BARRY L. BAYUS, SANJAY JAIN, and AMBAR G. RAO*

The authors address the following key questions: (1) When should a firm introduce a new product? (2) What should its performance level be? and (3) How do the decisions of a competing firm affect a firm's timing and product performance decisions? The authors present a detailed case study of the initial competitors in the personal digital assistant (PDA) industry on the basis of which they construct a stylized game-theoretic model of entry timing and product performance level decisions in a duopoly. Situations in which the duopolists are symmetric as well as asymmetric in terms of their estimates of market size and product development capabilities are considered. When firms are symmetric, the authors show that an equilibrium exists when the firms enter at different times with different performance levels. In the asymmetric cases, the firm that has a higher estimate of market size enters first, as does the firm with a superior development process. The performance level decisions, however, depend on the sensitivity of demand to this variable. The results provide one explanation for empirical observations that market pioneers maintain their leadership in some cases, and later entrants eventually dominate in other cases. The authors then relate the model results to actual decisions in the PDA market, finding that Apple’s Newton was “too little, too early.”

Too Little, Too Early: Introduction Timing and New Product Performance in the Personal Digital Assistant Industry

Voltaire once said “The best is the enemy of the good.” When applied to new product development this statement provides some insightful advice; namely, firms should not sacrifice product performance in order to rush new products to market. Although time-based competition is the latest mantra being touted as the way to achieve a competitive advantage (e.g., Smith and Reinertsen 1991; Stalk and Hout 1990; Wheelwright and Clark 1992), comparatively little effort has centered on examining the trade-off between the time-to-market and product performance decisions. In the economics literature, for example, efforts have focused on the timing of innovation (e.g., for a comprehensive review, see Reinganum 1989). In marketing, research indirectly addressing the time-to-market decision has examined the advantages and disadvantages associated with pioneering a market. Several empirical studies report that market pioneers have an advantage (e.g., see the review by Kalafatnam, Robinson, and Urban 1995), with the implication being that firms should always speed new products to market. At the same time, however, other empirical studies find that later entrants have an advantage (e.g., Cooper 1979; Glazer 1985; Golder and Tellis 1993; Lilien and Yoon 1990; for excellent reviews and critiques of this research stream, see Kerin, Varadarajan, and Peterson 1992; Schmacker 1994). Unfortunately, the existing literature does not consider the product performance decision, nor does it offer a strong consensus on the speed-to-market question.

We simultaneously analyze the introduction timing and product performance decisions for a situation in which competition is endogenous. Three questions form the core of our analysis: (1) When should a firm introduce a new product? (2) What should its performance level be? and (3) How do the decisions of a competing firm affect a firm’s timing and product performance decisions? Answers to these questions are particularly critical for companies developing products with new technologies. More important, there does not seem

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to be one obvious answer to these questions. Firms have pursued various strategies, including being a market pioneer with a high performance product (e.g., Cuisinart in the home food processor market; Schnaars 1994) and allowing competition to enter first while waiting to develop a product with a higher performance level (e.g., Microsoft in the PC [personal computer] operating systems market with Windows 95; Cortese 1995; Nintendo in the video game market with its 64-bit system, Carlton 1995c).

Our analyses demonstrate the importance of considering the interrelationship between the introduction timing and product performance decisions in a competitive environment. We show that either a market-pioneering strategy or a later-entrant strategy can be consistent with profit-maximizing behavior. We also identify various conditions involving the firm’s revenue and product development cost functions that lead to alternative timing and performance decisions. Thus, we provide an explanation for the inconsistent empirical findings that have been reported; that is, observations that market pioneers maintain their leadership in some cases, and later entrants eventually dominate in other cases, is not surprising.

Following an established tradition of inquiry (e.g., Ghemawat 1991; Postrel 1990; Scherer 1992; Swann 1985; Teisberg 1993), we present a detailed case study of one industry. Then, we formulate and analyze a stylized game-theoretic model of introduction timing and product performance decisions. The case study enables us to (1) formulate a general model that includes the key parameters for this industry situation and (2) relate our analytical results to observed firm decisions. Although a single case study does not allow for rigorous empirical testing, it does provide a rich context for model development. Generally, the model and analysis enables us to formally identify the conditions under which Voltaire’s wisdom holds true.

The recently emerging personal digital assistant (PDA) industry provides an ideal setting for studying these questions. First, many details of the product development decisions are available, including, most importantly, detailed information on product performance and introduction timing (for more detailed information, see Bayus 1996). We draw on numerous information sources, including books (e.g., Menez 1993; Williams and Leverette 1994), computer magazines (e.g., Byte, InfoWorld, PC Magazine, PDA Developer, Pen Computing, Upside), popular press (e.g., Business Week, Wall Street Journal, New York Times), business wires, case studies (e.g., Davis and Ptaszynski 1992), and internet bulletin boards (e.g., NewtNews, Motorola URL). Second, all competitors had access to a common body of knowledge—in fact, many of the key players were partners in a joint venture. Third, despite this common knowledge, firms entered the market at different times and with products offering substantially different performance levels.

The remainder of the article is organized as follows: In the next section, we present the case study of the PDA industry and its evolution. We then formulate a stylized model of new product introduction timing and product performance level decisions in a duopoly and use this model to determine the structure of optimal policies. Models in which firms are symmetric and asymmetric in their product development costs and perceptions of the potential payoffs from a new product introduction are studied. Our normative results are then related to the observed decisions within the PDA industry, and finally, we provide a discussion of managerial implications.

**THE PDA INDUSTRY**

*What Is a PDA?*

Several PDAs and PDA-like products are available in the market today. Recent offerings include AT&T’s EO Personal Communicator, a clipboard-sized pen computer; Hewlett-Packard’s 95 LX, 100 LX, and 200 LX DOS-based palmtop computers; Sharp’s pocket-sized Wizard personal organizers; and Apple’s Newton MessagePad. But just what is a PDA? Is it a smaller version of a notebook computer? Is it a “personal organizer on steroids”? Is it the ultimate in portable computing?

As defined by Byte magazine, PDAs are “highly portable, easy-to-use computing and communications devices aimed at the mass market” (Halfhill 1993, p. 72). The purpose of a PDA is to help people communicate more effectively and efficiently in an era of global mobile communications. Furthermore, a PDA should assist people in managing all their information needs. Key functions are thus communications and intelligent assistance. As John Sculley, former chairman and chief executive officer (CEO) of Apple, has stated, “Communications will be as important to Newton as graphics was to the Macintosh” (Williams and Leverette 1994, p. 8). Designers of PDAs believe these devices will be used by consumers of information rather than creators of information (Halfhill 1993). Consequently, PDAs are not meant to replace desktop or laptop computers. Instead, they represent a new market opportunity.

