ALPHASMART

Providing a smart solution for one classroom-computing "job"

AN EDUCATION CASE STUDY

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EXECUTIVE SUMMARY

In 1992, when personal computing was in its relative infancy, Apple Computer engineers Joe Barrus and Ketan Kothari, later joined by Ketan's brother, Manish, launched a successful effort to produce and market "smart keyboards." With these word-processing devices, the entrepreneurs targeted elementary school teachers who found personal computers unsatisfying for the tasks that they were trying to do. Joe, Ketan, and Manish's new company, called AlphaSmart, Inc., developed and marketed a disruptive innovation that capitalized on the extraordinary growth of personal computing during the 1990s.

The company developed a device, also called the AlphaSmart, which was a portable, battery-powered, word-processing keyboard with a small LCD display. It functioned essentially like a simple digital typewriter, but it could be plugged into an Apple Desktop Bus (ADB)* port for transferring text into a computer's word-processing program for further editing or printing.

The AlphaSmart was successful in schools because it focused on a critical job elementary school teachers were trying to do that desktop computers were not doing well. Although desktop computers were powerful and versatile, they were complicated for many teachers to deploy, expensive for schools to own in large numbers, and distracting to students during the composition process. Teachers wanted a simpler, less expensive device that would enable students to spend more time learning to type and compose without the distraction of myriad other functions, the scheduling limitations of computer labs, or the demands of complex deployment and maintenance.

Understanding that elementary school teachers had a fundamentally different job to be done enabled the company to develop a product that performed well when measured by the desired attributes of simplicity, durability, portability, intuitiveness, and cost—even though the AlphaSmart underperformed desktop computers along dimensions such as speed, power, and graphics. This understanding of the job to be done led the company to target other groups that could also benefit from a "smart keyboard" and then adapt and promote the product effectively. The product and marketing strategy resonated with teachers, and thus the company brought computing power to millions of students around the globe.

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* See glossary of computer terms in Appendix A

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This case study describes how a company developed and marketed a disruptive innovation that capitalized on the extraordinary growth of personal computing during the 1990s. The story illustrates how disruptive products can gain traction in the education space by filling an important and unmet need, or "job to be done."

The emergence of personal computers

During the 1980s and 1990s, personal computers were changing the way the world worked, played, and learned by offering consumers the power to complete a rapidly expanding range of tasks at home, work, and school. Following the release of the Apple II in 1977 and the IBM PC in 1981, combined with the introduction of Graphical User Interfaces (GUI)* in the 1980s, personal computing grew substantially throughout the 1990s, as shown in **Figure 1.**[1] In 1993, 23 percent of U.S. households owned a computer, and 43 percent of employed U.S. adults were enlisting a computer at work.[2]

That same year, over half of U.S. students were using computers at school, primarily for keyboarding, word processing, and educational gaming.[3] The ratio of students to computers, however, was only 14-to-1, which meant that students were limited in how much time they could spend using computers at school.[4] Additionally, nearly 50 percent of these computers were located in computer labs shared by an entire school, which meant that teachers had to coordinate student use of computers in advance.[5]

In addition to the logistical limitations of computers in schools, elementary school teachers were finding it challenging to use computers effectively in instruction. During this time, as many as 50 percent of public school teachers had little or no experience with technology in the classroom, and only 14 percent had received more than eight hours of training in educational technology during the year.[6] Over 80 percent of teachers cited lack of time to learn to use computers as a barrier to integration of technology with instruction.[7]

