E Ink: Financing Growth

“We signed it!” Russ Wilcox exclaimed to James Juliano over his cellular phone. Wilcox, E Ink’s Vice President of Business Development, was referring to the meeting he had just come out of with executives from JC Penney. It was March 4, 1999 and JC Penney’s managers had just agreed to test E Ink’s latest prototype large-area display signs in 10 stores located in four different U.S. cities. The JC Penney deal was significant because it gave E Ink its first commercial forum in which to test its revolutionary electronic ink technology.

The timing of Wilcox’s call could not have been better. Juliano, President and CEO of E Ink, was in his Cambridge, Massachusetts office preparing for his upcoming meeting with Doug Eller, the Chief Financial Officer of Newstime Publishing. The purpose of Juliano’s meeting was to raise a portion of the $20 million needed for E Ink’s second round funding. Wilcox’s accomplishments with JC Penney represented the company’s first commercial deal and could only improve E Ink’s attractiveness to Eller. While Juliano was excited by the leverage Wilcox had just provided, he could not help but wonder if he was making a mistake by bringing this investment opportunity to Newstime Publishing. After all, E Ink still had $9 million in the bank from its $15.8 million first round of financing ten months earlier. Perhaps more importantly, E Ink had generated an almost unprecedented level of “buzz” regarding its electronic ink technology. Even without a released product, E Ink had already been featured in over 30 publications ranging from Fortune’s list of “Cool Companies 1998” to the L.A. Times to Popular Science, and interest continued to build. The excitement surrounding E Ink had created a unique financing problem for Juliano—how to politely turn away the numerous venture capitalists, technology companies and publishers who wanted to participate in the current round of financing.

The interest in E Ink stemmed from the vast potential of the company’s electronic ink technology. Juliano, Wilcox and the rest of the E Ink team had their sights set on revolutionizing the way people viewed information. The technology would hopefully one day result in an ability to print electronic ink on virtually any surface; enabling people to change displayed information through the use of a paging-type network. If successful, E Ink’s technology could be used for a seemingly endless number of applications such as embedding updatable maps on the sleeves of hiking jackets, creating more “readable” displays on cellular phones and enabling a fleet of billboards to change messages on command. E Ink’s technology could alter existing information display mechanisms as well as enable information displays that did not currently exist. Despite the numerous possibilities for the technology, E Ink had fixed its sights on “radio paper,” an actual book or newspaper printed with electronic ink and able to receive information wirelessly, as the company’s

Entreprenurial Studies Fellow Matthew C. Lieb prepared this case under the supervision of Professor William A. Sahlman as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. Some data is disguised.

Copyright © 1999 by the President and Fellows of Harvard College. To order copies or request permission to reproduce materials, call 1-800-545-7685 or write Harvard Business School Publishing, Boston, MA 02163. No part of this publication may be reproduced, stored in a retrieval system, used in a spreadsheet, or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise—without the permission of Harvard Business School.

Purchased by Lex McCusker (lmccuske@stevens.edu) on May 15, 2012
end objective. Iuliano's upcoming meeting with publishing executive Doug Eller highlighted E Ink's commitment to creating a radio paper that would replace the traditional printed newspaper.

Background

The Idea

Electronic ink was the brainchild of Joe Jacobson, a professor at the Massachusetts Institute of Technology's (MIT) Media Laboratory. During the summer of 1995, Jacobson was enjoying the California sun at a beach near Palo Alto when he was confronted with a practical problem that formed the genesis of electronic ink. Having just completed the book he was reading, Jacobson had two choices: he could pack up and head home to get another book, or he could bake in the sun with nothing to read. This simple dilemma spurred Jacobson into action. Rather than choosing another book, he began to sketch out possibilities for creating a single book that could morph into other books by changing the ink on the page. Jacobson, having recently completed his postdoctoral work in quantum mechanics at Stanford University, commented on his early vision of electronic ink:

The idea of an electronic book seemed like an exciting challenge. I knew it had to be done on paper or something pretty similar to paper. People are so used to reading from real paper that the whole notion of using some type of liquid crystal display didn't appeal to me. Second, it needed to use very little power so you could eliminate the need for heavy battery packs or other power sources. Lastly, it needed to be crisp in appearance—just like regular ink on paper. Taking these factors into account, I defined the parameters more narrowly. The electronic book must have 200 or more pages printed on real paper, each capable of displaying information. It must look as good as real ink. The cost per page must be comparable to traditional publishing costs. And the power required to run the book must be sufficiently low that the entire power source could be contained in the spine of the book at almost zero weight.

With rough parameters for electronic ink outlined in his mind, Jacobson turned his attention to various technologies that he could employ to meet his specifications for an electronic book:

I had experience working with a type of vinyl that could conduct electricity. I figured if you could cover a sheet of paper with millions of two-toned conductive particles you could then create images by carefully applying an electric charge. You could, theoretically, alter the content of each page by simply adjusting the flow of electricity across the page.

The Theory of Electronic Ink

With a vision in mind of what his end product would be, Jacobson came to the MIT Media Lab seeking the best way to develop electronic ink. He formed a team of students that included J.D. Albert and Barrett Comiskey. The two MIT seniors, under the direction of Jacobson, embraced an "Edisionian Approach" in developing the technology. Unlike traditional scientific work where only one variable at a time was modified with results carefully recorded, Albert and Comiskey adopted a more ad hoc approach of changing multiple variables with great frequency in an effort to hone in on a successful combination that would yield the required properties for electronic ink.

