



Keio Business School

3M Product Development (Abridged Version)

3M (3M Company; Minnesota Mining and Manufacturing) is a materials and finished goods manufacturer headquartered in St. Paul, Minnesota in the United States. The company was originally established for the purpose of extracting corundum, an abrasive material used in sandpaper. However, based on surface treatment and adhesion technologies acquired in manufacturing sandpaper, the company expanded its business and went on to develop numerous new products, including waterproof sandpaper, cellophane tape, medical tape, nonwoven fabrics and waterproofing sprays.

As of 1996, 3M was selling 50,000 different products, from sandpaper to artificial joints, and was placing 500 new products on the market every year. Ever since its founding in 1902, 3M has consistently placed the development of revolutionary new products at the heart of its management strategy. 3M Chairman Livio DeSimone says, “There’s absolutely no way of anticipating what kinds of new products there’ll be in the future.” Nevertheless, 3M is a large, financially stable company. It boasts a workforce of 75,000, and it has an annual turnover of \$14.2 billion, an operating profit of \$2.4 billion, and a AAA credit rating from both Moody’s and S&P. Between 1962 and 1986, the company had an average return on assets (ROA) of 23.2 percent , a return on equity (ROE) of 34.4 percent , and a return on sales (ROS) of 20.3 percent .

In their book *Built to Last: Successful Habits of Visionary Companies*, Jim Collins and Jerry I. Porras state, “Indeed, if we had to bet our lives on the continued success and adaptability of any single company in our study over the next fifty to one hundred years, we would place that bet on 3M. ” In 1995, 3M was awarded the National Medal of Technology and Innovation by President Bill Clinton for its innovation and development of numerous products over the past 90 years.

This material was created by Associate Professor Atsuomi Obayashi of Keio Business School as material for class discussion and is not intended as an example of appropriate business management.

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This case study will introduce you to the 3M system of product development along with examples. Examples have been selected from 3M's internal program called Legend. Legend features points that the company considers important for stimulating innovation, and presents them in detail in a visual way. The first example is Post-it Notes. Post-it Notes are a truly everyday product that look like someone has just put glue on a piece of colored paper. However, the history behind development of the Post-it Note provides us a splendid illustration of the conditions necessary for innovation to occur. In fact, Post-it Notes have been 3M's biggest seller in recent years, and are a major source of earnings.

Post-it Notes

10 One December Sunday in 1974, Art Fry, a researcher in 3M's Commercial Tape Division, was singing hymns in the church choir. When he picked up his hymn book, the bookmark he had placed in the book to mark his page fell to the floor. He picked up the bookmark, and while staring at it, he began to wonder if there was some way to keep it from falling. He knew that if he folded over a page to mark
15 his place, it would damage the hymn book. And even if he put glue on the bookmark, it would damage the page when he removed it. While pondering, Fry was struck with an idea.

About one year earlier, Fry had attended a 3M technology seminar. Here, a researcher who had been developing strong adhesives reported about how he had created an adhesive that would stick
20 to anything but could easily be peeled off. Although his research project had ended in failure, the researcher was colorfully pleading with others about how there should be some product that could benefit from this adhesive. Fry thought that, if he could use this adhesive, he could create a bookmark that would not fall and would not damage the book.

25 Through the efforts of Spencer Silver—the developer in question—samples of the “flop” adhesive had been distributed around the company. Fry was attached to the Commercial Tape Division, and he had a lot of work on his plate. Nonetheless, without telling his boss, he sought help from experts within 3M, and while using the company's equipment without permission, he began research on a bookmark that would stay in place. To mass-produce the bookmark commercially, machinery was needed to apply
30 adhesive evenly to one part of the bookmarks before stacking and bundling them together. Moreover, an idea was needed to stop the bundles of bookmarks from getting thick near the end with the adhesive. There was no such machinery at 3M, so Fry built his own machine in the basement of his home. The machine grew quite large, and when it was finally decided to carry it out of Fry's home, they had no choice but to knock out a wall.