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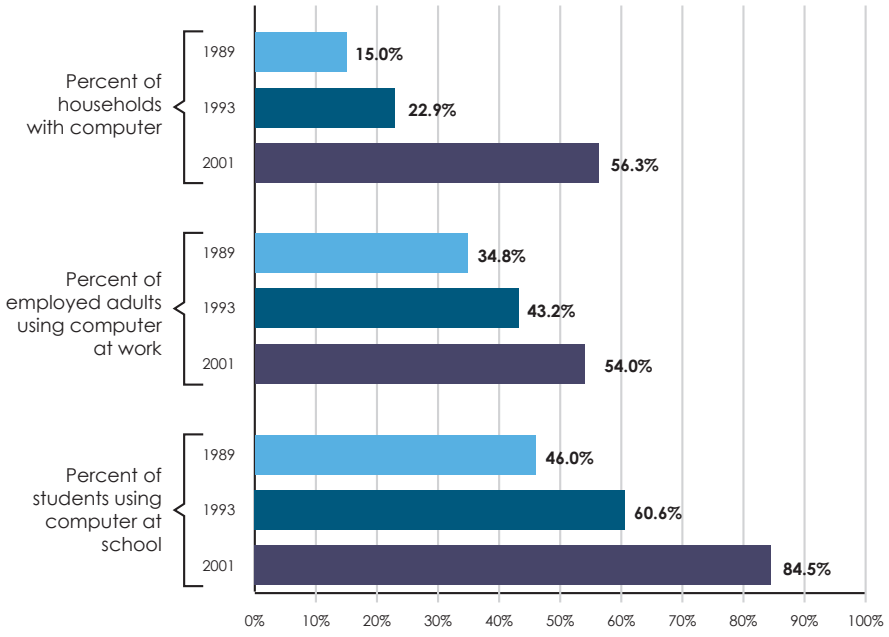
* See glossary of computer terms in Appendix A

Figure 1 *Use of computers by location and year*



(Source: U.S. Census Bureau Current Population Surveys)

Entrepreneurs discover an idea

One day in early 1991, Joe Barrus was at work at Apple Computer (Apple) when he overheard a hallway conversation about Apple's consideration of a product idea for a "smart keyboard." He learned that Apple had received multiple requests from elementary school teachers for a word-processing device that would be simpler, cheaper, and more durable than a desktop computer and that could be used to teach typing, grammar, and composition. Although Apple had rejected the idea, Joe thought it had merit and decided to discuss the idea with his friend and fellow Apple employee, Ketan Kothari.

Joe and Ketan had become friends as undergraduates at Brigham Young University before both obtained engineering jobs at Apple in the late 1980s. Both men were consummate tinkerers with a mutual interest in new business development, and they had begun searching in their free time for ideas that could fuel new businesses that would make them "rock stars within Apple," as Ketan said, or even allow them to launch their own company.

Joe and Ketan's latest explorations into new business ventures had centered on uses for the Apple Desktop Bus (ADB)*, a new interface that enabled users to connect peripheral devices to Apple computers without requiring any configuration, such as driver† installation or baud rate‡ settings. The flexibility of the ADB offered the potential for a wide range of devices to be connected to a desktop computer for programming or data transfer and then disconnected and used remotely. Joe and Ketan had considered several ideas for this interface, such as sprinkler control systems, barcode scanners, and "power gloves" that would allow computer control through hand motions, but none of these ideas had resulted in a viable product.

When Joe and Ketan discussed the "smart keyboard" idea that Joe had overheard at Apple, they decided to explore its potential. They began tinkering with devices in their spare time and sought to understand the potential market for such a device. They also enlisted support from Ketan's brother, Manish, who had attended college with the pair. Manish had recently finished his MBA and was working in product development at a medical device company, but he began helping the team in his free time.

During their exploration of the "smart keyboard" idea, Joe, Ketan, and Manish discovered an online discussion board, where a group of technically savvy elementary school teachers was chatting about a variety of education topics. Some teachers were using the discussion board to air their frustrations with computing in the classroom, recount the shortcomings of desktop computers, and articulate the need for a product like a "smart keyboard."

One issue that elementary school teachers cited was that desktop computers were complicated to set up and maintain. "Many teachers were technophobes," Joe said. "They didn't feel confident using computers; they didn't grow up in the computer age." Unfortunately, computers often required extensive configuration to accomplish simple tasks. Even a simple keyboarding program required that someone install and configure the software on each machine. When such a program did not work as planned, the teacher had to interrupt the lesson and spend time troubleshooting cables, drivers, and settings—leaving the students to their own

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* See glossary of computer terms in Appendix A

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devices. Teachers wanted something simpler than a personal computer so that they could focus on teaching.

