America’s Ice Industry: A Case Study

The American ice industry thrived in 19th century New England. The “Ice King,” Frederic Tudor of Boston, sent his first shipment of ice from the port of Charlestown, Massachusetts, to Martinique in the West Indies in 1806. Fifty years later, his company was shipping nearly 150 tons of ice per year to several U.S. ports, the Caribbean islands, Rio de Janeiro, Bombay, Hong Kong, and sites in between. Tudor benefited from collaboration with Nathaniel Jarvis Wyeth, who invented an ice plow and more than 50 other tools for harvesting natural ice from local ponds and storing it. These innovations are said to have cut the price of delivered ice by one-third.

Tudor’s growing success attracted others to the business, so that by the late 1870s there were no fewer than 14 firms in the Boston area alone cutting almost 700,000 tons of ice each year. Maine and New Hampshire also had thriving ice companies. Innovations continued to make the product more uniform and lower the cost of production. The ice business became an important part of the U.S. economy and continued to expand as households became regular consumers of harvested ice. City dwellers had begun purchasing ice boxes in growing numbers after 1850, and these soon became a modern necessity.

Yet—though no one recognized it at the time—the 1880s were to be the zenith of the harvested ice
industry. The market for refrigeration was to continue expanding with the growing nation, but a radical innovation based on a totally different technology had already invaded the periphery of the industry.

Machine-made ice began to bite off chunks of the harvested ice industry during the 1860s. These inroads started slowly, as many early attempts to produce ice by mechanical or chemical means proved more costly than harvesting natural ice. Summer prices in the North typically ranged between $6 to $8 per ton of harvested ice; in the South, though, prices were much higher—often as much as $125 per ton. As a result, Southern markets offered the greatest receptivity to innovations affecting the supply and price of ice. As experiments with vapor compression machines and various refrigerants improved ice-making technology in leaps and bounds, costs fell. In 1868, New Orleans got its first ice-making plant, which began manufacturing and selling ice for around $35 per ton, substantially less than the price of natural ice. Some 20 years later, by 1889, there were well over 200 ice plants, mostly in the South. New England ice was finding itself effectively driven out of the Southern markets.

Yet, even as new technology and innovations were transforming the industry, the ice merchants of the North pushed ahead with their own improvements and still greater production. They developed and refined a production, storage, and distribution system for harvested ice that was remarkably efficient, so much so that the 1886 harvest was the biggest ever—25 million tons. The Northern ice merchants’ response to the challenges to their dominant position, and their failure to recognize that the changes in their industry were indeed revolutionary, illustrates a widespread pattern: Powerful competitors often not only resist innovative threats, but also resist efforts to understand them, preferring instead to further deepen their commitment to their older products. Failing firms tend to be remarkably creative in defending their entrenched technologies, which often reach unimagined heights of elegance in design and technical performance only when their demise is clearly predictable.

The ice industry case also illustrates how the demise of a technology can be obscured by a growing market. While the demand for ice and refrigeration continued to expand, ice harvesters steadily lost markets to plant-made ice. The coup de grace came after World War I when old-fashioned ice boxes began to give way to electric refrigerators. By the mid-1940s, the natural ice industry was gone for good. It had served, though, as an important step toward greatly expanding affordable refrigeration and the availability of fresh food, and likewise significantly improving the overall diet of the general population.

The Invasion Process

The invasion process of a radical technological innovation, as described in the ice industry case, tends to follow a predictable pattern. Generally, in any product market there are periods of continuity, when the rate of innovation is incremental and major changes are infrequent, and periods of discontinuity, when major product or process changes occur. Radical changes create new businesses and transform or destroy existing ones.

At the time an invading technology first appears, the established technology generally offers better performance or cost than does the challenger, which is still unperfected. The new technology may be viewed as crude, leading to the belief that it will find only limited application. One problem with early machine-made ice, for example, was its cloudiness, making it seem less clean or pure than harvested ice. A more recent example is early word processors: Apple’s first personal computer was difficult to master and produced only uppercase letters. Few were willing to give up their IBM Selectrics for it! The performance superiority of the established technology may prevail for quite some time, but if the new technology has real merit, it typically enters a period of rapid improvement—just as the established technology enters a stage of slow incremental improvements. Eventually the newcomer improves its performance, matches the established technology, and then rockets past it.

Lessons Learned

Although I do not expect colleges and universities to meet the same fate as the natural ice industry, it is the case that American higher education today faces similarly radical
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innovations in the development and delivery of its core product—knowledge. Given the invasion of technology and the rate of innovative improvements in the application of multimedia methods to teaching and learning, it is likely that colleges and universities will be transformed in this century. Thus, a review of the lessons learned from research on how leading enterprises in tangible products tend to react to the challenges posed by innovations may serve a useful purpose in the higher education setting.

