DETERMINANTS OF ‘TAKE-OFF TIME’ FOR EMERGING TECHNOLOGIES: A CONCEPTUAL MODEL AND PROPOSITIONAL INVENTORY

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The central concern of this paper is how firms can reduce “take-off time” for emerging technologies. We propose a set of strategic alternatives and specify the determinants of strategy selection for stimulating initial demand for a new technology. The intended contribution is to enrich the diffusion and technology adoption literature by developing a propositional framework from a strategy perspective and by providing managerial guidelines for achieving more rapid technology take-off.
INTRODUCTION

The business and trade press constantly herald the arrival of new technologies, such as network computers, high-definition television, desktop video-conferencing, digital cameras, digital video disks and voice recognition computing. In such technology-based product categories, marketing managers are faced with a difficult set of intertwined questions, foremost of which are: (1) which of these technologies will actually take-off, (2) at what speed, and (3) what is the appropriate set of marketing strategies to use to accelerate take-off? If answers were available to these questions, they would be key inputs for decisions regarding the deployment of R & D resources and the allocation of marketing funds behind the most promising technologies.

Our concern is with only one question: what strategies can be employed to encourage rapid take-off in order to shorten the risky and resource-intensive introductory stage of the life cycle? This question is obviously interrelated with the other questions regarding market potential and the projected demand function, but our interest at present is not in modeling or forecasting diffusion. Our goal is to present a conceptual model and propositional framework drawn from literatures in multiple disciplines -- economics, strategy, and marketing -- that identifies the key strategic actions that the firm can take to reduce the time to take-off for a new technology. Additionally, we will specify the determinants of the strategic actions which will be most appropriate as a function of three sets of factors: technology characteristics, industry characteristics and firm level characteristics.

The marketing manager generally wants to accelerate take-off for a technology. This bias may be driven by such objectives as to leverage patents while still valid, to leverage competencies before
imitated, and/or to fulfill potential demand before competing technological solutions appear. However, for emerging technologies there may be some considerable period after launch before rapid diffusion actually occurs. Lehmann (1994), for example, suggests that in the case of the zipper, the time between patenting the technology and successful commercialization was 44 years. Numerous more recent technologies from automated tellers to microwaves to VCRs required over a decade to reach take-off. The zipper example may constitute an extreme case, but recent studies confirm that take-off time generally spans many years. In consumer durables, for example, an average take-off time of 10 to 12 years seems to be the norm (Lehmann 1994, Tellis 1994), although Tellis (1994) observes that this period is shortening. He speculates that this is due to the pace of technological change and that higher disposable income and the availability of mass communication may also be driving factors.

One managerial implication, given the tortuous diffusion of many emerging technologies, is that “…a firm ought to keep early commitments low and make decisions faster.” (Moore 1994, p.8). There is a certain logic to this, especially the value of making rapid real-time decisions in an evolving manner as consumer preferences are clarified. However, managers may have to make substantial commitments of resources to “remain in the game” as technology emerges, especially if economies of scale or experience curve effects are important, or if early mover advantage is likely to be an important factor.

Microsoft is an interesting current case-in-point of the need to make resource commitments. It underestimated the potential and the time-to-takeoff for the internet and lost advantage to Netscape. In order to remain a player, Microsoft had to make radical changes in its strategy and undertake major commitments to internet technology, which it has done with considerable success. Other firms which have not made adequate and early-enough commitments to emerging technology, such as IBM in workstations, often have paid a heavy penalty of low market share and an inability to overcome early mover advantages garnered by firms such as Sun and Hewlett Packard. Other reasons for requiring major commitments to minimize take-off time are if the technology is subject to the need for a dominant standard or if network externalities are a factor. We shall explore these issues shortly.
When marketing managers are faced with decisions about how to launch a new technology, there is often an interesting contrast between the relative “certainty” of the technological solution versus the relative uncertainty of marketplace acceptance. In other words if the company decides to market the technology, it is generally the case that R&D has signed-off on technological performance and Operations has concluded that products based on the technology can be manufactured. However, there often exists a considerable degree of market uncertainty as to: (1) the likely magnitude of market acceptance, (2) the timing of market acceptance, and (3) the particular applications based on the technology that will actually generate demand. This is not the case after take-off when demand side uncertainty is substantially resolved (Wernerfelt and Karnani 1987, Lambkin and Day 1989).

For purposes of this paper, we will define an emerging technology as a new product category that is low on technological uncertainty but high on market uncertainty. This distinction between technology versus market uncertainty is a familiar one in the literature (Walker and Weber 1984, Moriarty and Kosnik 1989, Klein, Frazier and Roth 1990). The concept of network computing, for example, represents an emerging technology. As visualized by Larry Ellison of Oracle, it is a stripped-down computer appliance that can access intelligence on the network (Business Week 1996). However, the particular form that this product takes is conceptualized differently by various competitors and members of the supply chain. The technological solution is low on uncertainty but market uncertainty is presently high.

The process by which a product or technology acquires initial acceptance has for the most part been neglected in the marketing literature (Mahajan, Muller and Bass 1990). In the diffusion theory literature, Rogers (1995) argues that the diffusion process begins when a set of innovators, who have higher propensity to engage in trial, adopts an innovation. In this framework, a technology takes-off when it passes from the introduction to the growth phase, that is, when the first inflection point in the non-cumulative adoption curve is reached. In a similar manner, Bass (1969), in his seminal paper, models the diffusion of innovation assuming that a certain number of consumers have already adopted before the imitation process commences, i.e. \( N( T = T_a ) > 1 \). (See Mahajan
and Peterson 1985 for a review). In other words, the Bass model of diffusion assumes that initial take-off has occurred. This suggests that a critical number of consumers has reached adoption at time $T = T_0$ to accentuate the contagion process and to encourage take-off. Recently, in an interesting reexamination of the classic medical diffusion study of Coleman, Katz and Menzel (1966), Van den Bulte and Lilien (1996) have concluded that the social contagion effect was overstated and the marketing effect understated. Again, however, this is not our concern since their analysis was beyond the take-off point.

Although the importance of take-off has been recognized in the diffusion literature (Muller, Mahajan and Bass 1990, Rogers 1995) little effort has been made to specify and operationalize this construct. An initial contribution comes from Tellis (1994), who identifies take-off by using a combined set of descriptive measures. More specifically, he identifies take-off by looking at the period with the largest percentage sales growth, the first doubling in sales, the largest absolute sales growth, and the steepest increase by visual inspection. Across twenty-two product categories, he identified take-off based on the set of four criteria. For an additional eight categories, he used either two or three criteria.

Despite this notable exception, research is needed to rigorously operationalize the take-off concept. For the purpose of this paper, we suggest that take-off (TO) is the point at which the acceleration of sales growth reaches a maximum. Figure 1 provides two case examples delineating take-off. Conceptually, take-off can be described as a threshold which determines a switch of regime in terms of probability of diffusion. Managerially, take-off represents that point at which market uncertainty about the product category is diminished and the risk of being locked into the wrong technology is accordingly reduced. We also argue that this point in time represents the penetration level which necessarily must be reached to initiate the possibility of a contagion effect and to observe the familiar logistic diffusion curve.

The research problem to be addressed, therefore, takes as its central concern how a firm can accelerate time-to-take-off for an emerging technology and to what extent the strategic pursuit of a high acceleration strategy is moderated by technological, industry and firm factors. Our vantage
point is from the perspective of managers actively trying to manage the initial stage of the diffusion process. Their objective is to implement proactive strategies that can foster initial adoption of emerging technologies subject to the firm’s financial objectives and resource constraints. Managers also wish to minimize the risk of triggering competitive reactions.

The Conceptual Model

The model proposed is represented in Figure 2. This conceptualization describes the moderating effects of technological, industry and firm variables on the selection of the firm’s strategic actions to accelerate the acceptance of an emerging technology. These actions are shown to affect the behavior of customers which, in turn, determines time-to-take-off. Our dominant concern is how the manager’s selection of strategic actions to minimize time-to-take-off is affected by variables related to the nature of the technology, the firm launching it, and the industry into which the technology is launched.