As referenced above, a second issue—which had originally prompted elementary school teachers to approach computer manufacturers—was the teachers' contention that the 30 to 50 minutes per week that their students were spending in a computer lab was not enough time for students to learn basic keyboarding and word-processing skills, much less become good writers. Yet because desktop computers were quite expensive—over $2,000 each—most schools could not afford to buy more of them. Furthermore, the infrastructure in classrooms often could not accommodate 20-plus desktop computers because of restricted desktop space and too few electrical outlets. Nevertheless, as Manish said, paraphrasing Seymour Papert*, "You can't share a pencil among five kids and think you're going to produce great writers. . . . The feedback from the teachers was, 'Give us something less expensive and portable so that we are not tied to the lab and our students can have more time.'"

Traditional computers didn't work well in typical elementary school classrooms because they were:

- Too complicated to deploy
- Too expensive to purchase in large quantities
- Incompatible with classroom infrastructure
- Loaded with too many features that distracted students

Lastly, the elementary school teachers considered the robust capabilities of desktop computers distracting. In teaching students how to write, the teachers wanted to separate the composition and publishing aspects of the process, but desktop computers did not make this separation easy to accomplish. Joe said, "Students would write a sentence, then play with the font, the color, or the spacing. Teachers wanted students to focus on the language, the words, and how they tied together—basic writing skills."

To ameliorate these frustrations, the teachers wanted a device that would be simple to use, inexpensive enough to allow each student to have his own device, and durable enough to withstand student abuse. With such a device, elementary school teachers believed they could devote significantly more time to teaching keyboarding, spelling, grammar, and composition. They could teach students to compose without the distraction of games, font sizes, or colors, and then they could later connect the device to a computer to teach the elements of publishing. Perhaps most important, the teachers' time could be spent teaching, not managing technology.

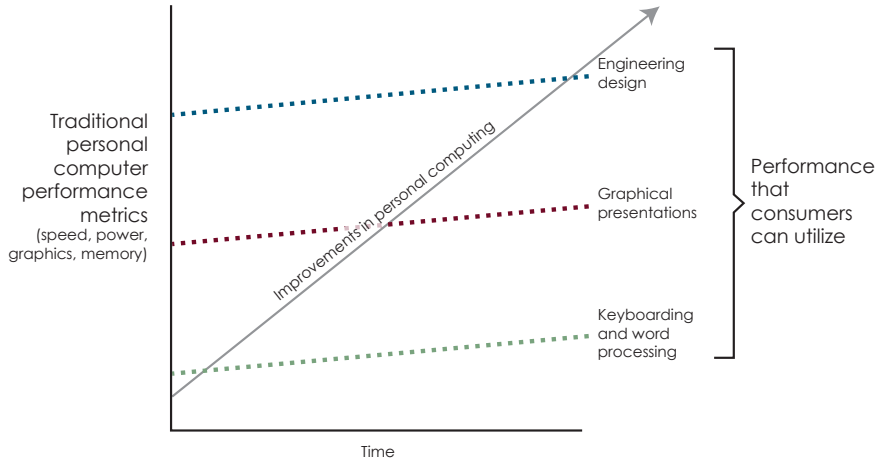
This scenario bore the classic hallmarks of an opportunity for a disruptive innovation to emerge. A disruptive innovation is one that transforms a sector

* Seymour Papert is a mathematician, computer scientist, and MIT professor whose research includes the use of technology in education. He was a founding member of the MIT Media Lab, which spawned the One Laptop Per Child project.

characterized by products that were typically too expensive, inconvenient, centralized, and complicated to use into one characterized by products that are affordable, more accessible, and simple. Disruptions nearly always start in areas of nonconsumption—where the alternative is literally nothing at all. In such areas, the initial users of disruptive products are delighted with a product that is "good enough" for their needs because the existing products were prohibitively expensive, complicated, or inaccessible.

The fact that computers were expensive to purchase and maintain, often located in centralized computer labs, and complicated to use because they did not fit naturally into most schools' infrastructure and schedule made many classrooms classic areas of nonconsumption. Indeed, personal computers' capabilities had significantly overshot teachers' needs, as they had advanced well beyond providing basic keyboarding functionality to offering the power to perform complex calculations, engineering design tasks, and graphical presentations (see **Figure 2**). For some teachers, a simple device that focused on ease of use, low cost, and durability would better do a job they needed done.

