Let Us Now Praise The Humble Post-it

Contemplating the manifold uses of the Post-it Note, one might wonder how humankind ever managed to get along without it. As engineer-author Henry Petroski relates, the story behind this product's relatively recent development demonstrates not so much how "form follows function" but rather how "the form of one thing follows from the failure of another thing to function as we would like."

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by Henry Petroski

Many a writer on technology has been struck in a moment of pause between sentences or an hour of distraction between paragraphs by the extraordinariness of ordinary things. The push-button telephone, the electronic calculator, and the very computer on which these words are being processed are among the more sophisticated things we use, and they awe into silence those of us who are not electrical engineers. By contrast, low-tech objects such as pins, thumb tacks, and paper clips are frequently and verbosely praised for their functionality and beauty of line, but are seldom the subject of study, unless it is for the sake of learning how to market something that people use much but consider little. The most common of objects are certainly not generally thought to hold lessons for technological process, prowess, or progress.

But if there are general principles that govern the evolution of technology and its things, then the principles must apply equally to the common and to the grand. And how much easier it might be to understand how technology works if we could pursue it in the context of something that is less intimidating than a system that takes teams of engineers years to develop. The individual complexity of supercomputers and skyscrapers, nuclear power plants and space shuttles, distracts from the common basic elements of technological development that are behind all things—the great and the small, the seemingly simple and the clearly complex. The individual designer and engineer involved in the production of large systems is often lost in numerous management shuffles, and the story of the end product is frequently a major enterprise with an anonymous if professional cast of thousands, no one of whom is commonly known to be the designer or the engineer. But, while the often-amateur actors in the little-theater pieces surrounding the design and development of many of our simple objects may also be anonymous as far as myriad consumers are concerned, the plot is usually much easier to follow.

Ironically, the largest and most anonymous engineering structures and sys-

tems—such as bridges, skyscrapers, airplanes, and power plants—are frequently produced by companies named after people. Thus we have the Brown and Roots, the Bechtels, and the countless regional and local founder-named construction companies that ultimately shape so much of our public space and convey a sense of civic pride and achievement. We have the airplanes called McDonnell-Douglases, Curtiss-Wrights, and Boeings, namesakes of inventors and developers whose pioneering has, directly or indirectly, given us the space shuttles, superjets, and even corporate jets of today. And we have the Westinghouses and the Edisons that have provided us with the electric-power stations and distribution networks that make modern life so comfortable and convenient. We have the Fords, Chryslers, Mercedes-Benzes, Rolls-Royces, and other automobiles carrying on their grilles the names of long-gone entrepreneurs. Even the giant corporations called General Electric, General Motors, and General Dynamics can evoke more the sense of a leader of manufacturing troops than the culmination of a concatenation of once-individual and private companies.

The names commonly associated with some of the more familiar and cherished products on our desks, however, are enigmatic if known at all. Items such as pins and paper clips certainly do not carry nameplates or medallions memorializing their makers. If we examine the box that paper clips come in, it tells us our clips were made by Acco or Noesting, which hardly sound like the names of inventors or even people. Many a desk stapler is labeled Bostitch. Is this someone's name, or what? Modest products tend to have, at best, pseudonyms that give little hint of their in-

During the long centuries before the invention of the Post-it, lovers of books, including the great humanist Erasmus, had to make do with imperfect versions of bookmarking technology. (The etching, by Albrecht Dürer, was completed in 1526.)

The company letterhead of 3M in 1908.

ventors, but the brand name of a product and that of the company that makes it often do hold clues to how the product evolved, thereby providing tremendous insight into the evolution of things. And the stories of their names often parallel those of the products that were developed to solve problems with, if not the downright failure of, preexisting products.

On the back of a pad of the original Post-it Notes, those yellow slips of paper that stick to everything from irate correspondence to refrigerator doors, were the trademark Scotch and a bold 3M, which older thingophiles and trivia buffs may recall was once known as the Minnesota Mining and Manufacturing Company. How did such a seemingly self-explanatory and no-nonsense–sounding company get involved with little sticky notepads? Besides, isn't Minnesota peopled by Scandinavians rather than Scots?