Machine-made ice vastly expanded the use of refrigeration and its value in preserving and distributing food. Similarly, electric refrigeration not only further expanded the use of refrigeration, but it made possible widespread air conditioning and other applications. The Internet and multimedia methods may well have similar effects on our profession. While it is difficult to judge who may win and who may lose as a result of such innovations, it is clear that judging the new primarily as a substitute for the established is a common error. It is often the case that innovations capture the richest emerging opportunities and for a time at least may be more symbiotic than threatening. Every ton of the new machine-made ice, for example, at first led to the sale of three additional tons of harvested ice by making refrigeration more reliable and widespread. It took nearly half a century for machine-made ice to become a mortal threat to natural ice in its most established markets.

Generally, established leaders in their fields face two major hurdles in their contest with invading innovations. First, the leaders need to develop an awareness of their own vulnerability—a slow and difficult process for any firm or organization that has experienced substantial success. But recognition of an external threat is the first requirement for effective action.

The second hurdle is to make the necessary organizational adjustments. The organizational problem for most established firms is that they and their technology are often stuck in a relatively static stage of development, while the challenger and its innovations are still in a dynamic and fluid stage. The challenger brings a new and perfectible product with better performance (or performance potential), organizational flexibility, and entrepreneurial spirit; the challenger is encumbered by human and physical assets geared to highly specific production. The established firm, on the other hand, is more bureaucratic, enjoys economies of scale (but in the wrong product), has tremendous investments in inflexible systems, and is most likely managed by nonentrepreneurs.

It’s easy to understand how established firms can ignore radical innovation when it first appears. For one thing, in the early stages it is far from clear that the radical innovation will have much impact. Established firms also carry the burden of large investments in people, equipment, plants, materials, and knowledge, all of which are closely linked to the established technology. It takes a rare kind of leadership to shift resources away from these areas where one currently enjoys success to an area that is new and unproven.

Findings in fields as diverse as the history of technology, corporate strategy, and the dynamics of innovation have reached a common and disturbing conclusion: An unhappy by-product of success in one generation of technology is a narrowing of focus and vulnerability to competitors championing the next technological generation. Modern managers must develop a broad vision of the future and nourish organizational capabilities that will carry them successfully forward. This may be the ultimate managerial challenge.

Research on the most successful firms and organizations over the last century reveals a timeless characteristic, namely, respect for the value of human resources and skills and their continuing development. The most important strategy of all appears to lie in top managements’ appreciation of the people who build and sustain their enterprises, and in respect for their ability to learn and to adapt to changing and challenging circumstances.

Further, campus leaders would do well to develop or-
ganizational plans that encourage monitoring the external environment, self-examination, and constant renewal. The best leaders will also develop contingency plans to address the unexpected circumstances that are almost certain to arise. In the best of cases, those unexpected changes will open the way to greater opportunities than at first imagined. Indeed, technological advances have spurred many changes that hold much promise for improving higher education.

Envisioning how the Internet and related new media technologies can help advance higher education is an exciting exercise. Multimedia educational tools such as The Valley of the Shadow, developed by Edward Ayers and his colleagues at the University of Virginia’s Institute for Advanced Technology in the Humanities, illustrate the potential of technology to enrich teaching and learning. The Valley of the Shadow catalogs online and in great detail the daily lives of the people who lived in quite similar towns at opposite ends of the Shenandoah Valley, placing them north and south of the Mason Dixon Line during the Civil War. This interactive tool not only enables students to deeply engage historical material in a totally new way—to learn by doing, through guided experience and mentoring—but also enables them to make scholarly contributions as they work with the material and break new ground.

New multimedia-based methods of working with students and content simply have no precedent. Among their many advantages, these tools help build networks that bring in diverse information and encourage experiments, keeping perspectives fresh and generating new knowledge. Perhaps most important, they mitigate the narrowing of focus that can be the downfall of organizations at the top of their fields.

The virtual classics consortium in the Associated Colleges of the South presents another level of the use of technology to enhance teaching and learning. There, 15 colleges are collaborating by using technology to pool the resources of their individual classics departments and create a powerful example of the benefits to be gained by working together. The opportunities for classics students at any one of the member institutions are greatly enhanced by access to resources across the consortium; faculty gain too by collaborating on courses and thereby expanding their perspectives.

I believe we are on the threshold of breaking down divisions across disciplines as well as across institutions. Technology enables scholarship and experimentation that breaks out of the boundaries that separate us, vastly expanding the possibilities for discovery at the intersection of disciplines.

I do not think that one of the inevitable results of technological innovation for higher education will be the scaling up of colleges and universities to massive proportions, able to serve many more students at once as a result of the economies of scale made possible by technology. Indeed, one potential result of the multimedia tools and efforts described above is to allow intellectual endeavors to be pursued on a small but efficient scale. In many ways, technology works against the idea of scale through the creative and collaborative means it enables.

Conclusion

The direction of change and progress is often unclear except in hindsight. Yet when or how change will occur is not so important as is recognizing that it undoubtedly will happen. In the final analysis, only that understanding will allow institutions to successfully make the transition to a new future. For higher education to play a meaningful role in building a new and better future for the world’s citizens, education must be made more widely available, more reasonably priced, and more tailored to learners. Innovations in technology and new learning media hold tremendous promise for achieving those goals.

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