Near the end of 1996, after countless hours in the laboratory experimenting across scientific disciplines, Albert and Comiskey produced dramatic, though preliminary results. Their efforts had
yielded a technological foundation for an electronic ink that drew from two typically unrelated fields: electrophoresis and microencapsulation. Electrophoresis is the motion of a charged particle in response to an electric field. It could be used to create an electronic image display by using white particles suspended in a black liquid: when the particles are floating on top the viewer sees white, but when the particles are submerged the viewer sees black. Based on electrophoresis, an array of electrical fields such as a pixel array could move particles up and down to create white and black in a pattern. This formed the basis for making images with true black and white color. The question that remained was how to hold the liquid onto a flexible piece of paper? The answer was microcapsules: hollow shells about the size of a grain of laser toner that could be filled with the electrophoretic liquid and fabricated in bulk. The shells could then be printed onto just about any surface, just like traditional ink. A pattern of pixel electrodes could also be printed using conductive inks, completing the electronic display (see Exhibit 1 for a schematic drawing of electronic ink). Thus, the technology allowed for fabricating thin, flexible, low cost displays with significant economies of scale.

Liquid crystal displays and cathode ray tubes (CRTs), the two most popular forms of electronic displays, suffered from numerous drawbacks that had limited their ability to displace paper for markets such as books and newspapers. The advantages of electronic ink versus traditional display technologies were dramatic. First, electronic ink would be made of the same pigments and dyes as ink on paper. As a result, it would have the superior viewing characteristics of paper such as high contrast, wide viewing angle, and a paper white background. Second, electronic ink could be printed on almost any surface ranging from plastic to metal to paper and could cover large areas inexpensively. Third, the ink was capable of holding its image even after the power was turned off, just like ink on paper, and was legible enough in low light that a backlight would rarely be needed. The team felt this would significantly extend the battery life for portable devices. Lastly, the process was highly scalable, suggesting that electronic ink could catch up on a cost basis with more mature technologies.

Jacobson and his team dreamed of the day when they could beam digital information from a wireless transmitter directly to a sheet of electronic ink that incorporated a printed antenna and processor. This would allow people to read whatever they wanted, whenever they wanted, wherever they were. Achieving this ambitious goal would require another three to five years of well-funded R&D in both ink technology and pixel circuitry.

The Company

By early 1997, it was clear that electronic ink held strong commercial potential if sufficient resources and passion were committed. At this stage, Jerry Rubin, Chairman of the “News in the future” forum at the MIT Media Lab and a veteran of the publishing and information management industries, offered to help the team incorporate a company to pursue electronic ink and achieve the ultimate vision of radio paper. Together, Jacobson and Rubin brought Russ Wilcox, a 1995 graduate of Harvard Business School, on board to lead the effort to raise capital. By April 2, 1997 E Ink was incorporated and Wilcox was hard at work on a business plan.

Armed with a potentially revolutionary technology, Wilcox was able to quickly raise a seed round of $1.7 million in convertible debt from three local venture capitalists. In addition to the venture money, Wilcox arranged for a $2 million capital equipment credit facility with Imperial Bank. Wilcox then devoted his time to recruiting both scientists and managers while Comiskey and Albert built an R&D lab and began to move the technology forward. Wilcox also negotiated term sheets for a first equity round that would convert the $1.7 million in debt and add $14.1 million in new capital from the venture capitalists as well four major corporations (see Exhibit 2 for a list of equity investors). By May of 1998, the equity round was closed and by October 1998, E Ink had a team of 22 people in place focused on advancing the technology.
The surge in employees was highlighted by the arrival of Iuliano and an array of high profile scientists (see Exhibit 3 for the management team and board of director’s biographies). With the nucleus of a team together, Wilcox assumed the role of Vice President for Business Development and Jacobson refocused on his teaching efforts at MIT while continuing to serve as a consultant to E Ink.

The technical efforts quickly produced results. By March of 1999, the scientists at the company’s laboratory had increased the brightness and contrast of the display by a factor of five. Additionally, reflectivity increased from 15% to 35% while switching voltage dropped from 300 volts to 90 volts. Prototypes increased in size from 3 square inches to 25 square inches. The progress of the technology was highlighted by E Ink’s production of the world’s first all-printed flexible reflective display. While the technology was evolving, Iuliano moved aggressively to protect E Ink’s technological progress via a series of patents. By the time of Eller’s visit, Iuliano and his team had succeeded in acquiring, filing or licensing a large number of patents including a license from MIT that gave the university a small ownership stake in E Ink in exchange for rights to the patents filed by Jacobson, Albert and Comiskey.

The technological improvements had made the company’s prototypes sufficiently attractive that E Ink began to receive requests for shipment from potential customers. Strong customer interest and the advancement of the technology led Iuliano to aim for commercial readiness of the technology in the form of large-area retail displays in some form by the end of 1999. The deal with JC Penney represented a significant step forward in achieving Iuliano’s goal for retail displays.

**The Critical Path**

E Ink’s founders were driven by a desire to answer a single question: How could E Ink provide all of the benefits of digital content yet retain the pleasures of reading in bed, browsing a newspaper on the subway or thumbing through a magazine on the beach? Attempting to answer this question had set the company on a course to transform one of the world’s largest industries: publishing.

While radio paper was the pot of gold at the end of E Ink’s rainbow, there were many other potentially distracting and/or profitable applications along the way. E Ink’s technology could one day be used to replace almost any display currently in use or to create displays that had never before been possible. In fact, E Ink’s original business plan mentioned applications for electronic ink ranging from sneakers that track the number of steps taken to drug dispensers that indicate remaining doses to cereal boxes that scroll during breakfast reading. The media coverage of E Ink’s progress regarding the technology had already led to a flood of interest from potential partners such as JC Penney and other large corporations.

