

Research Paper

Towards a phenotype of the amphibious company: an illustrative case from the chemical industry

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The paper explores the phenotype of the amphibious company, which is intended as the fittest economic species in today's hypercompetitive business arenas and hence the most likely to survive and prosper. Four behavioral traits are proposed and discussed as distinctive of amphibious companies: doing different jobs good, diversifying in multiple market arenas, brokering and bridging across business networks and absorbing knowledge from the outside. The paper illustrates these arguments through a paradigmatic case study of an Italian firm operating in the chemical industry, which has been able to survive a challenging crisis by adopting an amphibious behavior.

Introduction

Classical strategic management theories, such as the five competitive forces (Porter, 1980) or the strategic conflict (Shapiro, 1989) approaches, advocated that a firm's competitive advantage is achieved and protected by seeking the most favorable industry positioning and by erecting strong entry barriers. In an environment characterized by largely predictable changes in markets and technologies, well defined industry boundaries, and fairly limited international competition, firms tried to maximize value creation by combining internal investments in R&D and in downstream assets, such as manufacturing and distribution (Chandler, 1990). This resulted in what has been called "closed" approach to industrial innovation management, which is based on the assumption that successful innovation requires control. Accordingly, companies invested heavily in internal R&D and hired the best people to invent, research, develop, manufacture and commercialize in-house new products

and services. For the largest part of the 20th century, this closed model worked well, as evidenced by the history of success of corporate R&D centers such as IBM's and AT&T's Bell Labs (Chesbrough, 2003).

However, at the end of the 1990s a number of dramatic environmental changes have started to challenge these traditional views in strategic management and industrial innovation. Knowledge and technologies are increasingly fragmented and internationally dispersed. Information grows in importance as a determinant of economic value creation (Shapiro and Varian, 1999). Change in markets and technologies occurs at a rate faster than ever and, most importantly, is largely unpredictable (Chesbrough, 2003). Technology fusion and industry convergence continuously redefine blurring knowledge and industry boundaries (Kodama, 1992). The number and complexity of technologies incorporated in new products and services are soaring, whereas industry lifecycles increasingly shorten (Bayus, 1998). Many more markets have taken on the cha-

characteristics of networks and economic actors are increasingly interconnected (Chakravorti, 2003).

Under these circumstances, established strategic management paradigms become clearly inadequate, due to their static underlying assumptions on positioning and entry barriers. As a result, new strategic frameworks have been proposed. One of the most influential is the resource-based view (RBV) of the firm, which argues that competitive advantage stems from scarce difficult-to-imitate, firm-specific resources owned or controlled by firms (Wernerfelt, 1984). Accordingly, the firm is seen as a portfolio of idiosyncratic and difficult to trade assets and competencies (Teece, 2007), which are becoming predominantly knowledge- and technology-based (Grant, 1996; Granstrand, 1998). However, some scholars have recognized that resources alone are not sufficient to explain a firm's competitive advantage (Ray et al., 2004). A company may have indeed technologies which can eventually ensure superior value creation performance, but may lack the capability to undertake the efforts necessary to realize this potential. This argument is brought forward by the dynamic capabilities (DC) framework, introduced by Teece and colleagues (Teece et al., 1997), which argues that competitive advantage not necessarily stems from firm-specific assets, but from how they are configured by managers (Cavusgil et al., 2007). Dynamic capabilities are a set of specific and identifiable strategic and organizational processes through which firms within dynamic markets manipulate resources into value-creating strategies (Eisenhardt and Martin, 2000).

Dynamic capabilities have been associated with a set of firm-level characteristics and recurrent behaviors like flexibility, velocity, collaboration attitude, ability to create and exploit connections (Helfat et al., 2007). Companies like Google, Procter & Gamble or IBM have been cited as exemplary of these attitudinal traits (Huston and Sakkab, 2006; Harreld et al., 2007). Much research has been done to investigate the antecedents of firm-level dynamic capabilities (Rothaermel and Hess, 2007) and, in this regard, a set of organizational routines have been identified as managerial and controllable antecedents of superior capabilities (Bianchi et al., 2009). However,

what is lacking is a complete understanding of the phenotype¹ of those firms that are the fittest to survive the current environmental context. Put it differently, what is the internally consistent set of observable characteristics of the most successful companies? Organizational routines and capabilities have been conceptualized as the genotype² of a company (Nelson and Winter, 1982) and have attracted much attention from strategic management and organization scholars. We need however to search for the external manifestation of this genotype, so as to improve our ability to identify those companies that are the most likely to survive the current competitive environment and those that, instead, will suffer from competition and therefore deserve managerial attention and intervention. This would significantly increase the predictive power of our knowledge regarding the roots of sustained competitive advantage.

Our main argument in the remainder of the paper is that firms possessing dynamic capabilities that make them apt at successfully competing in the current economic and competitive environment show a phenotype which is similar to that of amphibious species in the animal world. Indeed we claim that certain observable characteristics of amphibians (e.g., frogs, toads, salamanders) resemble those of companies outperforming their competitors in high-technology, high-velocity and turbulent industries. We illustrate our arguments through a paradigmatic case study of an Italian firm operating in the chemical industry, which has been able to outperform competitors and to survive a challenging crisis by adopting an amphibious behavior.

The phenotype of the amphibious company

Which are the typical observable traits of the amphibious company, that underlie its superior chances of survival and success in the current hypercompetitive and highly interconnected business environment? The purpose of this section is to introduce the distinguishing elements of the phenotype of the amphibious company, using comparisons taken from the natural world and making explicit reference to established management and organizational theories. Amphibians have been iden-

1) Phenotype is defined as "the physical appearance of an organism as distinguished from its genetic makeup. The phenotype of an organism depends on which genes are dominant and on the interaction between genes and environment", Collins English Dictionary, 2003.