Underlying this model are two fundamental tenets. The first is that the firm’s strategic actions affect adoption behavior and therefore time-to-take-off (Gatignon and Robertson 1985, Robertson and Gatignon 1986, Karshenas and Stoneman 1993). In particular, we specify a set of strategies that can facilitate adoption and, therefore, minimize time-to-take-off (i.e., penetration strategy, product compatibility, new product preannouncements and marketing alliances). The second tenet is that technology, industry and firm characteristics moderate the selection of strategic actions which the firm pursues to generate demand. For the purpose of this study, we have taken these variables as given and, therefore, we treat them as exogenous. As depicted in Figure 2, we limit consideration to a subset of the possible relationships and ignore interactions in order to provide a concise and delineated set of ideas.

STRATEGIC ACTIONS: THE FOCAL POINT

The discussion of the model begins with the set of proactive strategies that a firm can take to accelerate time-to-take-off. These actions aim to hasten the adoption process (Gatignon and
Consistent with the literature which deals with the adoption process in a decision theoretic framework (Jensen 1982, Chatterjee and Eliashberg 1990), we contend that adoption takes place when the difference between the perceived relative advantage of an emerging technology and the hurdle of adoption (price hurdle, expressed in terms of price and switching costs, and cognitive hurdle, expressed in terms of learning requirements) is positive (Sinha and Chandrashekaran 1992). Of course, the customer’s expected value of benefits from an emerging technology potentially increases as more information becomes available and uncertainty is resolved (Jensen 1982, Kalish 1988).

In this study we argue that strategic actions can be undertaken in order to reduce the perceived uncertainty surrounding an emerging technology and to reduce the hurdle of adoption for initial users. This is of particular value since rapidly reaching take-off is the necessary condition to activate the possibility of a contagion process. We identify the following four strategies from the literature as key initiatives to induce an acceleration in time-to-take-off: (1) penetration strategies, (2) product compatibility, (3) new product preannouncing, and (4) marketing alliances.

(1) **Penetration Strategies** entail aggressive pricing and high resource commitments to advertising, sales force and promotional activities. The selection of a penetration strategy is driven by multiple factors. First, the objective of this strategy is to gain rapid market acceptance and, thus, to stimulate demand through a diffusion effect (Kalish 1988). Secondly, penetration strategies are selected in order to benefit from cost reductions through learning effects (Dean 1969, Robinson and Lakhani 1975). Finally, the choice of an aggressive introductory strategy is a preemptive move to discourage other competitors from taking an equally strong stance toward the target market.

In the 1970s as the concept of experience curve effects was promulgated, penetration pricing became a key strategic issue (Abell and Hammond 1979) with documented successes (such as Texas Instruments in calculators) and failures (such as Texas Instruments in digital watches). In the 1980s penetration strategies were often attributed to the Japanese, who tended to price aggressively to gain market share with the objective of long-run rather than short-run profits. The transition over time has been to think of penetration strategy more broadly than pricing and for our
purposes we will think of a penetration strategy as aggressive pricing coupled with high resource commitments in advertising, sales, and distribution.

Penetration strategies are generally compared to skimming strategies, whereby marketing strategies are focused sequentially on particular segments of customers. Skimming strategies allow the firm to price discriminate throughout the product life cycle. The classic notion of Bain (1956) was to “skim the cream” by charging high prices initially to price insensitive customers and then reducing price in a stepwise manner over time to bring new segments of customers into the market. If we think of a skimming strategy more broadly than pricing, we realize that the diffusion literature’s admonition to market initially in line with “innovator” characteristics (venturesome) and then to change the marketing program to reach early adopters (opinion leadership), early majority (deliberate), late majority (skeptical), and laggards (traditionalists) is more akin to a skimming strategy than a penetration strategy. We compare these two strategies and we examine under which circumstances a penetration strategy leveraging on the diffusion effect is traded for a skimming strategy.

(2) Product Compatibility. The recent growth in importance of the information technology and telecommunications industries has given rise to a great deal of research on compatibility and standardization issues. In particular, the economics literature (Farrell and Saloner 1985, Katz and Shapiro 1985, Gilbert 1992) has focused on the social and private incentives to achieve compatibility among components or products within a system. The basic thesis is that the utility that the consumer derives from a technology depends on the total system compatibility with complementary technologies. The transition from a previous technology to a new technology may carry excessive costs of incompatibility for early adopters and, therefore, retard technological substitution and take-off.

Compatibility can be pursued by designing new products to be consistent with the existing installed base or by endorsing coalitions for the setting of standards. However, these decisions are not always managerial options. In some cases, technological improvement can be achieved only by introducing a radically new product which breaks with an existing industry standard (Dhebar
1995). As a result, compatibility becomes technologically infeasible. Our objective is to examine situations in which compatibility is under managerial control, such as the recent reconciliation of the two competing digital video disk technologies from the Sony-Phillips camp versus Hitachi-Matsushita.

Strategic issues related to compatibility decisions are not negligible, especially when network externalities characterize the industry. More specifically, the firm’s incentives to achieve compatibility revolve around the opportunity to eliminate inter-technology competition and, consequently the uncertainty surrounding the network which will dominate. The pursuit of compatibility may allow the firm to charge higher prices, since consumers are willing to pay a premium for compatibility which allows them to access a larger network, or to assemble a product system that is closer to their ideal configuration (Matutes and Regibeau 1988, Economides 1989, Economides and White 1994). However, compatibility with existing standards makes firms share the benefits generated by a growing installed base with incumbents of the previously marketed technology. It may also be that achievement of compatibility is costly (Katz and Shapiro, 1986a). Costs to achieve compatibility include the incremental expense of design and development and the expense of negotiating to reach a standard (Besen and Farrell 1994).

By contrast, the choice of launching a technology which is incompatible with an existing installed base, or with emerging rival technologies, may retard market acceptance and alter the competitive dynamics. Early adopters may postpone their purchases when they have uncertain expectations about the network which will prevail. On the other hand, deliberate incompatibility protects returns from R&D and conveys a credible signal of the firm’s ability to control the market in the future (Padmanabhan, Rajiv and Srinivasan 1996) Our study addresses the strategic issues surrounding compatibility decisions.

(3) New Product Preannouncing. Preannouncing conveys information about a forthcoming technology. In doing so, it can facilitate the creation of an installed base by potentially reducing customers’ costs of changing from an existing technology to an emerging one and by ameliorating information asymmetries between the firm and its customers. In our paper we focus on the impact
of preannouncing on the consumer base. We recognize that preannouncing behavior is also driven by competitive rationales designed to discourage rivals from following preemptive announcements (Robertson, Eliashberg and Rymon 1995, Bayus, Jain and Rao 1997). However, the latter is not our focus and earlier research by Eliashberg and Robertson (1988) has documented that the vast majority of external preannouncements are to customers and not for competitive purposes. In this vein, our objective is to examine to what extent the decision to preannounce to consumers is moderated by the nature of the emerging technology as well as by firm and industry characteristics.

(4) **Marketing alliances.** The route to market for an emerging technology can be a key management decision variable. The difficulty is that independent marketing channels (distributors, dealers, agents, etc.) with appropriate expertise and adequate market coverage may not be available due to the technological newness of the product or may be under the control or influence of other manufacturers. The firm’s options may be limited, therefore, to the creation or adaptation of its own salesforce or the formation of marketing alliances, sometimes on a horizontal basis with other manufacturers.