Although consensus on a specific product definition of a PDA has not yet been reached, the PDA has been “productized” (one of Sculley’s favorite terms), that is, the product concept has leaped from the possible to the producible. Several desirable features can be identified (see also Halfhill 1993; Menez 1993; Williams and Leverette 1994). A PDA should have significant computing power with several different functions, which rules out high-end calculators and language translators. It should be easily held in one hand and capable of running on battery power for long periods of time, which rules out most laptop and notebook computers. It should offer flexible communications options, which rules out many personal organizers. It should have a pen interface, which rules out many palmtops. It should be affordable so as to attract the millions of people who have so far resisted desktop computers, which rules out most pen-based tablets. It also should be able to offer intelligent assistance. The result is a device that enables a person to send and receive data in various forms (e.g., e-mail, fax), organize schedules and contact information, jot down notes in his or

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1There is disagreement on the importance of pen input (e.g., Briggs et al. 1993). For example, Psion and Hewlett-Packard believe that future of PDAs is ultimately voice interface. Psion has thus focused their new product research around using voice recognition, bypassing the development of pen-based technology (Andrews 1993). On the other hand, Radio Shack and Apple believe that keyboards are too intimidating for the computer-illiterate mass market. Dataquest has predicted that QWERTY-based products such as the HP 100 LX and Psion 3a will eventually be replaced by PDAs (Halfhill 1993). We follow the industry experts and computer magazine writers and consider pen-input to be a defining characteristic of PDAs. Also, see the survey of current and former users of PDAs by Byte magazine (June 1994).
Getting the PDA to Market

We now discuss the introduction timing and product performance decisions made by the various competitors in the PDA industry. In Appendix A, we provide a timeline of key events in the evolution of this industry, and in Table 1, we summarize the product features at the time of introduction.

Figure 1
THE ROOTS OF THE PDA CONCEPT

Table 1
PDA CHARACTERISTICS OF SELECTED COMPETITORS (AT TIME OF INTRODUCTION)

<table>
<thead>
<tr>
<th></th>
<th>Amstrad PenPad</th>
<th>Apple/Sharp Newton</th>
<th>Tandy/Casio Zoomer</th>
<th>Bell South Simon</th>
<th>Sony Magic Link</th>
<th>Motorola Envy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>Eden Group</td>
<td>Newton</td>
<td>Geoworks</td>
<td>DOS/Custom</td>
<td>Magic Cap</td>
<td>Magic Cap</td>
</tr>
<tr>
<td>Battery</td>
<td>3 AA alkaline</td>
<td>4 AAA alkaline</td>
<td>3 AA alkaline</td>
<td>NiCad</td>
<td>6 AAA alkaline</td>
<td>NiCad</td>
</tr>
<tr>
<td>Text Entry</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Free Form</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Cursive</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Ink as Data</td>
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<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Organizer</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Spreadsheet</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Wordprocessing</td>
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<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Pocket Quicken</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Communication</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Fax/Modem</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Fax/Receive</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Two-way Wireless</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Price</td>
<td>$499</td>
<td>$699</td>
<td>$699</td>
<td>$899</td>
<td>$995</td>
<td>$1000–1500</td>
</tr>
</tbody>
</table>

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for the primary competitors. Note that the PDA concept is not entirely new (Williams and Leverette 1994). It has evolved from the 1970s Dynabook concept of Xerox’s Palo Alto Research Center: a device would be issued to a person at birth, accumulate knowledge as he or she grew, and eventually be able to anticipate his or her information needs and act on his or her behalf in learning and communicating with the world. Apple’s Advanced Technology Group also produced the Knowledge Navigator video in the 1980s that featured several futuristic scenarios for the possibilities for new portable computers.2

Since 1993, eight firms have introduced PDAs (see Appendix A): Amstrad (United Kingdom), Apple, Sharp, Tandy, Casio, IBM, Sony, and Motorola. Strategic alliances among these firms have resulted in six different product platforms (see Table 1): PenPad, Newton, Zoomer, Simon, Magic Link, and Envoy. Although Apple has garnered most of the “credit” for developing this product and market, all the competitors have a long history of research and development (R&D) in one or more of the enabling PDA technologies (see Figure 1).

From the timeline in Appendix A, it is clear that the PDA development process involved several man-years of effort. For all the competitors, the time between product development and product announcement was at least a year. In the case of Newton, for example, Apple began developing a new, high-level programming language (code-named Ralph, after Ralph Ellison, author of The Invisible Man) in early 1990 and later that fall committed to using a RISC chip from ARM, Ltd. (Levine 1993; Menezes 1993). The General Magic joint venture among Apple, Motorola, and Sony (which eventually led to the development of the Magic Cap operating system used in the Magic Link and Envoy devices) also started several years before PDAs were even announced (e.g., Yoder and Zachary 1993). The time between product announcement and actual shipment adds another several months to the total time to market.

The prior research and development activities of these companies, combined with the long lead times required for product development, indicate that the key competitors had knowledge of and access to the important technologies necessary for the development of a PDA product that could be marketed. Thus, we believe that the various product introduction times of the competitors reported in Appendix A are associated with different marketing strategies. Table 1 is consistent with this idea because the six product platforms offer different product features. For example, the PenPad, Newton, and Zoomer products are less expensive and more portable (compare the size, weight, and battery attributes) than Simon, Magic Link, and Envoy. However, this portability comes at the expense of communications capability3 (compare the fax receive and wireless features), which, as was previously noted, is a critical feature for PDAs. In addition, as is shown in Table 2, these competitors have emphasized different advertising and distribution strategies (e.g., Johnson 1994; Lepesi 1994; Parker 1994).

These competitors also have targeted their devices to different markets (e.g., Seybold 1994). The Newton and .

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2Several science fiction movies and television shows have used PDA-like devices. For example, Commander Adams in the classic 1950s movie, Forbidden Planet, uses a belt-mounted PDA with a retractable microphone (that doubles as a video camera) to communicate with his crew and his flying saucer’s computer. Gene Roddenberry’s Star Trek television series introduced the Communicator and Tricorder as integral devices “to go where no man has gone before.” Interestingly, one reviewer described the Newton prototype at the 1992 Consumer Electronics Show as a “cross between Kirk’s Communicator and a black Porsche” (Williams and Leverette 1994).