2) Genotype is defined as "the genetic makeup of an organism as distinguished from its physical characteristics", Collins English Dictionary, 2003.

tified as the “perfect pioneers” in the animal world, as they have managed to spread the most, and best, across the Earth (Van Bocxlaer et al., 2010). Their evolution started from South America, but they were able to rapidly diffuse through Asia, Europe and Africa. In Australia, amphibians have been imported by man and they have spread like wildfire. They attained a sub-cosmopolitan distribution in a very short time frame and the 500 known species show an interesting diversity in larval and adult adaptation on each continent. Like toads and frogs, amphibious companies are the pioneers of the business world. The next paragraphs illustrate the four behavioral traits that characterize amphibious companies, i.e. doing different jobs good, diversifying in multiple market arenas, brokering and bridging across business networks, absorbing knowledge from the outside. Of course these four logically distinct courses of action are strictly intertwined and reinforce each other, therefore it is very likely that they are observed contemporarily.

Doing different jobs good

A first distinctive trait of the successful company in today's business environment relates to its ability to effectively administer internal operations, i.e. those processes that occur within the corporate walls, as well as external relations, i.e. those governance forms that involve interaction and collaboration with external stakeholders (suppliers, clients, competitors, universities, etc.). The benefits of establishing external linkages include access to complementary assets and competencies (Teece, 1986), increased flexibility, sharing of risk and costs, learning opportunities and creation of shared standards (Schilling, 2005). The most successful companies have shown an incredible capacity to combine and balance internal and external operations both in the exploratory and exploitative phases of the innovation process (March, 1991). Effective exploration of new value creating opportunities is achieved by integrating in-house R&D efforts with technological collaborations, in the form of acquisitions of new technology based firms, in-licensing, corporate venturing, R&D consortia and joint R&D with universities and research centers (Bianchi et al., 2010; Van de Vrande et al., 2006). Similarly, superior exploitation has been increasingly secured by using a carefully balanced mix of internal application of new technologies, through new product development, and external commer-

cialization of proprietary knowledge, in the form of out-licensing, spin-offs and joint-ventures (Lichtenthaler, 2005), as well as outsourcing of low value added activities and contract manufacturing. The following quote by Jeff Weedman, vicepresident of P&G's external business development, is exemplary of how the wise combination of inward and outward operations is at the basis of a firm's search for competitive advantage: *“There are many kinds of competitive advantage. The original view was: I have got it, and you don't. Then there is the view that I have got it, you have got it but I have it cheaper. Then there is I have got it, you have got it, but I got it first. Then there is I have got it, you have got it from me, so I make money when I sell it, and I make money when you sell it”* (Chesbrough, 2006, p. 201). However, the practice of balancing internal and external operations is extremely complex: these are often dissimilar and somehow antithetic business activities, which typically require highly heterogeneous organizational cultures and values. Amphibious companies are those that have overcome inertia to change, have surpassed strong cultural barriers, also known as Not-Invented-Here (NIH) and Not-Sold-Here (NSH) syndromes (Chesbrough, 2003), and have opened their organizational boundaries to the external environment.

This ability to be good at very dissimilar activities, e.g., hunting, moving and escaping predators in water as well as outside it, is a typical trait of amphibious species. Amphibian is derived from the Ancient Greek term “αμφίβιος” (amphibious), which means both kinds of life, “amphi” meaning “both” and “bio” meaning “life”. The term was initially used for all kinds of combined natures. Eventually it was used to refer to animals that live both in the water and on land.

Diversifying in multiple market arenas

Instead of playing defensively and erecting barriers to protect market position, the fittest companies rapidly diversify their activities in different market arenas, in search for superior rents and growth opportunities (Wernerfelt and Montgomery, 1988). Diversification along various dimensions, i.e. product and geographies, is a characteristic of successful firms and a fundamental determinant of corporate growth (Granstrand, 1998). Entry into new product markets gives rise to economies of scope and scale, enables information advantages and resource sharing,

reduces risks and earnings volatility in times of declining traditional markets (Kim, Hwang & Burgers, 1993). These benefits are especially evident when business diversification is technology related, i.e. it builds upon or extends existing technological competencies. The growing recognition of the general purpose nature of many technologies, i.e. of their "potential for pervasive use in wide range of sectors" (Bresnahan and Trajtenberg, 1995), has pushed firms to multiply the exploitation of their corporate jewels by adapting them to a broad number of application fields. This has been the case of P&G, which started in 1837 as a candle maker, and over 180 years has diversified into soaps, emulsifiers, surfactants, household, health and beauty care products, razors, batteries and chips, through a dynamic process of leveraging existing competencies and creating new ones (Sakkab, 2002). Supposedly Google is following P&G's footsteps, as from Web search engines it is moving to operating systems, cell phones, wind energy and cars that drive themselves (New York Times, 2010). Such a diversified strategy is consistent with the theory of core competencies by Hamel and Prahalad (1990), which argues that a limited set of core competencies, if wisely integrated in multiple combinations, can allow access to a wide spectrum of markets and result into a product's advantage that is perceivable to the customer and cannot be easily imitated by the competition.

An important feature in the evolution of amphibians is diversification (Van Bocxlaer et al., 2010). Toads and frogs have radically diversified their characteristics and behaviors to adapt to very dissimilar environments: toads that weigh more than 2 kilograms and are more than 20 centimeters long can be found in the Tropics as well as in semi-desertic areas, while those that are only 1 centimeter long and weigh less than a few grams live up on the African mountains. Some species are viviparous and give birth to 6-8 toads each time, others spawn more than 18,000 eggs every time. Overall, we are aware of the existence of more than 500 species of frogs and toads, but many more will be discovered in the near future.