35 Fry's enthusiasm spread to those around him, and the circle of cooperation widened. His bookmark had taken the appearance of a pad of removable sticky notes, and a sample product was test-marketed.

However, the results were poor. Around this time, a director in charge of technology conducted his own fact-finding survey, and advised his superiors that development should not be stopped, stating, “One-time users rated the product very highly , but explaining the value of the product to people who have never used it was difficult.” Fry distributed a prototype to secretaries in 3M, briefing them on how to use it and getting them to use it. Conservative sales representatives saw how the secretaries scrambled to use the scarce prototypes, and they began to think that the product could be a smash hit. Fry persuaded 3M’s Commercial Office Supply Division, and Post-it Notes were launched onto the market in 1981—seven years after Fry’s idea, and eight years after Silver’s presentation.

Research and Development at 3M

3M employs some 7,000 researchers. Its research and development budget is about \$1 billion a year, or 6.7 percent of sales. Its investment in production facilities is \$1.4 billion, or 10 percent of sales. 3M excels at developing a multitude of products by adding a stream of new ideas to existing basic technologies. Some of the basic technologies built up by 3M include nonwoven fabric technologies, microreplication technologies and conjugated polymer technologies. Those technologies that are able to be applied to a large number of products are called “technology platforms,” of which there are currently 40. Corresponding to each of these technology platforms, 40 divisions have been organized along separate product lines. On average, technology platforms are replaced at a rate of one a year. Engineers belong to either a Central Research Lab or a division.

Approximately 1,000 products will be developed from a single technology platform. As this demonstrates, rather than being market-oriented (developed based on the views of consumers), 3M’s approach to research and development is product-oriented (proposed and developed based on the ideas of engineers). Market-oriented development often only targets development which is an extension of an existing product likely to be wanted by customers. 3M’s traditional way of thinking is that revolutionary new products are more likely to come from the ideas of researchers.

To ensure that new products are continually developed, 3M has set a numerical target that at least 27 percent of sales must be comprised of new products launched within the past four years. Each division is required to achieve this target. If a division was to become preoccupied with only increasing sales of existing products, it would not be able to meet the target. Until 1992, the target was for at least 25 percent of sales to be of new products released within the past five years. Because of the subsequent increase in ICT-related products, which fall quickly out of favor, the target was amended to at least 30 percent of sales to be of new products released within the past four years, and this was further tweaked in 1995 to 27 percent.

As a company-wide management policy, more than anything else, 3M emphasizes giving freedom to researchers and engineers. It is believed that leaving matters up to frontline employees without much interference by management will better enable 3M to deal with changes in the environment. 3M's policy of driving the company as a group of autonomous employees has been constant since its founding. One example of this is 3M's so-called "15 percent rule." This unwritten rule states that employees in research and development divisions can devote 15 percent of their working hours to topics of their own interest. It does not matter if the topic they pursue is unrelated to their own division, and they may even personally carry on projects which have been discontinued. Moreover, there is no requirement for employees to report to their supervisors what they spend their 15 percent of time on.

10 While official company business is conducted discretely on a divisional basis, cross-divisional teams are frequently formed for product development projects. Likewise, in addition to creating opportunities for employees to experiment with their own ideas, the 15 percent rule also functions to facilitate the development of new products that span multiple divisions and which go beyond assigned duties. To
15 promote the sharing of information beyond divisional barriers, internal seminars are also frequently held for employees to exchange information with each other. Moreover, information on technology platforms can be accessed by all internal departments regardless of the division. It is not only information about successes that should be shared though. Information about failures offer employees just as many hints and ideas as successes. In order to ensure that information about failures is informed
20 to others and not concealed by those involved, little is made of R&D failures by 3M management. On the contrary, by holding events such as the "contest for the month's worst failure," management acknowledges failures positively, and if anything, is striving to create a corporate culture where employees learn much from failures.

