more consistent with the traditions in the field of strategic management. In the present context, it is more useful to think of industry as a complex set of actors and events revolving around a particular competitive arena. In examining the Formula One "industry," therefore we focus on relationships between rivals, buyers, suppliers, substitutes, and entrants, but we were aware of more specialised relationships that go beyond IO theory, such as between sponsor and racer, between constructor and advertiser, and between driver and managing director. Importantly, our analysis at the system level also included technological forces and seemingly random events, such as the deaths of key actors.

Schumpertarian view of the firm (Schumpeter, 1934), where entrepreneurs are constantly striving to bring in new ideas which move toward a state of disequilibrium.

Our second and related conclusion is that existing resource-based perspectives on knowledge are focused too inwardly on the firm and knowledge application processes. This is typified by the centrality of application (Penrose, 1959; Spender, 1996), development (Kogut & Zander, 1992) and co-ordination (Grant, 1996) in the theory. While these processes are important, the Formula One data suggest a broader conceptualisation. In particular, knowledge absorption processes which are focused on researching (Cohen & Levinthal, 1992) and appraising industry factors (Barney, 1986) appear to be critical in the firm's ability to develop new competencies and adapt to changes in the basis of competition.

Third, the historical analysis shows that absorbing knowledge, applying knowledge to resources, and enjoying competitive advantage are asynchronous phenomena. Most of existing theory, however, appears to assume they are coincident. By separating knowledge-absorption and knowledge-application in time, the proposed model explains how firm-level learning process may counter the inertial and myopic forces described by existing theory.

## **THEORETICAL BACKGROUND**

### **Knowledge as an outgrowth of the resource based view**

The RBV perspective considers a firm's resources as tangible or intangible assets which are tied to the firm on a semi-permanent basis. Examples of resources are brands, patents, cash, individual skills and knowledge (Grant, 1991). A number of different terms are used to represent the way in which resources are applied by the organisation, such as services (Penrose, 1959),

capability (Grant, 1991) and competence (Hamel & Prahalad, 1994; Snow & Hrebiniak). The goal of the resource based view is to provide a basis for identifying those elements which create and maintain competitive advantage: these have been referred to as distinctive competencies (Andrews, 1971); intangible resources (Hall, 1992); core competencies (Hamel & Prahalad, 1994); strategic assets (Dierickx & Cool; Amit & Schoemaker, 1993); strategic capabilities (Stalk et al. 1992); core capabilities (Leonard-Barton, 1992) and dynamic capabilities (Teece & Pisano, 1994). For these aspects of the firm to create and sustain advantage they are required to meet a number of criteria, such as those set out by Barney (1991), that the competence is able to create value, is rare, is difficult to imitate and unlikely to be substituted.

Knowledge is incorporated into the resource based view as an intangible asset, something which is held by particular individuals, for example: Maurice Saatchi's knowledge of the advertising process; a salesperson's knowledge of particular clients, a finance director's knowledge of the money markets. This view assumes that knowledge is created only by individuals and that the role of the organisation is to co-ordinate and thereby apply the knowledge of individual members. In the case of McDonalds the key element is their ability to integrate the specialised knowledge of individual members in food preparation, human resource management, advertising, and the like. "Knowledge acquisition requires greater specialisation than is needed for its utilisation", and firms exist, therefore, because production requires the "co-ordinated efforts of individual specialists" (Grant, 1996: 112).

The focus of Grant's theory is the concept of the firm as a device for co-ordinating the specialised knowledge of individual members. He traces the implications of this view for organisational structure and the boundaries of the firm. He does not change RBV tenets about

the source of economic rents, however. Knowledge itself is treated as a resource to be applied, but not created, within the firm. Thus, Grant's is a knowledge-based theory of the firm, but it is resource-based theory of competitive advantage.

### **The knowledge based view of competitive advantage**

The knowledge based view (KBV) draws from a distinct stream of literature. This includes work within the domain of organisational learning (Argyris & Schon, 1978; Huber, 1991), management of technology and innovation (von Hippel, 1994; Nonaka & Takeuchi, 1995), and managerial cognition (Weick, 1979; Lawrence & Lorsch, 1967; Stubbart & Ramaprasad, 1988). This eclecticism reflects a need to understand the phenomena of knowledge and its contribution to the economic performance of the organisation.

In his paper, which seeks to contrast knowledge based theory from the resource based and evolutionary views, Spender (1996) relates that, whilst the objective of these two perspectives is the same (to understand the nature of competitive advantage), the assumptions on which they are based are quite distinct. Some of the key contrasts are outlined in Table 1.

[Insert Table 1 about here.]

The major distinction between Spender's perspective on knowledge and that afforded by the resource based view is that the resource based view starts from an atomistic level in terms of bundles of assets and skills. Knowledge is simply one of these resources, albeit an important one. In contrast, the knowledge based view starts with a more holistic perspective. Knowledge is part of an "activity system," consisting of many elements and complex interactions, and it is the system which makes knowledge meaningful. For an organisation, "...to know is to be able to



take part in the process that makes knowledge meaningful” (Spender, 1996: 59). Organisations, therefore, are knowledge creating entities, as are the larger systems in which they exist..

The assumption that organisations create new knowledge is inconsistent with a purely resource-based view of competitive advantage. Rather than advantage stemming from the ownership or control of knowledge-based factors of production (potential resources) (Miller & Shamsie, 1996), a knowledge-based theory suggests that advantage stems from the knowledge generated within the firm. The difference is important because it shifts the focus of research away from the characteristics of firm-level resources toward the organisational processes that impede or facilitate the creation of knowledge.

### **Research Questions**

The purpose of this research is to develop a more integrative approach to the role of resources and knowledge in a theory of competitive advantage. Although extremely deep in their own element, neither the resource- or the knowledge-based school has taken a thorough approach to incorporating the other. In this study we ask a few basic questions about the relationship between the two sets of ideas:

#### **Research question 1: Are the effects of knowledge and resources on competitive advantage independent, dependent or inter-dependent?**

To begin the task of integrating the two ideas, we first try to disentangle them. Can the effects of knowledge and resources be accurately disentangled? Can reasonably valid indicators discriminate independent effects for them? Can the variables themselves be separated from their effects (competitive advantage)? If the two sources of advantage cannot be separated empirically

one from the other, then Ockham's law<sup>2</sup> probably means challenging the knowledge-based view (i.e. Spender, 1996), which operates at a higher level of abstraction and introduces difficult constructs like "activity systems." On the other hand, if measures cannot consistently discriminate between competitive advantage and its sources (i.e. resources), then perhaps even the RBV is redundant. The first challenge of our research design is, therefore, to conceptualize independent indicators of knowledge, resources and competitive advantage.

**Research question 2: Can knowledge-based explanations of competitive advantage be subsumed under the RBV? (or vice versa)**

It is easy to "read into" traditional resource-based discussions and see variables that are closely related to organizational knowledge, such as skills, competencies, and learning. Alternatively, the knowledge-based discussion in Spender (1996) embraces many of the principles of the RBV, literally *transforming* resources into knowledge by identifying them as part of a socially constructed reality. Thus, question two is the theoretical version of question one. Apart from whether the two ideas are distinguishable empirically, there is the conceptual issue of whether knowledge is part of a resource-based explanation or resources part of a knowledge-based theory.

**Research question 3: What is the appropriate conceptual (or causal) relationship between organizational knowledge and firm-specific resources as sources of competitive advantage?**

Rather than pitting the RBV and KBV against each other as alternative explanations, one might ask whether they can be combined to produce a simpler, more cogent argument. This is the essence of the third research question. It reiterates the purpose of this research: to move

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<sup>2</sup> All else equal, simpler explanations are preferred over more complex ones.

toward a theory of competitive advantage that integrates concepts from the resource and knowledge-based perspectives.

In the next section, we explain the research design and outline the methods used to investigate the three research questions. This discussion begins with the reasons for choosing the Formula One racing industry as an appropriate research context. Then follows a detailed comparison of the attributes of knowledge and resources. This theoretical discussion provides the basis for defining qualitative and quantitative indicators of knowledge and resources and distinguishes these from competitive advantage itself. The paper then turns to an analysis of data from three case studies. Finally, the patterns that emerge from this analysis are incorporated with existing theory to develop an integrative model. The paper closes with a discussion of the implications of the model for future research.