The challenge for Iuliano and his team was in pursuing only the opportunities that could generate short-term profitability while also serving to develop the technology along the path of radio paper. Iuliano explained the company’s predicament:

> Our stated goal has always been to create radio paper. Having said that, we know that we have a long way to go technologically to make radio paper a reality. In the meantime, we have a consortium of investors and a continual influx of potential customers and partners who all have different views on the best use for electronic ink. In fact, over the past 45 weeks, we have had 40 well-known companies visit our offices hoping to use electronic ink in some way to improve their business. The challenge for us as an organization is to very carefully select only the applications that can advance the technology along the critical path towards radio paper. We can’t afford to veer off track by pursuing seductive applications that have no
relevance to our end goal. We really need to be creative in developing the technology and disciplined in applying it.

After much analysis and debate, Juliano had chosen to set E Ink along a well-defined “critical path” towards the ultimate goal of radio paper. The path envisioned by Juliano would begin with (1) large area displays, followed by (2) battery-powered flat panel displays, ending with (3) radio paper. All of these steps represented entry to successively larger markets. The relevant portion of the large-area display market exceeded $600 million. The flat-panel display industry was expected to exceed $25 billion by 2004. The U.S. publishing industry alone exceeded $135 billion in annual revenue. With this critical path in mind, Juliano attempted to profitably steer the company through a series of obstacles in route to radio paper.

Phase I: Large Area Displays

E Ink’s first commercial venture would be in the large area display market. Convinced that E Ink needed to produce a “single product for a single market and a single market niche,” E Ink’s focus would be large area displays for retail signs, such as the prototypes developed for JC Penney. Large area displays represented an attractive market for E Ink because the opportunity was “big but with no entrenched gorilla” and a commercially viable product could be launched quickly based on the existing state of the technology.

Technically, electronic ink offered dramatic improvements over other large area display technologies. While other display technologies were glass-based and did not scale readily to large areas, electronic ink could be economically printed over large areas. The lightweight and visual appearance of electronic ink were key advantages over existing technologies.

The market for in-store displays was both large and ripe for improvement (see Exhibit 4 for market data on large area displays). LEK Consulting reported that the presence of machine printed signs could raise unit sales by an average of 200% based on a study of 143 different items. Despite the impact of signs, field compliance with prescribed messages for signs was remarkably low. In fact, only 33% of in-store displays conformed to specified requirements and the average lead-time to create a point-of-purchase program and deploy it to the field was nearly 90 days.

E Ink’s ability to incorporate a wireless communications interface such as an embedded pager offered another dramatic improvement versus existing in-store display options. Electronic ink enabled signs could be changed instantly from a central location, thus ensuring field compliance and quick response times. E Ink’s technology might also allow retailers and manufacturers to display more intelligent information based on factors such as time of day, demographics and sales trends. In addition to potentially delivering a higher quality product, E Ink also offered a cost advantage. A large two line LED sign would cost a retailer over $2,000 to install. The higher performing E Ink sign of similar dimensions was expected to sell for less than half the price of existing signs once production was ramped up to manufacture signs at a significant scale.

Wilcox, who headed up the Phase I effort for E Ink, estimated that the company could exceed a $20 million revenue run rate within three years. Wilcox also believed that the in store display business could exceed $100 million in revenue by 2004 if the technology advanced to the point of offering higher resolution and color. To fully take advantage of this opportunity Wilcox estimated E Ink would need to invest $10 to $20 million.

Despite the economic opportunity available in the in-store display market, it was the advancement of E Ink’s technology that interested Juliano the most. Juliano saw large area displays as a building-block opportunity. He described the in-store display opportunity from a technology development perspective:
The product requirements are right in line with our path to create electronic paper. By subjecting ourselves to marketplace demands early in our lifecycle, we can begin to build a customer and market-driven mentality that will serve us well going forward. As we enter the next phases along our critical path, the large-area display product line should be able to make use of all of the progress being made in our core technology.

**Phase II: Flat-Panel Displays**

Iuliano intended to make flat panel displays the second step on E Ink’s critical path to radio paper. Flat panel displays had received pervasive acceptance in the marketplace in a variety of forms for a number of uses. Most consumer electronics, computers, personal digital assistants and cellular phones utilized flat panel displays. In 1998, total flat panel display sales were nearly $14 billion and were expected to grow rapidly to over $25.9 billion by 2004.1

E Ink’s strategy in the flat panel display market was to identify specific niches of the market where the attributes of electronic ink created substantial value, permitting the company to price at a premium. Within this market, Iuliano sought applications requiring a high-contrast, low-power, thin and ultra-lightweight display. Such applications covered a wide array of products including communications, portable consumer and handheld devices. The market relevant to E Ink totaled almost $5 billion in 1998 and was expected to grow to almost $7 billion by 2002 (see Figure A for flat panel display market relevant to E Ink).

**Figure A** Global Flat Panel Display Market of Relevance to E Ink ($4.9 billion-$6.9 billion)

![Graph showing the market of relevance to E Ink.]

In researching the flat panel display market, Iuliano and others had engaged in conversations with managers at two major handheld device companies. These managers indicated a willingness to pay a substantial price premium for electronic ink versions of the typical hand held display, which typically cost $30 for volumes over one million. The premium was due to electronic ink’s greater visual appeal and lower power consumption.

