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Bringing new high-technology products to market: Six perils awaiting marketers

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Abstract In fewer than ten days during the summer of 2016, millions of smartphone users around the world went crazy over Pokémon Go, an augmented reality videogame app. If only all new high-technology products—and their investors—could enjoy such runaway success! Alas, the road to new technologies can be bumpy, and marketers of new high-tech products face numerous obstacles. Six perils await these marketers: significant market uncertainty, significant technological uncertainty, issues of compatibility within a product's complex multi-component system, struggles to orchestrate self-reinforcing network effects, challenges of navigating ecosystem complexities and competition, and inherent risks of making hard choices among multiple product-market options with significant path dependency. This article discusses these dangers and concludes with advice regarding steps marketers can and should take to make the journey to market less perilous.

1. New technology's unsure path in the marketplace

Featuring high contrast and low power consumption, electronic ink-based displays are used in mainstream products such as e-readers, mobile phones, and watches. Electronic ink's commercial fate seems secure—that is, until some other new technology comes along.

Electronic ink's fate was anything but secure in 1997 when E Ink pioneered the then-brand new technology. Even in 2005, a good eight years after E Ink's founding, the outlook for electronic ink was grim. A contemporary Harvard Business School case characterized the company as beset by "numerous false starts" and flirtation with various approaches (Yoffie & Mack, 2005, p. 1). I thought of electronic ink's early days when reading a recent article titled "The Bumpy Road to New Technology" (Plambeck, 2016):

> The hype of a new technology is outpacing commercial success. Sound familiar?
>
> These days, interest in artificial intelligence has probably never been higher. The biggest companies are chasing it and venture money is flowing toward it. The same could be said for

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> a couple of other technologies: virtual reality and self-driving cars.
>
> In all three cases, the road to widespread commercial success appears longer than [just] around the corner, despite the interest. So it goes with the technology industry.

Joseph Plambeck is spot on, both in his choice of the story's title and the claim, "So it goes with the technology industry." The road to new technologies is bumpy, and marketers responsible for bringing shiny new tech to market have a tough row to hoe.

An early look at why bringing new technologies to market is so difficult captured the essence of the answer in one equation (Moriarty & Kosnik, 1989, p. 8): "High Tech = High Uncertainty about Technology and the Market." Moriarty and Kosnik (1989, p. 8) defined *market uncertainty* as "ambiguity about the type and extent of customer needs that can be satisfied," and *technological uncertainty* as "not knowing whether the technology—or the company providing it—can deliver on its promise to meet needs, once they have been articulated."

To better elaborate why new high-tech products' road to market is bumpy and which perils await their marketers, this article expands in three ways on the aforementioned explanation of "high uncertainty about technology and the market." First, it offers more complete characterizations of both market and technological uncertainties. Second, it introduces four additional challenges. Third, and finally, it concludes with some advice to marketers of new high-tech products as they contend with the six perils that await them.

2. Significant market uncertainty

Moriarty and Kosnik (1989) equated 'market' with demand parties, but no market is complete without two additional components: (1) supply parties, and (2) the formal and informal rules/regulations governing how demand and supply parties meet and agree on, execute, and settle transactions. New technologies often are accompanied by significant uncertainty in each of these three facets of a market.

2.1. Uncertainty in market demand

I never cease to be amazed by the exact market-size forecasts that are offered for new technologies five, ten, and fifteen or more years into the future. *Transparency Market Research* ("Artificial intelligence," 2016) provided a case in point with its headline: "artificial intelligence market to reach US $3,051.35 billion by 2024. . . [driven by] deployment of disruptive technologies." The basis for this estimate? The 2015 global artificial intelligence market of $126.24 billion is expected to expand at a compound annual growth rate of 36.1%. While the forecast is qualified by appropriate words and measures of caution, the projected growth rate of 36.1% is very exact. . . and very iffy, especially when one considers the alleged motivator of the forecasted growth: deployment in disruptive technologies. If there is one thing we know about disruptive technologies, it is that there are no certainties when it comes to their rollout in the marketplace and adoption in society. We are left to wonder: Why aren't market-size forecasts for revolutionary technologies always accompanied by statements or measures of standard deviation?