## **METHOD**

### **Research Design and Study Context**

There is a considerable amount of theory in the RBV, and research has begun recently to focus on theory testing (e.g. Miller & Shamsie, 1996). In contrast, however, the knowledge based view has received much less attention, and little or no empirical research has come forward (Grant & Spender, 1996). Further, the development of the two conceptualizations has proceeded relatively autonomously, and a purely deductive integration would risk merely accounting for one in terms of the other. In order to address the meta-theoretical questions just identified, therefore, our approach is to explore empirically the interplay between variables identified in the two theories, and on this basis, begin to conceptualize how they relate to one another. Thus, our

design is grounded theory-building (Glaser & Strauss, 1967). Even though it takes advantage of existing theoretical knowledge wherever possible, the goal is to “let the data speak” with regard to relationships among variables. Put differently, this research uses an inductive logic (Eisenhardt, 1989).

As Mintzberg (1979) observed, “...theory building seems to require rich description,” and accordingly, the study employs a multiple case study approach to collecting data (Yin, 1981, 1984). The first and most crucial step in such a design is the selection of cases. The principle criterion for choosing is the theoretical usefulness of the data for observing relevant phenomena. The cases should be sufficiently homogenous to constrain extraneous variation, but they must be diverse enough to reveal variation in the variables of interest (Eisenhardt, 1989). In the present case, this “theoretical sampling” approach suggests the need for populations of knowledge- or technology-intensive firms, operating in fast-paced, competitive environments.

The Formula One industry represents the pinnacle of automotive technology. The circuits used in the championship require cars that are both powerful and maneuverable, and the industry has been punctuated by several technical revolutions in engine and car design (See Figure 1). Industry observers estimate that a minimum investment of 25 to 30 million pounds Sterling is required to support research in the industry. The pace and competitiveness of the industry is represented by the fact that no team or driver has won the championship consecutively more than four times. In such settings, there is a greater likelihood for observing resource-based competition than in mature oligopolies, for example (Porter, 1991).

Perhaps the most vexing issue in designing research on competitive advantage, however, is defining the dependent variable (advantage) and differentiating it operationally from its antecedents and outcomes (economic performance). While one expects correlation between

these variables, there are many other factors that are related to performance, including industry and corporate effects (McGahan & Porter, 1997; Rumelt, 1991). Thus, financial indicators (either accounting or market-based) of performance alone cannot be equated with sustained competitive advantage or the resources underlying it. Valid indicators of resources must be industry-specific and should correspond to rent-generating performance at the firm-level of analysis. Thus, Miller and Shamsie's (1996) study employed measures such as the number of Academy Awards received by Hollywood studios. Mehra (1996) used expert panel data to rate the profit potential of firm-level characteristics.

The Formula One industry provides an excellent objective measure of competitive performance, i.e. winning races. Consistently winning races seems to equate well with producing an outcome which represents a demonstrable and quantifiable advantage. Thus, in this industry, sustainable periods of competitive advantage are objectively observable without relying on surrogates such as market share or financial performance. Economic rents in this case flow from sponsor and advertiser dollars and from dollar prizes channeled through the official industry association (Formula One Administration Ltd). The economic connection to winning is quite direct. Advertising rates, for example, are set according to which teams make the best billboard, and since cameras focus on those who lead the pack, winning races means higher rates.

In particular, winners are declared each year both for "constructors" (race car construction companies) and drivers based on points accumulated over the season's races. Plots of constructor point totals from 1961-1994 reveal distinct periods of industry dominance--sustained competitive advantage--for just three firms: Ferrari in the 1970s, McLaren in the 1980s, and Williams in the 1990s. Thus, we decided to analyze the history of Formula One racing over 33 years, focusing on the three cases of clearly observable competitive advantage.

Formula One racing is also an industry that provides a particularly rich mix of technologies, assets and skills. These include automotive technologies, human capital (drivers), firm reputation and management expertise. Ron Dennis (CEO of McLaren International) characterized the basis of competition in Formula One as (1) finance (2) car design (3) engine (4) driver (5) organization. These comprise at least a partial list of critical resources or strategic industry factors (Amit & Shoemaker, 1993), and the data confirms their importance in team performance. Interestingly, no one firm has been able to dominate in all five of these dimensions.

### **Measures of Knowledge and Resources**

As suggested in the first research question, one of the goals of this research is to sort out the resource- and knowledge-based elements of advantage. To achieve independent observation and measurement of such complex and potentially over-lapping variables requires careful definition of categories, even when the measurement is qualitative. Accordingly, Table 2 attempts to distinguish knowledge and resources by comparing them along four attributes: tangibility, social, enduring and cumulative. These adjectives refer to characteristics which have been identified in the literature as important in explaining the link to competitive advantage. Since the two constructs share these attributes, or at least the “labels” attached to them, distinctions sharpen the focus of our observation. Based on these distinctions and other relevant literature, Table 3 provides operational definitions of the key variables in the present context, emphasizing their theoretical role in competitive advantage and illustrating them with examples from the F1 industry.

[Insert Tables 2 and 3 about here.]

### **Data Sources and Analysis**

Data for the study draws on an archival data base available for the Formula One (F1) racing industry. The data is uniquely rich because F1 is the subject of constant media attention. This generates an enormous amount of written material detailing the actual words and actions of industry players--both individuals as well as firms--all of which has been collected in an industry archive located at the in the southern region of the United Kingdom.<sup>3</sup> Moreover, the researcher's own geographic proximity to this data base and to the physical facilities of the companies themselves allows for substantial industry contact.

Published sources of data included periodicals (*Autosport*, *Autocar*, *Motor Sport*, *Motoring News*) which provided full race by race accounts of each season and detailed descriptions of the "behind the scenes" activity of each team. This data was supplemented by annual reviews such as the *Autosport* yearbook and other accounts including autobiographies of the key players to create a detailed chronological database. The more detailed accounts of sustained competitive advantage were sent to the three teams in question, these were then revised and amended following their input for factual accuracy. This process resulted in an industry note, short cases for a range of constructor firms, and longer cases for three firms.<sup>4</sup> The three longer cases (Ferrari, McLaren, Williams) are summarized briefly in Tables 4a-c, and Figure 1 depicts key events in the industry over the period.

[Insert Figure 1 and Tables 4a-4c about here.]

There are several ways that case studies can lead to the development of new theory. In the present case, we are interested in building an explanation of competitive advantage that integrates the knowledge- and resource-based views. This involves matching patterns in the data with theoretical explanations (Campbell, 1975; Yin, 1981). Studies involving multiple cases

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<sup>3</sup> BP Library of Motoring at the National Motor Museum. (Beaulieu), United Kingdom.

<sup>4</sup> Cases are available from the first author.

have the advantage of permitting comparisons between, as well as within, cases in the search for patterns. Fundamentally, however, even a single historical case can be a fruitful source of explanation when it is accompanied by techniques such as theoretical sampling and enfolding appropriate literature (Eisenhardt, 1989). Some of the best examples of theory development focus on one or a very few cases (e.g. Alison, 1971; Burgelman, 1983; 1991; 1994).

## RESULTS

### Firm-level analysis

Figures 2a-c provide a graphical depiction of the relationship between racing performance (note the periods of sustained advantage) and data on the knowledge, property-based resources, and competencies available to each firm. This analysis suggests several patterns.

First, the dominance of Ferrari during 1975-1977 resulted from their development and ownership of the 312T car, a tangible asset and property-based resource. But, to explain competitive advantage in terms of this single resource would be inaccurate. Indeed, the events leading up to the 312T car's launch are marked by the accumulation of a number of unique property-based resources (sponsor funding, test track, driver). Ferrari's reputation had frequently drawn in a quality set of resources before, but Enzo Ferrari's "divide and conquer" management style usually prevented the firm from realizing their value.

[Insert Figure 2a, 2b & 2c about here.]

In 1973, however, management expertise became available in the form of a new team manager, Luca Montezemolo. Montezemolo's professional approach led to more successful integration of resources, and in particular, it linked the organization's technical knowledge with



the skills of Niki Lauda as a driver. This combination produced a car that was not only powerful, but that also handled extremely well.

Ferrari's subsequent advantage, therefore, was caused not by the control of a single resource. Instead, the advantage resulted from the dynamic interaction between property-based and knowledge-based resources within the firm. Technical competencies developed as individual skills and facilities were successfully coordinated by management. When integrated with the unique driver assets available to the firm, this produced a winning combination.

Note that more evidence for the importance of coordinating resources and integrative knowledge is provided later in Ferrari's history. The accumulation of important designer skills in 1980 and the development of V6 turbo technology in 1981, while improving race performance, did not produce a sustained advantage in the 1980s. The departure of Montezemolo, in particular, and the death of Enzo Ferrari during this period left the organization without leadership, and therefore, without the ability to integrate technical competencies. Indeed, lack of management skill may be one reason that the tenure of World Champion driver Alain Prost at Ferrari was less than one year.