---

1 All market-size data in this section are from “Flat Information Displays Market & Technology Trends (1998)” by Stanford Resources, Inc.
**Liquid crystal displays** The flat panel display market was currently dominated by several large manufacturers of liquid crystal displays (LCDs). Despite the fact that Sharp, Toshiba and other makers of LCDs had significantly improved the technology over time (see Exhibit 5 for LCD technology progress), LCDs had many inherent shortcomings. Active-matrix LCD displays were costly because of the need for an ultra high-precision glass-based thin-film transistor (TFT) backplane for switching. The backlight in many LCD displays consumed significant amounts of power, while reflective LCDs tended to be dim under many viewing conditions. Also, LCDs were produced on rigid substrates.

**E Ink’s Flat Panel Display Advantages** Iuliano believed that E Ink’s technology offered the best combination of price and performance for flat panel displays. When comparing the promise of electronic ink versus traditional LCDs, Iuliano pointed out a number of benefits highlighted in Table A.

**Table A** Electronic Ink versus LCDs

<table>
<thead>
<tr>
<th>Electronic Ink</th>
<th>Liquid Crystal Displays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct color change</td>
<td>Requires a change in light transmission</td>
</tr>
<tr>
<td>Looks like real ink on paper</td>
<td>Lacks the appeal of ink on paper</td>
</tr>
<tr>
<td>Less than 1 mm thick</td>
<td>Significantly thicker than 1 mm</td>
</tr>
<tr>
<td>Flexible</td>
<td>Rigid</td>
</tr>
<tr>
<td>Easily scaled to large sizes</td>
<td>Significant price increase when scaled up</td>
</tr>
<tr>
<td>Holds image without power drain (bistability)</td>
<td>Requires significant power to hold images</td>
</tr>
<tr>
<td>Lightweight</td>
<td>Power supply and glass makes LCDs relatively heavy</td>
</tr>
<tr>
<td>Broad temperature range</td>
<td>Does not perform well in low temperatures</td>
</tr>
<tr>
<td>Readable in sunlight</td>
<td>Difficult to see in bright light situations</td>
</tr>
<tr>
<td>Wide viewing angle</td>
<td>Limited viewing angle</td>
</tr>
<tr>
<td>Does not distort under finger pressure</td>
<td>Distorts when pressure is applied</td>
</tr>
</tbody>
</table>

Given the current limitations of LCDs and the large and growing market for flat panel displays, a number of other display technologies were under development. Microdisplays, organic light emitting diodes (OLEDs), field emission displays, plasma displays, microsphere approaches and further improvements to existing LCDs were all in the works (see Exhibit 6 for information on competing flat panel display technologies).

**Technological hurdles** While E Ink had already made tremendous progress in developing its technology for use in large area displays, the leap to flat panel displays was still challenging. Specifically, E Ink’s scientists needed to combine their electronic ink with a transistor backplane. The backplane would serve as the “circuity” by which high-resolution images could be changed through the application of a charge to the ink. E Ink was aggressively pursuing several backplane technologies in parallel. E Ink’s team had identified both cooperative and proprietary approaches to solving this problem and expected to demonstrate a crude working device sometime in 2000, with product shipping roughly eighteen months later. To successfully launch into the flat panel display market, Iuliano estimated that E Ink would need an additional $30 to 50 million in financing.
Phase III: Publishing

Radio paper had been the ultimate goal at E Ink since Jacobson’s reading dilemma at the California beach. The notion of radio paper captivated the minds of employees, investors and the press. If Juliano and the rest of the team could deliver what they were aiming for, E Ink might revolutionize one of America’s largest industries.

The U.S. publishing industry generated over $135 billion in revenue in 1998 (see Table B for detailed breakout) from a variety of sources including purchases, subscriptions and advertising. Publishing revenues were surprisingly robust despite the growth of the Internet and the digital economy. For example, even though overall newspaper circulation had been on the decline since 1987, advertising sales were growing at a rate of nearly 8% per year. The growth in advertising rates yielded a forecasted industry revenue figure of over $160 billion by 2001.

Table B  U.S. Publishing Market Revenues in 1998

<table>
<thead>
<tr>
<th>Market</th>
<th>1998 U.S. Revenues ($ billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newspapers</td>
<td>$60</td>
</tr>
<tr>
<td>Professional / Educational Books</td>
<td>30</td>
</tr>
<tr>
<td>Consumer Magazines</td>
<td>18</td>
</tr>
<tr>
<td>Consumer Books</td>
<td>18</td>
</tr>
<tr>
<td>Business Magazines</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>$135</td>
</tr>
</tbody>
</table>

Juliano intended to leverage technological advancements achieved during the development of large area displays and flat panel displays to make radio paper a reality. The possible economic rewards associated with replacing much of traditional publishing with electronic ink technology were astronomical. All sectors of publishing could benefit economically from a paper-free distribution model that required $0 for manufacturing, no inventory, and $0 for distribution. Such expenses typically accounted for 20%-40% of publishers’ costs, suggesting a multi-billion problem that was E Ink’s opportunity.

Newspapers The newspaper industry was particularly ripe for an electronic ink enabled change. Nearly 65% of Americans read a daily newspaper, with 60 million daily newspapers sold on average each day and an average per-copy readership of 2.3. Thus 138 million people were reached on a daily basis. There were nearly 1,500 daily newspapers in the United States with the top 10 newspaper companies owning 325 newspapers that accounted for 43% of the total daily circulation.