Admittedly, there are at least two ways to forecast future demand for a new technology: (1) take some existing market with a known measure of demand (e.g., number of customers, units consumed, dollars in revenue), estimate an annual growth rate, and apply the rule of compounding; and (2) recognize that the post-new technology market may be very different from today's market, develop different scenarios for the markets in the future, and size demand by working bottom-up from a fundamental understanding of the drivers of demand. In a world where even "Silicon Valley veterans argue that people routinely overestimate what can be done with new technology in three years, yet underestimate what can be done in 10 years" (Plambeck, 2016), my word of caution for new-technology marketers is to beware of the first approach and dive into the second.

Doing so will not be easy. Any sizing of future demand in terms of sale dollars must necessarily be a product of at least two numbers: price and quantity. The marketer will choose price at some future point of time given his/her objectives, the prevalent market context, and any operating constraints. As for the quantity, it will be a function of the price and the distribution of willingness to pay among a heterogeneous population. The distribution is not static but dynamic as the marketer adopts different marketing strategies and tactics, the technology diffuses in the marketplace, new problem solutions appear on the horizon, and the world changes.

Moriarty and Kosnik (1989) identified five sources of demand/market uncertainty: (1) What needs might be met by the new technology? (2) How will needs change in the future? (3) Will the market adopt industry standards? (4) How fast will the innovation spread? (5) How large is the potential market? These five sources of uncertainty are not independent of each other. There is a logical structure linking heterogeneous customer needs to some aggregate measure of demand, and marketers of new high-tech products would be well served to work through this logic and be mindful of the uncertainties that manifest at each stage. In particular, new technologies often are accompanied by significant uncertainties concerning:

- Customer problem(s) that the technologies and derivative products may solve, and how this translates into customer needs;
- How customer needs may map into wants and preferences, especially given the possible influence of marketing decisions and actions;
- Demand segmentation, given the likely heterogeneity in a customer population in terms of needs, wants, and preferences;
- The relevant attribute set included in the product meant to address the needs, wants, and preferences of customers in any one segment;
- Tradeoffs that customers in any given segment may be willing to make between different attributes and the specific levels of each attribute;
- Customer willingness to pay given any one customer segment and attribute configuration;
- The quantity demanded given the marketer's choice of pricing;
- The evolution over time of all of the above, given the dynamics of social adoption of the new technology, the evolution of the technology itself, and marketing decisions and actions of the marketer.

2.2. Uncertainty in market supply

Next, let us turn to supply parties: competitors, substitutors, and complementors.[1] In the supply sphere, too, marketers must contend with significant uncertainties.

2.2.1. Competitors

For the known set of competitors, the nature and economics of—and the business model associated with—technology and product development, supply chains, manufacturing and operations, and/or distribution may be uncertain. In addition, there may be uncertainty about the different competitors' strategies and tactics with respect to technology, product-market scope, marketing decisions, and market moves. Finally, the competitive game itself may be unpredictable.

2.2.2. Substitutors

The major competition that faces new technologies often arises not from traditional competitors, but rather unknown substitutors crashing in from left field. In this context, Radio Corporation of America (RCA) leader and 'father of broadcasting' David Sarnoff's words are as relevant now as they were when he first spoke them in 1929 (Lewis, 1991, p. 261):

> While the sylvan mouse-trap maker is waiting for customers, and his energetic competitor is out on the main road, a third man will come along with a virulent poison which is death on mice and there will be no longer any demand for mouse-traps.

Sarnoff's 'third man' may come from a completely different industry and with totally different mental, business, and operating models. Unknown, unexpected, and different, the substitutor can be a source of great supply uncertainty.

2.2.3. Complementors

Many high-tech products are used along with one or more complementary products. Suppliers of the complements (i.e., complementors) add their own drama to the already-rich supply-side uncertainty. Like competitors and substitutors, complementors are independent players with interests of their own, and many of the uncertainties alluded to in reference to competitors and substitutors can also apply to complementors.

Additional uncertainty is introduced by the possibility that complementors may offer complementary products for other multi-component systems, some of which may compete to solve the same customer problem. For example, even early on, Apple iPads were viewed by some as potential substitutes for notebook computers. A critical determinant of substitutability was Microsoft's Office suite of applications for word processing, spreadsheet analysis, and presentation creation; in this regard, Microsoft was—and still is—Apple's complementor. But, as often happens in the technology space, the relationship between Apple and Microsoft is not merely that of complementors; they also are competitors in operating systems (OSs) for computing and mobile devices, and in productivity software (Apple has its own Pages, Numbers, and Keynote to compete with Word, Excel, and PowerPoint). Given the multiplicity of roles, one would need to be remarkably prescient to predict with certainty

[1] Note: 'supply' is used here to refer to alternatives available to solve the customer's problem, not the traditional construct of the upstream supply chain.

