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Battle for dominant design: A decision-making model

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ABSTRACT

This paper synthesizes, analyses and organizes the factors that can be decisive in a battle for a dominant design. The result is the construction of a rational decision-making model, where the relevant factors are grouped into three blocks – market, technology, and complementary assets. First, the firm must decide on the strategic manoeuvres that it is going to deploy to be able to capture the market that it has created or invaded. Second, technologically, it must decide whether to compete with its design made public or private, open or closed. Finally, it must plan its access to complementary assets without which it would be impossible to exploit the new design in a mainstream market. The proposed model is integrative in character and practical in approach, and it helps in forming a strategy and decision-making in the usual design wars today. It is aimed to contribute to a literature in which the analysis of factors is usually done in a fragmented form, without the systematic approach that would facilitate rational and dynamic decision making.

1. Introduction

Radical innovation can create a new industry or transform an existing one (Schumpeter, 1934). This process is not immediate, however, but often becomes a long and complex battle between several incompatible starting "designs" in which only one will emerge victorious and therefore dominant. The term design (Teece, 1986) is used synonymously with assembled product (Abernathy & Utterback, 1978), combination of components (Schumpeter, 1934), or architecture (Henderson & Clark, 1990); in the case of products with network externalities, as a synonym for hardware (in the hardware/software terminology paradigm), platform, or format. Radical innovations of non-assembled products, such as chemicals and pharmaceuticals, and of commercial, organizational, or financial products will not be considered here.

Generally, when a new design is introduced, the ultimate goal is to satisfy a mainstream market, which can either evolve from a niche or be created directly. The case may also occur that the new design is introduced in an already existing mainstream market, trying to displace the current design that the established firms are using, and this may be by direct attack or by coming from a related market. Whatever the scenario, they all have a common feature: a period during which there exist a variety of incompatible designs. This may be because, during the introduction of the new design, there are several pioneering firms trying to conquer the market with alternative technologies, or because the new design competes against one that is already in use. Whichever the case, the existence of this variety marks the beginning of a battle in which only one of them will be selected by the market as victor, becoming what the literature calls the "dominant design". At that point, the market will retain that design in order to continuously improve it through incremental innovations (Anderson & Tushman, 1990; Murmann & Frenken, 2006). After a while, a new design will emerge to trigger the next contest.

In today's competitive environment, these battle loops arise continually. It is therefore essential to collect, analyze, and model the factors that can determine whether one design and not another ultimately becomes dominant. While there has been some previous research focusing on the study of such factors (Lee, O'Neal, Pruett, & Thomas, 1995; Hill, 1997; Schilling, 1998; Suárez, 2004; van de Kaa, van den Ende, de vries, & van Heck, 2011), there still stands out the lack of any systematic approach (Narayanan & Chen, 2012) that would facilitate rational decision-making. This is precisely the objective of the present study, to link ideas and results from different research lines in order to develop a conceptual framework that can serve as a referent for planning the strategy to follow in a battle for a dominant design. This framework consists of three clearly distinct stages, although they are closely interrelated and there is a multiplicity of feedback from one to another. The first visualizes the creation or invasion of a mainstream market, outlining the possible strategic manoeuvres that could be deployed to capture it. The second is to analyze the technology that will satisfy that market, and

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to decide on the process with which to develop that technology. The third is to examine the manufacture and commercialization of the new design, structuring how the necessary complementary assets are to be accessed. In each stage, the firm must also decide whether to go it alone or to seek alliances. The solider the firm's situation in each of the stages, the less importance will be given to alliance-marketing. The proposed model serves as a referent for decision-making in any of the cases that may occur in the battle for the mainstream market, including the classic first-mover/follower battle.

After this introduction, we shall begin by delimiting the concept of dominant design, and then analyze the determining factors in the battle for dominance, organizing them into the aforementioned three groups of decisions. Finally, we shall present the conclusions.