**P1A: Sustained competitive advantage results from a unique and valued combination of competencies (knowledge-based resources) and property-based resources.**

**P1B: Unique and valued resources will not produce competitive advantage in the absence of the ability to integrate specialized competencies.**

It is notable that McLaren had been in existence just nine years and Williams only two at the starting point of Ferrari's period of sustained advantage (1975). This difference in life span may be crucial because the pattern of winning races in these two firms shows an decided upward

trend over a relatively long period of years. This trend suggests that both McLaren and Williams learned how to improve their ability to compete over time.

More than just learning how to coordinate a particular set of resources better than their competitors, these firms appeared to “learn how to learn” and were able to continue improving race performance even after a shift occurred in industry factors and the viable bases of competitive advantage in the industry. For example, in response to the introduction of ground effect technology by Lotus in 1978, Ferrari did not modify its drive-train design in ways that were necessary to apply the technology. Instead, Ferrari’s commitment to build a better engine caused it to ignore and undervalue this technology. In contrast, both McLaren and Williams were already outsourcing engines and were thus in a position to absorb and incrementally improve on ground effect technology.

**P2: The role of knowledge in creating competitive advantage is governed by two process:**  
**a: The application of knowledge to the coordination and development of resources,**  
**and**  
**b: The absorption of new knowledge that is unrelated to the firm’s existing resources.**

Successful application but not absorption is evident in Ferrari’s pattern of winning. The Italian company’s advantage seems to have developed in the mid 1970s because skilled management resulted in better application of resources for a limited period of time. But, there is no long term, upward trend line evident in Ferrari’s race performance anywhere in its history.. Rather than learn the importance of managerial competence to team performance (absorb new knowledge), for example, Montezemolo was promoted and became less involved with the team in 1976.

Thus, had either McLaren or Williams accumulated more experience prior to 1975, Ferrari's run of winning seasons might never have occurred. Indeed, the average point totals per race for McLaren and Williams during their winning years were 9.97 and 9.37, respectively, versus Ferrari's 6.79 (all out of a possible 20 points maximum). In short, had all three firms competed at the same point in their life span, the "learners" would clearly have had the advantage.

For McLaren, the pattern of improving race performance began at a low point in 1980 and culminated in 1988-1991. In 1980, the company reorganized itself and appointed Messrs. Dennis and Barnard to key leadership posts. These individuals were valuable because of their ability to coordinate and integrate resources. As in the Ferrari case, this knowledge made it possible to assemble and manage unique, property-based resources, including the best drivers (Lauda, Senna and Prost), best chassis, and best engine available. Unlike Ferrari, however, McLaren's pattern includes a learning trend. When the turbo engine was banned by industry officials in 1989, McLaren had already abandoned its turbo engine contract with Porsche and had negotiated virtually exclusive rights to the superior Honda engine. Importantly, Honda possessed capability in both turbo and normally aspirated engine development. By making the shift early, McLaren experienced the change in the basis of competition not as an industry jolt, but as the launching pad for a period of racing dominance. Thus,

**P3: Sustained competitive advantage is the result of a sustained learning process wherein firms develop the capacity to absorb new knowledge.**

The events leading up to Williams period of sustained advantage confirm these assertions and also tell a different story. Like McLaren, Williams has been able in recent years to comprehend shifts in the basis of advantage and absorb new knowledge. In addition, however,

Williams is noted for the continuity of their team, as manifest in the long partnership between Frank Williams and Patrick Head. Despite Williams' disability, he continues as the chief executive and sees his role as creating an organization environment in which the team can build the fastest and most reliable cars. The company is known for its consistent performance, and for its efforts to continuously improve the design relationships between the car's chassis and its engine. In short, Williams and Head are clearly the best "organization builders" in the industry, and their ability to create a culture of continuous learning has paid off. Williams continues in 1997 as one of the dominant Formula One contenders.

Williams success illustrates the self-reinforcing, learning effects that resources and competencies have on one another. Competent management brings individual skills and facilities together to create a competence in car design. This competence leads to the creation of a new car. This newly available, property-based resource is then used to attract a first rate driver, which yields the fundamental competence of winning races. Winning races in turn brings more financial (property-based resources), and this leads to the further refinement of chassis/engine design. Figure 3 illustrates the self-reinforcing circle implicit in this argument. More formally,

**P4a) The availability of property-based resources encourages the development of competencies as the resources are applied successfully to the solution of organizational problems.**

**P4b) The development of competencies leads to the availability of more complex property based resources, and hence, the development of higher order competencies.**

[Insert Figure 3 about here.]

Like McLaren, the Williams graphs shows a pattern of learning prior to the period of sustained advantage (i.e. a discernible upward trend line in point totals from 1988 through 1993) and the ability to integrate unique property based resources (Renault partnership and drivers

Nigel Mansell and Alain Prost). Again, the period is preceded by an event which makes management or coordinative knowledge available, in the form of an operating partnership between Frank Williams and Patrick Head and the increased involvement of Head in the overall management of the team due to Williams' accident. The Williams advantage, then, is a consequence of having the ability to manage the resources controlled by the firm. Such knowledge includes not only the development, coordination, and application of knowledge within the firm, but also the knowledge related to the appraisal and absorption of knowledge from outside the firm (e.g. Renault and Honda engine partnerships, drivers, car designers). Thus, Williams appears to have the capacity for both the absorption and application of knowledge, and this may account for its recent high levels of race performance.

**P5: Firms that have the capacity both to absorb and apply knowledge will outperform firms who have only one of these capacities.**

### **Field-level analysis**

The relationship between knowledge, resources and competitive advantage becomes clearer when viewed from an industry- or field-level perspective. In particular, the shifts in the basis of competitive advantage are seen to result from exogenous mandates (i.e. regulatory changes), random events (e.g. Bruce McLaren's death in 1970) or the responses of firms to a lack of some critical resource (e.g. Ferrari's development of 312T responds to the dominance of the Ford DFV engine). Figure 4 traces a six year period (1973 to 1979), mapping the relationship between industry level factors and firm-level activity.

[Insert Figure 4 about here.]

Figure 4 shows a pattern of interaction between changes in industry-level knowledge (e.g. end of Ford DFV 'kit car' dominance), firm-level appraisal and absorption of such knowledge

(e.g. decision by Ferrari to design new engine, decision by Lotus to design new car), and firm-level development, application and coordination of such knowledge (e.g. Williams incremental, simpler and lighter interpretation of ground effect design). At the field-level, then, first-order learning comes in the form of incremental firm responses to developing, integrating and coordinating an existing set of critical resources. Second-order learning, on the other hand, comes in the form of firm responses to shifts in industry factors.

**P6a: Learning how to apply a given set of resources in the development of competencies (first-order learning) may be stimulated by activities within firm boundaries, depending on the availability of managerial knowledge about how resources and competencies may be developed and coordinated in the pursuit of competitive advantage.**

**P6b: Learning what new resources and competencies are needed to achieve competitive advantage (second-order learning) may be stimulated by activities in the industry, depending on the availability of managerial knowledge about the technical relevance and market value of new resources and competencies in the pursuit of competitive advantage.**

## DISCUSSION AND CONCLUSIONS

We have, perhaps over-ambitiously, focused our study on developing the basis for a theory of competitive advantage, building on the resources and knowledge based perspectives. However, whilst we do not purport to have developed an overarching theory, we are able to propose how such a theory may evolve from these perspectives. These ideas can be traced back to the initial research questions.

**Research question 1: Are the effects of knowledge and resources on competitive advantage independent, dependent or inter-dependent?**

If the role of resource based and knowledge based theory is to develop a theory of competitive advantage then these case studies indicate how, independently, both these perspectives provide understanding and partial explanation of competitive advantage. However,

the cases emphasise the essential inter-dependence of the resources and knowledge perspectives when considering real-world phenomena. Every resource has a knowledge based component in some form, and every knowledge based element requires a resource in order to release the potency of the knowledge in pursuit of advantage. The data suggests that neither is sufficient in isolation as a basis for understanding competitive advantage. What is highlighted here is the need for a theory which accounts for the nature of resources and knowledge needed for competitive advantage, but in a way which both transcends firm level analysis and which is inherently dynamic and transformational.

**Research question 2: Can knowledge-based explanations of competitive advantage be subsumed under the RBV? (or vice versa)**

The discussion on the first research question suggests the appropriate basis on which we can respond to the second. To subsume the knowledge based view within RBV is to extinguish the very aspects (multiple and dynamic levels of analysis) that provide a richer insight into the nature of competitive advantage. It would be impossible, for example, to explain McLaren's or Williams advantage without identifying industry- or field-level phenomena, i.e. the availability of ground effect technology and engine technology external to the firm. The capacity to absorb new knowledge appears crucial in understanding how changes in industry factors affect competitive advantage.