We will define a marketing alliance as a contractual relationship between the technology provider and an independent entity for the purpose of achieving market access. In general, such alliances will be focused on distribution but they may also involve issues of complementary assets, such as access to a partner’s brand reputation or access to complementary technology components when sold as part of a total system. Such inter-firm marketing agreements may allow firms introducing emerging technologies to acquire complementary marketing assets and competencies in order to encourage an easier and faster market acceptance (Teece 1992). As Pisano, Russo and Teece (1988) note, the successful commercialization of emerging technologies requires a range of assets that rarely exists within the capabilities of a single firm. This may be particularly the case for new entrants, such as biotechnology firms, which have formed alliances with the established pharmaceutical firms to come under their reputation umbrella and to access their salesforce resources to gain market coverage. However, even established industry participants, such as IBM, may use marketing alliances to reach the market when introducing new technologies. For example, as IBM entered the workstation market with its RS-6000, it created a customized route to market
via the extensive use of alliance partners including value-added resellers, licensed software providers, and systems integrators. These partners were often selected for their industry expertise, such as value-added resellers focusing on health care and delivering total systems of which the workstation was only one key component.

Now that we have introduced the set of strategic actions, our discussion will proceed as follows. First, we will examine the determinants of which strategic actions the firm should pursue. Secondly, we will look at the effects of these strategic actions on time-to-take-off. Finally, we will conclude with a discussion of managerial and researcher implications.

Determinants Of Strategic Actions To Reduce Take-Off Time

The set of strategic actions just outlined may potentially accelerate time-to-take-off by facilitating the adoption process. The appropriateness of these strategies, however, is moderated by three sets of factors: technology characteristics, industry characteristics and firm characteristics. We now pursue each set of factors, while formulating hypotheses on the moderating effect of each on a firm’s strategic pursuits.

TECHNOLOGY CHARACTERISTICS

Technology related characteristics are seen as exogenous factors which influence strategic actions. The nature of the new technology affects the menu of possible actions to be considered by the firm (Kotabe, Sahay and Aulakh 1996). The technology characteristics, as indicated in Figure 2, examine the effects of network externalities and technology appropriability on the firm’s strategic actions.

Network externalities

Telephone, fax and desktop video conferencing require a “critical” number of adopters in order to be effectively used. Their utility is an increasing function of the number of people they network. In a similar vein, the number of users of a new technology may influence the availability of future
applications (software) or the creation of technological infrastructures. This suggests that consumers ascribe a value to the size of the actual or potential network of subscribers. We may think of externality as an effect which occurs whenever the “utility that a given user derives from a good depends upon the number of other users who are in the same ‘network’” (Katz and Shapiro 1985, p.424).

The externality effect has attracted a good deal of interest in various fields, such as industrial economics (Rohlfs 1974, Katz and Shapiro 1985, Farrell and Saloner 1985, Choi 1994), strategy (Wade 1995) and marketing strategy (Esser and Leruth 1989; Kotabe, Sahay and Aulakh, 1996). Recently, some notable attempts have been made to validate this construct empirically. In an analysis of the computer spreadsheet market, Gandal (1994) tests whether this technology exhibits network externalities. The estimation of a hedonic price equation shows that compatibility with a dominant installed base increases consumer utility, providing evidence of a positive role of network externalities. Brynjolfsson and Kemerer (1996) have extended Gandal’s work by incorporating unit sales and market price data. Their results are consistent with the previous research effort and show the positive effect of the installed base on consumer utility. In a different vein, Saloner and Shepard (1995) assess the effect of network externalities on the adoption of automated teller machines (ATMs) by banks. By considering the number of branches that a firm has as a proxy for the expected network size, the authors find network size increases the probability of early adoption.

Network externalities have been distinguished as direct and indirect. The former ascribes to situations in which a technology requires direct interaction among consumers (telephone, fax etc.). By contrast, indirect externalities arise when compatible products or infrastructure become more plentiful as the number of users increases, as, for example, in the case of Microsoft Windows-based applications.

The presence of network externalities has important consequences on both the demand and supply sides. On the demand side, direct or indirect benefits induce consumers to make decisions conditional on other consumers’ adoption. Consumers are encouraged by network benefits to prefer the adoption of a “dominant technology” to the one they might individually prefer, since
dominant products tend to be supported by a wide variety of services (Chou and Shy 1990). The presence of network externalities might encourage customers to delay adoption until the uncertainty concerning the network that will prevail is alleviated (Farrell and Saloner 1985). Alternatively, the customer faces the possibility of being stranded when other people adopt a different and incompatible technology (Choi 1994).

The effect of network externalities on the demand side is such that multiple equilibria may exist and the process of preference aggregation occurring at the initial stage of diffusion is a critical determinant of the final success of a new technology (Granovetter 1978, Arthur 1989, Cabral 1990). In other words, the success of an emerging technology in the presence of externalities is influenced fundamentally by events occurring early in the diffusion process. Therefore, the ability to gain a critical mass of early adopters and the speed at which this task is accomplished (Katz and Shapiro 1986b) become crucial factors for a technology to diffuse successfully.

The presence of externalities has important implications on the supply side as well. Following a game theoretic approach, Katz and Shapiro (1985) examine the optimal strategies of new entrants with regards to compatibility. They show that private incentives to achieve compatibility are low when a firm has a large installed base and a strong reputation. In a not dissimilar manner, the same authors further explore this topic in a two-period game and industry evolution (1986a). By analyzing a duopoly market with homogenous consumers and where marginal costs are known, they study the compatibility decision as a function of the firm’s relative cost advantage and installed base. They find that the firm which holds the cost advantage in the first period, but is overtaken in the second period, always prefers compatibility, whereas the other firm which holds the cost advantage in the second period may or may not prefer compatibility.

Similarly Dhebar and Oren (1986) examine optimal pricing policy for a monopolist to follow for a technology characterized by network externalities. Their results suggest that an increasing, then decreasing price path should be followed in order to subsidize early adopters for the excessive costs due to incompatibility. The same recommendation emerges from Xie and Sirbu (1995). Their study examined the dynamic price behaviors of both a new entrant and an incumbent. They found
that an increasing and then decreasing price is the optimal price trajectory for a monopoly and oligopoly, when network externalities are strong.

**Network Externalities and Penetration Strategies**

Marketing scholars have investigated the role of marketing mix variables on the diffusion of innovation for some time (Robinson and Lakhani 1975). In particular, price has received a good deal of attention because of its critical role in influencing the demand for new products (Dolan and Jeuland 1981, Rao and Bass 1985, Jain and Rao 1990). However, less effort has been devoted to the analysis of how price can modify the diffusion of technology in the presence of network externalities (Dhebar and Oren 1986, Xie and Sirbu 1995).

In the presence of network externalities, time-to-take-off depends on how quickly the uncertainty among customers regarding the dominant design that will prevail is alleviated. Penetration strategies have a particular value in markets with network externalities. The ultimate objective is to reach consumers’ reservation prices sooner and, therefore, to accelerate adoption. Dhebar and Oren (1986) examine the dynamic non-linear pricing case in the presence of externalities. They argue that price incentives can be offered to initial adopters in order to attract a stream of future adopters, each of whom contributes to increase the externalities’ benefits and to induce additional adopters. Analytical models have also shown that an introductory price allows a new entrant to legitimize a new technology faster. For instance, Cabral, Salant and Woroch (1992) argue that the monopolist wants to set a price schedule such that a “medium valuation customer” prefers to adopt the new technology in the initial stage. More recently, Economides and Himmelberg (1995), in an empirical analysis of the fax market, show that rapid expansion of the network is associated with low then increasing prices, even when marginal costs are decreasing over time (Economides 1996).

Therefore, in the presence of network externalities we would expect that a low initial pricing policy would be adopted. We would also expect that the firm would commit other marketing resources to accelerate adoption. This is in line with the tenets of critical mass theory (Oliver, Maxwell and Teixera 1985; Markus 1987) that “interventions” to increase interest in the technology will increase the likelihood of “universal access” and the network externality benefits that result.
The higher the network externalities, the greater the likelihood of a penetration strategy to reduce time-to-take-off.

**Network Externalities and Product Compatibility Decisions**

Do network externalities predispose the firm to seek product compatibility for an emerging technology or to create a proprietary standard? The key issue is that of dominant design, which implies the acceptance of a specific architecture by consumers (Henderson and Clark 1990). Anderson and Tushman (1990) refer to a “period of ferment” for new technologies in which organizations compete to achieve a dominant design, both against the incumbent technology and against particular manifestations of the emerging technology.