Microsoft's moves with respect to Microsoft Office applications for the iPad.

2.3. Uncertainty in market rules and regulations

Finally, markets are also characterized by the formal and informal rules, regulations, and mechanisms that help or hinder the demand and supply parties meeting each other. For instance, there is significant regulatory and policy-making uncertainty regarding—among others—solar energy, driverless cars, digital currency, labor-displacing artificial intelligence, and robotics. What will be encouraged or discouraged, and how? What incentives or consequences may there be, and under whose auspices? While market forces often determine how demand and supply uncertainties play out, uncertainties in the regulatory and rule-making environment are often borne out on the political stage, and a regulator's decision can with the stroke of a pen upend much hard work in the marketplace.

A good example of this is solar energy and the part regulators play in determining its fate. One company trying to push solar energy in the U.S. is SolarCity, established in 2006 by Tesla founder Elon Musk and two of his cousins. Operating in over a dozen states, SolarCity designs, installs, and leases rooftop solar panels, and uses a revenue model relying on government subsidies and net metering whereby unused solar energy is sold back to the electric grid. Noah Buhayar (2016) described SolarCity's tussle with traditional, fossil fuel-based utilities in the state of Nevada as a particularly political struggle:

> Like more than 40 other U.S. states, Nevada forces utilities to buy the excess energy at rates set by regulators—usually the same rate utilities charge (hence, the net in net metering). In Nevada, it's worked well. So well, in fact, that NV Energy, the state's largest utility, is fighting it with everything it's got.
>
> First, NV Energy deployed its lobbyists to limit the total amount of energy homeowners and small businesses were allowed to generate to 3 percent of peak capacity for all utilities. Then it expertly argued its case before regulators, who rewrote the rules for net-metering customers. In December [2015] it scored a major win: Nevada's Public Utilities Commission (PUC) imposed rules that not only make it more expensive to go solar, but also make it uneconomical for those who've already signed up.

SolarCity is not Elon Musk's only challenge in terms of regulatory uncertainty. Musk's other, more commonly known venture is Tesla, a maker of electric and—since October 2015—autopilot-mode cars. In May 2016 in central Florida, a Tesla autopilot-mode car was involved in a fatal accident. The accident was still under federal regulatory investigation at the time of this writing; suffice it to say the event introduces a significant dimension of market regulatory uncertainty in relation to Tesla cars in particular and self-driving cars in general.

3. Significant technological uncertainty

A second reason why the road to market is bumpy for new high-tech products is significant technological uncertainty. Moriarty and Kosnik (1989) detailed five sources of technological uncertainty: (1) Will the product perform as promised? (2) Will the delivery timetable be met? (3) Will the vendor give high-quality service? (4) Will there be side effects of the product or service? (5) Will new technology make ours obsolete?

These five points are really consequences for customers or the marketer, more than sources of uncertainty surrounding the actual technology being brought to market. We should consider technological uncertainty from the perspective of technology and not the consumer or marketer. In that vein, a major reason for uncertainty is technological newness; any new technology is still in its evolutionary phase, and often ambiguity exists concerning how the technology evolution may play out and along which dimensions. Conceptualizing technology evolution as a trajectory with time along the horizontal axis enables us to formulate an interesting set of questions and identify major sources of uncertainty: What technology-performance variable does the vertical axis represent? Can performance be measured or must it be qualitatively characterized? How is the axis scaled? Is there only one vertical axis representing one technology performance measure or are there several vertical axes representing several technology-performance characterizations?