To subsume the resource based view within a knowledge driven perspective presents different problems. Because the knowledge-based view incorporates the value of resources, the problem is not loss of conceptual richness. Rather, the problem with moving to a purely knowledge-based explanation of competitive advantage is that it may not be accurate. It is

possible to explain, for example, Ferrari's period of advantage within the resource based view. Ferrari learned how to develop and co-ordinate a unique and valued set of competencies and resources. Lack of change in the factor markets mitigated the requirement for research about and appraisal of potentially new resources. Ferrari's advantage relied very little on the firm's ability to absorb new knowledge. For relatively stable factor markets, the resource-based view may, therefore, provide an accurate and more elegant explanation of competitive advantage.

**Research question 3: What is the appropriate conceptual (or causal) relationship between organizational knowledge and firm-specific resources as sources of competitive advantage?**

We have developed a number of ideas which may help in defining the characteristics of an integrated theory of competitive advantage. First, the knowledge and potential resources needed by the firm grow outside it. Firm level advantage is therefore created by the movement of knowledge and resources between the firm- and field- levels of analysis. Our theory must therefore centre on the dynamic interface between these two levels. This accords with Spender's (1996) notion of an "activity system". Here, firms interact with one another, with individuals, and with a complex, moving stream of events: "[S]trategists are.. nodes of imaginative leadership and influence in the complex of heterogeneous emotionally and politically charged knowledge systems." (60).

Second, the dynamic nature of the interface between firm and field levels, highlights a major limitation of the resource based perspective. The assumption that competitive advantage is built on the deployment of existing resources is challenged by the case data. The case data suggests a far more fluid approach to continually appraising, absorbing, applying and co-



ordinating resources which may often be highly mobile and imitable. Therefore to develop a theory of competitive advantage we must include, not just the application of existing resources and knowledge but also the appraisal and absorption of new knowledge and resources.

These issues relate to Teece et al's (1996) theory of dynamic capability which explains competitive advantage in terms that weave together the concepts of resources and knowledge. In particular, they argue that dynamic capability is a function of a firm's position (existing resource configuration), path (unique history) and process (management and organisation). Process--the co-ordination and integration of activities by management--represents the knowledge or learning component of Teece et al's (1996) theory. The outcomes of this process may be (1) learning to do more or less the same things quicker or better, or (2) learning to do new things (reconfiguring/transforming resources) (Nelson, 1991). The findings of this study suggest that dynamic capability extends beyond the application and co-ordination of resource bundles within an organisation to how the firm responds to changes in industry factors. This is where the concept of absorption (research and appraisal of resource bundles outside the organisation) provides a broader and richer perspective for understanding competitive advantage.

Third, our findings suggest that competitive advantage may develop in a series of learning phases relating to the absorption and application of resources/competence. This phased characteristic can also be recognised in Penrose's view of the dynamics of growth and in models such as that developed by Greiner (1982) which identifies the characteristics of particular learning phases. Our findings suggest, as with firm growth, that developing sustained competitive advantage is a dynamic process which can be explained in distinct phases:

application and absorption. Table 5 summarise the nature of the two phases, and Figure 5 shows how the phases operate in a cyclical manner.

[Insert Table 5 and Figure 5 about here.]

Application of a given set of resources leads to the development of competencies which leads to the co-ordination of the competencies in pursuit of competitive advantage. This self-reinforcing process is significant because it represents the firms learning process and because it is a “closed loop.” Thus, without the absorption of new knowledge into the firm, the cycle provides momentum for learning, but such learning is focused on how to apply a fixed set of resources to pursuing advantage. When changes in available factors occur, such a cycle can become produce myopia within the firm. Thus, left unchecked, first order learning causes firms to build an increasingly elaborate number of routines that serve to develop and co-ordinate a set of resources; these become a source of inertia which constrain the historical trajectory of the firm (represented by the large arrow in Figure 5).

The absorption phase is important in changing the firm’s path. This requires the capacity to conduct research about and to appraise the potential value of industry factors within the firm. Ferrari was unable to get on a learning trajectory for lack of this capacity. McLaren and Williams seemed better able to absorb new knowledge, perhaps because of differences in their resource positions (i.e. no commitment to engine technology within the firm). For whatever reason, the ability to absorb new knowledge changed the trajectory of these firms, and these changes positioned them to achieve periods of sustained competitive advantage.

Recognising the distinction between the absorption and application of knowledge may provides a basis for resolving the one of “paradoxes” of organisation learning. Learning is required to adapt, but the process of learning creates inertial forces which impede adaptation (Huff, Huff & Thomas, 1992; Leonard-Barton, 1992). By separating absorption from application, the present theory shows that the inertial forces of the latter are overcome by the transformational forces embodied in the latter. This is not to suggest that second-order learning is disconnected from first-order learning. Rather, based on the data from the Formula One industry, it appears that the two phases occur within organisations at different points in time based partly on triggers for change that develop outside the firm. Thus, to adapt to changing factor conditions, the momentum and trajectory that results from the inertia of first-order learning must from time to time be corrected by the absorption of new knowledge.

This study presents a number of issues which we hope will inform future research in the study of competitive advantage. First, research into competitive advantage needs to incorporate multiple levels of analysis in order to capture the firm/field interaction. Second, the dynamic nature of the phenomena requires research designs which are both longitudinal and able to identify the changing basis of competitive advantage within the industry. Third, we need develop methodologies which enable us to examine the idiosyncratic and fine-grained nature of property and knowledge based resources in this context. These are significant challenges. We hope meeting them will lead to the development of better theory and inform those who are in the practice of strategic management.

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	Resource Based View	Knowledge Based View
The organisation is..	Unique bundles of resources energised through competences	A system of knowing created by an alliance of independent knowledge creating entities (individuals, teams or other organisations)
Competitive advantage is achieved through....	Possessing resources and competences which are unique, non-imitable and non-tradable	A unique embedded deep knowledge coupled with the ability to generate and transform this knowledge
Resources are...	Independent elements, the basic unit of analysis	Resources and competences are dynamic and interrelated.
Competences are...	The means by which resources are activated. This includes the integration of individual knowledge as a intangible resource	Individual knowledge merges into organizational routine and becomes systemic. Core competence is part of the systemic or deep knowledge of the system.
Knowledge is...	An objective, transferable resource. An intangible asset where individuals hold specific knowledge about specific activities	It is embedded in the system and can be seen as an outcome of the system's activity. It holds the system together.

**Table 1**

Contrasts between the Resource Based and Knowledge Based Views

(after Spender, 1996).

	Resources	Knowledge
Tangibility	Resources may be tangible or intangible (intellectual capital). Resource intangibility (asset or skill based) is associated with inimitability (Barney, 1991).	Knowledge is generally intangible (exceptions may be physical artifacts as symbols of culture). Knowledge may be implicit (tacit, unconscious) or explicit (declarative) (Kogut & Zander, 1992; Spender, 1996)
Social	Critical resources are often bundles of assets and skills (Barney, 1989; Diercryx & Cool, 1989)	Individuals are “sources” of knowledge (Nonaka, 1994; Spender, 1996). Culture, meaning, and structure represent forms of shared knowledge (routines) (Nelson & Winter, 1982)
Enduring	Advantage-sustaining effects of rent-producing resources derives from non-substitutability, non-tradeability and inimitability (Conner, 1991).	Individual and organization knowledge endures in the form of “memories,” institutionalized routines, symbols, etc. (Leonard-Barton, 1992)
Cumulative	Accumulation of resources is an historical and path-dependent process. Firms learn to do some things well as a result of an idiosyncratic experience base (Diercryx & Cool, 1989; Nelson, 1991).	First-order learning (capability development) occurs in the transformation of resources into deployable competencies/skills/routines; second-order learning (dynamic capability development) occurs in achieving innovative forms of advantage (new competencies/skills/routines) (Nelson, 1991; Teece, et al, 1996)

**Table 2**

Distinctions between Knowledge and Resources



**“Pure” knowledge (know-what):** For our purposes, certain kinds of organizational knowledge can be divorced from context. This is accomplished by making the substance of what is known explicit and thereby removing its tie to a particular experience. Pure knowledge is distinct from competencies (or knowledge-based resources; see below) because the latter is tied to a specific task and set of resources. In Formula One racing, examples of pure knowledge can be observed in the “ground effect” design principle which was first codified by Lotus and later copied by Williams, among others.