The average circulation revenue per year per subscriber was $175, with an additional $600 per year in per subscriber advertising revenue. Newsprint was the single largest expense for newspapers besides labor. Newsprint prices were volatile, ranging 40% from peak to trough in the space of a single year. This instability added risk to the newspaper business and made profits hard to predict. In 1996, 11.1 million tons of newsprint was purchased by the U.S. newspaper industry at a cost totaling $7 billion. Newsprint alone represented a cost of roughly $115 per subscriber every year. Adding other variable manufacturing and distribution costs, newspapers spent roughly $350 per customer each year.
While Iuliano was unclear as to the specific business model he would employ to exploit the newspaper opportunity, it was clear that the impact of electronic ink could be dramatic (see Exhibit 7 for economics of the newspaper industry). E Ink might one day offer consumers the ability to have one newspaper where content could be updated and customized instantaneously at the push of a button.

Books Books represented another large segment of the publishing industry where E Ink’s technology might one day become applicable. Jacobson’s initial vision was centered on the ability to provide consumers with a single paper based book that could be updated with customized content through a wireless network. While newspapers had not received much attention from other display technology companies, electronic books were not a new phenomenon. In fact, in 1999 several electronic book products were scheduled to be available to consumers (see Exhibit 8 for a description of competing electronic book products). Additionally, Microsoft was already in the process of devising an industry standard for the operating system that would enable electronic books.

E Ink hoped to differentiate, and eventually dominate, the electronic book industry by utilizing the inherently superior display technology of electronic ink. Iuliano and his team intended to comply with whatever standards were developed and believed that an early electronic ink based book could be ready in two to three years, with the ultimate radio paper version arriving in four or five years.

While the rewards associated with transforming the publishing industry were great, the investment required for success was not inconsequential. Depending on the business model Iuliano could envision needing an additional $50 million to $100 million in capital to fully exploit the publishing opportunity.

Financing

Despite still having $9 million on hand from E Ink’s first round of financing, Iuliano was now in the process of raising still more capital. His upcoming meeting with Eller would hopefully yield a portion of the $20 million in funds he hoped to raise during the second full round of financing. The company was consuming nearly $500,000 in cash each month and the burn rate was forecasted to increase to nearly $1 million per month as Iuliano ramped up personnel and development efforts. Iuliano estimated that E Ink would need over $16 million to sustain progress over the next five fiscal quarters. He described his motives and strategy for the company’s second round financing:

We are trying to revolutionize an entire industry within five years, so going slow is not an option. We have quite a bit of momentum right now in terms of the attention we are receiving and the progress we are making. This is critical and a second round of financing, despite our cash position, is integral to keeping that momentum.

This round of funding will be used primarily to fund the large area display business and second generation technology development. But I can see additional fund-raising over the next few years. It will not be long before we need another $30 to $50 million to launch the flat panel display business. Shortly thereafter, we will require another infusion to grow our radio paper business. So I intend for this current round of financing to be a mezzanine round that will allow us to prove some things and give us the ability to go public if we so choose.

Sizing a round is about more than money. I am convinced that raising capital more frequently in smaller rounds as the technology is demonstrated will
minimize dilution. On the other hand, raising bigger amounts of capital may block out competitors and improve our flexibility. We need to strike the right balance.

Conclusion

Everyone involved with E Ink believed in the company’s ability to achieve its end goal of radio paper. To attain this goal, Iuliano knew that he and his team of managers and scientists would need to aggressively maneuver past a series of technological, financial, marketing, manufacturing and human resource obstacles (see Exhibit 9 for goals and responsibilities of E Ink functional areas). The pace of business for E Ink was extremely aggressive with a 1999 schedule including a move into a new facility, ramping up production of large area displays, more than doubling the number of in-house scientists, achieving demonstrable progress in the area of transistor backplanes and raising a second round of funding.

While the critical path to success was both disciplined and well thought out, Iuliano knew there were hundreds of things that could go wrong. In particular, Iuliano was focused on choosing the right partners for both financing and technology development. As he prepared for Eller’s arrival, he contemplated the journey ahead:

While we have a lot of people interested in partnering with us, we must be very careful in choosing the right partners. Financing in particular is going to be very important as we will need a lot of capital in a relatively short period of time to achieve our goals. Our current investors are very valuable, but their resources are limited and we can’t count on them to finance all of our efforts.

I spend a lot of time thinking about who the right investors are for this opportunity. Venture capitalists are capable of moving very quickly, which is a positive, but it is not clear to me what new VC’s will add above and beyond what our current venture capital investors provide. Corporate investors might also be attractive, but they also have drawbacks. Chemistry companies might give us valuable assistance in our R&D efforts while sign companies could speed up the development and implementation of our large area display business. Down the road, handheld device manufacturers and publishers could prove to be invaluable in achieving our Phase II and Phase III objectives. The problem with corporate investors is that they tend to move cautiously and they may want to tie their investments to specific rights and restrictions that would limit our flexibility.

Getting to radio paper is not going to be easy and there is not much room for error. We need to make the right decisions in so many areas. Who do we partner with for financing and technology development? Can we beat competing technologies to market? How will the company’s culture evolve as we grow so quickly? What will our business model look like as we move along the “critical path”? All of these questions represent inflection points in the growth of this business and the repercussions of making the wrong decisions could be disastrous.
Exhibit 1  Schematic Drawing of Electronic Ink

- Positive Charge
- Microcapsule containing electrophoretic liquid
- Negative Charge
- Microcapsule containing electrophoretic liquid
Exhibit 2  E Ink’s First Round Financing as of March 1999:

E Ink was funded by a $15.8 million first round of equity that included the following investors:

**Applied Technology**: Applied Technology, a venture capital firm founded in 1983 with more than $80 million in capital under management, maintains offices in Lexington, MA; Austin, TX; and Menlo Park, CA. Focused on early stage high tech companies, it offers a unique framework for maximizing investment returns by coupling an experienced management team with both corporate partners and academic experts. The Partnership is actively investing from its third fund with investments in 32 companies to date.