The presence of externalities induces consumers to choose one or another technology based on their expectations about the network which will prevail. Uncertainty about the installed base may delay consumer’s adoption of an emerging technology and, therefore, take-off. Under these circumstances the probability that firms seek compatibility is high (Katz and Shapiro 1985, 1986a). In this vein, Esser and Leruth (1989) argue that a joint move among technology providers increases the probability of imposing a standard. In particular, when the unilateral enforcement of a dominant design is difficult, or when a standard battle would slow the rapid and successful diffusion of an emerging technology, the benefits of standard-setting alliances increase.

In markets not subject to network externalities, there will be less pressure to achieve a single design in order to accelerate take-off. In fact, consumers may prefer variety (Katz and Shapiro 1986a) and multiple standards may be possible. However, under network externalities the relative attractiveness of competing technologies to the consumer is affected both by prior sales and by expectations of future sales. In effect, according to Katz and Shapiro (1985), there are “demand-side economies of scales”.

When compatibility is achieved, competition is then redirected toward more conventional dimensions, such as price and marketing variables (Besen and Farrell 1994). In other words, by
pursuing compatibility, firms eliminate network rivalry, without, of course, eliminating other aspects of competition.

P2 The higher the network externalities, the greater the likelihood of product compatibility to reduce time-to-take-off.

Network Externalities and Preannouncement Decisions

Do network externalities encourage the firm to make product preannouncements in advance of market availability or to maintain secrecy? The literature suggests a positive relationship between network externalities and preannouncements (Farrell and Saloner 1986a). Our purpose now is to develop this point as related to time-to-take-off.

One dominant rationale for preannouncing is when faced with a large installed base of the previous technological solution. According to Farrell and Saloner (1986a), the installed base may constitute a barrier to entry. However, when there are significant network externalities, the timing of the announcement of a new incompatible product can crucially determine whether the new product supersedes the existing technology. This results from both a reduction in sales for the existing technology, if consumers decide to wait, and an increase in sales for the new technology due to pent-up demand.

Of course, other factors also influence the likely success of preannouncements, such as the credibility and level of commitment demonstrated by the preannouncing firm (Robertson, Eliashberg and Rymon 1995, Bayus, Jain and Rao 1997). Evidence of credibility, for example, might be whether the firm names a set of lead customers, which is a means to develop indirect externalities. The existing incumbent might also preannounce to protect the installed base, as Microsoft successfully did against IBM’s OS-2 operating system software. Ultimately, the consumer’s evaluation of credibility and commitment determines the success of competing announcements. Credible preannouncing can reduce customer uncertainty and facilitate demand coordination and more rapid take-off.
The higher the network externalities, the greater the likelihood of new product preannouncing to reduce time-to-take-off.

Network Externalities and Marketing Alliance Decisions

The necessity to acquire rapid market acceptance places a premium on immediate market access. This mitigates against the firm creating its own salesforce or against the use of its existing salesforce unless appropriate expertise exists. Under conditions of network externalities, these pressures are accentuated due to the need to create a dominant standard quickly.

Marketing alliances are the natural outcome of these pressures. The firm aligns with distribution partners to acquire complementary assets allowing rapid market coverage -- salesforce and marketing expertise. These partners may also be critical in achieving a total systems solution, if the new technology must fit as part of a broader solutions package for the customer. When the products within a system (such as a computer system consisting of CPU, software, printer, modem, etc.) are made by different vendors, not only might design alliances be necessary but marketing alliances might be needed to engage in a total system sale (Morris and Ferguson 1993). The interdependence of products in many technology systems means that the marketing strategy is often bound to the product’s role in conjunction with other products (Hakansson and Snehota 1989). The level of uncertainty surrounding an emerging technology also has important consequences on the willingness of the launching firm to commit to irreversible investments, such as creating a new distribution system when the existing one does not have the necessary expertise.

The higher the network externalities, the greater the likelihood of marketing alliances to reduce time-to-take-off.

Appropriability

The second technology-related factor that we consider (Figure 2) is appropriability. Appropriability refers to the attributes of an innovation that allow the firm to capture profits from its innovative activity. Teece (1986) suggests that low appropriability encompasses innovations which are difficult to protect because they can be easily codified and/or legal protection mechanisms are
ineffective. High appropriability includes innovations which are easy to protect because knowledge about them is tacit or they have legal protection.

The most obvious basis of appropriability would seem to be patents. However, the relevance of patents varies considerably for different technological domains. Taylor and Silberston (1973), for example, documented the “strong and pervasive influence” of patents in pharmaceuticals and specialty chemicals but not in basic chemicals, oil refining, or electronics. Mansfield (1986) found the pharmaceutical industry to rely most on patents, whereas industries such as instruments and office equipment attached little significance to patents. The variation in the value of patents as a form of appropriability, according to Geroski (1995), is a function of three factors: (1) the ability of imitators to “invent around” a patent, (2) the ease of actually delineating a patent, and (3) the fact that patent filings can actually disclose enough information to allow imitators to develop variants. Geroski concludes that these limitations apply more to process than to product innovations.

If patents are not always a means of providing appropriability, what other means are available to the firm? The distinction drawn in the marketing literature (Kotabe, Sahay and Aulakh 1996) is between appropriability regimes based on the legal enforcement system versus regimes based on learning curve, lead time and the independent ability of other firms to develop a similar technology concurrently. This definition builds on work by Levin et al., (1987) who studied methods of appropriating the benefits of innovation across a cross-section of R&D executives. Results indicate that first mover advantage, learning curve advantage, and superior sales or service are more important than patents in achieving appropriability benefits. For process innovations, secrecy was also more important than patent protection. Only in pharmaceuticals and certain specialty chemicals did patents achieve prominence.

We now examine the impact of appropriability (however achieved) on the mix of strategic actions that the firm will pursue to accelerate time-to-take-off. We believe that appropriability will be a key variable influencing the firm’s behavior at the early stages of commercializing an emerging technology. We also recognize that in today’s “high technology” environment, with the exception
of pharmaceuticals and specialty chemicals, most appropriability advantage will be due to other factors, such as the ability to limit imitation based on scale and experience curve advantages.

**Appropriability and Penetration Strategies**

How does appropriability affect the likelihood of adopting a penetration versus a skimming strategy? Under conditions of high appropriability, the firm has the discretion of whether to pursue skimming or penetration. However, our expectation is that high appropriability is associated with a penetration strategy under the assumption that the firm’s objective is to minimize time-to-take-off. Skimming strategies may be preferable to maximize short-run profitability but they assume an absolute confidence in the appropriability regime and would seem to apply mainly for stand-alone products not subject to issues of standards and network externalities. Given that it is not our intent to specify interactions, we will pursue only the dominant conclusion that strong appropriability favors penetration.

The logic for this relationship is that a penetration strategy requires protection from rapid competitive imitation. Under high appropriability the innovating firm can seize market initiative to accelerate customer acceptance without running the risks of new entrants eroding its potential returns. If appropriability is weak, the firm runs the risk that its investments in customer education and demand creation will be expropriated by other firms. By the same token if the firm under high appropriability conditions were to pursue a skimming strategy (high pricing, segmentation, limited marketing allocation), it would deplete its appropriation advantage over time and allow imitators to enter before it had moved down the demand elasticity curve to reach broader market segments. In effect, penetration or limit pricing strategies are most likely to discourage the expansion of potential rivals (Scherer and Ross 1990).

Under conditions of low appropriability, by contrast, the firm has little discretion to pursue a penetration strategy since its investments will not be protected. It runs the risk of the hazard of expropriation (Pisano 1990). Therefore, its most likely option is to pursue a skimming strategy to a limited niche within the market, to limit its investment, and to recognize that imitation is inevitable (Nascimento and Vanhonacker 1988).
Of course, the reader might observe that cause and effect could be in dispute in that penetration strategies might be used to create a level of appropriability based on lead time and learning curve advantages as documented in the Levin et al. (1987) study. That is, if patents can be imitated, then perhaps speed of entry is a potential advantage (Mansfield 1985). Nevertheless, we would argue that it is appropriability that drives the selection of strategy and not the reverse. Therefore, the general thesis is that a penetration strategy is the result of an appropriability consideration.