3The fax/modem option can be added to the Newton and Zoomer devices for an additional $500.

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### Table 2: Marketing Launch Strategies of Selected PDA Competitors

<table>
<thead>
<tr>
<th></th>
<th>Amstrad PenPad</th>
<th>Apple Newton</th>
<th>Tandy Zoomer</th>
<th>Bell South Simon</th>
<th>Sony Magic Link</th>
<th>Motorola Envoy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target Market</strong></td>
<td>Mass Market</td>
<td>Horizontal Markets (e.g., consumers that use personal electronic devices)</td>
<td>Horizontal Markets (e.g., consumers that use personal electronic devices)</td>
<td>Vertical Markets (e.g., mobile professionals that use computers)</td>
<td>Vertical Markets (e.g., business people that are early adopters of technology)</td>
<td>Vertical Markets (e.g., business people that are early adopters of technology)</td>
</tr>
</tbody>
</table>
| **Advertising and Promotion** | $10–12 million introductory campaign ("What is Newton?"
  campaign aired on Monday Night Football and
  U.S. Open Tennis tournament); generally split between
direct marketing and print in business,
  computer, and travel magazines | Very small budget limited to trade magazines | Supplies a manual
  and video to distributors; advertising is
  handled on a market-by-market basis | $10–12 million
  introductory campaign
  generally split between
  direct marketing and print
  in business, computer,
  and travel magazines | Very small budget limited to trade magazines |
| **Distribution**    | Exclusive Licensing Agreement with Scottsdale Technologies for Distribution in the United States | Retail Channels (e.g., Circuit City, Radio Shack, Office Depot) | Retail Channels (e.g., Circuit City, Radio Shack, Office Depot) | Corporate Resellers | Retail Channels (e.g., Circuit City, Radio Shack, Office Depot) | Corporate Resellers |

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Zoomer devices initially were targeted to large, horizontal markets (e.g., Christopher 1991; Jerney 1993). This is an attractive market, because a large number of these consumers use personal electronic devices (e.g., in 1993 there were approximately 16 million cellular phone subscribers, 19 million Americans carrying a pager, and 17 million computers in homes; Dunkin 1994). This targeting is consistent with their product feature emphasis on pen-input and low price. Given its low price and limited functionality, it is also clear that PenPad was targeted as a mass market device. On the other hand, the full featured Simon, Magic Link, and Envoy devices with extensive communications capability (see Table 1) were targeted to mobile professionals that use computers (e.g., Carlton 1995a; Hill 1994b; Kneale 1993). Sony and Motorola, for example, are targeting a base of about 6 million business people who are early adopters of technology (Johnson 1994). These marketing decisions indicate that the competitors were planning for markets of different sizes. Amstrad, Apple and Sharp, and Tandy and Casio initially perceived a much larger market potential than IBM and BellSouth, Sony, and Motorola.

Key Observations From the PDA Industry

Although this industry is still in its infancy, a few clear facts emerge from our examination of the initial competitor behaviors. First, PDA product development is relatively long and involved. All of the competitors did, however, have knowledge of and access to the important technologies. Second, competitors in the PDA industry can and did choose different introduction times and product performance levels. As is summarized in Figure 2, two general types of decisions were made. Amstrad, Apple and Sharp, and Tandy and Casio were the first firms to ship PDAs; and these devices had relatively lower performance levels. IBM and BellSouth, Sony, and Motorola shipped their full-featured PDAs a year later. Third, competitors in the PDA industry have different perceptions of potential sales and thus choose different initial target markets. Again, two general targeting decisions were made (see Figure 3). The Newton, Zoomer, and PenPad were positioned as consumer products (i.e., more toward horizontal markets), whereas Simon, Magic Link, and Envoy were targeted to mobile professionals that needed communication capability. Fourth, as we discuss subsequently, these initial competitors in the PDA industry obtained varying market results using these different introduction timing and product performance level decisions.

A MODEL AND ANALYSIS

The previous discussion indicates that one group of firms rushed to market with a product that was lacking in performance relative to a second group of firms that entered later with a full-featured product (see also Figure 2). In addition, firms differed in their perceptions of the initial target market and, thus, in the potential payoffs. We now investigate whether these observed decisions are consistent with profit-maximizing behavior in a competitive environment. To simplify the mathematics and yet retain the key aspects of the decision making situation, we formulate and analyze a model of the new product introduction timing and product performance level decisions in a duopoly. Note that a duopoly is consistent with the general pattern observed in Figure 2. Each firm must decide on the time of introduction and the performance level of its product. Development costs are increasing at an increasing rate in product performance levels and speed to market. If either firm introduces a new product before the other, it can expect to make substantial

![Figure 2: The Relationship between Time of Introduction and Product Performance](image-url)
profits during the monopoly period. When both competitors have products in the market, the profits obtained depend on the competing product performance levels. Each firm must therefore balance the benefits and costs of speeding products with various performance levels to market, as well as take into account its rival's strategic behavior. We assume firms are symmetric in their development costs and perceptions of the potential payoffs from a new product introduction. We then consider cases in which firms are asymmetric in their payoff perceptions and product development costs. We subsequently relate these analytical results to actual firm decisions observed in the PDA industry.

**Symmetric Firms**

Two firms (1,2) that choose their introduction times ($T_1$, $T_2$) and product performance levels ($Q_1$, $Q_2$) are considered. Firms can introduce a product at any time. Firms maximize their discounted expected profits over time. Time is assumed to be a continuous variable, and the game has an infinite horizon. We make few assumptions about the underlying profit and cost functions so that our results can generalize across functional forms.