**Atlas Venture**: Venture capital firm focusing on information technology and life sciences with offices in Boston, Menlo Park, Amsterdam, London and Munich. The firm manages over $850 million with over $400 million committed from the most recent fund formed in 1999. Since its inception in 1980, Atlas Venture has funded more than 200 companies. Of these companies, 39 have successfully completed initial public offerings, 76 have been acquired and 81 are still developing.

**Creavis GmbH**: Headquartered in Marl, Germany, Creavis is a wholly owned subsidiary of Degussa-Hüls. Degussa Hüls is one of the world’s largest specialty chemical companies. Creavis specializes in investing in and developing innovative products with a heavy reliance on chemistry.

**The Hearst Corporation**: The Hearst Corporation is one of the nation’s largest diversified communications companies. Its major interests include magazine, newspaper and business publishing, cable networks, television and radio broadcasting, Internet businesses, television production and distribution, newspaper features distribution, and real estate.

**Interpublic Group of Companies, Inc.**: Interpublic Group specializes in advertising and communication services. IPG operating companies include McCann-Erickson WorldGroup, Ammirati Puris Lintas, The Lowe Group and Western International Media.

**Motorola, Inc.**: Motorola is a global company specializing in providing integrated communications and embedded electronic solutions. Motorola is a leader in software-enhanced wireless telephone, two way radio, messaging and satellite communications products and systems. Motorola also offers networking and Internet access products.

**Solstice Capital**: Solstice Capital is a private venture capital partnership formed in 1995 to invest in seed and early stage private companies. The partnership oversees the investment of $22.75 million of committed capital and has invested in 20 portfolio companies. The basic strategy of the Fund is to identify companies which are positioned to capitalize on major change factors. Solstice believes that a number of long term trends such as concern for the environment, clean water, whole foods, and quality of life create opportunities for new companies. The primary factors which are determinants of success for investment are quality of management, technology advantage, and market positioning.

---

2Information on investors taken from the websites of the respective companies or was supplied by E Ink management.

* Received a position on the E Ink Board of Directors.

** Received observer rights on the E Ink Board of Directors.
Exhibit 3   E Ink Management Team as of March 1999

James P. Iuliano, President and CEO, is also a member of the board of directors. Iuliano was recruited to develop and implement the strategy for commercializing electronic ink. Prior to joining E Ink, Iuliano was president, director and CEO of Molecular Devices Corp. of Sunnyvale, CA (NASDAQ: MDCC), an analytical instrumentation company in the life sciences market. At Molecular Devices, Iuliano completed a successful turnaround, generating 20 consecutive quarters of record profits and growing revenues 300% in five years. Iuliano led Molecular Devices through a highly successful initial public offering and grew its market capitalization to nearly $250 million. In his career, Iuliano has raised over $100 million in public and private financing, negotiated several acquisitions and technology licensing deals and built worldwide market leadership positions in emerging technologies. He earned an M.B.A. from Harvard Business School and a B.S. from Boston College.

F. Javed Chaudhary, Vice President Operations, is responsible for all operational and manufacturing activities at E Ink. Most recently as Vice President and General Manager of Seagate Technology (Thailand), Chaudhary was responsible for building over 20 million assemblies annually with a P&L budget exceeding $280 million. He holds an M.S. in Engineering Management from Northeastern University and a B.S. in Mechanical Engineering from the Engineering University Lahore, Pakistan.

Russell J. Wilcox, Vice President and General Manager (co-founder), holds P&L responsibility for launching the large-area display business, encompassing wireless networks of billboards, signs and displays. One of the founders of E Ink, Wilcox led the company during its first ten months of operations as Vice President of Business Development. He was instrumental in recruiting the initial team, securing $18 million in debt and equity financing, licensing intellectual property and developing corporate relationships. Wilcox was previously Director of PC Products for venture-backed PureSpeech, Inc. Wilcox earned honors degrees from Harvard College in Applied Mathematics and the Harvard Business School MBA Program where he was named a Baker Scholar.

J.D. Albert, Principal Engineer (co-founder), is the lead design engineer behind the company's large-area display product line. At the MIT Media Lab, he developed novel methods of making electronic ink and flexible displays. He is an MIT graduate, with a B.S. in Mechanical Engineering.

Barrett Comiskey, Principal Scientist (co-founder), works on intellectual property, quality testing, and future technologies. Comiskey pioneered the original research at the MIT Media Lab. Comiskey graduated from MIT, earning a B.S. in mathematics. He has published several papers and holds patents on technologies related to electronic ink, digital and analog steganography and cryptography.

Dr. Paul Drzaic, Director of Display Technology, has extensive experience in both display systems and materials science. Prior to joining E Ink, Drzaic was the principal scientist leading the polymer-dispersed liquid crystal (PDLC) effort for Raychem Corporation, where he developed new materials for use in flat-panel displays. Drzaic is the author of *Liquid Crystal Dispersions* (1995).

Dr. Ian Morrison, Director of Ink Technology, leads E Ink’s ongoing development of enhanced versions of electronic ink. Prior to joining E Ink, Morrison had a distinguished career at Xerox Corporation where he held a variety of high-level research and development positions. Most recently, Morrison researched electrical, rheological and optical properties of nonaqueous dispersions. Morrison holds 19 patents, has written numerous technical articles published in scientific journals.

Purchased by Lex McCusker (lmccuske@stevens.edu) on May 15, 2012
Exhibit 3 (continued)  E Ink Board of Directors as of March 1999

**Tom Grant, Managing Director, Applied Technology**  Tom Grant selects and manages investments for Applied Technology and serves actively on the boards of several portfolio companies. Applied Technology focuses on early-stage companies developing enabling information technologies and content.