In 1902 five businessmen from Two Harbors, Minnesota, formed the Minnesota Mining and Manufacturing Company to quarry what they thought was a local find of corundum, a mineral just short of diamond in hardness and thus an abrasive valuable to grinding-wheel manufacturers. The ore proved to be a substance other than corundum, and thus less suited to the making of grinding wheels. So in 1905 the fledgling company turned to making sandpaper in Duluth. Difficult years followed, with new financing staving off bankruptcy, but true success in selling sandpaper could come only with a product at least as good as the other guy's.

In 1916 the company's sales manager insisted that a laboratory be formed to carry out experiments and tests to ensure quality control so that salesmen would not be embarrassed by faulty products. The laboratory in time made possible the research and development necessary to produce new and improved items in response to problems experienced by sandpaper users. While a manufacturer's salesmen might say that after quality control the purpose of a company's laboratory was to respond to customers' needs for new products, engineers saw a laboratory more as a troubleshooting workshop in which to deal with the horror stories of product failures and the general tales of irritating shortcomings brought home by the salesmen. In the course of troubleshooting, new products would naturally evolve in response to shortcomings in existing products.

Sandpaper is made by bonding an abrasive material to a paper backing, and the quality of the product depends not only on the quality of the principal raw materials of

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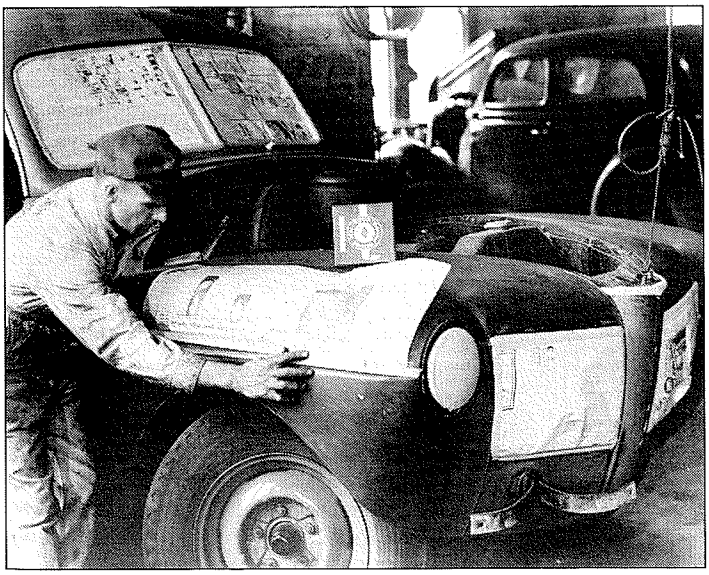
grit and paper but also on how uniformly and securely they can be combined. Hence, to manufacture sandpaper it was necessary to develop an expertise in coating paper with adhesive. Unfortunately, even with good glue, the paper used in early sandpaper fell apart when wet, and so using sandpaper was necessarily a very dry and dusty operation. But in the growing automobile industry—where, in the 1920s, a considerable amount of sanding was needed to finish the paint on auto bodies—the dust was causing lead poisoning among workers. Making waterproof sandpaper would allow wet sanding that in turn would cut down on dust, and thus be a great improvement. In response to the failings of existing sandpaper, the Minnesota Mining and Manufacturing Company developed a waterproof paper that one of its young lab technicians, Richard Drew, was asked to take to some St. Paul auto shops for testing. In doing so he became aware of another problem.



"Scotch" masking tape was used in the painting of cars during the 1920s, when two-tone paint finishes became all the rage.