2. The dominant design

The dominant design is a combination of principal components and basic core concepts that do not vary significantly from one product architecture to another and allow the needs of a mainstream market to be met (Abernathy & Utterback, 1978). Such a design drastically reduces the number of performance requirements that a new product must satisfy by embedding many of them in the design itself (Utterback, 1994). Rather than maximizing technical performance or some individual characteristic, the dominant design tends to include a combination of functional characteristics that satisfy the demands of the mainstream market (Teece, 1986). It is the result of a technological trajectory comprising a series of technical decisions about the product which are themselves limited by previous technical choices and the evolution of customer preferences (Utterback & Suárez, 1993).

In the economics literature, a dominant design is often termed a standard, especially for products with network externalities (Shapiro & Varian, 1999). Therefore, the terms dominant design and standard may be regarded as synonymous (Anderson & Tushman, 1990; Besen & Farrell, 1994; Schilling, 1998; Suárez, 2004), and the whole process of evolution from the initial variety of designs to the selection of the dominant design is also known as a war of standards or formats.

A complex dominant (or standard) design may be formed by several more elementary (standard) dominant designs within a product hierarchy (Clark, 1985). For example, the PC includes, among others, the following standards: Wintel, QWERTY keyboard, USB slots, and TCP/IP modem. In its simplest form, a standard defines the physical union of two compatible components. Standards are needed in complex designs (products) that have interdependent components, and in products with network externalities that require direct or indirect connections with each other (Evans & Schmalensee, 2016). Thus, at a high level of aggregation, one can identify standard with dominant design, as in the case of the PC which is a dominant design or standard in the computer sector, apart from comprising various components that are also considered to be standards (dominant designs) although at a lower level of aggregation, such as the QWERTY keyboard. Therefore, it may be that a design which has not become dominant and maintains itself in the market with a reduced quota is formed by several individual standards (dominant designs), without it being possible to say that the non-dominant design is itself a standard in the sector (for example, the Apple Macintosh operating system).

3. Major decisions in the battle for the dominant design

In the battle for the dominant design, wise decisions need to be made on three key aspects: the market, the technology, and complementary assets. In this section, we shall analyze the factors determining success or failure in the battle, organizing them in terms of these three groups of decisions (Fig. 1). Of course, some of the factors will have greater or lesser presence and/or relevance depending on the starting scenario at the origin of the battle.

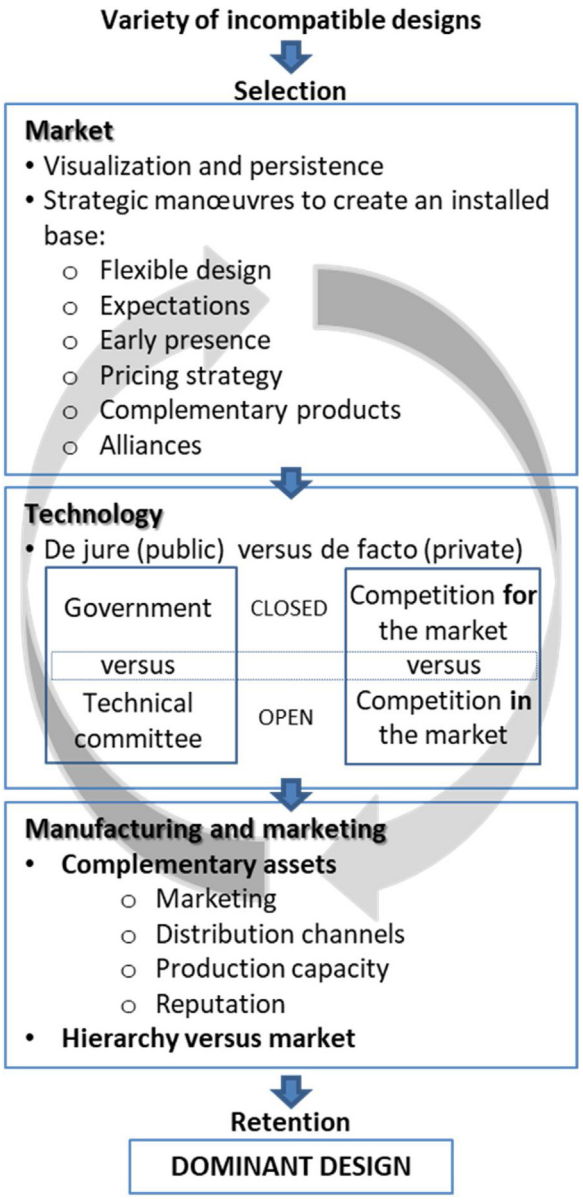

Fig. 1. The decision-making process in the battle for the dominant design.