Brokering and bridging across business networks

A third distinctive trait of the most successful companies is their ability to broker, i.e. to connect otherwise disconnected actors and

knowledge pockets. Brokers create bridges which cross structural holes (Burt, 1992). These connections represent invaluable business opportunities whereby the "tertius iungens" actor is in the best position to spot new discoveries and to control information flows (Obstfeld, 2005). In a globalized world characterized by highly distributed knowledge and competencies, it is not "know how" which matters in determining a firm's competitive advantage. Rather, it is "know where" and "know who" that discriminate between successful and unsuccessful innovators. Amphibious companies have realized that going too deep into all the relevant scientific domains or technical fields is not worth the required investment: staying at the frontier is extremely costly and the payback time is not compatible with today's shrinking technology life cycles. Instead they rapidly move on the surface of business networks and knowledge landscapes, aware that breakthrough innovations increasingly stem from the cross-fertilization of traditionally unrelated scientific disciplines (Kodama, 1995). This practice has been named technology brokering by Hargadon and Sutton (1997) and refers to the intelligent recombination of existing knowledge from different sectors. Using the words of the science-fiction author William Gibson, technology brokering draws on the belief that "the future is already here. It's just not evenly distributed" (The Economist, 2003). Geox, an Italian footwear manufacturer, has grown to be one of the world leading players thanks to its breathable waterproof sole shoes. This breakthrough innovation was achieved by using a special membrane from NASA's astronaut spacesuits. Immersion, a small California-based company, showed a similar ability to fill technology gaps by successfully transferring the proprietary Touch-Sense technology, developed mainly for medical applications, to the automotive industry, thanks to a properly managed collaboration with BMW.

The ability to rapidly move on the surface can be observed in frogs and toads. Amphibians are not as effective as fishes when it comes to swim in the depth of a pond. However, they are much faster and more agile when they move close to the surface of the water and when they jump on the land to hunt insects or escape a predator. This startling agility derives from their long and slender legs and from the suction pads on the ends of the toes.

Absorbing knowledge from the outside

The fittest firms show a superior attitude when it comes to absorbing knowledge from the environment and make a profitable use of it. The concept of absorptive capacity has been developed to identify a firm's ability to recognize the value of external knowledge, assimilate and utilize such knowledge to commercial ends (Cohen and Levinthal, 1990). In today's hypercompetitive business arenas, this capability has become of paramount importance for ensuring sustained competitive advantage. Put it with the words of Astra Zeneca's CEO, "ninety-nine percent of everything exciting that happens will happen outside your own research lab" (Escribano et al., 2009). Amphibious companies have porous boundaries that allow the effective osmosis of knowledge from outside in. In addition, they are equipped with organizational mechanisms, e.g., dedicated functions or gatekeepers, that ensure a proper identification, evaluation and reception of that knowledge (Kale et al., 2002). Genzyme has achieved its success by absorbing early stage ideas and projects from universities or small biotech companies and developing them into novel therapies for previously untreatable diseases (Chesbrough, 2006). Thanks to this business model, Genzyme is one of the only three companies, the others being Amgen and Genentech, that make profits in these hard times of the biotech industry (Pisano, 2006).

Amphibians (especially frogs) are known for the unique feature of breathing largely through their highly permeable skin. Oxygen is dissolved in an aqueous film on the skin and passes from there to the blood. Tiny blood vessels and capillaries, under the outer skin layers, make this possible. The ability of frogs to absorb a critical resource like air through several dispersed elements of their body resembles the capacity of amphibian firms to assimilate knowledge and technologies from the many inter-organizational relationships they establish with external organizations, such as clients, suppliers, competitors, universities and individuals.

Phenotype and genotype

Our main argument in this paper is that these four behavioral traits, which can be observed in the fittest and most successful companies competing in today's hypercompetitive businesses, are the external manifestation of a set of dynamic capabilities which

have been extensively investigated by strategic management and organization research in the last years. A well-known taxonomy of a firm's dynamic capabilities is that proposed by Teece (2007), who identifies "sensing opportunities", "seizing opportunities" and "reconfiguring assets and management systems" capabilities as those underlying sustained competitive advantage. These should be conceived as three classes of routines - the "genes" of the organization (Nelson and Winter, 1982) which enable a firm to express a certain behavior and course of action, precursor of superior competitive advantage, when interacting with the external environment. The same genes seem to characterize amphibious species. For instance, they are extraordinary at sensing future events. Scientists have discovered that toads are able to detect earthquakes up to five days in advance, because they are able to detect pre-seismic cues such as the release of gases and charged particles (weak signals), and use these as a form of earthquake early warning system (Grant and Halliday, 2010). Furthermore, the reconfiguring ability is clear in amphibians' metamorphose from a juvenile water-breathing form (tadpole) to an adult air-breathing form.

In this section of the paper we have described the externally observable behavior of the fittest firms in today's business environment, in the belief that this will increase the predictive and practical impact of research into the most recent conceptualization of the RBV. In the remainder of this article, we will discuss the case of a chemical company which is illustrative of the phenotype of the amphibious firm.

Methodology

FROG Inc. (the real name of the company has been blinded for confidentiality reasons) is an Italian firm operating in the electrochemical industry, which employs 700 people and has an annual turnover of €250 million (data as of 2008). Its core business is in the supply of components for the production of chlorine, caustic soda and other industrial electrochemical applications. FROG is an exemplary case to investigate in the scope of our research because it has managed to recover from a difficult crisis at the end of the 1990s thanks to a radical shift toward an amphibious behavior. Indeed, the four behavioral traits identified in the previous section can be clearly observed together with their impact on the

impressive record of sales and profits that FROG has scored in the most recent years.