**Property-based resources:** These are the stocks of available factors which are controlled by firms as a result of property rights (ownership, contracts). Typically it is only the fortunate or insightful firms that are able to gain control over valuable property-based resources before the value is known generally (Miller & Shamsie, 1996: 521). Protection comes from trade restrictions, law, or first-mover pre-emption (Conner, 1991; Grant 1991). In this study, therefore, property-based resources relate to individuals and their knowledge and/or skill (designers, drivers), to facilities such as factories and testing tracks, to financial resources and to other factors such as logistical systems, brand names, etc.

**Competencies (knowledge-based resources or know-how):** Competencies represent the capacity to deploy property-based resources. They are “subtle and hard to understand.” In the language of knowledge theorists, they are “tacit.” They are protected from imitation because they involve talents that are elusive and whose connection to results is hard to discern (Miller & Shamsie, 1996: 522). Competencies may be technical, creative or collaborative and are always tied to a particular set of resources. For example, developing a car requires the ability to integrate the efforts of drivers, designers, telemetry systems, support teams, etc.

**Sources of advantage:** Competitive advantage comes as a result of “pure” knowledge, property-based resources and/or competencies which are owned or controlled by the firm and which--separately or in combination--are difficult to imitate, scarce, immobile, and valued in the market.

**Table 3**

**Operational Definitions of Knowledge, Resources and Competencies**

**Table 4a: Case Summary**

<b>Case History: Ferrari 1975-1977</b>	
Constructor's cup: 1975; 1976 & 1977	Average: 6.79 points per race (theoretical max. 20) nearest rival achieved 74% of points score during same period (McLaren)
Key Resources	<p><i>Technical Director:</i> (Mauro Forghieri) supported by designers and technicians</p> <p><i>Technical Facilities:</i> Factory at Maranello for development and production of all key car components (chassis, engine, suspension, gearbox); Test track close by at Fiorano, most sophisticated and up to date test track in the world, Ferrari were the only team to have their own dedicated test facility</p> <p><i>Finance:</i> In 1969 Ferrari merged (in effect a takeover) with Fiat. This provided unrivalled financial supported in comparison with other teams who relied on their ability to attract commercial sponsorship.</p> <p><i>Driver:</i> Niki Lauda recruited in 1974 was a good race driver, but also a highly competent development driver.</p> <p><i>Management:</i> In 1974 Enzo Ferrari (then 74) brought in Luca de Montezemolo, a 25 year old Lawyer to run the team.</p> <p><i>Reputation:</i> Ferrari have a charisma and reputation that does not exist in the British constructors, in particular drivers dream of driving for Ferrari, whether they are currently competitive or not.</p>
Competence	Foremost competence was the design and development of race cars which, in Ferrari's case, involved exhaustive testing and constant innovation
Sources of Advantage	The 312T car was instrumental in creating the advantage. It was notably different from the competition in that it had a flat 12 engine and transverse gearbox which made it extremely powerful, but more importantly it handled very well. Ferraris had always been fast, but seldom easy to drive or reliable - this constant development programme created a well balanced and very reliable race car. All the major competition were using outsourced Ford Cosworth V8s with Hewland gearboxes and were therefore unable to directly respond to the Ferrari advantage. Whilst Ferrari had always had a wealth of technical talent it was seldom able to get the best use from this resource due to the divide and rule approach taken by Enzo Ferrari. The management style of Montezemolo (who developed clear lines of responsibility and delegation)brought much needed clarity to the Ferrari team. He was able to link together Forghieri's technical skills to Lauda's understanding of the car. This combined with Lauda's total commitment for development and the availability of the best test facilities in the world appears to have been the elements behind this period of sustained success.
Reason for loss of advantage	Three factors appear to be contributory to the inability to sustain this advantage. The first involved key individuals: Montezemolo was promoted and became less involved with the team, his role in creating a linkage between Lauda and Forghieri was lost. Second a near fatal accident in 1976 meant that Niki Lauda lost almost two months development time, this loss of momentum was never regained and Lauda left the team at the end of 1977. Third, a new technical innovation: 'ground effect', pioneered by Lotus, required engine gearbox configurations which were much narrower in order to work properly. This suited the 'V' configuration engines of the competition and left the Ferrari flat 12 at a clear disadvantage.

**Table 4b: Case Summary**

<b>Case History: McLaren 1988-1991</b>	
Constructor's cup: 1988, 1989, 1990 & 1991	Average: 9.97 points per race (theoretical max. 20) nearest rival achieved 47% of points score during same period (Ferrari)
Key Resources	<p><i>Designer</i> (John Barnard) and a design team which pioneered the use of carbon fibre to build a race car chassis.</p> <p><i>Drivers</i>: Two world champions Alain Prost and Ayrton Senna</p> <p><i>Engines</i>: Honda were committed to achieving success in Formula One and had put a huge amount of financial resources and people into this project.</p> <p><i>Finance</i>: Sponsor Philip Morris (Marlboro) brought significant resources and stability to the team (flagship sponsor since 1974)</p> <p><i>Management</i>: CEO Ron Dennis is credited with bringing professional management style and approaches to F1.</p>
Competence	Race car design and development; Commercial opportunism and negotiation
Sources of Advantage	In this instance McLaren were able to bring the best of everything to bear at the right time. They had the best drivers, best chassis and best engine. Ron Dennis had been able to negotiate the exclusive use of the Honda engine after Honda decided to leave Williams in 1987. This arrangement was linked to the recruitment of driver Ayrton Senna who had worked with the Honda technical team whilst he was at Lotus. The linkage between Senna, Honda and the McLaren design team became crucial to developing an advantage.
Reason for loss of advantage	In the same way that it had all come together it all fell apart. John Barnard had actually left before the period of advantage, but many felt that his design ideas were well ahead of their time and therefore the results of his expertise remained with McLaren during this winning period. In 1992 Honda decided that they had achieved all their aims and would no longer participate in F1. This seemed to catch Ron Dennis totally unprepared and without any viable alternatives to start working on over the important winter development period. This was subsequently followed by the departure of Ayrton Senna who had developed a strong relationship with Honda and no longer believed he had the best car at this disposal.

**Table 4c: Case Summary**

<b>Case History: Williams Grand Prix Engineering 1992-1994</b>	
Constructor's cup: 1992, 1993 & 1994	Average: 9.37 points per race (theoretical max. 20) nearest rival achieved 55% of points score during same period (Benetton)
Key Resources	<p><i>Technical Director</i> (Patrick Head) the Williams team had been able to develop many good ideas into fast and reliable components of a race car.</p> <p><i>Management:</i> CEO Frank Williams an experienced and entrepreneurial individual who saw his role as create the environment and resources for the team to build the fastest and most reliable cars.</p> <p><i>Engine:</i> Supplied and supported by Renault</p> <p><i>Drivers:</i> A collection of the both established and up and coming drivers, but period of tenure relatively short</p> <p><i>Finance:</i> Provided by a number of sponsors: Rothmans, R. J. Reynolds &amp; Canon</p>
Competence	Design and Development of race cars Application of others' innovations Overall automotive engineering competence
Sources of Advantage	Whilst the Renault engine plays an important part in the team's success, much of the consistency of performance has been due to their careful, incremental development of the chassis to suit the characteristics of the engine. This success has also been attributed to the enduring relationship between Frank Williams and Patrick Head, this has brought enviable continuity to the team. They have also been able to attract some of the best new designers and engineers, although these individuals have often then taken up more senior positions in rival teams.
Reason for loss of advantage	Williams have not lost their advantage in the dramatic fashion achieved by McLaren or the slower decline of Ferrari. Williams are still near or at the top but without the clear advantage held earlier. The reasons for this loss of relative position is due to Renault making their engine available to the highly competitive Benetton team and also to the loss of a number of their younger designers to other top teams, most notably Ross Brawn to Benetton and more recently Ferrari.