25 In a twist on Christianity's Ten Commandments, "Thou shall not kill a new product idea" is regarded as the eleventh commandment within 3M. This means that, unless it can be proven that the idea will clearly fail, even bosses must not stop an idea put forward by an eager employee. 3M has a "sponsorship program" designed to pick up employee ideas. Under the program, in which employees with an idea are provided budgetary and personnel support by management, sponsors may be the employee's direct
30 supervisor or a supervisor from another department. The extent to which the supervisor provides support as a sponsor in this program forms part of their evaluation. Even in cases where an idea fails to gain support because it does not accord with the division's strategy, a budget will be allocated by headquarters if an application is submitted and accepted for the "Genesis Program." Another initiative, the "Mentor Program," allows employees to freely immerse themselves in research by having an
35 experienced researcher, who is not their direct supervisor, give counsel and provide advice on how to conduct research and how to handle the organization.

Phrases such as “lifetime employment” and “seniority” are often used when introducing 3M. Although lifetime employment as an institution does not exist, 90 percent of new employees to 3M are recent graduates, and few people resign midway through their career. There are also few dismissals. Many employees are from Minnesota or neighboring Midwestern states, and it is not uncommon for three generations in the one family to be employed at 3M. Regarding employment, if pressed to put in words, the company would be described as tending to employ “better-than-average good-natured people” rather than “the best and brightest.” People in managerial positions normally rise up through the company rather than being recruited mid-career. 3M’s 11 corporate officers have served the company for 34 years on average, and even the shortest service record is 26 years (as of 1996). 3M’s style of innovation is believed to be underpinned by long-serving employees who understand the corporate culture and who form networks that go beyond organizational barriers. Again, while seniority is not an institution, since 3M is a company where experience is valued, employees find it easier to demonstrate their abilities the longer they are there.

3M’s wage levels are more or less in line with standards in the labor market. The company’s remuneration (system) is based on assessment of actual performance against objective standards, but in a way that does not overly encourage internal competition. Moreover, managers are regarded as being responsible for the achievements and developments of their staff. Remuneration of corporate officers is linked to 3M’s overall economic profit (similar to what is commonly known as EVA). Employees who achieve outstanding performance are recognized by way of compensation that includes stock options, as well as by commendation and tribute. In the 3M Museum, located at the back of the lobby near the entrance to corporate headquarters, company commendations are displayed at the very front of the exhibitions. Here, 3M employees working as guides explain to visitors about the significance of each of the awards and about the achievements of the award recipients.

If development were left entirely to divisions, there would be an increase in simple upgrades, and the speed of development would slow. For this reason, 3M decided to designate those projects, which showed promise of becoming a bright new product and which needed to be developed quickly, to its “Pacing Plus” program so that injections of human and financial resources could be prioritized. As of 1998, 25 projects had been designated to the Pacing Plus program, generating \$650 million a year in sales (just under 5 percent of all sales). This percentage is expected to increase further.

However, in recent years, as the percentage of ICT-related products increases, more and more 3M is being compelled to adopt the market-oriented approach to development. Development of products in this sector requires an extremely fast response to market, a situation which does not go well with 3M’s culture of product-oriented development whereby technology is nurtured slowly and carefully. A problem facing 3M, therefore, is that its growth in sales is failing to keep pace with the rapid growth of the market.

Product Development in the Early Days of 3M

3M was established by five investors in 1902 for the purpose of purchasing a mine in Crystal Bay, Minnesota. Their plan was to extract corundum from the mine, and sell it to abrasives manufacturers as a raw material for sandpaper, demand for which was growing at the time. However, the quality of the corundum extracted from this mine was poor, and sales grew not in the slightest. Subsequently, in 1905, new investors joined the venture, and the decision was made to produce sandpaper themselves, using imported ore. But again, this did not make much profit. While trying to somehow get good ore of its own, in 1914, they succeeded in developing a synthetic abrasive material. Being extremely suited to polishing metal, once the material had been acclaimed by the then burgeoning automotive industry, business performance began to improve rapidly. It was 1916 before the first dividend was paid to shareholders, and for the 11 years between foundation and 1913, the company had been unable to pay its president a salary. The experience at this time became the starting point of 3M's culture of tenaciously developing its own products.