**James P. Iuliano, President and CEO of E Ink Corporation**  Mr. Iuliano serves as the company’s chief executive officer.

**Dr. Joseph Jacobson, Assistant Professor, MIT Media Lab**  Joseph Jacobson is an Assistant Professor at the Massachusetts Institute of Technology (MIT) Media Laboratory, where he initiated a program to develop electronic paper-books with pages consisting of electronically addressable, rewritable displays formed on real paper. He holds several patents and patents pending in electronic display technology. Dr. Jacobson received his Ph.D. in physics at MIT in 1992 in femtosecond laser engineering. He created the world’s shortest pulse laser (in optical cycles) in 1991. He was a post-doctoral fellow at Stanford from 1992 to 1995, working on experimental and theoretical nonlinear non-local quantum systems. His theoretical work, published in the Physical Review, has been written up in the New York Times and Physics Today.

**Jerome S. Rubin, Founder Lexis/Nexis, and Managing Director Veronis, Suhler & Associates (Chairman)**  Jerry Rubin was first exposed to electronic ink while serving as Chairman of the M.I.T. Media Lab’s research initiative, News in the Future. He joined M.I.T. in December 1992 after retiring from the Times Mirror Company, where he was Chairman of the Professional Information and Book Publishing Group. Before joining Times Mirror in 1983, Mr. Rubin developed and brought to commercial success LEXIS, the computer-assisted legal research service (launched in 1973), and NEXIS, the on-line news research service (launched in 1978). Combined, these constitute the world’s largest on-line textual information service. In 1985 the Information Industry Association inducted Mr. Rubin into its Hall of Fame for his pioneering achievements in electronic publishing. Since September 1995, Mr. Rubin has been a Managing Director of Veronis, Suhler & Associates, the foremost investment banking firm specializing in communications & media (newspaper, magazine & book publishing, radio, TV & cable, and online information systems). Mr. Rubin is a Director of several corporations besides E Ink and also of some not-for-profit organizations. Mr. Rubin holds two Harvard degrees – a bachelor’s degree in Physics (1944) and a law degree (1949). He was a co-author of Toward the Year 2000: New Forces in Publishing (Bertelsmann, 1989) and of Mastering the Changing Information World (Ablex, 1992).

**Larry Silverstein, Esq., Partner, Bingham Dana (general counsel)**  Larry Silverstein practices as a member of the Entrepreneurial Services Group at Bingham Dana. Mr. Silverstein acts as counsel to many emerging growth, middle market and established companies, both public and private.

**Christopher Spray, General Partner, Atlas Venture Capital**  Christopher Spray founded Atlas Venture’s US partnership in 1986. He began his international venture capital career in 1983, when he joined CINVen, a leading European venture fund based in the UK. Atlas Venture is a partnership of international venture capitalists formed to finance high-technology businesses seeking success in the global economy. Investments are concentrated in two sectors - life sciences and information technology.

**John Steadman, Vice President, Motorola Messaging Systems Products Group**  Mr. Steadman is currently Vice President of Motorola’s Messaging Systems Products Group (MSPG). MSPG is responsible for all aspects of Motorola’s paging business worldwide. Motorola’s 1997 sales were $29.8 billion.
### Exhibit 4  Segments of the Large Area Display Market Relevant to E Ink ($ millions)

<table>
<thead>
<tr>
<th></th>
<th>LED Matrix</th>
<th>Incandescent Bulbs</th>
<th>Electro-mechanical</th>
<th>Total ($610M)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Purpose</td>
<td>$80</td>
<td>$50</td>
<td>$15</td>
<td>$145</td>
<td>24%</td>
</tr>
<tr>
<td>Casino &amp; Bar</td>
<td>20</td>
<td>125</td>
<td>-</td>
<td>145</td>
<td>24%</td>
</tr>
<tr>
<td>Government</td>
<td>75</td>
<td>35</td>
<td>25</td>
<td>135</td>
<td>22%</td>
</tr>
<tr>
<td>Retail &amp; Food</td>
<td>70</td>
<td>-</td>
<td>-</td>
<td>70</td>
<td>11%</td>
</tr>
<tr>
<td>Sports</td>
<td></td>
<td>35</td>
<td>10</td>
<td>45</td>
<td>7%</td>
</tr>
<tr>
<td>Transport</td>
<td>10</td>
<td>-</td>
<td>3.0</td>
<td>50</td>
<td>7%</td>
</tr>
<tr>
<td>All Other</td>
<td>15</td>
<td>15</td>
<td>-</td>
<td>30</td>
<td>5%</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>$270</td>
<td>$260</td>
<td>$80</td>
<td>$610</td>
<td>100%</td>
</tr>
</tbody>
</table>

Purchased by Lex McCusker (Imccuske@stevens.edu) on May 15, 2012
Exhibit 5  Technological Progress of Liquid Crystal Displays

Thickness Trend (10-Inch Class TFT-LCD)

Weight Trend (10-Inch Class TFT-LCD)

Power Trend (10-Inch Class TFT-LCD)

Adapted from: Flat Panel Displays, Toshiba America Electronic Components, Inc.
Exhibit 6  Competing Flat Panel Display Technologies

Enhancement of LCDs—the LCD is not a fixed technology. With hundreds of millions of dollars being spent annually on incremental improvements, the LCD is getting cheaper and better with each passing year. Enhancements include new ways of addressing passive displays, filters to improve light transmission, the development of plastic-substrate LCDs, wider viewing angles, and a sustained and massive effort by Asian display companies to drive down costs.