P5  The higher the appropriability of the technology, the greater the likelihood of a penetration strategy to reduce time-to-take-off.

**Appropriability and Product Compatibility Decisions**

The degree to which an emerging technology is protectable influences the firm’s propensity to make the technology compatible with an existing installed base. A strong appropriability regime allows the firm to enforce its technology (Teece 1988) and gives it the discretion of incompatibility. The selection of compatibility becomes more critical when it entails information disclosure which may place property rights at risk. For instance, Apple contended that the disclosure of the necessary information to release a compatible standard would have marred its property design (Economides and White 1994). Therefore, although considerations as to whether the firm actually pursues an incompatible standard depend on other factors, we argue that the incentive for compatibility is reduced in the presence of strong appropriability regimes (Besen and Farell 1994).

P6  The higher the appropriability of the technology, the less the likelihood of product compatibility to reduce time-to-take-off.

**Appropriability and Preannouncements Decisions**

New product preannouncing has the potential to accelerate time-to-take-off. A major risk, however, is in cueing competitors as to the firm’s future actions and giving competitors greater time to respond (Heil and Robertson 1991). The ability to signal (preannounce) suggests the concurrent ability to protect via barriers to entry. Appropriability constitutes a protection barrier
which gives the firm the ability to achieve preannouncement benefits without the risk of inducing competitive response in the short run.

The reverse logic is that secrecy (as opposed to preannouncement) may be the means of protecting the technology when appropriability is weak. Levin et al. (1987) found secrecy to be particularly important for process innovations, which as suggested, are less subject to patent protection. Hiding the innovation is the antithesis of public preannouncements.

P7 The higher the appropriability of the technology, the greater the likelihood of new product preannouncements to reduce time-to-take-off.

Appropriability and Marketing Alliances
In a strong appropriability regime, we have argued that the firm is likely to pursue a penetration strategy to minimize time-to-take-off. Strong appropriability also allows the firm to extract rent from other parties, which places the firm in an advantageous position to form marketing alliances. Given the objective to minimize time-to-take-off, therefore, the firm under high appropriability conditions will be likely to form marketing alliances to access a broad profile of markets. By contrast, under a weak appropriability regime, the firm has little to offer potential marketing partners. It may have the incentive to seek marketing alliances, but, in reality, it will have difficulty in agreeing such relationships.

P8 The higher the appropriability of the technology, the greater the likelihood of marketing alliances to reduce time-to-take-off.

INDUSTRY CHARACTERISTICS
The next set of characteristics affecting the firm’s strategic actions is at the level of the industry. Our specific focus is on two dimensions of market structure: industry concentration and level of incumbency. The former captures the level of concentration among firms in an industry, whereas
the latter captures the existence of an installed base and the effect on selection of strategies to accelerate time-to-take-off.

**Industry Concentration**

The number of competitors affects the level of expected cooperation and, hence, the level of competitive rivalry (Scherer and Ross 1990). Research in industrial organization, for example, suggests that rivalry tends to intensify as the number of competitors increases and as they become more equal in size and capability. Similarly, Moore and Moore (1990) show that rates of cooperation are lower the greater the number of subjects that participate in an interaction. From these arguments we can infer that the lower the level of industry concentration, the higher the level of competitive intensity.

Our interest is in examining the direct effect of industry concentration on strategy selection and, in particular, how the number of actual and potential players competing in the early stage of an emerging technology life cycle influences the manner in which market acceptance is pursued (Dolan, Jeuland and Muller 1986). Of course, industry concentration for emerging technologies is a somewhat nebulous concept. The rapid changes, including introduction of rival technologies, characterizing the early stage of an emerging technology life cycle may modify the industry structure. However, we contend that the release of a new technology is not necessarily associated with a complete redefinition of the industry profile.

**Industry Concentration and Penetration Strategies**

Under conditions of high competitive intensity, greater resource allocations and more aggressive pricing policies are likely to occur, thus encouraging rapid take-off (Brown 1981, Robertson and Gatignon 1986). Eliashberg and Jeuland (1986) have shown that prices decrease after a new entry and that demand increases as a result of price sensitivity.

Nevertheless, the diffusion modeling literature is not consistent in its recommendations concerning dynamic pricing strategies to foster rapid diffusion of new durables under different levels of industry concentration. Results vary with the specification of demand functions. For instance,
Robinson and Lakhani (1975) show that when the word-of-mouth effect is assumed to be the primary force driving new product acceptance, a penetration price is found to be the optimal strategy for the monopolist (see also Dolan and Jeuland 1981, Kalish 1983, Horsky 1990). A similar result was obtained by breaking down the process through which an innovation spreads into two components: a demand saturation effect (whereby demand decreases as cumulative demand increases) and a diffusion effect (whereby demand increases as cumulative demand increases) (Rao and Bass 1985). Whenever the demand saturation effect is dominant, a skimming price strategy is recommended; by contrast when the diffusion effect is dominant, a penetration price is suggested.

Results obtained in the oligopoly case have been shown not to differ from the monopoly case when the diffusion effect is dominant. However, the incumbent’s expectations on the timing of a rival’s entry have been shown to affect the “aggressiveness” of the penetration strategy (Eliashberg and Jeuland 1986). The lack of consistency of results and the lack of a strong conceptual argument cause us not to specify an expectation regarding industry concentration and the value of a penetration versus skimming strategy.

**Industry Concentration and Compatibility Decisions**

Incentives to achieve product compatibility decrease if the industry in which an emerging technology is introduced is characterized by a limited number of players. Each may seek to impose its own standard, hoping to reap the rewards of creating the industry’s dominant design. As the level of market concentration and the market power of each competitor increases, the probability that a firm is in the position to enforce its own standard and initiate a “bandwagon of innovation” increases (Axelrod et al. 1995). Hence, the incentives to engage in a “winner-takes-all” race are higher compared to the incentives to develop a standard-setting alliance or to manufacture products which are compatible to those of a rival.

In fragmented markets, by contrast, the need for coordination (e.g. through standard-setting alliances) is stronger, since the presence of various technologies may prevent or retard the
emergence of a “market generated” de facto standard (Farrell and Saloner 1986a). This, of course, increases a firm’s incentives to pursue compatibility.

P9 The greater the industry concentration (excluding monopoly), the less the likelihood of compatibility to reduce time-to-take off.

Industry Concentration and New Product Preannouncing

Industry concentration is also expected to influence the intensity of preannouncing for emerging technologies. When industry concentration is low, the risk of rivals’ reactions to a firm’s preannouncement is limited, since each competitor is too small to secure profitability by rapidly matching preannouncements. Thus, the firm may gain through preannouncing by allowing consumers to engage in advance planning for changeover.

In more concentrated markets competitors can monitor their rivals more carefully and they are in the position to react more quickly to their actions. This reduces the benefits and the incentives to preannounce. It should be noted that empirical research on reaction to entry has not found industry concentration to be a significant predictor of reaction intensity within oligopolistic markets (Robinson 1988a, Bowman and Gatignon 1995).

Nevertheless, as concentration becomes very high, competitors tend to react slowly and cautiously to new product introduction (Chen and MacMillan 1992), since they expect a new product to have a gradual impact on their shares. Thus, we anticipate that there are incentives to preannounce under high concentration given such low speed of reaction.

P10 Under conditions of moderate industry concentration, the less the likelihood of preannouncing to reduce time-to-take off.

Industry Concentration and Marketing Alliances

The lower the industry concentration, the lower the probability that a single player has the skills and the marketing resources necessary to rapidly penetrate the market for an emerging technology. This
increases the incentives to acquire complementary marketing assets externally which are necessary for the commercialization of an emerging technology (Teece, 1992).