3.1. Market related decisions

In working to achieve a dominant design, an advantageous prior step would be to clearly visualize the mainstream market. It is also necessary persist in wanting to conquer that market (Tellis & Golder, 1996), which entails high-risk decisions and the assignment of copious resources. At a certain moment, Intel decided to stop making memories and focus exclusively on microprocessors (Grove, 1996). The firm took the risk of cannibalizing its main business in order to ensure the future dominance of its new design.

The pioneer's attitude to the development of the market (or the installed base, as the design's users are called) must be aggressive (Hill, 1997). This is especially the case if the switching costs to the new design are very high. Such costs might generate excessive inertia (Farrell & Saloner, 1985) which, by making no actor wanting

to be the first to switch (the penguin effect), ties (i.e., "locks in") customers to the design already in use (Arthur, 1996).

A large installed base is important for two reasons: it activates the bandwagon effect by increasing people's preferences for the design as it increases the number of adopters (Leibenstein, 1950), and it attracts risk-adverse clients (Arthur, 1996) when they begin to perceive the broad acceptance and success of the new design.

If a firm wants to achieve a broad installed base, there are several strategic manoeuvres it can deploy: (1) create a flexible design; (2) generate expectations; (3) have an early presence; (4) apply an aggressive pricing strategy; or (5) in the case of products with indirect network effect,[1] manage complementary products.

The pioneer can create a flexible design that is compatible with the design in use and that it intends to replace, thereby taking advantage of the installed base (Suárez, 2004). This requires offering consumers a transition path whose focus is on reducing switching costs so that consumers can gradually go trying out the new design. This has not only to be compatible with the existing design, but also superior. Sometimes, however, there are legal barriers hindering the transition from one format to another.

In the competition for a large installed base, consumer expectations are also crucial (Shapiro & Varian, 1999). The decision to purchase is heavily influenced by expectations about the evolution of the design and the consideration that the best design available at present will still be accepted in future (Choi, 1996). In a sense, the design that is expected to become dominant will be the one that does eventually become dominant.

Expectations are one of the manifestations of positive feedback phenomena: as the user base increases, the more users there will be for whom it will be worth to adopt the new design. Success breeds more success (Arthur, 1996). Over time, the design acquires a critical mass and dominates the market. In its most extreme form, positive feedback can make a single firm or design defeat all the others, resulting in a market in which the "winner takes all" (Hill, 1997).

One way to generate expectations is to convince customers, suppliers, and the manufacturers of complementary products that you are winning the game. Expectations can also be created with grandiloquent statements (Shapiro & Varian, 1999), product pre-announcements (Besen & Farrell, 1994), and expenditure on promotion and advertising (Eisenmann, 2007). To be effective, statements need to be supported by the producer's reputation (Porter, 1980). Pre-announcement of the introduction of a new design may slow the growth of a rival design (Besen & Farrell, 1994). This strategy is generally known as vapourware because the new design may be far from actual introduction in practice or may even not exist at all. According to Haan (2003), it is an extensively used method to prevent new entries into the market, and one that can be very effective. Pre-announcements also carry risks, however, since customers may delay purchasing the firm's existing products to wait for its new design. Finally, expenditure on promotion and advertising are very useful in influencing customers with respect to the product's characteristics and gaining their loyalty to the design.

Another manoeuvre in achieving a broad installed base is to stake out an early presence on the market (Schilling, 1998), since the pioneer can take the first-mover advantages (Lieberman & Montgomery, 1988). An example is the protection afforded by property rights. In addition, customers are loyal to the first brand (Schmalensee, 1982), especially if they have imperfect information (Kerin, Varadarajan, & Peterson, 1992) and the pioneer already has a good reputation (Carpenter & Nakamoto, 1989; Gallagher & Park, 2002). A pioneer offering a quality design supported by an aggressive advertising campaign can gain a high market share (Schmalensee, 1982). The advertising expenditures of pioneers are more effective, contributing to the dissemination of the design and creating barriers to entry (Comanor & Wilson, 1979). An early presence allows the firm to see how the evolving design is used in reality, whether or not it satisfies the customers' needs, and what improvements are needed. Close contact with customers helps the firm specify the features the design must have to satisfy the mainstream market (Utterback, 1994). But being first out of the gate usually entails sacrificing some technical advances, giving rivals room to develop a revolutionary incompatible design (Shapiro & Varian, 1999).