The new two-tone style of painting automobiles was popular in 1925, but it presented considerable problems for auto manufacturers and body shops alike. In order to get a clean, sharp edge when applying a second color, workers had to mask the first color, of course, and this required that newspaper or butcher paper be fastened to the car body. If shop-brewed glue was used, it would sometimes stick so well that it had to be scraped off, more often than not pulling paint with it. Surgical adhesive tape was sometimes used, but its cloth backing tended to absorb solvents from the newly sprayed paint and cause the masking materials to stick to the paint they were intended to protect. Clearly, the existing means of masking had serious drawbacks. One day, while dropping off a batch of waterproof sandpaper, Drew overheard some body-shop workers cursing two-tone painting. The young technician, who had studied engineering through correspondence-school courses, promised he would make something to solve the problem.

As in most design problems, Drew's objectives were most clearly expressed in negative terms: He wished to have a kind of tape whose adhesive would not stick very readily. Not only would this allow the tape to be formed in rolls from which it could be removed easily and cleanly but it would also make it easy to peel the tape from a freshly painted auto body. But stating the problem and finding the right combination of adhesive and paper were two different things. The first could have come in a flash at a body shop. The latter took two years of experimenting with oils, resins, and the

like, not to mention papers to which they could be applied. After many negative results and suggestions that the problem should be dropped, Drew tried some crepe paper left over from unrelated experiments and found that its crinkled surface provided an ideal backing. Samples of the new product were taken to Detroit auto manufacturers by the company's chief chemist, who returned to Minnesota with orders for three carloads of Drew's masking tape.

According to company lore, the tape came to be called Scotch because on an early batch of two-inch–wide tape, the adhesive was applied only to the edges, presumably because this was thought to be sufficient and even perhaps desirable for masking. One edge of the tape would hold the paper, the other would adhere to the auto body, and the dry middle would not stick to anything. However, with so little adhesive the heavy paper pulled the tape off the auto body, and a frustrated painter is said to have told a salesman, "Take this tape back to your stingy Scotch bosses and tell them to put more adhesive on it." While some company old-timers have labeled the story apocryphal, others give it credibility by recalling that the incident "helped spark the inspiration for the name" of the line of pressure-sensitive adhesive tapes that now carry the tartan trademark, presumably not because the manufacturer is stingy with adhesive but rather because consumers can use the tape to make economical repairs on so many household items.

Cellophane was another new product in the late 1920s, and its being transparent and waterproof made it ideal for packaging everything from bakery goods to chewing gum. It was even natural to want to package masking tape in cellophane, and so someone in St. Paul began to experiment with the transparent material. At the same time Drew was working to overcome a serious shortcoming of the tape: Not being waterproof, it was of little use in very moist environments. He got the idea of coating cellophane with his adhesive, which if it worked would yield a tape able to make clear packaging watertight. But sticking an adhesive that works wonderfully on crepe paper onto cellophane is easier said than done, and using existing machinery to manufacture a new product made of a new material usually involves considerable experimentation and development. In the case of Scotch cellophane tape, Drew's initial attempt to make it waterproof fell short: "It lacked proper balance of adhesiveness, cohesiveness, elasticity and stretchiness. Furthermore, it had to perform in temperatures of 0 to 110 degrees F in humidity of two to 95 percent." At first, not surprisingly, it did not, and the failure engendered some well-defined problems to be solved.