In addition to great uncertainty regarding dimensionality of the space over which technological trajectory may be charted, significant uncertainty may exist regarding slope of the trajectory's multi-dimensional surface[2], and fundamental discontinuities and points of inflection in the trajectory. Hydrogen fuel cell technology, which could perhaps power the zero-emission car of the future, is an

[2] If there is only one relevant dimension of technology performance, the surface will be a curve.

example of technological uncertainty. While the hydrogen fuel cell itself is not new—indeed, it has been used in spacecraft, submarines, boats, forklifts, motorcycles, and bicycles, and has even been tested for airplanes—it is only now being brought to market to fuel everyday cars. The road to market for hydrogen fuel cell cars is anything but fully paved and mapped, for a number of reasons—one being that the technology is still evolving. In particular, there is significant uncertainty in its practical implementation in terms of form factor, performance level, cost, manufacturing scale, and acceptable driving risk. Furthermore, the technology's evolution along these and other dimensions is likely to be anything but smooth and gradual; if other technological evolutions are good predictors, there are bound to be incremental changes interrupted by significant breakthroughs. Substantial technological uncertainty will accompany any attempt to bring hydrogen fuel cells to market in cars.

Technological uncertainty is amplified multiplicatively when one considers that many high-technology products incorporate not one technology, but several elemental technologies—some or all of which may be accompanied by major technological uncertainty. Consider unmanned drone aircraft. Many technologies are incorporated in working drones, including a frame made of composite materials; motors to drive blade mechanisms; an electronic speed control; a flight controller; a battery; a power distributor; a GPS system to aid navigation; a thermal or simple digital camera for imaging; a remote-control application, possibly on a smartphone, to instruct the drone; and an OS to manage/translate remote commands into specific actions. Several of these elemental technologies are relatively new—especially in forms fit to use in a small, unmanned aircraft—and each may contribute to the overall technological uncertainty calculus of drone technology being brought to market.

Technological uncertainty may be compounded for two additional reasons. First, some of the elemental technologies (e.g., thermal imaging) may be used not only in drone aircraft but also in other products completely unrelated to drones, and these other uses may fundamentally impact the trajectories of the elemental technologies. Second, with the elemental technologies evolving in their own way and along different paths with different inflection points, the nature of this multi-technology cosmic dance is not one of choreography, but chaos.

As if significant market and technological uncertainty-related road bumps were not challenge enough for the marketer in bringing new high-tech products to market, four additional factors contribute obstacles of their own. It is to these that we turn in the following sections.

4. High-tech products and Alice's adventures playing croquet

In Lewis Carroll's (1971, p. 66) classic *Alice's Adventures in Wonderland*, Alice finds herself in the Queen's croquet-ground, trying to play on a surface that is all ridges and furrows. Flamingoes serve as the croquet mallets, hedgehogs as the balls, and the Queen's soldiers as arches:

> The chief difficulty Alice found at first was in managing her flamingo. . . when she had got its head down, and was going to begin again, it was very provoking to find that the hedgehog had unrolled itself. . . besides all this, there was generally a ridge or furrow in the way wherever she wanted to send the hedgehog to, and, as the doubled-up soldiers were always getting up and walking off to other parts of the ground, Alice soon came to the conclusion that it was a very difficult game indeed.

Consumers also can feel that new high-tech products are a "very difficult game indeed." Like Alice playing croquet with flamingoes as mallets, hedgehogs as balls, and the Queen's soldiers as arches, consumers typically use high-tech products not on a standalone basis but as part of a system comprising the user, the product, one or more complementary products, and, at times, databases. Consumers only derive value when all parts of the system interconnect with compatibility. Furthermore, many of the complementary products and databases are themselves technology-based, and—like Alice's live flamingoes, hedgehogs, and Queen's soldiers—these, too, are fluid components with evolution paths and intents of their own. Finally, shifting standards and regulatory regimes in the high-tech space can create a landscape filled with plenty of ridges and furrows.

For insight into possible product-user issues, consider the example of self-driving cars. A few accidents and one fatality notwithstanding, different automakers and technology giants seem intent on bringing driverless cars to the road. Let's assume that all the technology kinks will be worked out eventually. Questions still arise: What about the human drivers who had become proficient at driving, pre-driverless cars? How will their driving experience change? Will there be a steering wheel? Who will monitor the driving context, and how? With artificial intelligence in full swing, who—or what—will have the final say about the controls: the human driver or the software, with its pre-programmed learning algorithms and heuristics? There is no consensus on these issues.

Also of consideration is the interconnection between the product and its complement components. Apple's rumored plans for the iPhone are a case in point, specifically regarding the possibility that the next version of the device will have no headphone jack. Such a sudden alteration to the product-complement relationship potentially leaves users in the same position as Alice, whose flamingo mallet decides to crane its neck to the side as she strikes at a hedgehog.