P11 *The greater the industry concentration, the less the likelihood of marketing alliances to reduce time-to-take-off.*

**Level of Incumbency**

Industries in which an emerging technology is introduced are likely to be comprised of some range of new entrants (generally start-up firms rather than firms from other industries) and incumbents; i.e. firms that participated in the previous technology. For our purposes we will think of three ideal types of industry configuration for emerging technologies: (1) industries represented only by new entrants (2) those represented by a mix of incumbents and new entrants, and (3) those represented only by incumbents.

Incumbency captures the impact of the existence of an installed base on firms’ conduct to accelerate time-to-take-off. An installed base forms an entry barrier to firms considering the launch of an emerging technology due to a reduced customer ability to switch to a new technology (Gilbert 1989). Furthermore, an installed base does not necessarily correspond to the market share of each incumbent as more than one player can compete within the same technological specification (e.g. IBM compatible micro-processors). By abandoning a technology with an established installed base, a customer incurs the costs of converting, such as those arising from the need to unlearn how to use the previous technology and to learn how to use the new one (Dhebar 1995). In other words, customers have to sustain high switching costs due to their commitment to the previous technology (Klemperer 1987, Heide and Weiss 1995). It is our thesis that the level of incumbency characterizing the industry into which the emerging technology is launched is a key determinant of the strategic actions best taken by firms in that industry.

*Incumbency and Penetration Strategies*

The literature is unified in specifying the relationship between the installed base and the likelihood of aggressive pricing strategies for existing technology players. The dominance of incumbent firms
is often reflected in temporary price reductions for an existing technology to act as a barrier to entry against new entrants which try to introduce a new technology in the market (Farrell and Saloner 1986a). In this situation incumbents may deter future entry and, therefore, protect the revenue stream generated from the installed base. But problems may occur when incumbents with large installed bases are also competing in the emerging technology. Several studies have shown that in such a situation, incumbents’ investment efforts in the new technology will not be optimal, mainly due to inertia and the fear of cannibalizing their own revenue streams (Reinganum 1983, Ghemawat 1991).

P12 The higher the level of incumbency, the less the likelihood of a penetration strategy to reduce time-to-take-off.

Incumbency and Compatibility Decisions
When a new technology is launched in a market characterized by a high level of incumbency, the issue of compatibility versus previous standards becomes relevant. Incumbents generally will seek to promote standards compatible with their previous installed base and to increase the commitment to the status quo (Cooper and Schendel 1976). This generally leads to sub-optimal design of the new technology and it is unlikely to be a successful long-run strategy (Cooper and Schendel 1976, Tushman and Anderson 1986).

Conversely, when the industry contains primarily new entrants, firms tend, ceteris paribus, to choose incompatibility with their rivals, since they have high incentives to create their own installed base. Finally, when the industry consists of a mix of incumbents and new entrants, the propensity of the latter to opt for compatibility with dominant players as a way to reduce excess inertia will be moderated by their own ability to initiate a bandwagon of adoption (Besen and Farrell 1994).

P13 The higher the level of incumbency, the greater the likelihood of compatibility to reduce time-to-take-off.
**Incumbency and New Product Preannouncing**

Research by Eliashberg and Robertson (1988) has found that preannouncing behavior is positively related to a firm’s low market dominance and small size. They argue that this finding is related to the dominant firm’s fear of cannibalization of existing revenue streams and to risk of potential antitrust actions for “predatory preannouncing”, that is, when preannouncing occurs prematurely to deter customers from purchasing competitive products or technologies which will be available sooner.

In the case of launching an emerging technology, preannouncing would seem to depend heavily on level of incumbency. The logic is straightforward. In an emerging technology characterized by new entrants, firms will be inclined to preannounce due to the lack of exposure to potential cannibalization and to the low risk of competitors’ reactions. On the contrary, in industries characterized by a high level of incumbency, firms will be reluctant to preannounce due to the risk of adversely affecting sales of the existing technology (Farrell and Saloner 1986a, Gatignon and Bansal 1987). Consumers may delay purchase in anticipation of the new product or, as Levinthal and Purohit (1989) have shown, consumers are willing to pay less for existing products due to their perceived loss of value because of impending obsolescence.

Incumbents will be reluctant to preannounce due to the fear of cannibalization, whereas new entrants will have high incentives to preannounce in order to reduce customers’ switching costs (Eliashberg and Robertson 1988). However, new entrants’ benefits from preannouncing will be moderated by the high probability that incumbents will match the signal, since this increases with a firm’s commitment to a product category (Robertson, Eliashberg and Rymon 1995).

P14 **The higher the level of incumbency, the less the likelihood of preannouncing to reduce time-to-take-off.**

**Incumbency and Marketing Alliances**

In industries characterized by a high level of incumbency, firms will be more inclined to develop internally the appropriate skills and expertise to market an emerging technology. The rationale for
this belief is based on a transaction cost argument. More specifically, we contend that a firm’s propensity to externally acquire vital assets to market an emerging technology is negatively related to its previous investments in the product category. This logic is supported by various studies in the context of channel integration (Anderson 1985), international distribution (Klein, Frazier and Roth 1990), and R&D alliance formation (Robertson and Gatignon 1997). Conversely, when the industry consists primarily of new entrants, the incentives to acquire co-specialized assets externally will dominate in order to penetrate the market rapidly.

P15 The higher the level of incumbency, the less the likelihood of marketing alliances to reduce time-to take-off.

Reputation

The concept of reputation refers to a firm’s behavior that is expected by other players and consumers in the market in incomplete information settings. The literature in economics and management views reputation as an asset that has a potential positive influence on future rents (Wilson 1985, Shapiro 1982) and which can provide a firm with a sustainable competitive advantage (Hunt and Morgan 1995). A firm’s reputation is a signal of the stance it is likely to take in the market. For instance, from a consumer’s standpoint, a firm’s reputation is a signal of its new product quality (Tirole 1991, Wernerfelt 1988). In particular, when product attributes are difficult to evaluate, as in the case of emerging technologies, the consumer’s past experience with a firm’s previously marketed product can be used as an indicator of new product quality (Shapiro, 1983). It should be noted, in accordance with this view, that a firm’s reputation might not necessarily be related to market power. In the same vein, in the consumer behavior literature, reputation is treated as a component of source credibility (Goldberg and Hartwick 1990) where an advertiser’s reputation relates to the perceived truthfulness of its advertising.

Firm reputation also has been treated as an indicator of a firm’s market commitment and its willingness to defend. For this reason reputation-building behavior is strategically important (Weigelt and Camerer 1988) and has been discussed in the literature in conjunction with entry deterrence (see for example, Scherer and Ross 1990, Milgrom and Roberts 1982, Weigelt and
However, in this study, we focus our attention on how a firm’s reputational stock influences its strategy instead of looking at reputation-building behavior. Accordingly, in the case of a firm launching an emerging technology, reputation can be seen as the present effect of its previous conduct in the product category or in related product categories. The level of reputation acquired in different product categories is particularly relevant when firms launching emerging technologies come from a range of industries and converge to form a new industry (e.g., telecommunications, computing, media and entertainment that are competing in the multimedia industry). If a firm has a “good” reputation, it is able to capitalize on this asset and it will be able to influence positively the expectations of potential users (Shapiro 1983).

Reputation and Penetration Strategies
Emerging technologies, characterized by high market uncertainty, may be subject to reputational effects of the supplier. In economics, earlier work has shown that reputation at the brand level works as a mechanism for ensuring quality to the consumer (Hayek 1948). Similarly reputation will also influence consumers’ expectations about new technologies and, therefore, affect their quality perception (Nelson 1970, Margulies 1977, Shapiro 1982, 1983). Hence, if there are uncertainties about the emerging technology’s quality or performance, a good reputation mitigates those uncertainties and may foster a faster take-off (Montgomery 1975, Robertson and Gatignon 1986).

All other things being equal, therefore, the high reputation firm has less incentive to engage in a penetration strategy. It can borrow from its reputational stock to encourage initial adoption and will be less inclined to engage in aggressive pricing or to make substantial resource commitments in marketing.

P16 The higher a firm’s reputation, the less the likelihood of penetration strategies to reduce time-to-take-off.