In a scenario of capturing a broad market share, an aggressive pricing strategy can also be decisive. Thus, penetration pricing is often very effective (Besen & Farrell, 1994) at attracting a large number of users and creating a broad installed base (Oren & Dhebar, 1985). Also, for core products requiring complementary products, the "razor-and-blades" strategy can be determinant. Likewise, offering discounts to attract major customers is almost inevitable in a design war. For example, Microsoft licensed MS-DOS to IBM at a very low price. The profitability came from granting MS-DOS licenses to computer firms wishing to offer machines compatible with the IBM PC (Gates, 1995). Promotions can also be used in any of their multiple forms (coupons, free gifts or samples, etc.). In other cases, a good strategy is to sell the new design in a package with a design that already has a large installed base (Eppen, Hanson, & Martin, 1991). In addition, a pioneer can reinforce all of this by using long-term contracts to assure its customers that they will not be victimized by price increases once they have become tied to the design, including clauses that the price they pay will also be lowered if a decrease is offered to new customers (Katz & Shapiro, 1986).

Finally, the attractiveness of product designs with indirect network effect also depends on the number of complementary products that are available. Thus, a design may have little or no value in isolation, but generate value when combined with complementary products (David & Greenstein, 1990; Besen & Farrell, 1994), whether physical (videotape for video recorders) or intangible (typing skills to write on a keyboard) (Gallagher & Park, 2002). Although one can see there being a "chicken and the egg" problem in this of the complementary products, Stremersch, Tellis, Franses, and Binken (2007) conclude that the installed base induces the supply of such products. The availability of complementary products will subsequently influence users' future choice from among incompatible designs (Schilling, 1999). In general, the lack of complementary products delays the emergence of a dominant design (Gupta, Jain, & Sawhney, 1999).

The desire to increase the installed base can encourage firms to cooperate (David & Greenstein, 1990). In general, a dominant design backed by many firms enjoys greater credibility (Wade, 1995) since there will be future competition in the market, reducing uncertainty and fear of lock-in. In turn, by attracting more adepts and thereby increasing the installed base, this credibility is strengthened even further. The odds of achieving the dominant design are also better if the firm has market power (Axelrod, Mitchell, Thomas, Bennett, & Bruderer, 1995). As will be seen below, cooperation can be undertaken to develop the technology and/or to access the complementary assets needed to commercialize the design in the global market.

[1] The network effect arises when the value of the product increases for the user as the number of users increases. The network effect is based on two sources of value: the direct effect and the indirect effect. The direct effect arises from the benefit that the user of the product obtains from being able to connect with other users; for example, a telephone network. The indirect effect arises from the interdependence in the consumption of complementary products. Some products have no value in isolation, but generate value combined with others; for example, video recorders and video tapes.

3.2. Technology related decisions

In the battle for the dominant design, there are two decisions to be made from the technological perspective: whether the process will be *de jure* or *de facto*, and whether the design will be open or closed (Fig. 1).

In a *de jure* process, the standard is fixed by the government or a technical commission. In the former case, the pioneer can pressure the government to regulate its design, with the result that it will become dominant (the standard) in the sector (Islas, 1999). In that case, the government can put the design into the "public domain", meaning that any company can freely incorporate the knowledge and technology that support it into their products, or otherwise require the pioneering firm to license all the patents essential for its manufacture under fair, reasonable, and non-discriminatory terms (Saloner, Shepard, & Padolny, 2001). The advantages of the design itself having to be accepted by the entire industry are considerable. The pioneer who developed it may have productive assets that are co-specialized with the design (Teece, 1986), which would constitute an important competitive advantage. The competitors' assets will, however, be specific to the design that they had been marketing, which will mean they will have switching costs. Not only will they take losses on specific investments, but they will need time and resources to manufacture and market the dominant design.