Our empirical analysis is based therefore on a single case study methodology, which allows to study a complex phenomenon under particularly insightful circumstances, capturing its intangible and hidden facets (Eisenhardt and Graebner, 2007). This paper makes an illustrative use of the case study, i.e. it leverages qualitative evidence to illustrate with practical examples the concepts that are developed in the conceptual argument (Siggelkow, 2007). To this purpose, the investigated firm has to be *“very special in the sense of allowing one to gain certain insights that other organizations would not be able to provide”* (Siggelkow, 2007, p. 20). The major strategic shift implemented by FROG in order to surge back to profitability is exemplary in this regard. The single case study methodology has obvious limitations, in terms of generalization and external validity, as noted by Yin (2003). However, the reader should notice that we do not attempt to draw generalizations from the single case study under analysis, but we use this paradigmatic case as a helpful illustration of the phenotype of an amphibious company.

Information about FROG, Inc. was collected through semi-structured interviews with key informants and internal documentation. Specifically, we went after the following steps during the analysis:

- First, we met the Chief Executive Officer of FROG to inform him about our research project. During this meeting, we asked the CEO to introduce ourselves to several respondents who could help us in data collection. We decided to interview: (i) the head of the R&D function; (ii) the head of the Business Development function; (iii) the Chief Execution Officer of one of the joint ventures established by FROG; (iv) a university professor who advised FROG on its strategic plan. Interviewing multiple respondents is beneficial to reduce the risk of retrospective and personal interpretation biases, that might undermine the validity of case study research (Yin, 2003);
- Then we personally interviewed the selected informants; we undertook one semi-structured interview for each respondent (each interview lasted on average two hours). Direct interviews followed a semi-structured guide, that comprised a set of open questions regarding the evolution of FROG’s strategic management approach over time;

- Secondary information was collected in the form of reports, charts and transcripts of meetings between managers. This provided the researchers with background information about FROG and the strategic decision making to which it was accustomed. Above all, these information sources were integrated, in a triangulation process, with data drawn from the direct interviews, in order to avoid post hoc rationalisation and ensure construct validity (Yin, 2003). No relevant inconsistencies between information collected through interviews and secondary sources were identified;
- All interviews were tape-recorded and transcribed. After transcription, a telephone follow-up with each respondent was conducted with the aim to collect missing information.

Data collected through the case study were manipulated before being analysed. In particular we applied the following methods (Miles and Huberman, 1984): (i) data categorisation, which requires the decomposition and aggregation of data in order to highlight some characteristics (e.g., type of relationships that the firm establishes with external actors during innovation activities) and to facilitate subsequent analyses; (ii) data contextualisation, which entails the analysis of contextual variables that may cause unpredictable relationships between facts and circumstances. Then, the manipulated data were aggregated to obtain a systematic description of the evolution of FROG’s strategic behavior over time. Finally, explanation-building procedures were used so that the causal relationships between events and circumstances could be identified. These structured procedures for data collection and analysis helped enhance the reliability of the research (Yin, 2003).

The case study

Founded in the 1920s and still led by an Italian family, FROG is an established, leading player in the global chemical industry. In particular, FROG, Inc. is a major supplier of process technologies and equipment for the production of chlorine, caustic soda and derivatives, as well as of noble metal-coated electrodes for chlor-alkali applications. Its main customers are large chemical producers. The business arena is characterized by industry concentration and slow technical change, with traditional technologies still playing a critical role.

Within this context, FROG has distinguished itself as a successful innovator, with 60 professionals and more than €10 million annual investments devoted to Research & Development activities. A long record of breakthrough technologies, in the form of anodes and electrodes for electrochemical processes, has enabled FROG to control more than 50% of its reference markets and experience high profit margins. This until the end of 1990s.

The traditional business model of FROG can be defined as vertically integrated. Economic value is created through investments in the development of strong technological know-how and in the design of superior electrochemical components. The components are manufactured and incorporated into the production of chemical reactors, which are then sold to chemical producers. All these activities are performed in-house under the strict hierarchical control of FROG's management. At the turn of 20th century, however, changes in the competitive scenario, including raising levels of competition, shrinking market demand and