Microdisplays—being commercialized by Kopin, DisplayTech, Colorado Microdisplay, Siliscape, and others. These devices consist of a 1-inch or smaller display, which must be magnified for the viewer to discern an image. Microdisplays are suited for virtual reality headgear, camcorders, PDA with lens attachment and projection TVs where the image can be expanded onto a distant surface.

Organic LEDs (OLEDs)—under study by over 60 companies worldwide, including most major display companies. OLEDs offer full color capability in a flexible light-emitting display (i.e., visible in the dark). This is described as a “high potential new display technology” but is still in the development stage. OLEDs are likely to achieve commercial status in the next few years.

Field Emission Displays (FEDs)—being commercialized by Candescent, Motorola, and PixTech. This technology is based on the same principle as the television, but replicated on a tiny scale with one emitter per pixel. While original prospects were strong for this technology to replace laptop screens, several years of delay have allowed LCDs to narrow the gap in price/performance.

Plasma (PDPs)—being commercialized by several Japanese companies, especially Fujitsu. Plasma displays offer a better alternative to the LCD for large displays from 40-80 inches. While starting factory prices were at $15,000 for a 42” display in 1996, prices reached $7,000 in 1998 projected at $2,600 by 2002, according to Fujitsu. The emphasis in PDP technology has been on large-area displays, competing primarily against projection display systems.

Gyricon—Xerox, as long ago as 1977, began research of the ‘Gyricon’ in which half black/half white microspheres are encapsulated in a rubber sheet. This is considered a rival technology to E Ink’s for creating an electronic paper. No product plans have been announced.
Exhibit 7  Potential Radio Paper Economics versus Traditional Newspapers

<table>
<thead>
<tr>
<th>Line Item</th>
<th>Traditional Newspapers (billion)</th>
<th>Radio Paper (billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newspapers Per year</td>
<td>22.50</td>
<td>22.50</td>
</tr>
<tr>
<td>Sales Per Paper</td>
<td>$2.18</td>
<td>$2.18</td>
</tr>
<tr>
<td>Operating Costs</td>
<td>$1.75</td>
<td>$1.40</td>
</tr>
<tr>
<td>Operating Margin</td>
<td>$0.44</td>
<td>$0.78</td>
</tr>
<tr>
<td>Net Income</td>
<td>$0.18</td>
<td>$0.40</td>
</tr>
</tbody>
</table>

Source:  E Ink estimates.

Additional benefits of radio paper versus physical newspapers:

- Faster turnaround eliminates 11:30 p.m. deadlines to deliver by 5:30 a.m.
- Elimination of vulnerability to hyper-cyclical input cost of newsprint.
- No space constraints (can expand size of paper and therefore advertising space as desired).
- Ability to microsegment delivery zones.
Exhibit 8  Competing Electronic Book Products

**RocketBook**—a small, lightweight device with medium memory but long battery life. Partnered with Sharp to help design and manufacture the device, with Levenger and Franklin Electronics to sell it by mail order and retail outlets, with many publishers to provide content, and with Barnes & Noble to sell electronic versions. Consumer focus, especially popular business books for traveling executives. Users are demanding ability to store user files and HTML on device. Sells for $499. Must buy books from barnesandnoble.com.

**SoftBook**—a large, heavy device with much memory and short battery life. Fewer partners. Some consumer sales but oriented to fleet sales to corporate customers who must publish many pages of documents to mobile workers. Sells for $599 or $299 with 24 months subscription at $19.95/month. Must buy books from proprietary store.

**Everybook**—a large, heavy device with much memory and short battery life. Focused on selling to the professional/educational market as a replacement for heavy textbooks. Full color screens with high resolution for precise book reproduction. Sells for $1000-$1500 with two full side-by-side screens. Must use proprietary store.

**Librius**—a small, lightweight device with limited memory and long battery life. Focused on selling romance novels to consumers. Sells for $199. Must buy novels in proprietary store; priced at 20-25% less than paper.
Exhibit 9  E Ink Functional Area Objectives

Marketing

E Ink’s goal is to distinguish the company as more than a component supplier. Efforts will involve both consumer marketing and industrial marketing campaigns. The company intends to develop a two-tiered strategy with a flagship E Ink brand and product line names for each major product category (large-area, flat-panel, publishing).

Near-term marketing responsibilities include corporate identity and branding, creation of sales demo kits and printed collateral, public relations and evaluating customer feedback to display designs.

Research & Development

Near-term R&D objectives include optimizing first-generation ink that can be sold, developing enhanced second-generation ink and adding additional layers of patent protection. Following the achievement of near-term objectives, R&D efforts will focus on minimizing the cost to manufacture the ink, optimizing the visual appeal of the displays, further reducing power and voltage requirements and exploring third-generation ink possibilities.

Engineering

The engineering department is primarily responsible for applying R&D technologies to products. Near-term priorities for the engineering team include designing large area text displays, developing volume production processes, engineering custom designs for major corporate partners and building prototypes to support sales activities.

Manufacturing

E Ink’s manufacturing employees will develop and control all critical manufacturing processes to commercialize electronic ink in large area displays, portable flat panel displays and publishing applications. The manufacturing strategy consists of demonstration of process capability ready for scale up by E Ink followed by in-house pilot production of selected key process steps. Volume production of most process steps will be maintained at sub-contract supply partners and controlled by E Ink technical support staff for conformance to E Ink specifications.

Near-term manufacturing objectives include start-up of new E Ink consolidated facility and scale production of large area displays.