When the standard is going to be set by a technical committee, in which competitors, suppliers, and customers will participate, its appearance will be delayed by the difficulty in reaching a consensus (David & Greenstein, 1990). Nevertheless, these committees have rules of fair play and openness, as well as incentives to choose the best design and bring it to market (Farrell & Saloner, 1988). In return for approving the standardization of the design, they require that no firm or group of firms maintain ownership.

The *de facto* dominant design emerges from a market process, i.e., competition among various designs that is characterized by the uncertainty of the outcome and switching costs (Burnham, Frels, & Mahajam, 2003). Every market process requires that the design be protected. To this end, its core technology must be covered by a system of appropriability, understood as those properties of technological knowledge and technical artefacts, markets, and the legal environment which allow innovations to be protected to varying degrees from imitations by competitors, maintaining them as rents-producing assets (Dosi, 1982). The appropriability regime is stronger if part of the essential knowledge to configure and manufacture the design is tacit in nature (Teece, 1986), and therefore difficult for competitors to decode. It is also difficult to access the knowledge that is kept secret in the production processes. In what follows, we shall call protection of the design generically a patent, regardless of whether or not the appropriability is a multifunctional construct that includes other mechanisms of protection (industrial secret, leadership time, ...) (Levin, Klevorick, Nelson, & Winter, 1987).

History confirms the power of patents, particularly in inventions that contribute to creating new technology-based industries. The patent protection that Edison's company obtained for its carbon filament lamps and other system components, as well as its tenacity to successfully defend them in court, was essential for its incandescent light bulb to become the dominant design of the industry (Utterback, 1994). In addition, the process of patent accumulation to some extent becomes a snowball effect (Scherer, 1980), which enables the firm to cover its discoveries with hundreds of patents and thus prevent other firms developing alternative products. When a firm dominates a technological field by accumulating a massive portfolio of patents, it not only prevents rivals from entering the market without its acquiescence, but also becomes the logical purchaser of new related concepts patented by independent researchers.

In a *de facto* process, in addition to protecting the design, the firm must decide whether to compete "in" the market or to compete "for" the market. The former would open the design to competitors so as to obtain their support and increase the installed base, as JVC did in licensing its VHS design to competitors. The latter would be based on exploiting the design exclusively, as Sony did by not providing its Betamax design to rival firms (Cusumano, Mylonadis, & Rosenbloom, 1992).

The strategy of competing "for" the market, if successful, would imply greater benefits for the owning firm. However, the refusal to open the design could lead to failure from limiting the spread of the product and market expansion if users fear lock-in (Arthur, 1996) or if the firm faces powerful rivals whose designs are not monopolized and offer comparable performance. Sony's Betamax technology, while of higher quality, lost out to the VHS technology, and ended up being expelled from the market (Cusumano et al., 1992).

The strategy of competing "in" the market is a more prudent option than "for" the market (Shapiro & Varian, 1999). Its purpose is to give up control over the design so as to achieve greater mobilization in the sector (den Hartigh, Ortt, van de Kaa, & Stolwijk, 2016). A firm can choose to share its design if it believes that this will be the only way for its design to dominate the market or if it finds itself behind in the technological race with a competitor. An open design appears to be more likely to succeed because, being sponsored by a group of firms, it will attract more users since they know they have at least a second source of supply. However, there is as yet insufficient empirical evidence for the superiority of either strategy (Shapiro & Varian, 1999).

Within the "in" the market category, a distinction should be made between fully opening the design and following an alliance-marketing strategy.

In the former case, anyone has the right to use the design, whether or not it contributed to its development, as with the Linux operating system (Remneland-Wikhamn, 2013). Since there is no clear sponsor, there are two fundamental threats (Shapiro & Varian, 1999): Who will be in charge of setting the course of evolution of the standard? And who is going to invest the resources needed for improvements to be made so that the dominant design does not get stuck and stagnate?