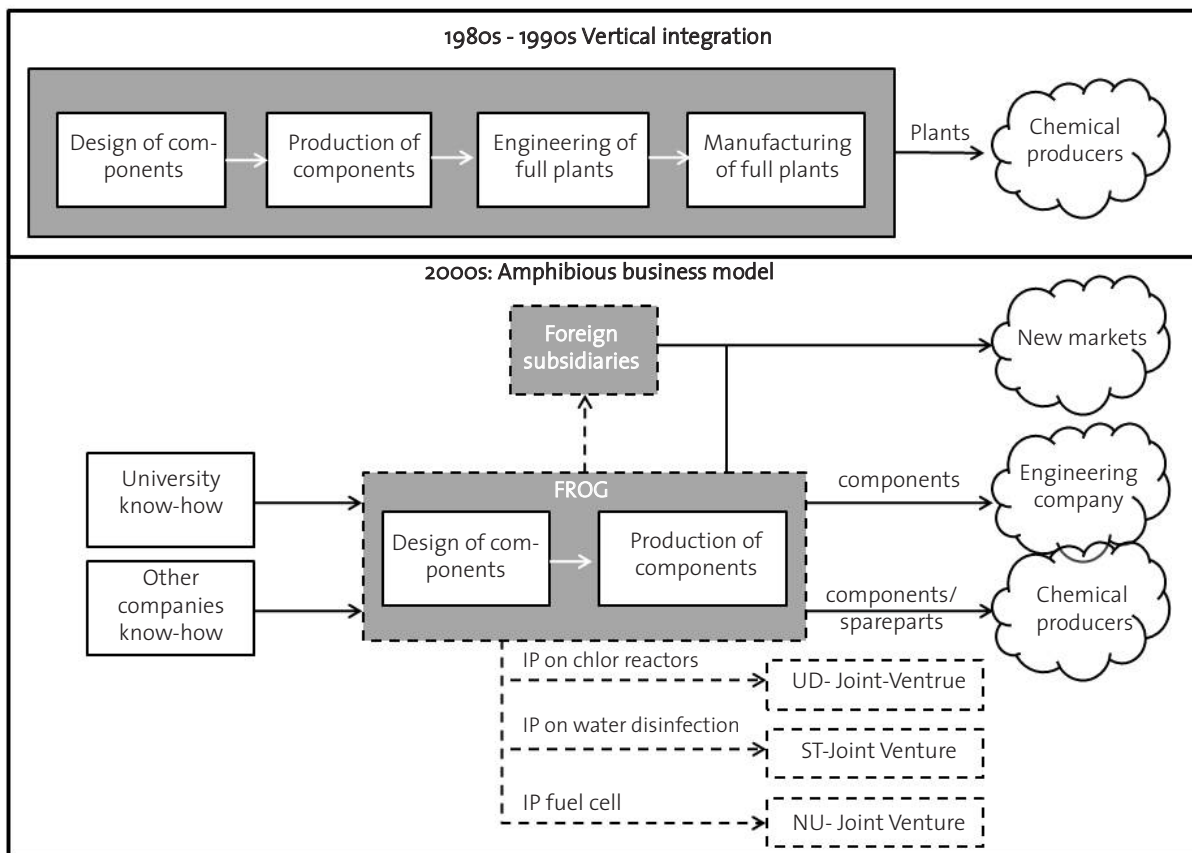
reduced margins, especially in the business of chemical reactors' manufacturing, had very negative impacts on FROG's economic and financial results. FROG's profits plummeted by more than 40% in the first years of the 2000s and the firm had to lay off 10% of its workforce. The competitiveness of FROG was indeed severely challenged by this downturn.

FROG jumping out of the crisis: the amphibious strategic shift

The initial strategic response to the crisis turned out to be unsatisfactory. A number of isolated initiatives, such as the relocation of some products to the low-end of the market or the closure of a few factories, were soon discarded. Things changed after an internal reorganization and radical turnaround, with the design and implementation of a major shift in FROG's strategy.

The key initiative regards the incisive re-invention of the firm's business model, devised after a careful look and understanding of its

Figure 1 Re-invention of business model by FROG, Inc.



changed environment. In fact, FROG divests its downstream, and now less profitable, activities related to the production of reactors, while focusing on the upstream development and supply of high-tech components. Managers realize that core components are now the “bottleneck” assets in the value chain, the critical elements enabling differentiation and value creation, while resources and competencies related to machinery and equipment for chemical plants are “commoditized” and can be more easily “cashed out” through external paths to market. The re-invention of the business model is depicted in Figure 1. This strategic shift gives rise to a number of amphibious initiatives that are described in the following.

The first relates to technology exploitation. The new strategy can be described with the words of the Head of the Business Development function: *“an exclusively internal appropriation of value for core technologies on components; an outward exploitation approach with external partners for non-core technologies on plants and reactors”*. Accordingly, while intellectual property (IP) on components and related production processes continues to be vertically controlled and internally exploited, about 100 patents related to machinery and chemical plants are transferred to three newly formed joint ventures (JV), labeled in this paper NU-JV, UD-JV, ST-JV (see Table 1 for additional information). These technologies worth €10 million are used to capitalize the new compa-

nies and FROG gets in return equity stakes in the JVs from 50 to 20 per cent. Joint venturing is chosen as an external governance form because the resulting fully-dedicated firms allow to achieve an effective integration between FROG’s superior technology and the downstream complementary assets held by leading partners in some segments of the chemical market. FROG has paid particular attention to the selection of the most suitable allies. In the case of UD-JV, an established leader is selected to provide best-in-class distribution channels, brand and market presence. In NU-JV, FROG partners with a small and highly entrepreneurial firm possessing fuel cell technologies that are perfect complements to FROG’s IP. The ally in ST-JV is instead chosen because of the existence of a close alignment of strategic objectives and similarity of culture.

The impressive economic results achieved by these joint ventures and their leading position in their own market niches provide evidence for the development by FROG of a superior ability in managing external relations in addition to internal operations. In 2008, the total revenues earned by the JVs and accruing to FROG proportionally to the equity owned, amount to €60 million, twice the figure in the 1990s when the related technologies were exploited in-house. Revenues from the JVs currently constitute 22 per cent of FROG’s total turnover. The effective combination of inward

Table 1 Main features of the Joint Ventures established by FROG, Inc.

JV Name	Birth Year	FROG % Equity	Objectives	FROG contribution	Partner contribution	JV business
NU-JV	2001	20	Risk and cost sharing	Technological	Technological	Fuel cells
UD-JV	2000	50	Achieve large scale	Technological + Marketing	Technological + Marketing	Engineering company
ST-JV	2002	30	Access to complementary assets	Technological	Marketing and brand	Seawater treatment

and outward modes is an amphibious trait that distinguishes FROG from its closest competitors: *"FROG's approach is unique: competitors in the industry play alone, they barely have any collaboration"* (CEO of UD-JV).