Figure 2 *Improvements in personal computing*



The team develops a product

The teachers did not view the the device they had requested as a computer in the traditional sense; they were asking for a "smart keyboard."

Using the information they had gathered from the online discussion board, Joe, Ketan, and Manish set to work developing a prototype for a "smart keyboard" that would better meet elementary school teachers' needs. They created the prototype by replacing the workings of a standard keyboard and adding a small LCD display to the top.

Several of the discussion-board teachers from the Pacific Northwest had offered to serve as a focus group of sorts, and the team drove to Seattle to share the prototype with these teachers and collect their reactions. The reception was positive, though the meeting did result in a list of improvements. During the discussion, one teacher mentioned an upcoming Northwest Council for Computer Education (NCCE) conference that would feature thousands of educators from across the Northwest. The teacher said, "If you can come back with a prototype along the lines of what we've told you, I will facilitate a workshop, and at the end of it, you will get orders."

Excited by this eager reception, the team members toiled away for the next month to refine the prototype. They enlarged the LCD display, converted the machine to battery power, and made other adjustments, but it was still simply a keyboard—no monitor, disk drives, mouse, or tower. They named their device the "AlphaSmart."

The elementary school teachers had made an important distinction that had helped guide Joe, Ketan, and Manish in developing the product. The teachers did not view the device they had requested as a computer in the traditional sense; they were asking for a "smart keyboard." Manish stressed the importance of that distinction: "The key innovation in my mind . . . was that they turned it from being a computer substitute or a 'low-end laptop' to being a 'smart keyboard,' and there's a big difference between the two."

That difference is exemplified by the "low-end laptops" that a few desktop computer manufacturers had begun to offer. In the team's view, these products were still not addressing the teachers' needs well. The laptops sold in the $300 to $500 range, but they did not feature full-size keyboards, adequate durability, or suitable battery life. Additionally, they were complicated to deploy. One low-end laptop, the Tandy WP-2, had a manual that was 150 pages long, whereas the AlphaSmart manual was only 11 pages. Using such devices required downloading and configuring software, which often caused compatibility issues. They required drivers and configuration of the serial port's baud rate and other settings. They also included extra software, such as a terminal emulator and calendar that was a

distraction.[8] "In our minds, low-end laptops were clearly way too complicated," Ketan said. "With its longer battery life, integrated software, universal compatibility, and the resulting 1-key dump feature, the AlphaSmart was an order of magnitude better." It was with this mindset that Joe, Ketan, and Manish developed the product.

When the team presented the AlphaSmart to a few hundred teachers at the NCCE workshop, "literally people were signing us personal checks at the end. . . . We didn't even have a company then," Ketan said. With such a positive response, the team members knew they were onto something, but they had to decide how to pursue the idea.

Apple passes on the idea

Having received positive feedback on their prototype from teachers at the NCCE workshop, Joe, Ketan, and Manish decided to present their idea to Apple management in hopes of gaining approval either to launch the product within Apple or to pursue the idea on their own. The director of the Macintosh hardware division was excited by their idea. During a review of the prototype, he typed a single line into the AlphaSmart's interface: "This could sell millions."

Unfortunately, he did not feel that he could champion the idea further, as he categorized the machine as an input device because it was more of a keyboard than a computer. He connected the team members to Apple's vice president of input devices and arranged a meeting for them to present the idea. During that presentation, the vice president of input devices was less enthusiastic. Ketan said, "They only thought keyboards and mice; they couldn't think computers. He literally slept halfway through the presentation. We knew it was not going any further at that point." As predicted, after six months of stalling, in late 1991, Apple management declared that Apple was not interested in pursuing the idea but gave the team license to pursue it independently.

This response is representative of the classic behavior that existing companies exhibit naturally when they encounter a product that is disruptive relative to their existing business. The innovation does not look attractive because it is inferior when judged by traditional performance metrics, is less expensive, and often has lower margins.

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cost. Apple did not recognize that, for some occasions, elementary school teachers had a fundamentally different job to be done and that targeting this job with a different product represented an opportunity to create another line of business.