The costs for developing a product of performance level $Q$ at time $T$ is given by $c(Q,T)$. As new product development times are compressed, development costs are assumed to increase at an increasing rate. As more people are added to a project, diminishing returns are observed because overall productivity drops as a result of the additional communication and training necessary for new team members (Brooks [1975] calls this the *mythical man-month*). Traditional network or PERT analysis of R&D activities also leads to a convex time-cost trade-off (e.g., Rosenbloom 1964). Using a probability approach, Scherer (1966) finds a similar result. Concurrent engineering has also been found to be more expensive than sequential development (Ait-Sahalia, Johnson, and Will 1995). Consistent with prior empirical work (e.g., Griffin 1993; Ulrich et al. 1993), development costs are assumed to increase at an increasing rate as the performance level is raised. Finally, we simplify our analyses by assuming that $c(Q,T)$ is additively separable:

$$c(Q,T) = \phi(Q) + \psi(T).$$

where $\phi' > 0$, $\phi'' > 0$ and $\psi' < 0$, $\psi'' > 0$. We note that our model still includes the trade-off between time and product performance: a company that introduces a product of performance $Q$ at time $t_1 > t_2$ incurs less costs, because $c(Q,T)$ is decreasing in $T$ as a result of improvements in technology. To allow for the possibility of immediate introduction, we assume $\psi(0) > -\infty$. To ensure that product introduction is optimal in a finite duration, it is assumed that for some $t < \infty$, $\psi(t) = 0$; that is, after $T$, further reductions in costs are not possible. We consider a situation in which development costs are asymmetric among firms in a later section.

The rate at which firms earn revenues is a function of the competing product performance levels and is affected by environmental uncertainty. There are many reasons for a particular timing strategy, including market intelligence, intellectual property rights, systems standardization, entry deterrence, and brand equity. At some level, however, all of these possible motives affect the firms' perceptions of the revenues that can be earned. We implicitly account for these factors by considering a general revenue function.

Making the usual assumption that firms are risk-neutral, we define the expected revenue function for Firm 1 as $E(Q_1,Q_2)$, where $\partial E/Q_1 > 0$, $\partial E/Q_2 < 0$, and $\partial^2 E/Q_1^2 > 0$. Asymptotic revenue functions among firms are considered

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*The time-cost trade-off for a specific development project is generally approximated by a U-shaped function (e.g., Bayus 1995, Smith and Reinertsen 1991). We here focus on the part of this function for which development times are less than the minimum of the U-shaped curve, because companies currently to the right of this minimum can improve their effectiveness by reducing development time and costs. For a model that considers a U-shaped development cost function, see Bayus (1995).

*We can also consider exogenous market growth factors in the model by including an appropriate term. For example, exponential growth can be incorporated into the expected revenue function for Firm 1 as $E(Q_1,Q_2)$, where $\partial E/Q_1 > 0$, $\partial E/Q_2 < 0$, and $\partial^2 E/Q_1^2 > 0$. Asymptotic revenue functions among firms are considered.
subsequently. When only one firm is in the market, the expected revenue function for the monopolist is defined as \( \pi_m(Q) \), where \( \pi_m'(Q) > 0 \) and \( \pi_m(Q_1) > \pi(Q_1, Q_2) \) \( \forall Q_2 \). This last assumption ensures the usual condition that a firm would always prefer to be a monopolist. Finally, to ensure that there is an upper bound to the product performance level that will ever be offered, we assume there exists a \( q < \infty \) such that \( \pi_m(q) < c(q, \infty) \).

To determine optimal policies, we consider a leader-follower structure. Without loss of generality, let Firm 1 be the leader (denoted by the subscript \( L \)) and Firm 2 be the follower (denoted by the subscript \( F \)). Firms are assumed to discount profits at the same rate \( r \). The expected profit functions in such a leader-follower game are

\[
\Pi_L(Q_L, T_L; Q_F, T_F) = \int_0^{T_L} e^{-r_t} \pi_m(Q_L) dt + \int_{T_L}^\infty e^{-r_t} \pi(Q_L, Q_F) dt - \int_0^{T_L} e^{-r_t} c(Q_L, T_L) dt
\]

and

\[
\Pi_F(Q_F, T_F; Q_L, T_L) = \int_0^{T_F} e^{-r_t} \pi(Q_F, Q_L) dt
\]

Similar to Reinganum (1981), it is assumed that each firm must precommit itself to an introduction date and product performance level. Because of the long and involved nature of the new product development process, this assumption is reasonable. The implication is that once the development project is underway any changes or adjustments are prohibitively costly. Thus, we focus our analysis on open-loop policies.\(^6\)

In an open-loop concept, firms choose their control variables by taking the other firms' reactions as given. The first-order conditions for the follower in the leader-follower game evaluated at the optimal point are

\[
\pi(Q_F, Q_L) - c(Q_F, T_F) = -\frac{1}{r} \frac{\partial \psi}{\partial T}
\]

and

\[
\frac{\partial \pi(Q_F, Q_L)}{\partial Q_F} = \frac{\partial \phi}{\partial Q_F}.
\]

For the leader, the corresponding equations are

\[\begin{align*}
\pi_m(Q_L) - c(Q_L, T_L) &= -\frac{1}{r} \frac{\partial \psi}{\partial T} \\
(e^{-r_t} - e^{-r_{T_F}}) \frac{\partial \pi_m}{\partial Q_L} + \frac{\partial \pi(Q_L, Q_F)}{\partial Q_L} e^{-r_t} &= e^{-r_{T_F}} \frac{\partial \phi}{\partial Q_L}.
\end{align*}\]

Using these conditions, several results are obtained.\(^7\)

First, consider the decision strategy of the leader. This firm can take into consideration the possibility of entry by the follower (i.e., the foresighted leader) or ignore the follower. The following result is obtained for this situation:

Proposition 1:

(a) The introduction time \( T^* \) of the foresighted leader is larger than the \( T^* \) of the leader that ignores the threat of entry.

(b) If \( \pi_m < \pi_m', \) then the product performance level \( Q^* \) of the foresighted leader is smaller than the \( Q^* \) of the leader that ignores the threat of entry. Otherwise, the \( Q^* \) of the foresighted leader is larger than the \( Q^* \) of the firm that ignores the threat of entry.

The intuition for this result is as follows: When a firm introduces a new product it balances its marginal costs of introducing the product sooner with the corresponding increase in its expected marginal revenues. For a monopolist, the marginal profits from early entry are higher than for a firm that expects competition; thus, the monopolist will choose to enter sooner than the firm that anticipates entry. This result is not surprising, and in fact is the basis of all patent laws. The argument is that firms are less likely to innovate and introduce new products if they foresee the entry of similar products. Patents are therefore granted to provide partial monopolies and thus encourage innovation. Also, note that our results show that the threat of competition can increase the product performance offered by the leader.

The remaining results deal with a foresighted leader.