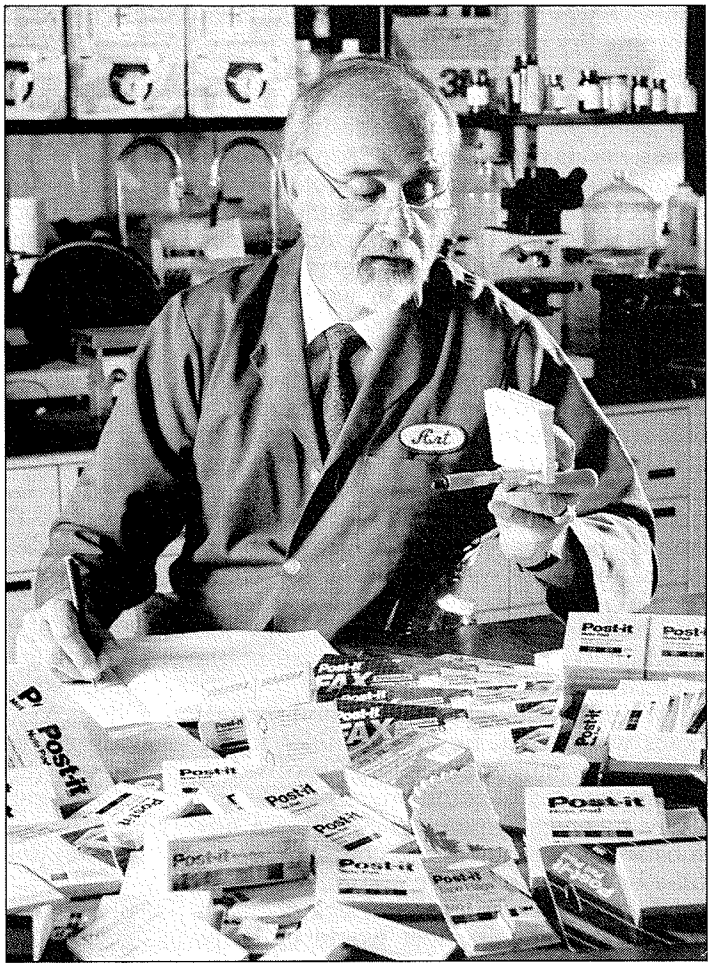
After a year of work, Drew did solve the problems, at least to a satisfactory degree for the time, and shiny-backed cellophane tape was the transparent tape used for many years for all sorts of mending and attaching jobs. Its tendency to yellow with age, curling up and coming off with time, and its notorious habit of hiding its end and tearing diagonally off the roll were accepted by users as just the way the tape was—nothing better was available. But inventors and tinkerers like Drew saw each shortcoming as a challenge for improvement, in part because they and their bosses knew that competitors did also. Difficulties in getting Scotch tape off the roll, for example, prompted the development of a tape dispenser with a built-in serrated edge to cut off each piece squarely and leave a neat edge handy for the next use. (This demonstrates how the need to dispense a product properly and conveniently can give rise to a specialized infrastructure.)

As changes in the tape were made and offered as new and improved versions, users wondered how they ever got along with the old tape. Indeed, the company's own description of the latest version of its product can be read not only as praise for Scotch Magic Transparent Tape but as an indictment of cellophane tape: "It unwinds easily. You can write on it. You can machine-copy through it. It's water repellent. And, unlike the earlier tape, it won't yellow or ooze adhesive with age." This list of implicit and explicit faults of the "earlier tape" makes it sound disgusting and inadequate, but in its day it was peerless. Our expectations of a technology rise with its advancement.

The company that began by making an adequate sandpaper might not have fore-

seen the nature of its products many years hence, but the experience 3M gained by attaching adhesives to paper and other backings and the public's receptiveness to new applications of that expertise—and other applications accumulated along the way—enabled the Minnesota Mining and Manufacturing Company eventually to make tens of thousands of products. Since the old name no longer fully described the diverse output of the giant manufacturing company, it came to be known more and more by the abbreviation 3M, and in a recent annual report to the stockholders the full name appeared only in the report of the accountants.

The characteristic of 3M that enabled it to attain such diversity in its product line is a policy of what generally has come to be called "intrapreneurship." The idea is to allow employees of large corporations to behave within the company as they would as individual entrepreneurs in the outside world. A model "intrapreneur" is Art Fry, a chemical engineer who in 1974 was working in product development at 3M during the week and singing in his church choir on Sundays. He was accustomed to marking the pages in his hymnal with scraps of paper so that he could quickly locate the songs during the two services at which he sang. This worked fine for the first service, but often by the second some of the loose scraps of paper had fallen out of their places. Fry, not having noticed this, was sometimes at a loss for words. Loose scraps of paper have long been used as bookmarks—some are clearly visible in the foreground of Albrecht Dürer's famous etching of the great humanist Erasmus—and one can safely say that many a bookmark had lost its place in the four-and-a-half centuries between that etching's date of 1526 and when Fry reflected on the failure of bookmarks to do all that might be expected of them.