One reason Apple missed this opportunity to create another line of business was because it had segmented the market by product, not by job to be done. This segmentation drove Apple to focus on the sustaining trajectory of cramming more and more features into an increasingly commoditized personal computer and ignoring other jobs that offered ways to differentiate its products.

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The team forms a company and launches the AlphaSmart

After receiving the green light from Apple to pursue the idea on their own, Joe, Ketan, and Manish formed a new company in early 1992 to develop and market the AlphaSmart. They called the company Intelligent Peripheral Devices, but changed its name to AlphaSmart, Inc. in 1999 after the AlphaSmart's success had grown. Unwilling to give substantial control to investors, Joe, Ketan, and Manish pooled family savings and configured a lean operation to manufacture, promote, and sell the product.

Joe and Ketan continued working at Apple in order to collect salaries, while Manish nurtured the company full time from Ketan's spare bedroom. The company incurred few sales and distribution expenses because the majority of its units were sold directly. The company spent its limited marketing budget largely on trade shows, which it sometimes even managed to attend for free by sharing space with Apple distributors. The trade shows, along with a free "loaner" program the company had introduced to allow teachers to test devices for free, helped create buzz about the new product. Several districts clamored for the product even as the cash-strapped start-up struggled to refine it and solidify its manufacturing strategy. Eventually, the company identified a manufacturer willing to produce the circuitry in batches as small as 100 units at a price that made the company profitable on a per-unit basis, and Joe assembled the first few units in his garage.

This lean structure allowed the company to focus on getting the product right while remaining patient for growth. "We didn't have a growth objective," Manish said. "We said, 'Let's get it right and the growth will come.'" After a year of perfecting the product and arranging production, the company launched the original AlphaSmart device in August 1993.

The original AlphaSmart included a full-size keyboard with an adjacent 4-line display. Two AA batteries powered the device, which made it portable and freed it from requiring one of the limited electrical connections in most classrooms, all while offering hundreds of hours of use. It functioned as a standalone writing device, and it stored and retrieved up to eight files, each of which could be accessed with one press of the corresponding file button. It could also be linked to a host computer for programming or for transferring those files for editing and publishing. The ADB interface made the device compatible for such connections without software or drivers, thus enabling one of the most acclaimed features: the 1-key "dump" function, which allowed the user to transfer files from the AlphaSmart to an Apple desktop computer with only one key press. The device's simplicity eliminated the need for an operating system (OS)*, command prompt, or GUI; it included only limited firmware† to operate the word-processing and file-management systems seamlessly and intuitively. This simple firmware allowed the device to power on and off instantly. Because there was no hard disk drive‡, and because it was constructed of durable plastics, the device could withstand quite a bit of abuse. **Figure 3** depicts a later model of the AlphaSmart, which, despite its improved industrial design, was similar in size and concept to the original model.

Figure 3 *AlphaSmart 2000*

(Source: Company promotional materials)

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* See glossary of computer terms in Appendix A

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The company sold $250,000 worth of AlphaSmarts during the remainder of 1993. By 1994, sales had leapt to $2.5 million, which gave the company a cumulative profit. At that point, Joe and Ketan left Apple to run the company full time.

As the sales figures suggest, the target market received the device's simplicity well. When teachers heard the company's explanation of its word-processing functionality, they would often ask, "'Is that all it does?'" Joe said. "I would answer 'Yes . . .,' crestfallen, but then the teacher would respond, 'Ah! I'm so glad!'" The teachers found having a simple device tailored to their needs that could be used almost without thought—a "word-processing toaster," as Joe called it—a relief.

The product line evolves

The team's focus on elementary school teachers' needs had helped the company create a strong foothold in a new market, but the company needed to continue evolving the product in order to continue meeting customer needs. The company continued to add features to the device and release new models every few years as outlined in **Figure 4.**