Finally, the overall system in which the new high-technology product is used could include a special category of complementary products: databases that users may already have assembled or may need to assemble with significant investment of their time, care, and effort. In this vein, it would be a painful shock to users if, for reasons of technological change or enterprise strategy, the next version of Microsoft Office would not be able to read existing files.

Given the imperative for compatibility between products, users, complements, and/or databases, frustration with this frequent technological croquet game is not the user's fault. Left unattended, issues of compatibility within complex, multi-component systems can be an obstacle for new technologies.

5. Network effects

Many high-technology products exhibit network effects, wherein product-user benefits grow exponentially as the network of product users grows. Difficulty of achieving network effects is yet another reason why the road to new technology is difficult.

Network effects are a consequence of what economists call externalities. One way to understand the concept of externalities is by contrasting products that exhibit network effects against products that do not. Using a bottle of water as an example, a friend sitting next to me derives benefit from drinking the bottled water depending on her thirst. This scenario has no impact on me as long as my own thirst does not interfere. In other words, no externalities affect the benefits of the bottled water. In contrast, if I drive around in a noxious-fume-emitting car with the windows open while playing punk rock at full volume, externalities come into play. The externalities are negative in the case of noxious fumes, and—depending on the listener—may be positive or negative in the case of loud punk rock.

Certain externalities are positive and are related to the size and composition of the product user network. If, for instance, an app developer has just introduced a new messaging application for the iPhone and I am the first person to download this app, there are no immediate benefits to be enjoyed. The application itself may be well designed and a joy to use, even indisputably the best messaging app available. As good as the app may be, however, I derive no benefits from using it because there is no one else to whom I can send a message. If, though, my wife downloads the same app on her smartphone, this immediately sends my benefits into positive territory; my wife and I can message each other. The benefits go up as my children, my friends, my acquaintances, and even chatbot-exploiting vendors join. And benefits may increase further as the app developer offers versions not only for Apple's iOS but also for Google's Android OS. Now the network effects are in full swing.

In the immediately aforementioned example, when the network has only one node and there are no possible links, the consumer benefits are zero. When the number of nodes goes up from one to two, there is one possible link in the network and the consumer benefits are positive. Extending this logic, when there are three nodes in the network, there are three possible links; when there are four nodes in the network, there are six possible links; and so on. As the number of network nodes grows one node at a time, the number of possible links grows exponentially, as do the consumption benefits that network members can expect to derive from joining. What we have here is Metcalfe's Law (2011) in play. Attributed in 1980 to Robert Metcalfe in the context of the Ethernet and communications between devices such as telephones, fax machines, and networked 'dumb' terminals and intelligent computers, the law codifies the fact that the number of possible unique connections in an interconnected network of n nodes is $n*(n-1)/2$ (Gilder, 2002).

The messaging app example illustrates the case of a technology product exhibiting what Katz and Shapiro (1985) called *direct network effects*: a network member directly—and exponentially—benefits from the size and composition of the network. Then, there are *indirect network effects* (Katz & Shapiro, p. 424):

> An agent purchasing a personal computer will be concerned with the number of other agents purchasing similar hardware because the amount and variety of software that will be supplied for use with a given computer will be an increasing function of the number of hardware units that have been sold.

In the messaging app example, I intentionally alluded to the OS with which the new messaging app was compatible: the original version ran on the Apple iOS and, later, there was a version that ran on the Google

Android OS. While the messaging app itself illustrated direct network effects, the need for compatibility with the OS on which the app runs introduces indirect network effects. In particular, a consumer's benefits from using an iOS-compatible mobile device as compared to an Android-compatible device depends, in part, on the number and variety of apps compatible with each of the two systems. The number and variety of compatible apps, in turn, depend on the installed base of devices running the respective OSs. In that sense, the link between a network member's benefits and the network size (i.e., installed base) is indirect. Indirect network effects arise because of the complementarity between the mobile device and the OS software and the application software. In the presence of complementary products, there will always be indirect network effects. Having used the descriptors direct and indirect, we are left with the unimaginative label *other* to characterize a third type of network effect (Katz & Shapiro, 1985, p. 424):

> Positive consumption externalities [also] arise for a durable good when the quality and availability of postpurchase service for the good depend on the experience and size of the service network, which may in turn vary with the number of units of the good that have been sold.