Proposition 2: When: (a) the follower's expected profit associated with immediately introducing a product of performance level \( Q^* \) is greater than or equal to the discounted marginal benefit of waiting, and (b) the leader's expected marginal revenue equals its marginal cost at product performance level \( Q^* \), an equilibrium solution is for each firm to introduce a product of equal performance level \( Q^* \) at \( T^* = 0 \). In other words, firms enter simultaneously with equal product performance levels.

With symmetric competitors, it is not surprising that simultaneous entry with products of equal performance levels is an equilibrium solution to the game. However, we note that this proposition will only hold when firms introduce the new product immediately (\( T^* = 0 \)) and development costs decline slowly over time. The following proposition gives the equilibrium solution when it is not optimal to introduce products immediately:

Proposition 3: If there exists a pure strategy equilibrium with \( T_L^* > 0 \), then \( T_L^* > T_F^* \). Furthermore, if \( \pi_m > \pi_m' \), then \( Q_L^* > Q_F^* \). In other words, firms will introduce new products of different product performance levels at different times (for a proof of the

\[\text{Proofs are available from the authors on request.}\]
existence of a pure strategy equilibrium for a related timing model, see Reinganum 1981).

If it is optimal to delay product introduction, this result shows that the only equilibrium is one in which asymmetric product introduction times and product performance levels are observed, even though the firms are symmetric in other respects. Furthermore, because these asymmetric decisions are typically associated with different payoffs, a consequence of this result is that symmetric firms can end up with different profits. Thus, this result provides a possible explanation for observed asymmetries in entry timing and product performance levels of firms: that is, such asymmetries are inherent in the competitive process and can be observed even when firms are rational and have the same managerial and/or strategic capabilities.

The following proposition relates the product performance level decisions of the two competitors:

**Proposition 4:**

(a) If \( \pi_m > \pi_L \), then \( Q_L^* < Q_m^* \).

(b) If \( \pi_m = \pi_L \), then \( Q_L^* = Q_m^* \).

(c) If \( \pi_m < \pi_L \), then \( Q_L^* > Q_m^* \).

In other words, the leader’s product performance level depends on the market’s sensitivity to higher product performance levels.

Note that the conditions comparing \( \pi_m \) and \( \pi_L \) in Propositions 3 and 4 reflect the importance of product performance in different market situations. Both terms involve the expected marginal revenues associated with higher product performance levels. In markets in which the new product is based on familiar technology (e.g., a product line extension), we expect \( \pi_m < \pi_L \). In these markets, competition leads to products with higher performance levels. For this case, the leader rushes to market with a low-performance product, whereas the follower waits and introduces a high-performance product. Here, we expect the leader’s market share to erode over time, because the competitor enters with a product of superior performance. When firms are introducing a product with a new and unfamiliar technology, we expect \( \pi_m > \pi_L \), because the monopolist has a greater incentive to provide a high-performance product in order to develop the market than does the firm that Foresees competition (again, this is one of the reasons for the need of strong patent protection in such markets). Under this condition, the leader introduces a high-performance product before the follower, which enters later with a low-performance product. In these markets, we expect the first entrant to enjoy market leadership.

Together, these four propositions provide some insight into the optimal introduction timing and product performance decisions when firms are symmetric. Aside from the intuitive equilibrium solution in which both firms simultaneously enter immediately with identical products, our analytical results demonstrate that a profit-maximizing solution is for firms to enter at different times with different product performance levels when \( T^* > 0 \). Thus, one firm maximizes its expected profits by incurring high development costs to get to market first and obtain monopoly profits before the competitor enters. The other firm maximizes expected profits by spending less on product development and getting to market later. Furthermore, the leader prefers to develop a high-performance product in markets that are sensitive to performance, and a low-performing product otherwise. The situation of symmetric firms, however, provides little insight into why a particular firm would desire to be first to market. Subsequently, we examine the firm’s decision of whether to be the leader or follower.

**Asymmetric Revenue Functions**

We here consider the case of firms that are asymmetric in their perceptions of the potential payoffs from a new product introduction. Asymmetry is modeled by multiplying the expected revenue functions \( \pi \) and \( \pi_m \) for one firm by a constant \( \alpha \). Without loss of generality, let \( \alpha = 1 \) for Firm 1 (denoted with subscript \( lo \)) and \( \alpha > 1 \) for Firm 2 (denoted with subscript \( hi \)). Thus, Firm 2 believes that potential revenues are \( \alpha \) times larger than Firm 1 believes. In this case, we obtain the following result for the introduction timing decisions. First define

\[
k = \left( -\frac{1}{r} \frac{\partial \psi(t)}{\partial t} \right) \bigg|_{t=0} > 0.
\]

Note that \( k \) is the discounted marginal benefit of waiting. Let \( I > 0 \) be a function of \( I > 0 \). Also, we assume that a firm’s expected marginal revenue from increased product performance levels is higher when the competitor introduces a product with a low-performance level.

**Proposition 5:** There exists a number \( k_{\text{min}} \) such that if \( k \in [k_{\text{min}}, \infty) \), then \( \forall \alpha > f(k), T_{lo^*} = 0 \) and \( T_{hi^*} > 0 \). Furthermore, \( T_{hi^*} \) increases as \( \alpha \) increases. If \( k < k_{\text{min}} \), then \( T_{lo^*} = T_{hi^*} = 0 \). In other words, for sufficiently large values of \( \alpha \), the firm with the higher expected payoff estimate will introduce its product first. In addition, if the discounted marginal benefit of delaying introduction is small enough, then both firms will introduce their products immediately.

The following results for the product performance level decisions are also obtained:

**Proposition 6:** If \( T_{lo^*} = 0 \) and \( T_{hi^*} > 0 \), then for sufficiently high values of \( \alpha \), \( Q_{lo^*} > Q_{hi^*} \). In other words, the firm with the higher expected payoff estimate will have a higher product performance level than its competitor.

This proposition parallels Proposition 4 for the case of symmetric firms. The key difference is that the monopolist’s expected marginal revenue here includes \( \alpha \), which reflects the differences in the firms’ perceptions of the potential payoffs.

**Corollary 1:** If \( T_{lo^*} = T_{hi^*} = 0 \), then \( Q_{lo^*} > Q_{hi^*} \). In other words, when immediate product introduction is optimal, the firm with the higher expected payoff estimate will introduce a product with a higher performance level than its competitor.