	<b>Absorbition of Knowledge</b>	<b>Application of Knowledge</b>
<b>Core processes</b>	Research about and appraisal of resources (factors) outside the firm	Coordination and development of resources within the firm
<b>Dominant form of knowledge accumulated</b>	Explicit (know-what)	Tacit (know-how)
<b>Dominant learning outcome</b>	Second-order	First-order
<b>Importance to competitive advantage</b>	More important when factor conditions are unstable	More important when factor conditions are stable

**Table 5**

**Knowledge Modes and Competitive Advantage**

Figure 1

Strategic Industry Factors (1961-1994)

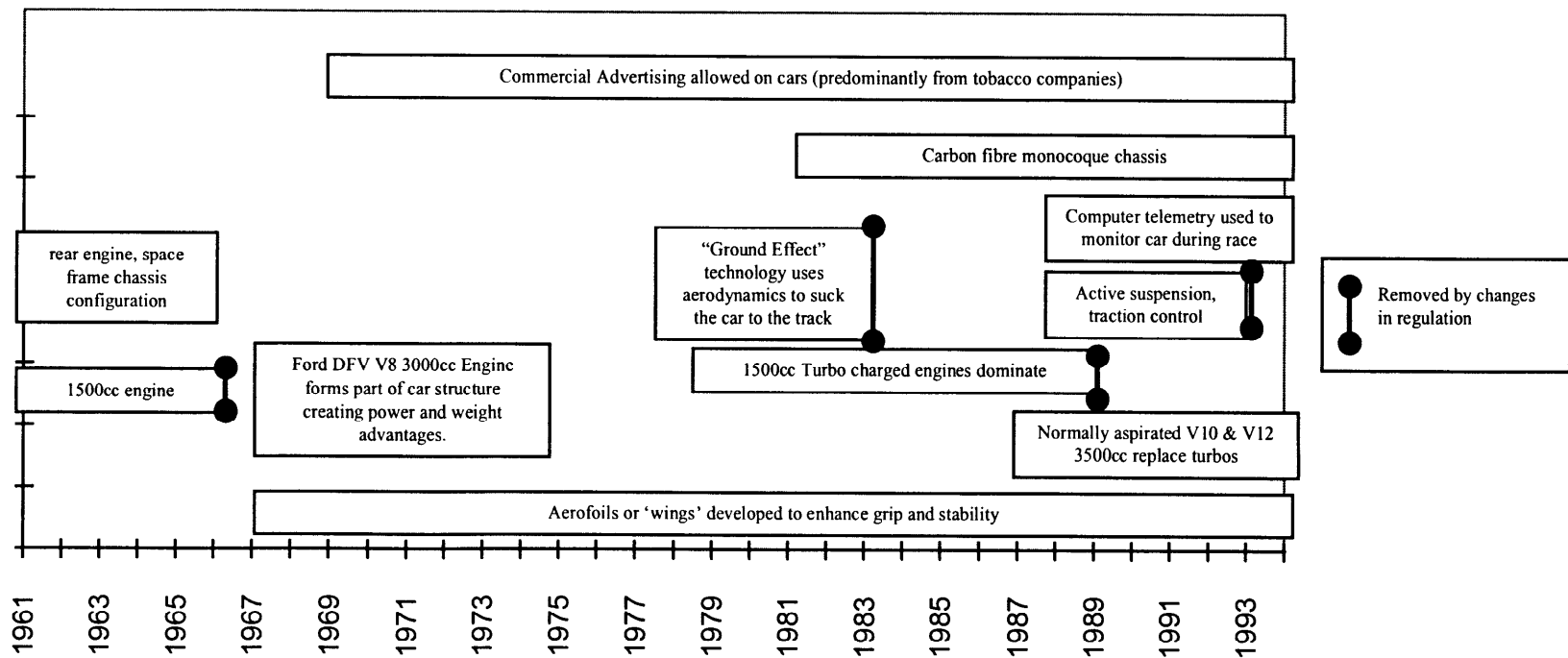


Figure 2a

Ferrari

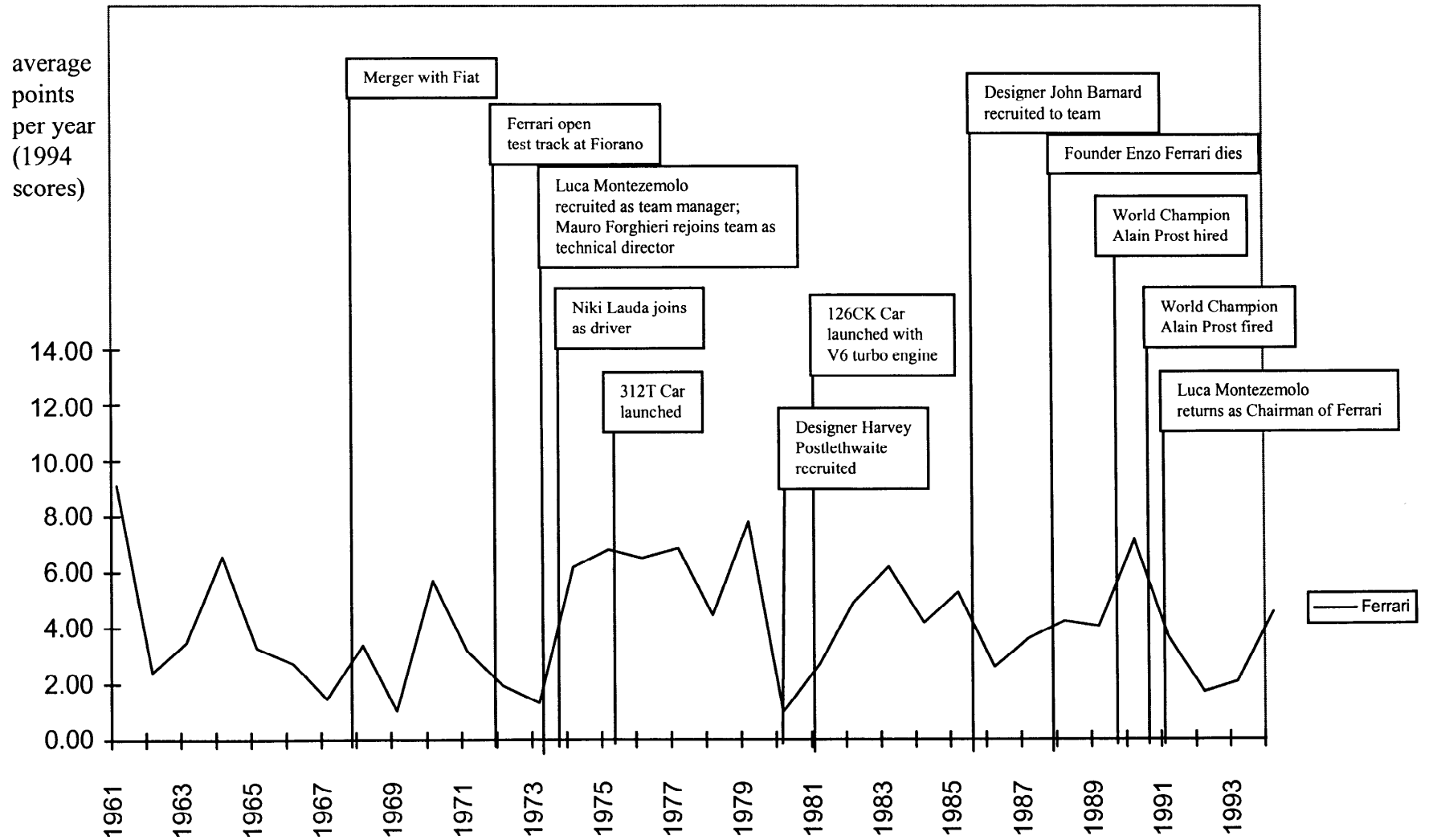


Figure 2b

McLaren

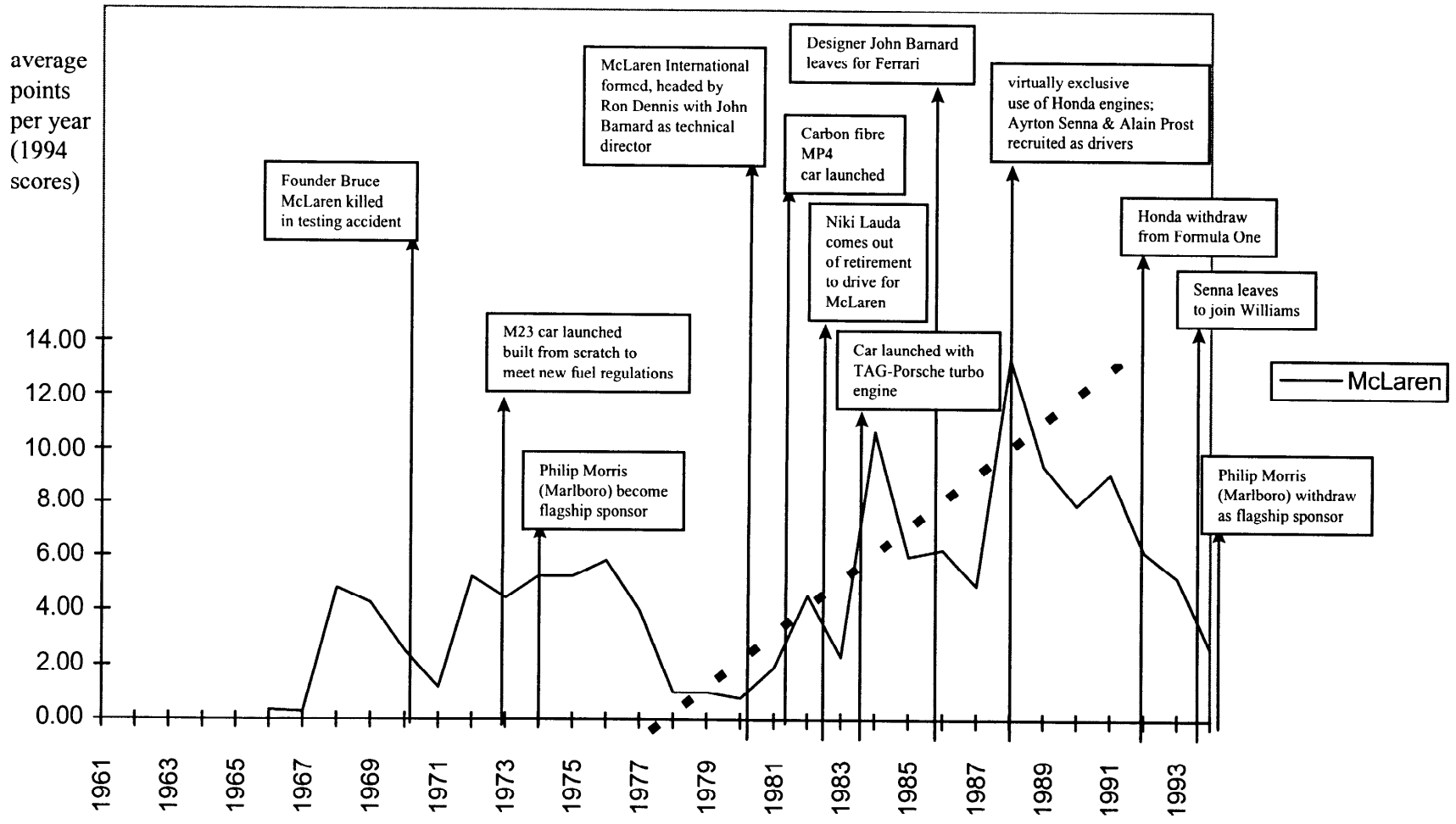
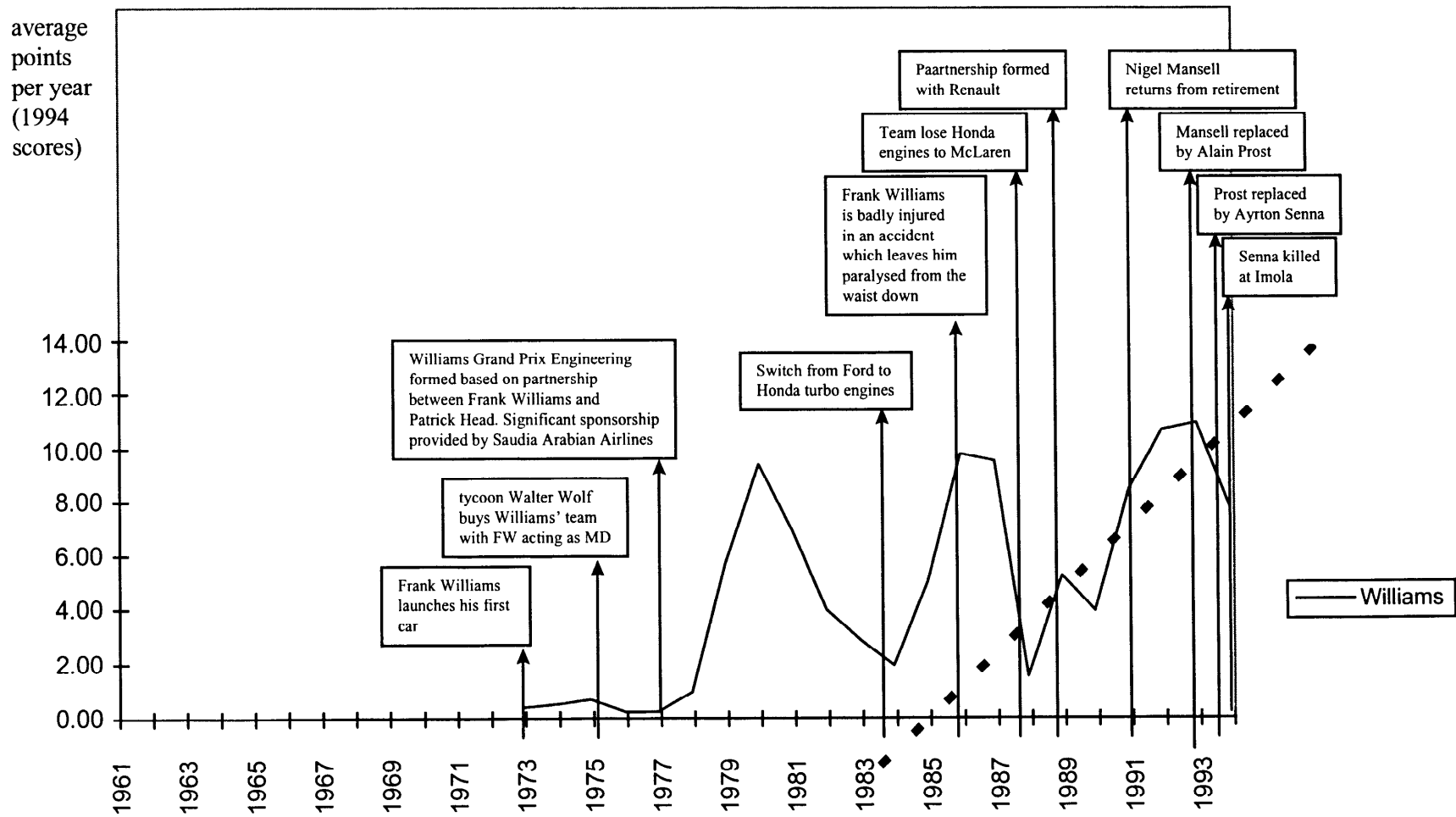
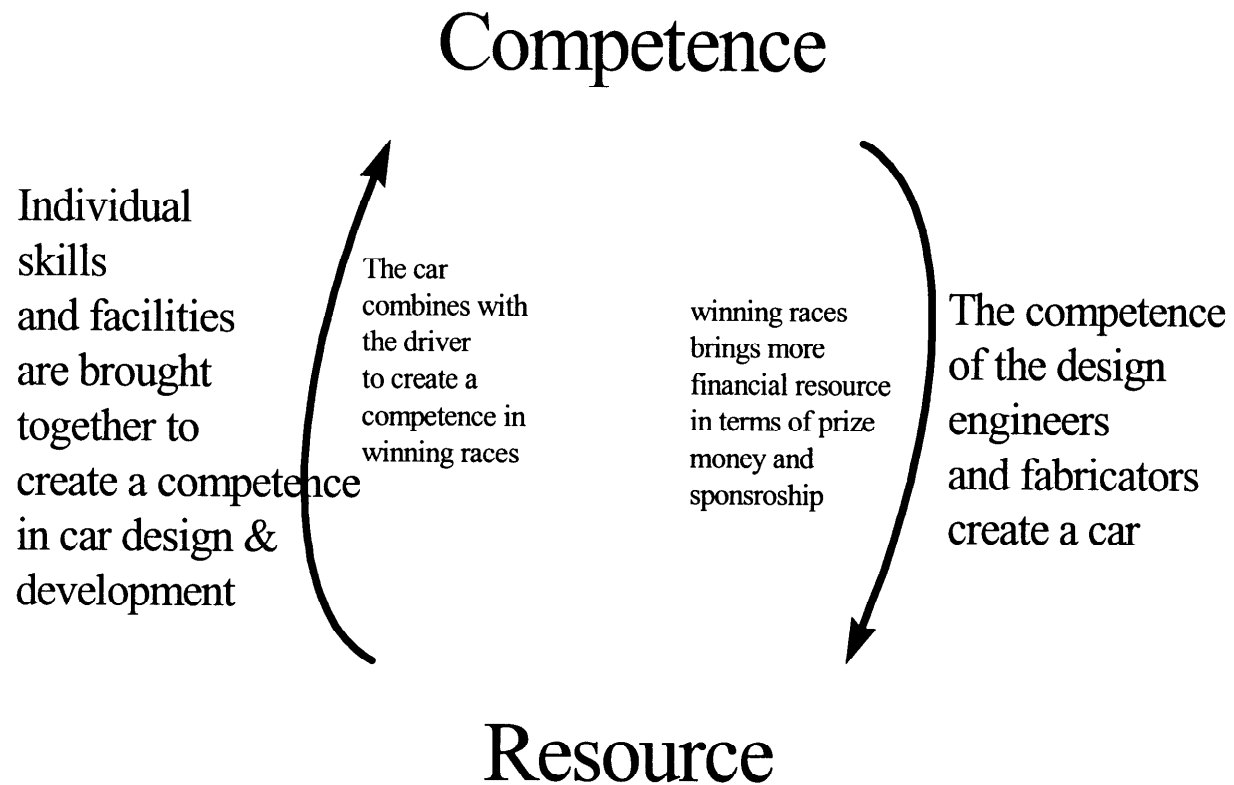