Chemical engineer Art Fry designed the Post-it Note by exploiting the peculiar adhesive properties of an "unglue" that had earlier been developed by another 3M researcher, Spencer Silver.

Fry remembered a curious adhesive, an "unglue" that was strong and yet easily removed, that Spencer Silver, another 3M researcher, had come upon several years earlier in the course of developing very strong and very tacky adhesives. Although not suited to solving his immediate problem, Silver felt the unusual adhesive might have some commercial value, and so he demonstrated it to various colleagues, including Fry. At the time no one had come up with a use for it, and so the formula for the weak

adhesive was filed away—until the Monday morning Fry came to work with the idea of making sticky bookmarks that could be removed without damaging the book. His initial attempts left some adhesive on the pages, and Fry surmises that "some of those hymnal pages I tested my first notes on are probably still stuck together." But since it is 3M's policy (and that of other enlightened companies) to allow its engineers to spend a certain percentage of their work time on projects of their own choosing, a practice known as "bootlegging," Fry was able to gain access to the necessary machinery and materials and to spend nearly a year-and-a-half experimenting and refining his idea for sticky—but not too sticky—slips of paper that could be used for "temporarily permanent" bookmarks and notes. While Fry wanted bookmarks to stick gently to his pages, he did not want their ends to stick to each other, and so adhesive was applied at one end only. This would also allow the product to be used for repositionable memos and removable notes.

When Fry thought the stick-and-remove notes were ready, he took samples to the company's marketing people, who had to accept the idea as commercially viable and likely to meet a market need before any substantial amount of the company's own time or money could be committed to the product. There was a general lack of enthusiasm for something that would be more costly than the scratch paper it was intended to replace, for it was felt that the greatest commercial application for Fry's invention was removable notes rather than sticky bookmarks. Fry was committed to his brainchild, however, and he finally convinced an office supply division of 3M to test-market the product that "met an unperceived need." Early results were not promising, but in those cases where samples were distributed, customers became hooked. While no prior need for the little sticky notes had been expressed, once they were in the hands of office workers all sorts of uses were found, and suddenly people discovered that they couldn't do without them. Post-it Notes generally were available by mid-1980 and are now ubiquitous, even coming in long, narrow styles to accommodate the vertical writing of Japanese. While it might be argued that they have reduced the recycling of scrap paper as scratch paper and bookmarks, the removable notes do have the potential to eliminate the use of unsightly and damaging tape and staples for posting notes and announcements in public places.

Years ago, when I would walk with my dean across campus to the Engineering School, he would invariably remove the numerous announcements of meetings, parties, and kittens for adoption that had been taped or tacked to the door since his last entrance. He carefully peeled off the tape that made posting notices so easy but which invariably marred the surface of the doorway. The dean explained how the tape became difficult to remove if it stayed up several days and nights, and how it had ruined some freshly painted walls that then required patching and repainting. The dean was opposed not to the notices but to the damage that the tape or tacks did to the main entrance of his school. How he might have loved Post-it Notes and dreamed of them in poster sizes.

Post-it Notes provide but one example of a technological artifact that has evolved from a perceived failure of existing artifacts to function ideally. Again, it is not that form follows function but, rather, that the form of one thing follows from the failure of another thing to function as we would like. Whether it be bookmarks that fail to stay in place or taped-on notes that fail to leave a surface clean and intact, their failure—or perceived failure—is what leads to the true evolution of artifacts. That the perception of failure may take centuries to develop, as in the case of loose bookmarks, does not reduce the importance of the principle in shaping our world.