In the latter case, the alliances can be built around a sponsor who charges the others royalties by licensing them the design while retaining the property rights and the control over its evolution. This is how Microsoft acted with MS-DOS, allowing IBM to use the software but without granting it an exclusive license or control over future improvements (Gates, 1995). Granting licenses to competitors ensures the owner a certain control of the design in so far as it discourages investment in alternative designs. In addition, licensing ensures the collaboration of other firms (Somaya, Kim, & Vonortas, 2011), even rivals, in improving the design for it to become dominant (Carpenter & Nakamoto, 1989). Likewise, licensing contributes to market expansion by using the partner firms' distribution channels and additional markets (Bekkers, Duysters, & Verspagen, 2002). IBM achieved dominance for its PC design over Apple by using non-exclusive licenses for two core components: the Intel microprocessors and Microsoft's operating system (Khazam & Mowery, 1994; Gates, 1995).

Some alliances operate as a consortium of independent firms who cooperate so that the design will become dominant. To this end, they create a common pool of patents that they use to coordinate interfaces, protocols, and technical details (Baumol, 2004). They also exchange confidential information about the design under a non-disclosure commitment. The patent pool can solve the patent-thicket problem of complex designs. The architecture of a complex product such as a computer comprises hundreds of components, many of them covered by patents. These patents normally

belong to different firms, some of whom will also be direct competitors in the end-product market. This puts any of these firms in a legal position which will allow them to stop production (Baumol, 2004). An effective form of avoiding this catastrophe is to create a patent pool in which the partner firms are ensured (usually cost-free) access, while firms that are outside the agreement can be prevented from fabricating the design or charged for it. Thus, each partner firm makes some contribution to the design, and in return is allowed to sell (perhaps with the mediation of some financial consideration) the design whose creation it contributed to under its own brand name.

These alliances are usually preceded by long negotiations on three key assets (Shapiro & Varian, 1999): control of the installed base, technical superiority, and industrial property rights. The more firms involved in the consortium or collaborating in the development of the technology, the more incentives they will have to support and advance the shared design and achieve its dominance in the sector (Wade, 1995), although agency costs tend to be high (Bergen, Dutta, & Walker, 1992).

However, an alliance-marketing strategy also carries risks (Shapiro & Varian, 1999). If a firm opens its design, it can find itself in a situation in which other producers can reduce their prices to the limit at which the firm is unable to recuperate its R&D investment. Competition may reduce the price to a level at which no producer's margin on the design will be sufficient to provide an incentive to continue developing it. Moreover, opening the design can lead to fragmentation as different producers alter it according to their needs, resulting in loss of compatibility among producers and potential erosion of the design's quality. Over time, there are strong incentives for the producers to differentiate themselves with the development of proprietary extensions while maintaining some degree of compatibility with older versions. Finally, an open standard may be "hijacked" by a firm seeking to extend it with a design for which it owns the exclusive patent, and thus gain control over the installed base.

3.3. *Complementary-assets related decisions*

Complementary assets are assets that complement a design and are essential for its successful introduction into the mainstream market (Teece, 1986). A new design can enter a niche and later attack a mainstream market. Transitioning from a niche to a mainstream market Moore (2002) called "crossing the chasm" for its riskiness. Every pioneer must take into account that the strategic manoeuvres and assets needed to introduce a new design into a niche are not the same as those for its introduction into the mainstream market (Macher & Richman, 2004), and also that they may even come into conflict with each other (Markides & Geroski, 2005).

Firstly, the early adopters who make up a niche are usually young, visionary, open-minded, adventurous and willing to take risks, with a solid financial position and high social prestige, and they value the product's uniqueness (Rogers, 1962). Customers in the mainstream market are more conservative, have fewer resources, and value product quality and price above all (Moore, 2002). Competition in the mainstream market tends generally to be in terms of differentiation, and this requires a major effort in marketing (Teece, 1986).

Secondly, access to the early adopters of the design is done through specialized distribution channels, with personalized promotion and word of mouth being of particular importance (Frenzen & Nakamoto, 1993). However, to reach the mainstream market requires wide-ranging channels of distribution to capture the greatest possible number of outlets with the highest exposure of the product, as well as conducting advertising campaigns in the mass media (Moore, 2002).