Figure 2c

Williams





**Figure 3**  
**The Reinforcing Cycle of Learning: Owning Resources and Competence Development**

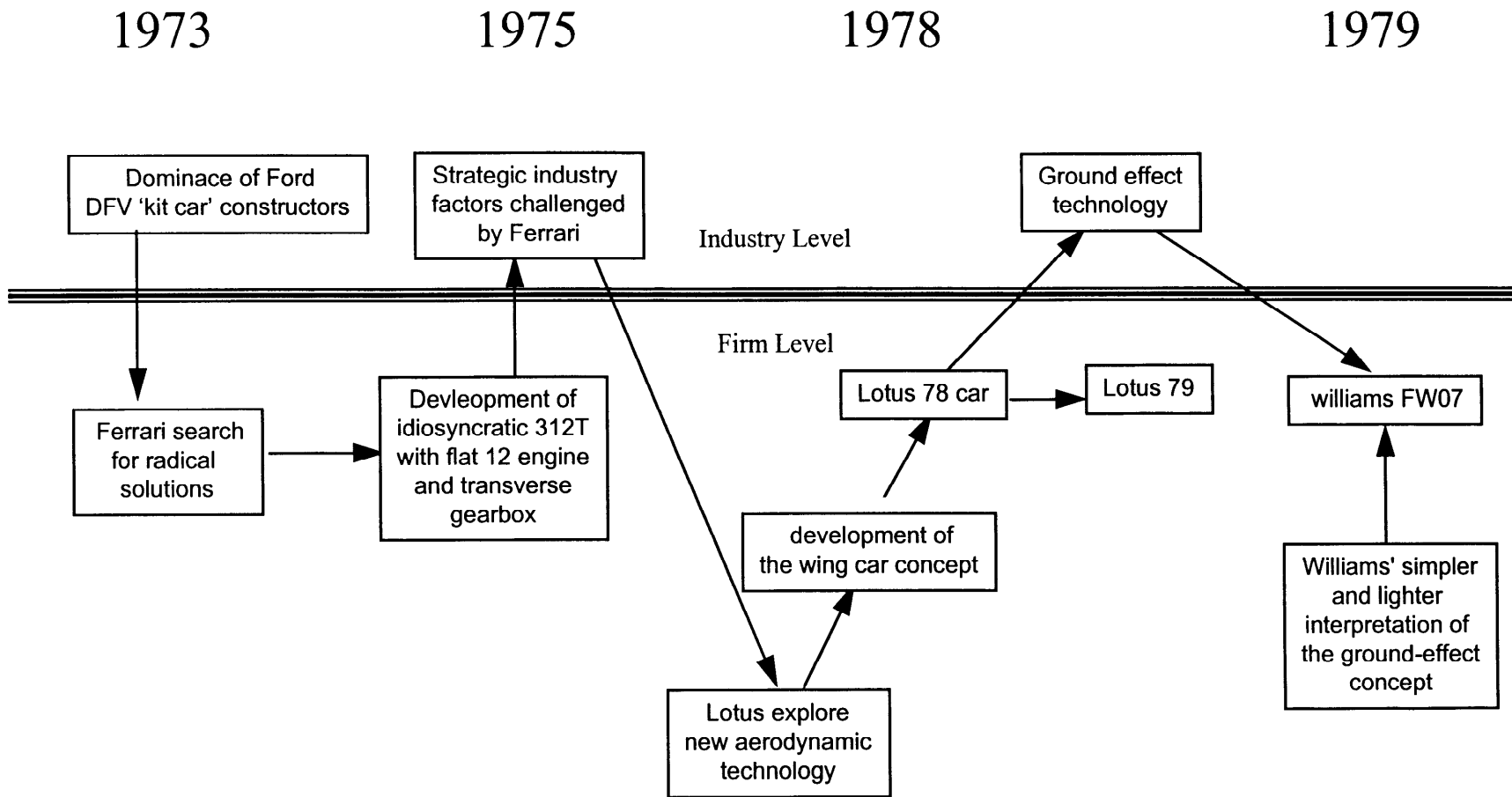


Figure 4  
Industry and Firm Level Factors

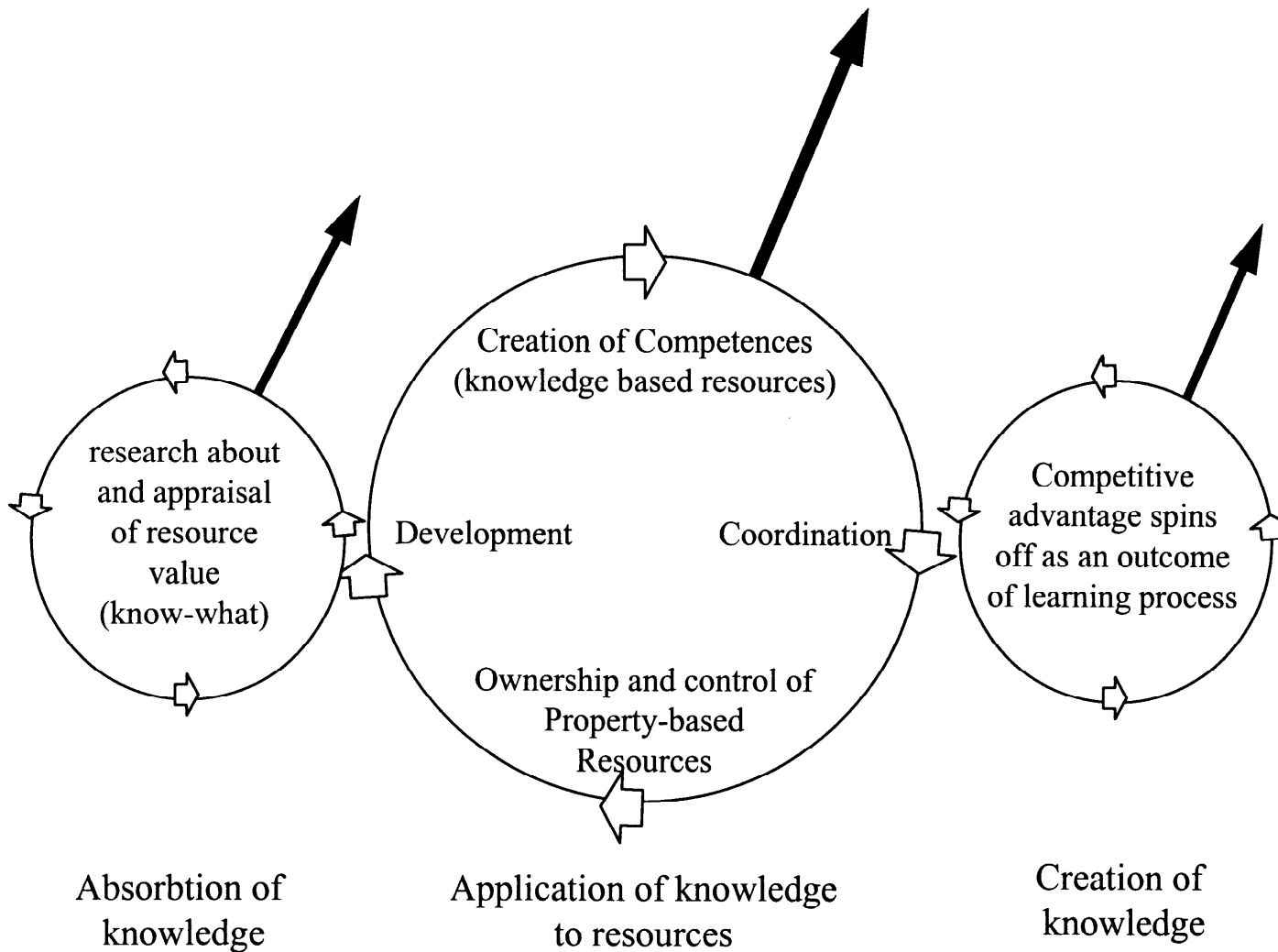


Figure 5  
 Knowledge, Competitive Advantage and the learning cycle

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