The Habits of Highly Successful Portable Document Readers

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A vision of electronic books (E-books) has perhaps existed for as long as the vision of the paperless office. Both were ideals that would incorporate the latest technological innovations, replacing existing paper artifacts and potentially transforming society. Both have taken on the label of myth. Still there is something compelling about an E-book, with the affordances and properties of real paperbacks allowing us to flip through pages of an entire library of books, insert bookmarks, and annotate in the margins. These properties distinguish E-books from general-purpose laptop computers. The traditional laptop form is not optimized for reading and most people find them awkward and tiring for prolonged work.

It would now seem that E-books have arrived! Softbook Press, NuvoMedia (Rocketbook) and Everybook are recent startups who are betting that the time is right for an E-book business (others exist but do not choose to announce themselves so prominently). Which new technologies are enabling the emergence of E-books? And how do the new E-books match with the early visions and aspirations?

A useful point to ponder is the similar view for PDAs. Why is the Palm Pilot(TM) a success, whereas the Apple Newton(TM) fell far short of expectations? There may be many reasons, but we believe there are three crucial factors. First, the Pilot is about half the weight and size of the Newton and crossed a crucial threshold that allowed a Pilot to be dropped into a shirt pocket or a purse. Second, it set out to be less ambitious in its range of applications, doing a few things very well. Third, it provided a simple solution for synchronizing data with a desktop PC in a form that everybody could readily use and understand (and hence enabled use in the broader work context).

With the E-books we believe there are seven critical factors: weight, battery life, display quality, capacity, look-and-feel, pen input and price. Carrying a book, or even several, still feels lighter than most laptops (typically 4 to 8lbs). Much of this weight comes from the batteries required to drive the displays and the glass in the displays themselves, usually about 1/3 of the total weight respectively. Furthermore, battery capacity improvements tend to be unpredictable and, historically, only tend to improve by small factors (x1.5 or less) with each new technology. That said, we have seen incremental improvements over the last decade in the form of NiCd, NiMH, Zinc/air and Li-ion that have extended the lifetime of our electronic gadgetry.

While we do not foresee battery technology taking huge leaps forward, we have observed interesting enabling trends in display technologies. Removing the backlight used with transmissive LCD displays reduces the display power consumption by well over 75%. Reflective color LCDs are now becoming available (although they tend to have very directional reading properties). Reflective LCD displays in monochrome seem to be the choice of today's market. Even newer monochrome displays with bistable properties such as ferroelectric displays, MIT E-Ink's electrophoretic display and Xerox's Electric Paper (based on Gyricon rotating balls) are examples of state-of-the-art technologies, currently in the advanced development phase.

Making the comparison between conventional printed text and a computer display, laser printed text is typically 300 dpi, while we find that most PC screens have a resolution of around 75 dpi. Similarly, contrast ratios for text on paper is 15:1, while traditional electronic displays vary from

5:1 to 10:1, with some of the newer bistable technologies at 6:1 presently. Not surprisingly, people have therefore preferred to read from print rather than electronic displays. However, recent advances now advertise LCD displays, which easily match or exceed the 10:1 contrast and have resolutions of up to 200 dpi. Higher resolution flat panel LCD displays are also available (300 dpi) though, at present, the cost and form factor make them infeasible for E-books.

Critical for both weight and utility, E-book capacity must be considered, the key advantage being multi-book storage. Here there are traditionally two choices: solid state memory or rotating disk media. The latter can be used but there are better choices when weight is critical. Beyond these two solutions, advances in solid state flash memory in the form of PC-cards is likely to be an important element of these future E-books. Recent developments in flash memory by SanDisk have allowed two bits to be stored in a single flash cell making a jump in capacity beyond an improvement in lithography. 400MB Type II cards will be available in 1999, with 1GB in Type III format. Although pricey at present, this cost per gig can be expected to plummet -- making this a favorite for content delivery. We can imagine PC-card "books" selling like CDs, tiny cover graphics and all.

In addition, to acquiring content through a memory cartridge, on-line delivery will be an important feature. Most advertised E-books have chosen to include a telephone modem, taking advantage of the most ubiquitous form of communication available to consumers. Future E-books will have high speed network connections, perhaps using ADSL as it becomes more widely deployed to the home. Wireless networks will enable continuous connectivity and although they tend to have low-bandwidth in the wide area, they can deliver content as a background activity when a network is experiencing low utilization (e.g., overnight). Satellite data networks such as Iridium and Teledesic, available in the not too distant future, may also play a role in this market, allowing global access to electronic content.

Assuming the above "magical combination" of technologies result in a light, high quality reading device containing multiple books, how might we further enhance the reading experience? Poking at tiny scroll bars and opening virtual windows is way off the mark. We need to be able to easily turn pages, annotate, and insert bookmarks – using physical manipulations akin to those we use in the real world. Furthermore, pen input, that earned a bad reputation in the early nineties due to poor text recognition algorithms, has an important role as simple electronic ink for marking up documents in the E-book market. The good news is that these are well-understood user interface mechanisms, some of which are appearing on the new E-books recently launched. Even more improvements can be anticipated as competition heats up.

A number of technological advances have converged making E-books an interesting reality. Early indicators show that these E-books will weigh between 1 and 3 lbs., will last a minimum of several hours of continuous reading, have high quality displays, and can contain 1000's of pages of content (at least text content). Prototypes being shown borrow various book attributes, which include leather covers, dual conjoined displays, and paperback sizes. What remains to feed into the potential success and viability, is how content is sold, how easily available it is, and the usage rights users have for copyright material. And lastly, and perhaps most important of all, how much will a user will have to pay? Pricing models vary widely from a fairly low cost investment tied to a book-of-the-month club type of fee to 3-figure one time payments. What is clear is that the game is heating up and exciting new products are on the horizon. E-books are no longer a myth.

Figure 1a. Envisionment of a future E-book in the 1970's (Dynabook - Alan Kay)
Figure 1b. Products in development today: Softbook and Rocketbook