Reputation and Compatibility Decisions
Reputation will mitigate the firm’s desire for product compatibility. The firm will rely on its reputation to enforce its own standard unilaterally, under the logic that consumers will use the
reputational factor as a cue for a dominant design. This is consistent with the analytical model of Katz and Shapiro (1985), who found that high reputation firms tend to be against compatibility, whereas low reputation firms favor compatibility.

P17  The higher a firm’s reputation, the less the likelihood of compatibility to reduce time-to-take-off.

Reputation and Preannouncing
Preannouncing ameliorates information asymmetries between the firm and its customers by conveying information about the forthcoming technology. The primary purpose is to signal the technology’s quality characteristics so that the customer makes an adoption decision in favor of the preannounced product. Signaling prior to launch is important since verification of quality is impossible for experience goods (Nelson 1970). It is, however, not always straightforward for the customer to judge the credibility of the signal sender. This is where reputation can significantly enhance the effectiveness of a preannouncing strategy as reputation is an important source of credibility, which in turn determines communication effectiveness (Hovland, Janis and Kelly 1953, McGinnies 1973, Sternthal et al. 1978).

From the preceding discussion we conclude that announcements of the impending introduction of an emerging technology may be more effectively issued by a firm with a strong reputation, since customers use reputation as an estimate of private information that cannot be obtained normally (Goldberg and Hartwick 1990, Robertson, Eliashberg and Rymon 1995). In other words, high reputation firms are more credible signal senders (Heil and Robertson 1991, Brockhoff and Rao 1993). This increases the probability of success for the preannouncement and the incentives for reputable firms to preannounce.

P18  The higher a firm’s reputation, the greater the likelihood of new product preannouncing to reduce time-to-take-off.
Reputation and Marketing Alliances

As Chu and Chu (1994) indicate, unknown start-ups can rarely make effective use of tools that the theoretical literature has shown to increase customer perception of product quality (i.e. advertising, brand names and warranties) and it may seek the reputation umbrella of a well established competitor. Our argument is that the lower the level of a firm’s reputation, the lower its ability to signal quality and technological superioriy. Under these circumstances, manufacturers of emerging technologies may decide to acquire complementary assets including reputation (Teece 1992) by commercializing their product through existing and reputable partners.

P19 The lower a firm’s reputation, the greater the likelihood of marketing alliances to reduce time-to-take-off.

Order of Entry

The reader will be familiar with the rich literature within marketing, economics and strategy regarding order of entry effects. The general proposition emanating from research in economics is that first movers will have lasting advantages (Bain 1956, Bond and Lean 1977, Schmalensee 1982). This has been confirmed in a number of marketing studies (Robinson and Fornell 1985, Urban et al. 1986, Robinson 1988b), and the mechanisms whereby pioneer advantage is derived have been explored. However, results are not unequivocable (Moore, Boulding and Goodstein 1991). In particular, it has been argued that first movers tend to have higher returns but their order of entry is also related to higher risk of failure (Kalyanaram and Urban 1992). Indeed, first mover advantages have been shown to be subject to a number of limitations and potential biases (Kerin, Varadarajan and Peterson 1992).

As related to emerging technology, it may be that early entrance is less important, since the prospect of market share advantage for a first entry is moderated by the high level of uncertainty of market acceptance (Kalyanaram and Urban 1992). By contrast, while acting in a less uncertain market, later entrants can take strategic actions to reduce the market share penalty due to their delayed entry. In their historical analysis of the cement, glass and minicomputer industries, Anderson and Tushman (1990) found that the pioneering technology was never dominant.
Relatedly, Kerin, Varadarajan and Peterson (1992) suggest that pioneer advantage is moderated by the nature of the product and the market and they conclude pioneer advantage is most pronounced in markets which remain stable for an extended period.

In this study, we treat the entry decision as exogenous and we contend that order of entry can help to explain a firm’s launch strategy for an emerging technology.

**Order of Entry and Penetration Strategy**

The first mover to an emerging technology will have the option of skimming vs penetration as influenced by factors already specified, such as externalities and appropriability. However, theoretical (Schmalensee 1982) and empirical research suggests that pioneers tend to charge higher rather than lower prices (Robinson and Fornell 1985, Robinson 1988b, Lambkin 1988). This might be due to a combination of lower price sensitivity levels among consumer innovators and the initial power of the first mover. On the contrary, later entrants may seek differentiation from the pioneer as their entry strategy but are quite likely to pursue a penetration price strategy backed by intense advertising expenditures (Urban et al 1986, Lilien and Yoon 1990). The basis for this is that the later entrant may gain advantage from lower imitation costs, free-rider effects, scope economies, and benefits by learning from the pioneer’s mistakes (Lieberman and Montgomery 1988, Kerin, Varadarajan and Peterson 1992). The more prevalent pattern as industries evolve is that most later entrants tend to enter based on a penetration strategy. This result is consistent with evidence shown in the Lambkin (1988) study.

P20  *The later a firm’s entry, the greater the likelihood of a penetration strategy to reduce time-to-take-off.*

**Order of Entry and Compatibility Decisions**

The first mover will have a tendency to seek market pioneer advantages and to ignore product compatibility. By influencing the way new product category attributes are formed, the pioneer tends to become associated with a product category (Carpenter and Nakamoto 1989) This suggests that the first mover will be more inclined to pursue the advantages deriving from its leading position rather than to try to achieve compatibility with actual and potential new entrants.
By contrast, later entrants will tend to take advantage of the reduced market uncertainty and, therefore, to accept the emerging dominant design. In order to seek advantage, they will attempt to compete on alternative dimensions, especially price or positioning (Lieberman and Montgomery 1988).

P21 The earlier a firm’s entry, the less the likelihood of compatibility to reduce time to-take-off.

Order of Entry and New Product Preannouncing
First movers may or may not preannounce based on their assessment of competitive cueing risks compared to switching and learning cost reductions (Eliashberg and Robertson 1988). For later entrants, however, there will be a strong tendency to preannounce in order to freeze consumer demand until the late entrant is represented on the market (Porter 1980). This has been demonstrated recently in the software industry and “vaporware” has become a common phenomenon -- new products that are announced yet whose very existence is questionable, or at least, questionable in the time frame suggested by the preannouncement.

P22 The later a firm’s entry, the greater the likelihood of preannouncing to reduce time-to-take-off.

Order of Entry and Marketing Alliances
Finally, later entrants will be more open to alliances in order to expedite market entry. As alluded to earlier, later entrants are faced with a lower degree of uncertainty, which facilitates the formation of marketing alliances since the transaction costs to specify, monitor and enforce a workable contract reduce when the uncertainty concerning market acceptance and market growth decreases (Balakrishnan and Wernerfelt 1986, Klein, Frazier and Roth 1990). Empirical evidence supports this hypothesis that later entrants externally acquire the resources necessary to enter and quickly gain market share (Robinson, Fornell and Sullivan 1992). For instance, Glaxo utilized a great number of marketing alliances as it introduced Zantac as a late entrant to Smith-Kline’s Tagamet in the anti-ulcer market.
The later a firm’s entry, the greater the likelihood of marketing alliances to reduce time-to take-off.

Management and Researcher Implications

The conceptualization suggested has its focus on a set of strategic actions that the firm can undertake to achieve faster take-off. Our interest has been in emerging technologies, thought of as a product category that is low on technological uncertainty but high on market uncertainty. Furthermore, unlike most research and theory in diffusion, we are concerned only with the component of the diffusion curve before take-off occurs.

Managers in emerging technologies face an interesting challenge in managing both type 1 and type 2 errors. They run the risk of investing prematurely in technologies and not receiving a reasonable return on their investment. But they also run the risk of being left behind if they underinvest in a technology that takes-off rapidly.

Emerging technologies span a considerable range of take-off times. Although the average is 10 to 12 years (Lehmann 1994, Tellis 1994), there is considerable variation. The Sony Walkman is considered to have achieved take-off within one year, whereas other technologies, such as ATMs and VCRs appear to have taken a full decade or more. In many cases the initial application is also not the application which eventually finds market success (Moore 1994).