Beginning from the 2000s, FROG has diversified in different arenas adapting its core competencies to market specificities, just as amphibians do. Diversification has occurred along both product and geographical dimensions. All the initiatives of product diversification can be defined as technology push, i.e. they build upon FROG's strong and distinctive electrochemical know-how. In few years, FROG has entered into several related markets: electrogalvanizing, surface finishing, industrial water treatment, electronic printed circuit boards, coating services, energy saving technologies. Not only these strategic moves exploit the general purpose nature of electrochemical technology, but they also leverage the rich humus of FROG's design and development engineers, process specialists, project managers, and quality engineers, to solve a wide range of customer needs. Some of these diversification opportunities are pursued through internal growth and direct investments into wholly owned divisions, as in the case of a new business unit for energy saving technologies, others are seized instead through external vehicles. This is the case, e.g., of FROG's entry into the copper electrowinning business. FROG's managers realize that their R&D department has developed a superior solution for the treatment of copper pickling. However, electrowinning has never been considered as an attractive or conquerable market for the vertically integrated FROG, due to its small size.

Consistently with the new amphibious business model, FROG's business development function proactively identifies and establishes a strategic alliance with an Australian minerals group, which possesses the most adequate machinery to incorporate FROG's anode. Although it is too early to say a definitive word, the success of this initiative is demonstrated by the uninterrupted sales growth since 2004. FROG has also diversified into new geographical markets. In addition to its traditional subsidiaries in Germany, Brazil and USA, FROG has opened branches in China and India, with the aim to meet the demand of rapidly developing local industries and provide superior service to regional clients. The Indian branch is actually a joint venture with a local partner. This and the copper electrowinning exam-

ples show that the amphibious traits that we have presented as distinct in our conceptual development are strongly intertwined in practice. They act in concert and make up the phenotype of an amphibious company, which ultimately allows to achieve and sustain competitive advantage. This reinforcing mechanism will also emerge in the remaining of the case study.

FROG's new strategic approach is not limited to technology push, i.e. driven by the need to maximize the exploitation of its technological assets. In the recent years FROG has also distinguished itself for spotting business opportunities in totally unrelated fields and making unobvious connections between users' unsatisfied needs, information holes and other firms' shortages. Playing the role of the broker and activating a network pull mechanism, FROG has developed product innovations by wisely mashing up ideas and knowledge dispersed in the environment. This has occurred, e.g., in the development of electrodes for swimming pools' disinfection. It all begins at an international fair, where people from the business development function at FROG are informed about the almost unseized potential of the residential swimming pool market and the large room for improving existing disinfection technologies. A business unit at FROG has a prior knowledge of the leading supplier of swimming pool controls in the U.S. market, which agrees to sign a commercial partnership. By doing so, FROG earns access to the ally's portfolios of customers, including construction companies and pool builders. From a technical point of view, FROG starts adapting its electrodes to the new application. To integrate a technology that is lacking in-house, FROG acquires the majority stake of a small supplier of electrodes. FROG's components have now reached 30% of the global swimming pools market and generate annual revenues in excess of €20 million. Although the profits in the swimming pools market are not so high, this cross-fertilization operation has generated additional cash for FROG and has helped diversify the risk of its business portfolio.

This last example also points to the importance of assimilating technological knowledge from the environment. FROG has formally dedicated 15% of its R&D budget to in-source ideas and solutions at different stages of development, which can be incorporated into its product development process. The preferred partners are universities. For instance, FROG

has absorbed from a university in Central Italy innovative know-how in microbiology and agronomy. This knowledge has allowed to adapt FROG's electrochemical technologies to the needs of agricultural businesses with the aim of improving cultivation processes. For this purpose, a spin-off venture has been created, where FROG holds an 80% equity share and university researchers the remaining 20%. The scouting of external innovations and their absorption has improved at FROG since the establishment of a dedicated business development function which acts as an effective antenna that scans and recognizes valuable knowledge pockets. The success with this business development function is due to the right mix of legal, marketing and technical competencies of its members and the decisional autonomy they have been assigned, coupled with a formal performance management system which makes them accountable for their choices.

Taken together, the introduction of external governance forms, the pursuit of business diversification, the brokerage across business networks and the absorption of knowledge from the environment have helped FROG to surge back to profitability. The company managers agree on the importance of these courses of actions, that we have classified as distinctive traits of the amphibious company: *"Re-inventing our business model has made FROG a very leveraged and asset light company. Our revenue per employee figures are the highest in the industry"* (Head of R&D function); *"Our EBIT margin is more typical of Armani and other fashion companies than of chemical businesses"* (Head of the business development function). Our analysis shows that the transformation of FROG into an amphibious company is the result of the development of a set of firm-level dynamic capabilities. Superior reconfiguring capability by FROG is evident if we consider its ability to adapt resources and management systems to match the requirements of a changing environment. Superior sensing capability has allowed FROG to timely identify and calibrate opportunities for new businesses. From the analysis of internal reports, it emerges that the number of new business plans evaluated by the strategic committee has more than doubled with respect to the end of the 1990s. Finally, superior seizing, i.e. the ability to promptly address opportunities by committing investments and resources without delay, is evident in the rapidity with which FROG has established its joint ventures and has laun-

ched new products in previously unexplored markets.

Although it is outside the scope of the paper to study how these dynamic capabilities develop over time, the analysis of the case study indicates that the following factors favor their emergence in an organization: (i) a period of economic crisis which makes it evident to top management that a change in the firm's strategic approach is needed; (ii) a strong commitment from top management toward championing a company-wide process of analysis and search of new sources of sustained competitive advantage; (iii) the presence of effective social integration mechanisms that favor communication across hierarchical levels and the assimilation of shared corporate values and mission; (iv) the existence of an organizational culture that does not hinder out-of-the-box thinking, risk-taking and entrepreneurial individual behaviors.