These results provide further insight into optimal introduction timing and product performance decisions. The leader is willing to incur large development costs to speed to market, because it believes there is a larger potential payoff than does the follower. In addition, the leader prefers to introduce a high-performance product (and incur the associated high development costs) when it perceives that a large potential payoff exists.
Asymmetric Development Cost Functions

We now consider a situation in which firms are asymmetric in their new product development cost functions. Various approaches and techniques for speeding up the development process have been proposed, including isolated facility/skunk works, multifunctional teams, concurrent engineering, quality function deployment, design for manufacturing and assembly, computer assisted design, and computer simulated testing. Asymmetry in development costs is modeled by assuming that only one firm takes advantage of the available approaches and techniques. As a result, this firm is more efficient and incurs lower development costs for a product with a given introduction time and performance level. Development costs are modeled as

\[ c(Q, T) = \phi(Q) + \beta \psi(T), \]

where \( \beta = 1 \) for Firm 1 (the efficient firm, denoted with subscript E) and \( \beta > 1 \) for Firm 2 (the inefficient firm, denoted with subscript I).

We make the reasonable assumption (see Carpenter 1989; Reinganum 1985) that own-effects on the profit functions are stronger than cross-effects:

\[ \Lambda = \frac{\partial^2 \Pi}{\partial Q_2 \partial Q_2} + \frac{\partial^2 \Pi}{\partial Q_2 \partial Q_1} < 0 \]

The following results are then obtained:

**Proposition 7:** For sufficiently large values of \( \beta, T_E^* < T_I^* \). Furthermore, as \( \beta \) increases, \( T_I^* - T_E^* \) increases. In other words, the more efficient firm will enter first.

**Proposition 8:** Let the efficient firm be the leader; then,

(a) If \( \pi_{m}^E - \pi_{E}^E > 0 \), then as \( \beta \) increases, the product performance levels of both firms increase (i.e., there is more intense product performance competition). Furthermore, \( Q_E^* > Q_I^* \). In addition, if \( \Lambda < 0 \), then \( Q_E^* > Q_I^* \) increases as \( \beta \) increases.

(b) If \( \pi_{m}^E - \pi_{E}^E < 0 \), then as \( \beta \) increases, the product performance levels of both firms decrease (i.e., there is less intense product performance competition). Furthermore, \( Q_I^* > Q_E^* \). In addition, if \( \Lambda < 0 \), then \( Q_I^* > Q_E^* \), increases as \( \beta \) increases.

In other words, the more efficient firm's product performance level depends on the market's sensitivity to higher product performance levels.

These results provide additional insight into optimal introduction timing and product performance decisions when firms differentially employ available product development techniques such as multifunctional teams. The firm that has the ability to effectively accelerate its development process prefers to speed to market with its new product. In addition, in markets in which competition leads to products with low-performance levels, the leader prefers to develop a high-performance product. The competitor, which is at a disadvantage in terms of its new product development process, is relegated to being a follower.

**DISCUSSION**

We here relate our analytical findings to the observed firm decisions in the PDA industry. Specifically, we are interested in whether our analytical results provide some insight into the observed firm’s introduction timing and product performance level decisions. A summary of our analytical findings is shown in Figure 4.

The actual decisions associated with the launch of any new product are a function of cool analytical thinking, as well as intuition and gut feel; the PDA industry is no exception. It is clear that Sculley was a true product champion of the PDA and Newton's development team had incredible zeal to complete the project in the face of severe pressures. An excellent presentation of the personal dramas and achievements associated with the Newton product development is in Menuez’s (1993) study. Despite the probable existence of impassioned motives for specific firm decisions, however, we can still relate our analytical results to some of the market events after 1993.

In Appendix B, we summarize the key events after the first PDAs were shipped. The following observations can be made: First, competitors in the PDA industry entered at different times, with different product performance levels. Although PenPad was introduced first in Europe, it has not been an important player in the U.S. market. The Newton and Zoomer devices were introduced within weeks of each other, and both had relatively low product performance levels (see Table 1 and Appendix A). As is shown in Figure 2, a second group of firms introduced competing PDAs well after this first group. The Simon, Magic Link, and Envoy devices followed Newton and Zoomer by about a year but had relatively higher product performance levels. These observed decisions are consistent with Proposition 3. If the first group of competitors believed that there was little additional benefit to having increased communication capabilities initially (i.e., \( \pi_m < \pi_I \)), then the observed product performance decisions would be consistent with Proposition 4.

Second, the Newton was “too little.” From Appendix B, it is clear that Apple rushed its product to market: The software was not completely debugged, and the handwriting recognition feature did not work as promised. Additionally, Apple reportedly had return rates as high as 30% in the first few months (see Lempesis 1994). Given Newton's subsequent management restructuring and reported losses of nearly $50 million, it appears that Apple's initial decisions in the PDA industry were ill-fated. It also seems clear that Apple could have delayed the introduction of Newton to fully test the operating system software and handwriting recognition engine. For example, in their two upgraded devices (MessagePad 110 and MessagePad 120), the software involved significant advances (e.g., Thompson 1995; Wildstrom 1995).\(^8\) Apple knew that communication was a critical and defining attribute of the PDA concept, yet chose to reduce its time to market by limiting the communication performance of its devices (e.g., Menuez 1993). Only with the recent launch of the MessagePad 120 does Apple now have a device that allows for an optional external wireless communication attachment (Carlton 1995b). The full-featured de-

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\(^8\)We note that less than a month after the launch of Newton, Palm Computing also announced Graffitii, a software package based on a widely acclaimed new handwriting recognition method (PDA Developer 1994).
vicies that followed (Simon, Magic Link, and Envoy) have so far received several kudos from reviewers (e.g., Magic Link has won a major 1995 award for world class advancement in personal communication from PC World). All of this suggests that PDA demand is sensitive to product performance (i.e., \( \pi_n > \pi_l \)), and thus from Proposition 4, the initial products should have had a higher performance level.

Third, competitors in the PDA industry had different perceptions of the potential market size. As is shown in Figure 3, products of the first entrants (which include Newton and Zoomer) were targeted toward the mass market, whereas the second group of firms targeted smaller, vertical market applications. Consistent with Proposition 5, the firms that were early to market believed that a larger potential market, and thus a higher payoff, existed.