There could be arguments that slower take-off is advantageous for the firm -- less up-front investment, less risk of product problems etc. The position of the monopolist might also favor retarding conversion to the new technology in favor of the earning’s stream for the existing installed base. Nevertheless, most managers seem to favor rapid acceleration in order to achieve a quicker return on investment, to achieve experience curve effects, to build share and reputation, and to block competitors (Robertson 1993). Thus, our purpose has been to discuss strategies for accelerating take-off and we recognize our pro-innovation bias. However, opportunity windows for
technology may open and close quickly thus necessitating a focus on rapid acceleration (Abell 1978).

The paper has suggested that take-off time can be reduced if industry participants pursue a composite of strategic actions. These are: (1) to pursue a penetration strategy, (2) to achieve product compatibility, (3) to preannounce new products, and (4) to engage in alliances. These strategies are instrumental at the customer level in reducing learning requirements, reducing switching costs, and enhancing the technology’s relative advantage, which encourages more rapid adoption.

Although managers may recognize the logic of these strategies and their effect on adoption behavior, their value and their particular effect is a function of a number of factors. In particular, the appropriateness of these strategies to accelerate adoption depends on the characteristics of the technology, the industry, and the firm itself. We have generated a set of hypotheses as summarized in Table 2 which probes the likelihood of the firm pursuing a particular strategy dependent on each characteristic.

In summary form, we would suggest that the manager should consider the following strategies under the following conditions:

- **Penetration strategy** (vs a skimming strategy) under conditions of high network externalities, high appropriability, a low level of industry incumbency, low firm reputation, and late market entry.

- **Product compatibility** under conditions of high network externalities, low appropriability, low industry concentration, a high level (but not moderate) of industry incumbency, low firm reputation, and late market entry.

- **Preannouncements** of technology under conditions of high network externalities, high appropriability, low and high (but not moderate) industry concentration, low level of industry incumbency, high firm reputation, and late market entry.
• **Marketing alliances** under conditions of high network externalities, high appropriability, low industry concentration, low level of industry incumbency, low firm reputation, and late market entry.

The reader will be aware that there are many limitations to these suggestions. In particular, the empirical base to support these propositions is not always extensive and much of the literature is based on game theory or is based on limited data sets. Additionally, we are not exploring interactions in this conceptual paper in order to make the task manageable. Interactions should be built-in to any research design to test these propositions empirically. Furthermore, we are dealing with a limited set of variables and may have omitted other important variables.

Researchers may find the propositional inventory to be a useful research agenda. Significant contribution could be made to the marketing literature by focusing on emerging technologies, since they represent an important management topic which has been underrepresented in empirical research within our field. In particular, research focused on time-to-take-off could contribute to both the behavioral and modeling literatures on diffusion. This is a rich research topic and may require innovative empirical approaches because of the difficulties of conducting research before actual market data exist and market acceptance has not been achieved.
### Table 1

**CONCEPTUAL AND OPERATIONAL DEFINITIONS OF KEY VARIABLES**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conceptual Definition</th>
<th>Operational Definition</th>
<th>Relevant Literature</th>
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<tbody>
<tr>
<td><strong>TIME-TO-TAKE-OFF</strong></td>
<td>Diffusion phase from introduction to growth.</td>
<td>The point at which the acceleration of sales growth reaches a maximum.</td>
<td>Rogers 1995; Muller, Mahajan and Srivastava 1990; Tellis 1994.</td>
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<tr>
<td><strong>STRATEGIC ACTIONS</strong></td>
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<tr>
<td>Penetration Strategy</td>
<td>An aggressive pricing, promotion and distribution strategy to achieve rapid market acceptance.</td>
<td>Price and marketing expenditure levels relative to similar technologies at market introduction.</td>
<td>Bain 1956; Robinson and Lakhan 1975; Dolan and Jesland 1981; Kalish 1988; Horsky 1990.</td>
</tr>
<tr>
<td>Preamnouncing</td>
<td>An announcement or move that precedes an actual new product introduction.</td>
<td>Formal deliberate communications in advance of when the product or service is actually introduced or test marketed (Robertson and Eliashberg, 1988).</td>
<td>Robertson and Eliashberg 1988; Robertson, Eliashberg and Rymon 1995.</td>
</tr>
<tr>
<td><strong>TECHNOLOGY CHARACTERISTICS</strong></td>
<td></td>
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<tr>
<td>Network Externalities</td>
<td>The utility that a given user derives from a good depends upon the number of other users who are in the same “network.”</td>
<td>The additional premium that consumers are willing to pay to have a product compatible to an existing installed base (Gandal 1993).</td>
<td>Katz and Shapiro 1985, 1986a, 1986b; Farrell and Saloner 1985, 1986a, 1986b; Choi 1994.</td>
</tr>
<tr>
<td>Appropriability</td>
<td>The attributes of the innovation that allow the firm to capture profits from innovative activity.</td>
<td>The firm’s ability to protect its innovation because knowledge is tacit or legal protection exists (Teece 1986).</td>
<td>Teece 1988; Geroki 1995; Kotabe, Sahay and Aulakh 1996; Anderson and Coughlan 1987; Robertson, Eliashberg and Rymon 1995.</td>
</tr>
<tr>
<td><strong>INDUSTRY CHARACTERISTICS</strong></td>
<td></td>
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<tr>
<td>Industry Concentration</td>
<td>Industry concentration reflects the number and the size of the firms operating in an industry.</td>
<td>Concentration ratios (e.g. market share of the three largest competitors in the market, Bowman and Gatignon 1995); Herfindahl-Hirschman Index (Scherer and Ross 1990).</td>
<td>Scherer and Ross 1990; Bowman and Gatignon 1995; Robinson 1988a.</td>
</tr>
<tr>
<td>Level of Incumbency</td>
<td>Level of incumbency reflects the proportion of firms deriving a rent from their own experience in the industry and their installed base.</td>
<td>Extent to which firms participating in a new technology also participated in the previous technology.</td>
<td>Gilbert 1989; Brynjolfsson and Kemerer 1996.</td>
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<tr>
<td><strong>FIRM CHARACTERISTICS</strong></td>
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<tr>
<td>Reputation</td>
<td>An asset that has a potentially positive influence on future rents.</td>
<td>Reputations is measured by quality chosen by a firm in t-1. (Tirole, 1991).</td>
<td>Shapiro 1993; Robertson and Gatignon 1986; Wernerfelt 1988; Goldberg and Hartwick 1990.</td>
</tr>
</tbody>
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Table 2

THE PROPOSITIONAL INVENTORY

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<tr>
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<th>Likelihood of Strategic Action</th>
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<tr>
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<td>CHARACTERISTICS</td>
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<tr>
<td>• Network Externalities</td>
<td>+ (P1)</td>
</tr>
<tr>
<td>• Appropriability</td>
<td>+ (P5)</td>
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<td>CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td>• Industry Concentration</td>
<td>*</td>
</tr>
<tr>
<td>• Level of Incumbency</td>
<td>- (P12)</td>
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<tr>
<td>FIRM</td>
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<td>CHARACTERISTICS</td>
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<tr>
<td>• Reputation</td>
<td>- (P16)</td>
</tr>
<tr>
<td>• Order of Entry</td>
<td>- (P20)</td>
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</table>

* No proposition proposed
** Under high and low (but not moderate) conditions.
FIGURE 1
EXAMPLES OF TIME-TO-TAKE-OFF

Fax machine, U.S.

Cellular phone, U.S.

Source: Economides and Himmelberg 1995
FIGURE 2
CONCEPTUAL MODEL OF TIME-TO-TAKE-OFF

Strategic Actions
- Penetration strategy
- Compatibility
- Preannouncing
- Marketing Alliances

Technology Characteristics
- Network Externalities
- Appropriability

Industry Characteristics
- Industry concentration
- Level of incumbency

Firm Characteristics
- Reputation
- Order of entry

Adoption hurdle

Time to take-off
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