Figure 4 *AlphaSmart product evolution*

	AlphaSmart	AlphaSmart Pro	AlphaSmart 2000	AlphaSmart 3000	Dana	Neo
Year	1993	1995	1997	2000	2002	2004
Memory	32 kB / (16 pages)	128 kB / (64 pages)	128 kB / (64 pages)	200 kB / (100 pages)	8 MB	400 kB / (200 pages)
Hardware features	• ADB port • 4-line display • 100+ hour battery life	• ADB + PS/2 • 200+ hour battery life	• IR port • Improved industrial design • 300+ hour battery life	• USB+ serial • Translucent case • 500+ hour battery life	• Wi-Fi • SD slot • Large touch-screen display • 25 hour battery life	• 6-line display • 700+ hour battery life
Software features	• 1-key dump • Integrated OS	• "Find" fxn • Password • Text retrieval • Special needs features	• Spell-check • Direct print • Auto power off • Typing timer	• Smart Applets • Cut/copy/paste	• Palm OS	• Variable fonts • Dynamic file resizing
Price	$270	$270	$250	$220	$400+	$230

(Source: Company promotional materials)

The company was careful to avoid "feature creep" by focusing most model upgrades on the four to five key features that teachers were demanding most frequently. "The single biggest challenge was how do we bucket features that still qualify it as a 'smart keyboard,' versus it becoming more than it should be," Manish said.

Ketan added, "We agonized over spell check. It was the number one requested thing. We felt it doesn't make sense to have a spell check, but at the end of the day, you listen to your customer."

By 1995, the "low-end laptop" competitors had begun taking notice of the AlphaSmart. One competitor responded to the AlphaSmart's traction by claiming that the AlphaSmart was "not a real computer" and advertising that its product offered more features than the AlphaSmart, such as web browsing and databases.[9] But the company considered such limitations to be a key advantage of the AlphaSmart. It ignored the claims of its competitors and chose instead to emphasize the attributes it knew its customers valued, such as simplicity, long battery life, and durability. "At trade shows, I would just wait for them to ask how durable it is, then drop kick it," Joe said. "Everyone would look down the aisle to see what happened. That was one thing our competitors wouldn't do." The company also made steady improvements to the battery life as well as to the industrial design of the product to give it a more recognizable and user-friendly design.

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As sales grew, the company began noticing other market segments that had similar needs for a simple word-processing device. One such segment was writers and journalists. For this group, the best alternative that was available at the time was a Personal Digital Assistant (PDA)* device combined with a folding keyboard. Compared to the PDA setup, however, the AlphaSmart was cheaper, more durable, more comfortable, simpler, and had a better battery life.[10] The company made a few product tweaks for this group, such as changing the feel of key travel, or the distance each key traveled and the springiness it possessed, to allow for faster typing.

Another segment the company believed could benefit from a "smart keyboard" was special needs students—particularly those who struggled with dysgraphia. Students with dysgraphia suffer the inability to write but can often type with less difficulty. The company began to incorporate and promote features that catered

* See glossary of computer terms in Appendix A

to special needs students, such as flexible font sizes, flexible keyboard layouts, and optional speech output.

The company also began thinking about teachers' needs in a holistic sense. It began including more software, such as a typing tutor program, which allowed for self-paced instruction. Later, it offered carts of 30 devices along with a USB hub for charging and programming the keyboards. By 2002, these carts accounted for nearly half of the AlphaSmart units sold. These innovations were very popular because they helped teachers more easily deploy and manage a classroom full of AlphaSmart devices, such as the one depicted in **Figure 5.**

Given all of these enhancements, the product's performance improved steadily through 2002 when AlphaSmart, Inc. released a new, higher-end product called the "Dana."

Figure 5 *Students using AlphaSmarts in a classroom*

(Source: Company promotional materials)

AlphaSmart, Inc. launches the Dana

The Dana departed radically from the trajectory of the company's previous product releases. It featured 8 megabytes (MB) of memory, the Palm OS, a touch-screen interface, a secure digital (SD)* expansion slot, and Wi-Fi† capability. With its improved memory, graphics, power, and software, the Dana narrowed the gap between the AlphaSmart's performance and that of personal computers.

Although the Dana was still targeted at teachers, the company had developed it in an attempt to create a two-tiered product offering. Some users had asked for a larger screen and more features, and the company had thought a higher-end product would have greater appeal for these users and consequently help grow the company.

Unfortunately, the Dana underperformed in many of the attributes desired of a "smart keyboard." Its battery life was a comparatively low 25 hours. The Palm OS resulted in much more complexity in deployment and teacher training, and although it had opened the door to additional applications, they were not as simple as those on the AlphaSmart, nor as intuitive as those on a PC. The touch screen was a creative new input method, but "it was a distraction," Manish said. Lastly, at a price of $400 or more, it also did not meet schools' low-cost needs or the prices of previous AlphaSmart versions.