Fourth, the Newton was “too early.” From Appendix B, it seems clear that PDAs are not a mass market product at this point in time. The Simon, Magic Link, and Envoy devices are targeted more conservatively, and even Apple has recently scaled back its PDA product plans and quietly repositioned the Newton to vertical market applications in areas such as health care, financial services, schools, and fieldwork (e.g., Carlton 1995b; Reinhardt 1995; Teinowitz 1995). If Apple had initially perceived that the potential for PDAs was in the much smaller vertical markets, then Proposition 5 suggests that Apple should not have rushed to market.

Finally, we can speculate about the relationship between the more recent PDA announcements and our analytical results for asymmetries in product development costs. In particular, Panasonic has announced a PDA with the same operating system and product features as the Magic Link more than a year after Sony began unit shipments (see Appendices A and B). By most accounts, Sony has the ability to effectively accelerate its new product development process (e.g., Weingerm 1993). On the other hand, Panasonic is not generally known for its product innovation. If Sony does have a more efficient product development process than Panasonic, then the observed decisions are consistent with Propositions 7 and 8.

It is clear that the first PDAs to market did not live up to expectations. These initial PDAs significantly underperformed the competitive devices that followed. Our model and analysis give us confidence to agree with the view expressed by one industry pundit that the Apple Newton was indeed too little and too early (Raskin 1994). Even Sculley now believes that Apple did not “get it right” that time—he has stopped carrying his Newton and instead opts for a pager. To add insult to injury, it has been reported that Apple has recently sent over 30,000 perfectly good Newton MessagePad 100’s to the Los Angeles landfill for permanent burial.

MANAGERIAL IMPLICATIONS

Although Voltaire gave his insightful advice many years ago, our analyses highlight that speeding a new product to market in an attempt to establish a first-mover advantage is not always a good idea. The success of this strategy depends on how well a firm understands the market (both the market size and market needs), and how well it understands its competitors’ strengths and weaknesses. To make the right decisions, a careful analysis of the potential trade-offs among time to market, product performance, and development costs should be conducted.
Although the competitors in the PDA industry had access to the same information, the first entrants overestimated the potential market size and underestimated the product performance desired by the market. Contrary to the conventional wisdom in technology-driven companies (e.g., for an interview with Steve Capps, the chief designer of Apple's Newton, see Jerney (1996)), marketing research techniques can be used to better estimate the potential demand for new products. These techniques include need-based market segmentation, positioning analysis, and the assessment of alternative designs (e.g., conjoint analysis). Moore (1991, 1995) provides an excellent discussion of these concepts applied to new technologies and products. Category problem analysis (involving initial focus groups to develop an extensive list of product problems, followed by a quantitative survey to measure the importance and frequency of each problem) and in-depth observations of customers (e.g., using anthropological methods) can be used when a target buyer group cannot (or will not) reveal what it really wants. Demand that reflects the real-world usage context can be estimated from actual usage experience through a home-use test, in-market testing using product and service mockups or prototypes, and simulated buying experiences (for an overview of their experiences using "information acceleration" approaches in the premarket forecasting of new automobile platforms and electric automobiles, see Urban and Weinberg (1993); for an application of marketing research techniques to a new transportation service, see Hauser and Wisniewski (1982)).

In the PDA industry, the later entrants had access to the same technology as Apple and the early entrants (remember the General Magic joint venture), but they made diverse entry timing and product performance decisions. Did firms assess their product development capabilities differently? Asymmetries may be addressed in at least two ways. First, it is possible that approaches and techniques such as Total Quality Management, quality function deployment, and cross-functional teams can be used to make a product development process more cost-efficient and effective. Asymmetries may still remain, however. Second, an advantage in product development over competitors, combined with an understanding of market needs, helps determine a firm's entry timing and product offering strategy. Specifically, when the market is sensitive to product performance and a firm's development process is more efficient than competitors, the firm should speed to market with a high-performance product. If the product development is not as efficient as the competitors', the firm should keep development costs low by entering later with a product (possibly lower in performance) aimed at a broad market.

The model and results presented here emphasize the importance of carefully considering the benefits and costs of accelerating the new product development process. Our analytical framework and results show that either a market-pioneering strategy or a later-entrant strategy can be consistent with profit-maximizing behavior. Further research should continue to dissect the new product development process by studying other possible factors related to the introduction timing decision. Empirical work assessing the trade-offs between time to market, product performance, and development costs is also sorely needed.

APPENDIX A

Timeline of Key Events in the Evolution of PDAs

1960s
Gene Roddenberry, the late creator of Star Trek, ordered that no paper or pencils would appear anywhere on the sets of the starship Enterprise. Crew members used handheld Tricorders and Communicators to collect data and transmit messages.

1970s
Xerox's PARC researches the Dynabook concept: a highly mobile, notebook-sized computer, with artificial intelligence capabilities.

1983
John Sculley, formerly of Pepsi, is recruited by Steve Jobs to join Apple Computer.

1987
Sculley, chairman and CEO of Apple, produces a video called Knowledge Navigator showing his vision of personal computing in the twenty-first century.

1988
After the successful introduction of Mac II, Apple puts together the Newton research group to develop the next generation of more personal and intimate computing devices.

Spring 1990
Newton concept approved; handwriting recognition, intelligent electronic ink, and communication functions are key features. The cost target is $1500, and the time-to-market target is two years.

Summer 1990
General Magic is spun-off from Apple. Its goal is to develop a new interface for smart mobile telecommunications (a software standard to be called Telescript). Apple, Motorola, Sony, and AT&T are investors.

Summer 1991
A small, hand-held device with pen-input, personal organization functions, and communication capabilities becomes the first planned Newton product. Although intelligent software is an essential element, this product is viewed as a smaller, cheaper, stripped-down version of the initial Newton concept that can be mass produced. The cost target is $500, and the time-to-market target is mid-1992.

January 1992
Sculley coins the name "Personal Digit Assistant" in his speech at the Winter Consumer Electronics Show.

Spring 1992
Apple announces Newton (which will be manufactured by Sharp). Later, Apple settles on MessagePad as the product name (after eliminating ZippyPad, BrainAmplifier, PowerEnabler, and KnowledgePad among others).

Fall 1992
Tandy and Casio announce development of the Zoomer PDA. IBM shows a prototype PDA device that resembles a cellular phone. Microsoft is rumored to be developing a Newton-killer called WinPad. General Magic is rumored to be developing a hardware product.

Spring 1993
Motorola is developing a PDA called Envoy. Motorola is also developing a PDA using the Newton operating system (code named Gecko).

March 1993
Amstrad (UK) ships the first PDA, called PenPad.

Summer 1993
Tandy and Casio announceZoomer products.