Conclusions

The aim of this paper is to present and discuss the phenotype of the amphibious company, which is intended as the fittest economic species in today's hypercompetitive business arenas and hence the most likely to survive and prosper. It emerges from our analysis that the amphibious company is characterized by a set of distinctive behavioral traits, which become evident when it interacts with its external context, namely doing different jobs good, diversifying in multiple market arenas, brokering and bridging across business networks and absorbing knowledge from the outside. Whereas amphibious companies are the fittest in the current competitive landscape, firms that struggle to identify the most favorable industry positioning, protect it by erecting strong entry barriers, exclusively rely on internal knowledge and capabilities to develop new products and services are at a severe disadvantage. These firms had prospered instead in the past, in an environment characterized by largely predictable changes in markets and technologies, well defined industry boundaries, and fairly limited international competition.

The amphibian phenotype described in this paper captures and synthesizes into a single organizational species several behavioral traits that have been separately identified and associated to superior performance by some recent theories in the field of strategic management, e.g., open innovation (Chesbrough, 2003) and

ambidextrous organization (Tushman and O'Reilly, 1996). It is the observable manifestation of a set of organizational routines, which should be conceived as the genotype of the amphibious companies, i.e. "sensing opportunities", "seizing opportunities" and "reconfiguring assets and management systems" capabilities, which have received much attention in the recent strategic management and organization research (Teece, 2007). This body of research shows that changing established organizational routines is a costly and complex task (Nelson and Winter, 1982). Therefore, especially in those organizations with institutionalized practices and processes that are incompatible with the amphibious behavior, introducing the new phenotype can be very costly and time consuming.

The emergence and the positive impact on value creation and profitability of this phenotype are discussed in the paper by using an illustrative case study of a chemical firm which has overcome a dramatic economic crisis by adopting an amphibious behavior. The chemical industry (as well as the pharmaceutical and biotechnology) is perhaps one of those that have most been impacted by the radical environmental changes (e.g., international dispersion of knowledge and technologies, velocity and uncertainty in market evolutions, technology fusion and industry convergence) that underlie the success of the amphibious company. Here the superior ability of the amphibious firm to survive and prosper is therefore more easily observable. However, we believe that its distinctive behavioral traits are critical for competitive advantage and value creation in many other high-technology, high-velocity industries and business arenas, as the anecdotes reported in this paper suggest. Therefore, future research should investigate the generalizability of our conclusions, through carefully designed and conducted quantitative studies, which attempt to find a statistically relevant relationship between the observable amphibious behavioral traits and the presence of underlying sensing, seizing and reconfiguring capabilities. Furthermore, these future studies should explore the generalizability of our preliminary findings in other industries.

Most of the examples and cases discussed in this paper refer to medium- and large-sized companies. As it often happens, it is these firms that are the first to experiment new strategic behaviors and approaches in the search for superior competitiveness and economic value creation opportunities. However, there are no

reasons to believe that small companies cannot benefit from becoming amphibious in the near future. Rather, the amphibious phenotype appears to be particularly adequate to enable small companies fill the resource gap with larger enterprises by leveraging their intrinsic flexibility and speed.

Despite its illustrative nature, our hope is that the paper can provide some valuable insights to managers in chemical firms about how to increase profits and fuel growth. This could be very important especially in the current economic downturn.

References

- Bayus, B.L. (1998): An Analysis of Product Lifetimes in a Technologically Dynamic Industry, *Management Science*, **44**, p.763-775.
- Bianchi, M., Chiesa, V., Frattini, F. (2009): Exploring the microfoundations of External Technology Commercialization: a dynamic capabilities perspective, *European Journal of Innovation Management*, **12** (4), p. 444-469.
- Bianchi, M., Cavaliere, A., Chiaroni, D., Chiesa, V., Frattini, F. (2010): Organisational modes for Open Innovation in the bio-pharmaceutical industry: an exploratory analysis, *Technovation*, **31**, p. 22-23.
- Bresnahan, T. F., Trajtenberg, M. (1995): General Purpose Technologies: Engines of Growth?, *Journal of Econometrics*, **5**, p. 83-108.
- Burt, R. S. (1992): *Structural Holes: The Social Structure of Competition*, Harvard University Press, Cambridge, MA.
- Cavusgil, E., Talay, M.B., Seggie, S.H. (2007): Dynamic Capabilities View: Foundations and research Agenda, *Journal of Marketing Theory and Practice*, **15**, p. 159-166.
- Chakravorti, B. (2003): *The Slow Pace of Fast Change: Bringing Innovation to Market in a Connected World*. Harvard Business School Press, Cambridge, MA.
- Chandler, A. (1990): *Scale and Scope: The Dynamics of Industrial Capitalism*. The Belknap Press of Harvard University, Cambridge, MA.
- Chesbrough, H. (2003): *Open Innovation: The new imperative for creating and profiting from technology*, Harvard Business School Press, Cambridge MA.
- Chesbrough, H. (2006): *Open Business Models: How to Thrive in the New Innovation Landscape*, Harvard Business School Press, Cambridge MA.
- Cohen, W.H., Levinthal, D.A. (1990): Absorptive capacity: a new perspective on learning and innovation, *Administrative Science Quarterly*, **35** (1), p.128-152.
- Eisenhardt, K. M., Graebner, M. E. (2007): Theory building from cases: opportunities and challenges, *Academy of Management Journal*, **50** (1), p. 25-32.
- Eisenhardt, K. M., Martin, J. A. (2000): Dynamic capabi-