Contemporary examples of other network effects are not difficult to identify. The adoption benefits of using an electric car—or, soon, hydrogen fuel-cell car—are contingent on the expanse and density of available recharging networks. To the extent that the car and the energy source are complementary in the product's overall system, there is a chicken-and-egg problem here as well, except in this case the circular problem concerns geographical expanse and density of the service network rather than app and OS compatibility and availability.

Whether the network effects are direct, indirect, or other, the marketer of a new technology exhibiting network effects can run into a significant problem: Until the installed-base network reaches a certain tipping point, the network risks collapse because the network effects are not strong. This risk, in turn, deters nonmembers from jumping on board.

In the cases of indirect and other network effects, it is necessary for marketers to overcome the initial problem of limited user adoption because consumers do not expect many compatible complementary products or the desired geographical expanse and service network density to be available. Meanwhile, complementary-product and service-network providers do not get on the bandwagon because they do not anticipate an installed primary product base that is large enough.

There is also an opposite scenario: A virtual cycle of reinforcing mutual expectations and self-fulfilling growth that propels the network of adopters beyond the tipping point. Neither scenario is predetermined, and much depends on how well the marketer of a new high-tech product orchestrates the self-fulfilling expectations game among many different players. The road to new technology just got more perilous.

6. Marketers, complementors, competitors, and ecosystem wars

Taken together, the bumps in the road to new technology, discussed above, necessitate adoption of the product by consumers beyond critical mass. In this urgent environment, the role of marketers, complementors, and competitors becomes more complex.

In light of the earlier comments on indirect and other network effects, product marketers and their complementors must cooperate to drive new technology adoption to the tipping point and beyond. While the case for cooperation seems obvious, given the two parties' different interests in multiple markets and ecosystems, such cooperation is neither always easy nor always forthcoming.

The relationship of marketers of new high-tech products and their competitors must also be addressed. Especially when technologies are new, these two parties can accrue mutual gains from cooperation to help establish standards, ameliorate technological and market uncertainties, accelerate the market up the learning curve (including demand parties, supply parties, and rules and regulations affecting any meeting of the two parties), and propel technology adoption to critical mass. While competition is healthy, not much is achieved from gaining demand share if new technology adoption never reaches a tipping point. Borrowing from game theory, what we have here is a call for *coopetition*: cooperation to grow the overall pie and competition over splitting the pie. In principle, the case for coopetition seems obvious, but practicing it is anything but easy as competitors with performance bonuses tied to market shares fight it out in the marketplace.

In addressing these three parties together, we have started talking about competition among ecosystems over formats and standards—something that tends to be part and parcel of new technology introductions. In the competing ecosystem context, the path to new technologies can get increasingly rough and the going can be Machiavellian. Stephen Elop (2011), Nokia CEO before the company's device business was sold to Microsoft, best captured the spirit of this in his 'burning platform' memo to Nokia employees:

> The battle of devices has now become a war of ecosystems, where ecosystems include not only the hardware and software of the device, but developers, applications, e-commerce, advertising, search, social applications, location-based services, unified communications and many other things. Our competitors aren't taking our market share with devices; they are taking our market share with an entire ecosystem. This means we're going to have to decide how we either build, catalyse or join an ecosystem.

Elop's contrast between a battle of devices (the traditional market-share game over products) and a war of ecosystems (with sophisticated coopetition among marketers, competitors, and complementors) is a useful one and suggests options—"build, catalyse, or join an ecosystem"—for minimizing the bump, if not averting it altogether.

Elop's recipe is especially difficult to implement given the complex roles of marketer, competitor, and complementor for today's technology heavyweights such as Amazon, Apple, Facebook, Google, Microsoft, and Samsung. Samsung, for example, (1) uses Google's Android OS in its mobile devices; (2) supplies critical components for Apple's iPhones; (3) competes with Google, Apple, and Microsoft in the mobile-devices space, and (4) must cooperate with Google and other Android-based device marketers to compete with Apple and Microsoft in a three-sided OS ecosystem war.

7. Multiple product-market possibilities and soggy choices

For discussion of a sixth challenge to new technologies, we return to the opening example of E Ink. The company initially struggled with its choice of product-market scope (Yoffie & Mack, 2005). E Ink questioned whether to be a technology licensing company or a material, subassembly, and/or final product mover (product scope decision). Likewise, the company had to decide whether to be an early mover in an emerging and potentially large, high-margin matrix display rife with indirect network effects[3] or to go after a mature, small, low-margin, saturated segmented display market (market scope decision).