Thirdly, early adopters are relatively few in number, so that the pioneer will use a flexible (small-scale) system of production, while mass production will be required to serve the mainstream market. Hence, an important asset to be able to compete in this market is production capacity. The battlefield will shift from design (product innovation) to process innovation (Abernathy & Utterback, 1978; Klepper, 1997; Brem, Nylund, & Schuster, 2016), and the producer's focus will shift to the factory which will have to have available highly developed technical and engineering knowledge (Utterback, 1994). According to Klepper (1996), the dominant design is supported by the economies of scale achieved by radical process innovation. Thus, the firm which develops an efficient production system (i.e., one of mass production) will find many opportunities to corner the mainstream market and overcome any barriers to entry. In short, it is generally considered that the mainstream market will be occupied by the first to attain economies of scale in production (Rao & Rutenberg, 1979) and to activate the experience effect (Spence, 1981). These will be the combined result of accumulated learning and technological advances leading to increased productivity and reduced costs.

And fourthly, reputation is a crucial strategic asset in the mainstream market (Gallagher & Park, 2002). In the battle for the dominant design, the producer's reputation is key to promoting the design's dissemination in the market. One way to improve that reputation and achieve a significant market share is to be the first to bring the new design to market (Scherer, 1980).

In deploying any of these additional assets, manufacturers can act alone or by assembling a powerful group of strategic partners. The integration process fosters the possibilities of innovating in the design's environment (Langlois & Robertson, 1995). Moreover, when a key component is available on the market and its supply is limited, the pioneer can purchase the resource provider, set up an exclusive long-term contractual agreement with him or negotiate some other type of strategic alliance (Tripsas, 2000; Helfat & Lieberman, 2002). In general, the support of complementors, competitors, or component suppliers (Shapiro & Varian, 1999) is needed to reduce uncertainty about the market's acceptance of the design (Leiponen, 2008). A particularly good partner would be a strong, "big fish", customer who agrees to commit themselves to purchasing the product (Suárez, 2004). IBM's choice of Intel as the supplier of its PC microprocessor was decisive for this to become the dominant microprocessor, accepted worldwide (Grove, 1996).

4. Conclusions

This paper has analyzed the battles between alternative designs, presenting a three-stage, dynamic model to orient decisions that will allow a firm's design to emerge victorious in the struggle to dominate the market. The model expands on the first-mover/follower battle, being applicable to any scenario that might arise, such as those among pioneers or between old and new designs.

In relation to previous work, the contribution has been not only that the factors which are determinant in a battle for the dominant design are collected together, but that the reasons for their relevance have been discussed in some depth, and, above all, that they are organized in accordance with a simple and rational process (Fig. 1). In particular, a first group of decisions that has to be successfully addressed is that related to the market. The eventual victor will need to visualize the mainstream market correctly, and work to achieve an installed user base that is superior to that of the competitors. There are several strategic manoeuvres that can help towards this end, including whether or not to seek alliances. The second group of crucial decisions consists of those related to technology. Success in this phase will involve reflection on two key

aspects – on the one hand, deciding whether the process will be *de jure* (public) or *de facto* (private), and, on the other, whether the design will be open or closed (controlled). The consequences of the design being public or private, and of pursuing a strategy of proprietary control as against one of openness (whether total or in the form of alliances) need to be evaluated and balanced correctly. Finally, the third group of decisions that need to be successfully resolved consists of those related to the access to complementary assets without which it would be impossible to be competitive in a mainstream market. In many cases, such access can be gained by establishing alliances with capable and reliable partners.

While we have presented the proposed model theoretically as a sequential process, in practice the three stages need not follow a linear sequence since many of the decisions they encompass are interrelated, and there exist multiple feedback loops between them. Consequently, some decisions must be addressed simultaneously, regardless of which stage they are grouped into.

In addition to the usefulness of the proposed model from a business point of view, one has also to highlight its contribution to the academic world insofar as it can serve as a guide for a systematized analysis of battles for dominant design, which would allow one to better understand the development of the struggle and provide pointers to which will be the potential victor. It may also be a starting point for further research. Thus, for example, it would be interesting to obtain empirical evidence about the similarities and differences between first-mover/follower and old design/new design battles, among others. Likewise, it would be interesting to look at the influence of the production process on the success of the dominant design. Another relevant question would be to determine in which competitive context an open strategy would be superior to one of proprietary control, and vice versa.

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