- lities: What are they?, *Strategic Management Journal*, **21**, (10/11), p. 1105-1121.
- Escribano, A., Fosfuri, A., Tribò, J.A. (2009): Managing external knowledge flows: The moderating role of absorptive capacity, *Research Policy*, **38**, p. 96-105.
- Granstrand, O. (1998): Towards a theory of the technology-based firm, *Research Policy*, **27**, p. 465-489.
- Grant, R.A., Halliday, T. (2010): Predicting the unpredictable; evidence of pre-seismic anticipatory behaviour in the common toad, *Journal of Zoology*, **281**, p. 263-271.
- Grant, R.M. (1996): Toward a knowledge-based theory of the firm, *Strategic Management Journal*, **17**, p. 109-122.
- Hargadon, A., Sutton, R. I. (1997): Technology brokering and innovation in a product development firm, *Administrative Science Quarterly*, **42**, p. 716-749.
- Harreld, J. B., O'Reilly III, C.A., Tushman, M. (2007): Dynamic Capabilities at IBM: Driving Strategy into Action, *California Management Review*, **49** (4), p. 21-42.
- Helfat, C., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J., Winter, S.G. (2007): *Dynamic Capabilities: Understanding Strategic Change in Organizations*, Blackwell, Oxford, U.K.
- Huston, L., Sakkab, N. (2006): Connect and develop inside Procter & Gamble's new model for innovation, *Harvard Business Review*, **84** (3), p. 58-67.
- Kale, P., Dyer, J.H., Singh, H. (2002): Alliance capability, stock market response, and long term alliance success: the role of the alliance function, *Strategic Management Journal*, **23** (8), p. 747-767.
- Kim, W.C., Hwang, P., Burgers, W.P. (1993): Multinationals' diversification and the risk-return tradeoff, *Strategic Management Journal*, **14**, p. 275-286.
- Kodama, F. (1992): Technology Fusion and the New R&D, *Harvard Business Review*, July-August, p. 69-77.
- Lichtenthaler, U. (2005): External commercialization of knowledge: review and research agenda, *International Journal of Management Reviews*, **7** (4), p. 231-255.
- March, J.G. (1991): Exploration and Exploitation in Organizational Learning, *Organization Science*, **2**(1), 71-87.
- Nelson, R.R., Winter, S.G. (1982): *An evolutionary theory of economic change*, The Belknap Press of Harvard University, Cambridge, MA.
- Markoff, J. (2010): *Google Cars Drive Themselves*, in *Traffic*, The New York Times, available at <http://www.nytimes.com/2010/10/10/science/10goog.html>, accessed 20 October 2010.
- Miles, M. B., Huberman, A. M. (1984): *Qualitative Data Analysis*, Sage, Newbury Park.
- Obstfeld, D. (2005): Social Networks, the Tertius Iungens Orientation, and Involvement in Innovation. *Administrative Science Quarterly*, **50**, p.100-130
- Pisano, G. (2006): *Science Business: The Promise, the Reality, and the Future of Biotech*, Harvard Business School, Cambridge, MA.
- Porter, M. E. (1980): *Competitive Strategy*, Free Press, New York, US.
- Prahalad, C. K., Hamel, G. (1990): The core competence of the corporation, *Harvard Business Review*, **68** (3), p. 79-91.
- Ray, G., Barney, J., Muhanna, W. (2004): Capabilities, business processes, and competitive advantage: Choosing the dependent variable in empirical tests of the resource-based view, *Strategic Management Journal*, **25** (1), p. 23-37.
- Sakkab, N. Y. (2002): Connect & Development complements research and development at P&G, *Research Technology Management*, **45** (2), p.38-45.
- Schilling, M.A. (2005): *Strategic management of technological innovation*, McGraw-Hill, New York, US.
- Shapiro, C., Varian, H.R. (1999): *Information rules: a strategic guide to the network economy*, Harvard Business School Press, Cambridge, MA.
- Shapiro, C. (1989): The theory of business strategy, *RAND Journal of Economics*, **20** (1), p. 125-137.
- Siggelkow, N. (2007): Persuasion with case studies, *Academy of Management Journal*, **50** (1), p. 20-24.
- Teece, D.J., Pisano, G., Shuen, A. (1997): Dynamic Capabilities and Strategic Management, *Strategic Management Journal*, **18** (7), p. 509-533.
- Teece, D.J. (1986): Profiting from technological innovation: implications for integration, collaboration, licensing and public policy, *Research Policy*, **15**, p. 285-305.
- Teece, D.J. (2007): Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainable) Enterprise Performance, *Strategic Management Journal*, **28**, p. 1319-1350.
- The Economist (2003). Books of the year 2003, http://www.economist.com/books/displaystory.cfm?story_id=E1_NNGVRJV, accessed 08 June 2006.
- Tushman, M. L., O'Reilly, C. A. (1996): Ambidextrous organizations: managing evolutionary and revolutionary change, *California Management Review*, **38** (4), p. 8-30.
- Van Bocxlaer, I. Loader, S.P., Roelants, S.P., Biju, S. D., Menegeon, M., Bossuyt, F. (2010): Gradual Adaptation Toward a Range-Expansion Phenotype Initiated the Global Radiation of Toads, *Science*, **27** (February), p. 679-682.
- Van de Vrande, V., Lemmens, C., Vanhaverbeke, W. (2006): Choosing governance modes for external technology sourcing, *R&D Management*, **36** (3), p. 347-363.
- Wernerfelt, B. Montgomery, C. (1988): Tobin's Q and the importance of focus in firm performance, *American Economic Review*, **78** (1), p. 246-250.
- Wernerfelt, B. (1984): A resource-based view of the firm, *Strategic Management Journal*, **5** (2), p. 171-180.
- Yin, R.K. (2003): *Case study research: design and methods*, Sage, London.