E Ink's situation is not unique. For many high-tech products sporting new technologies, there often is a choice of multiple product-market possibilities, each with its own business model that addresses value proposition; competitive space and differentiation basis; customer segmentation, targeting, and positioning; pricing model; customer interface design and management; business configuration in terms of competencies, assets, processes, systems, and structure; and place in a value network. Implementation of the appropriate business model for any one product-market option requires investment of resources and management bandwidth, and also raises the issue of significant and limiting path dependency where future product-market options are constrained by past product-market choices.

Furthermore, there is the risk of loss of focus and dissipation of energy if the marketer chases all possible avenues in the style of E Ink, flirting with one and then the other. The resulting marketing and business-definition sogginess imparts its own bumps on the road to new technologies.

8. Concluding comments

As I was finishing this article, Pokémon Go, an augmented reality smartphone app, took the world by storm. Released for public download in Australia, New Zealand, and the U.S. on July 6, 2016, the app was available in many European countries by the week of July 11. In little over a week, several million people had downloaded the app and users were swarming streets, neighborhoods, spaces, and places across three continents. True, the app was free (although in-app purchases were available), but regardless, Pokémon Go has been a big hit and a marketer's dream.

Runaway success like that of Pokémon Go is the one thing marketers cannot count on when bringing new high-technology products to market. As we have seen in this article, new technology's road to market is bumpy for at least six reasons: (1) the presence of significant market uncertainty, (2) the presence of significant technological uncertainty, (3) issues of compatibility within complex multi-component systems, (4) struggles to orchestrate self-reinforcing network effects, (5) challenges in navigating ecosystem complexities and competition, and (6) the difficulties of making path-dependent choices between multiple product-market options and their associated business models.

Like death and taxes, these six perils will always be with marketers of high-tech products.

[3] Electronic tablets and readers were still an uncertain category in 2005, their fate interdependently linked to the availability of digital content.

What can the marketer do to make new high-tech products' path to market less perilous? Here is a minimal set of suggestions addressing each potential challenge:

- *Significant market uncertainty*
  - Do not just work with top-down, aggregate industry-sales forecasts developed by technology forecasters; complement these with bottom-up marketing research tools to develop a discerning understanding of inherently uncertain demand.
  - Engage in outside-the-field-of-vision, competitive analysis that reaches beyond just the usual suspects.
  - Work with different scenarios of market rules and regulations.
  - Base marketing and related decisions on probabilistic outcomes and not deterministic forecasts. Stress test the marketing plan for different scenarios.
- *Significant technological uncertainty*
  - Develop a discriminating understanding of the multiple technologies going into the new high-tech product.
  - Identify and play out the forces driving—and the uncertainties underlying—the various technologies' evolutionary paths. In particular, focus on whether or not the trajectories for the different technologies are synchronized and if there are likely to be any inflection points.
- *The complex multi-component product system*
  - At the level of mindset, decision-making, execution, and management attention, shift the focus from the product to the overall system in which the product is used.
  - Remember at least two things:
    - The user only derives value when the whole system—and not the product—works as intended.
    - Do not let the user feel like Alice on the Queen's croquet-ground, forced to navigate an unnecessarily hampered environment.
- *Network effects*
  - Become comfortable with the interdependencies driving technology adoption.
  - Attend to the chicken-and-egg problem: focus on what it takes to orchestrate self-reinforcing virtual cycles of demand growth.
  - Be prepared to sacrifice margins in order to reach critical mass as quickly as possible.
- *Practicing coopetition in ecosystems*
  - Do not win the battle of devices only to lose the war of ecosystems.
  - Look after your complementors. Learn to compete and to cooperate simultaneously with competitors.
  - Align with keystone player(s) in the ecosystem. Better still, become a keystone player.
- *Dealing with multiple product-market possibilities and path dependencies*
  - Focus not only on the first move, but think ahead to future moves and the flexibilities that must be built in today to allow for choices tomorrow.
  - At the same time, make crisp choices. Indecisive flirting with different options may help continue development until tomorrow, but it will only add to the perils awaiting the marketer of new high-tech products.

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