In hindsight, Manish said that the company had lost its focus on the word-processing task with the Dana. "It was trying to be a low-end laptop. We thought when teachers came to us and said, 'This doesn't quite cut it for our middle school or high school students,' we would say 'Oh, great, we have the Dana; it does so much more!' but it just wasn't that simple. The category we were trying to establish didn't exist. What they wanted was a laptop, but they wanted it at a price point of $700," he said. Sales of the Dana reflected these shortcomings, as they hovered around 20,000 to 30,000 units per year, compared with approximately 150,000 AlphaSmart units per year. This behavior is a classic case of losing sight of the job to be done and cramming in features in an effort to introduce sustaining innovations. In contrast to disruptive innovations, sustaining innovations do not create new markets but rather only evolve existing ones with better value, thereby allowing the firms within to compete against each other's sustaining improvements.

This behavior is a classic case of losing sight of the job to be done and cramming in features in an effort to introduce sustaining innovations.

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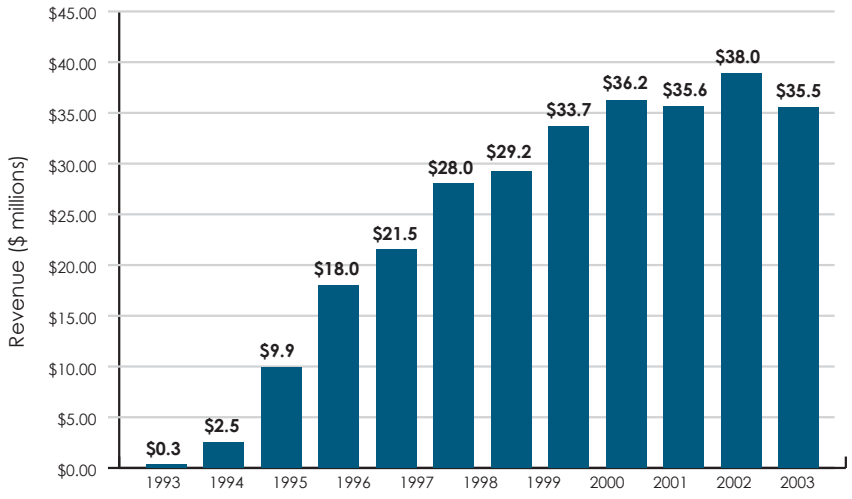
The company learned from this experience and renewed its focus. In 2004, it launched the final improvement, the Neo, which returned to the simple, stable, long-lived AlphaSmart paradigm of a simple interface without an OS, an LCD display without a touch screen, and hundreds of hours of battery life (see **Figure 4** for detailed descriptions of each model).

AlphaSmart, Inc. goes public

The company's continued focus on meeting the needs of elementary school teachers resulted in rapid growth, as shown in **Figure 6**. By the beginning of 2004, AlphaSmart, Inc. had 90 employees and an annual revenue of $40 million.[11] Although the company had originally favored family savings and "bootstrapping" over outside investments, in 1999, it had accepted a $20 million outside investment from the investment firm Summit Partners to fund further product development and growth. An Initial Public Offering (IPO) was one way to allow outside investors to recoup their investment plus receive a healthy return generated by the company's strong performance. Although going public would carry some drawbacks, such as a loss of autonomy and public disclosure of information that might be helpful to competitors, Manish and Ketan ultimately decided that taking the company public was the right decision and would be a good experience for them as entrepreneurs. AlphaSmart, Inc. (NASDAQ:ALSM) went public on February 6, 2004. It raised $24 million, which gave the firm a market capitalization of nearly $90 million.[12]

Figure 6 *Company revenue by year*



(Source: Company financial information)

AlphaSmart, Inc. is acquired

As the product matured, the company began recognizing that software could also enhance the AlphaSmart's ability to fulfill elementary school teachers' needs. Ketan said, "It was like the iPod, but what it really needed was the music." The company explored math quizzes and reading software. Eventually, it formed a partnership with Renaissance Learning, an educational software company, to provide a range of educational programs. It even envisioned the product as an assessment device, which could provide teachers near-instant feedback on students' progress.