August 1993
Apple ships Newton MessagePad.

September 1993
Sharp ships ExpertPad (a Newton clone).

October 1993
Tandy and Casio ship their Zoomer devices. Amstrad's PenPad is launched in the United States by Scottsdale Technologies.

Winter 1993
IBM and Bell South announce Simon.

Spring 1994
Motorola announces Envoy. Sony announces Magic Link. Both will use the General Magic Cap operating system.
APPENDIX B

Key Events After the Introduction of PDAs

August 2, 1993 Version 1.02 of Newton software is hurriedly downloaded to Newton MessagePads already packaged for sale at MacWorld just hours before the show will open. The first release has numerous bugs; the system generally crashes and needs to be reset at least once a day. After a few weeks, a free upgrade of the software to fix problems with handwriting recognition and the alkaline battery power supply is shipped to Newton owners.

August 2, 1993 At the MacWorld show in Boston, Apple shows several Newton design concepts, including the Newton Tablet (code-named Sweet Pea), Newton VideoPad (code-named Walt), Newton AutoDock, Newton On-Call, Sports Newton, My First Newton (for children), and Newton Jr. (for children).

End of August 1993 Newton’s handwriting recognition is lampooned in Doonesbury cartoon series. Many publications characterize the Newton as Apple’s electronic Eudel.

September 1993 Cumulative sales of Newton reach 50,000 units.

Fall 1993 Sculley leaves Apple; he is replaced by Michael Spindler.

December 1993 Sales of Newton are sharply below initial sales levels. Cumulative sales of Newton are only 80,000 units.

January 1994 Newton Professional, a device with larger liquid crystal display screen, built-in CD ROM, and detachable keyboard, is expected soon. Siemens NotePhone, a Newton with a phone appendage, is also expected soon.

February 1994 Microsoft chairman Bill Gates is quoted as saying the Newton may have “set the category back a couple of years” (Hill and Carlton 1994, p. R6).

March 1994 Apple ships Newton MessagePad 110, a device with more memory and improved battery life (priced at $599). The Newton MessagePad 100 is repackaged with upgraded software and priced at $499.

April 1994 In their product review of PDAs, InfoWorld (1994, p. 82) states, “Zoomer clearly demonstrates what was wrong with pen-based PDAs ... we can hardly recommend that you even consider the Zoomer.” Gaston Bataaen, the general manager that Apple hired to introduce Newton, resigns. Spindler states that Newton sales were weaker than expected.

May 1994 Apple cancels numerous follow-on projects to the Newton, including the Sweet Pea device. Apple’s Personal Interactive Electronics (PIE) division is restructured and streamlined (20% of the workforce is laid-off). Insiders say this unit lost nearly $50 million in fiscal year quarter ending in April.

Summer 1994 Apple reposiition the Newton to be “a practical, handheld device for mobile professionals.” Apple provides software-development tools to make it easier for companies to create customized software. Apple shifts their distribution to resellers that target corporate customers. Apple’s PIE division targets several vertical markets, including health care, field technicians, education, and financial services.

August 1994 Cumulative sales of Newton have only reached around 90,000 units. This number is far below even conservative sales expectations of 150,000 units.

September 1994 Apple announces the Newton MessagePad 120 (a device with more memory and upgraded software) in Germany.

November 1994 Apple ships Newton MessagePad 120 in Germany.

December 1994 Sculley is quoted in Information Week (1994, p. 8): "The first Newton didn’t live up to expectations, but I’m hopeful that General Magic or someone else will get it right.” Michael Spindler, Apple CEO, states that he has steered Apple away from novelties such as the Newton MessagePad and back toward its core business (Markoff 1994, p. D6) Casio (along with Sega Enterprises) hits the toy market with Secret Sender, a girl’s version of an electronic gadget that allows users to take notes, store phone numbers, and send messages through infrared signals. Apple is rumored to be developing Newton Operating System 2.0 software (code-named Dante), which is not backward compatible with early Newtons (MessagePad 100, 110, 120).

January 1995 Apple launches MessagePad 120 in United States. Motorola is ready to ship Marco, a PDA using the Newton operating system. Panasonic demonstrates a prototype PDA with the Magic Cap operating system.

May 1995 Dante (NewtonOS 2.0) is delayed until February 1996. Apple’s next generation Newton (code-named Que) and Panasonic’s Slate Newton will be released when Dante ships. NewtonOS 1.8 will be released around August 1995 at the MacWorld conference.

June 1995 Amstrad announces Infopad 700, their second generation PDA, in Germany. According to Robert X. Cringely’s “Notes from the Field” in InfoWorld, Apple recently sent over 30,000 perfectly good MessagePad 100’s to a Los Angeles landfill. Apple has been aggressively seeking opportunities to “expose” Newton to mass audiences through our Product Placement effort, which loans Apple products to film and TV productions; in the future, Newtons will appear in Steven Seagal’s “Under Siege II” and in next season’s “Melrose Place.” New products announced in PC Week include Sony’s new Magic Link (October 1995), HP’s Jidi (Fall 1995), Motorola’s new ENVoy and Marco (Fall 1995), IBM’s “smart phone and PowerPC based PDA” (Late 1995), Compaq’s “LITE Mobile Companion” (1996).

September 1995 It is reported that Apple has invested about $300 million in the Newton so far. CEO Michael Spindler reaffirms his support for the Newton technology despite criticism. According to the market research firm BIS Strategic Decisions, only about 110,000 Newtons have been sold.

October 1995 A survey of PDA owners is conducted over the internet and results are reported at http://www.clever.net/trista/survey.html. This survey indicates that most PDA owners use it for organizing schedules, and communications is a key function that is not well-developed.

November 1995 The Dilbert cartoon strip parodies the handwriting recognition of PDAs using state-of-the-art RAT technology.

June 1996

Steve Capps quits Apple and joins rival Microsoft. “I’m scurrying to learn how to use Windows ... I never tried it before” said Capps in an interview (Hardy 1996, p. B6).

July 1996

Various industry players continue to bet that the personal digital assistant will become a commercially successful product. In an interview (Hill 1996, p. B2), Gordon Mayer (CEO of Geoworks) conceded that "we’ve had our noses bloodied. The products failed because they did not do enough, did not have communications, and cost too much." According to Mayer, "It’s a matter of timing ... the hardware and software wasn’t there" (p. B2). In other words, the first PDAs were too little, too early!

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