As with the original product, however, the company recognized the importance of simplicity and fidelity, and it realized that even greater integration between hardware and software might ensure that the experience was truly "plug and play" the way teachers demanded. At the same time, Renaissance Learning sought an additional platform for its software. This synergy between the two firms resulted in Renaissance Learning's acquiring AlphaSmart, Inc. in 2005 for $57 million.[13] Joe, Ketan, and Manish stayed at Renaissance Learning for a short time to help integrate the companies before moving on to other ventures, and Renaissance Learning continues to sell the AlphaSmart Neo to schools around the world.

The AlphaSmart targeted customers trying to do a specific job, but for whom a simple, inexpensive solution was unattainable.

Conclusion

When a large set of consumers becomes over-served by existing products, the door is opened for disruptive products to enter the market and serve those consumers better. Such a disruptive product is more likely to be successful at capturing the market if it is focused on a specific job those consumers need to get done. This focus allows development of a product that has the right performance metrics at the right cost, and it allows the producer to target the right customer base with a clear message.

The founders of AlphaSmart, Inc. created one such product and followed several key tenets of disruptive innovation in the process. Their product targeted customers trying to do a specific job, but for whom a simple, inexpensive solution was unattainable. The company's focus on that job allowed them to develop the right product, market it effectively, and avoid distraction by competitors who were not as focused on that specific set of customer needs. Although their device was technically sophisticated, they deployed it in a "foolproof" manner. As a result, its simplicity and robustness delighted educators, and its rapid adoption brought technology closer for millions of students.

Appendix A *Glossary of computer terms*

Apple Desktop Bus (ADB) – Interface for connecting peripheral devices to Apple computers without any configuration such as driver installation or baud rate settings. It was an improvement over serial ports, but a precursor to the Universal Serial Bus (USB), which is now nearly universally used to connect cameras, mobile phones, mice, printers, and keyboards to a computer.

Baud rate – Measure of the rate of data transfer between a computer and a peripheral device.

Driver – Program that allows a computer to communicate and interact with a peripheral device such as a mouse, keyboard, printer, or joystick.

Firmware – Software that is written onto an electronic device's read-only memory (ROM) that is not intended to be changed. In devices such as mobile phones, digital cameras, and mp3 players, firmware is typically a very basic operating system that controls the hardware.

Graphical user interface (GUI) – Program that obtains user commands and input via graphics items such as icons, lists, and windows as opposed to text commands entered through a command prompt.

Hard disk drive (HDD) – Standard storage device for desktop and many laptop computers. It uses magnetic heads to encode and retrieve data on a rotating disk. Because they involve moving parts, hard disk drives are more susceptible to damage than "solid state" memory, which has no moving parts.

Operating system (OS) – Set of programs on a computer that manage how it uses resources, executes applications, and accesses information. The user interacts with the OS through a command prompt or a GUI. Examples include MS-DOS, Microsoft Windows, OS X, and Linux.

Personal digital assistant (PDA) – Handheld device commonly used to manage appointments, take notes, and read and write e-mail. Generally, a pen-like stylus provided input through a touch screen, sometimes even recognizing handwriting. Text entry using handwriting recognition was slow, prompting use of collapsible keyboards for any significant text entry. Examples include Palm Pilot, Handspring Visor, and HP Jornada Pocket PC. Many 21st-century mobile phones such as Blackberry, iPhone, and Android devices are also PDAs.

Secure Digital (SD) – A format of memory for storing information on portable devices such as cameras and mobile phones. It can store information even when not powered, and it is "solid state," meaning it uses no moving parts.

Wi-Fi – Standard method for connecting computing devices to each other without wires. It is commonly used to create networks of computers, mobile phones, and game consoles, generally connected to the Internet.

Notes

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About Innosight Institute

Innosight Institute, founded in May 2007, is a 501(c)(3) not-for-profit think tank whose mission is to apply Harvard Business School Professor Clayton Christensen's theories of disruptive innovation to develop and promote solutions to the most vexing problems in the social sector.

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