In 1920, a letter arrived at the desk of the 3M's fourth president, William McKnight, from a young man called Francis Okie, who was employed by a manufacturer of printing ink in Philadelphia. In the letter, Okie wrote that he wanted a sample sent of the abrasive material used in 3M's sandpaper. Although 3M was not actually selling the abrasive material, McKnight, with his interest piqued, instructed the sales manager of 3M's Eastern Division to meet with the letter writer to find out why the ink manufacturer wanted the abrasives.

The sales manager visited the small printing workshop in Philadelphia, and on asking Okie, found that the reason had nothing to do with his main job. A friend of Okie's, who worked nearby as a glassworker, had gotten ill from the dust created when polishing glass. To help solve this problem, Okie had apparently been developing a waterproof sandpaper that could be used to polish things wet with water. The sales manager immediately dispatched a telegram calling for McKnight to come. McKnight made his way from Minnesota to Philadelphia and listened to Okie. He was convinced this sandpaper had great potential, and at once began negotiating to purchase the rights to Okie's invention. The times were rife with occupational health problems, and if the sandpaper was waterproof, it could also be washed to prevent clogging. 3M released a waterproof sandpaper the following year in 1921. As expected, the new product was favorably received by the market. In 1922, inventor Okie also joined 3M.

In 1925, an assistant at the abrasives lab led by Okie, Richard Drew (aged 26 at the time), was making regular visits to a finishing shop in an automobile factory to test prototypes of water-resistant abrasive materials. One day, he heard a painter yell out in exasperation. It seems the painter was attempting to

paint two separate colors on the body of a car, but he was having a hard time of it as things were not going well. Two-toned cars were all the rage in the United States at the time. The painting process involved using old newspaper to cover the first painted color, fastening it with tape, and then spraying the second color over the top. However, paint would often soak through the newspaper and mix with the color below, or the coating would be spoiled when removing the tape. Drew approached his boss for advice on creating a tape suited to this work, and received both encouragement and a development budget.

The adhesive strength of the tape needed to be not too strong and not too weak, and the adhesive agent needed to not chemically react with the ingredients of the paint. Following a development process of trial and error, a product called “Non-Drying Tape” was released, generating massive sales, primarily to automobile factories. Drew continued to make further improvements over the next three years, and in 1928, created the “Scotch” brand of tape. Although Drew was subsequently sent back to the abrasives lab, he continued to secretly work on improving the quality of the tape, and in 1930, “Scotch Cellophane Tape” began to be produced commercially. The product would grow into a major earner for 3M. Incidentally, the Scotch tape dispenser, which makes using Scotch tape easier, is also a 3M invention. Complementary products like these also helped boost sales of Scotch tape.

Trizact abrasive belts

Conventional abrasive materials involved pasting abrasive grains onto cloth or paper, but the recently developed Trizact abrasive belt is an abrasive where regular pyramid-like structures of abrasive grains are formed onto the substrate surface. If the structure is aligned perfectly with the same size and shape grains, polishing can be performed evenly without waste, even if the fineness of the abrasive is the same. Using a Trizact abrasive belt will enable a more precise finish, and will save on materials lost in cutting.

Trizact was the brainchild of Mike Mucci and Jon Pieper, two researchers in the Abrasive Systems Division. Since their idea was not accepted under any official 3M program, it began as an initiative borne of the 15 percent rule. At first, they obtained supplies of equipment, materials and expertise from the Central Research Lab. They later secured a budget by applying for the Genesis Program which covered their equipment, materials and personnel costs. Then, after delivering a presentation at the Optics Technology Center, strong support was received from management, and an official development team was launched. Before long, the project was designated to the Pacing Plus program, allowing development to be accelerated. Trizact abrasive belts were ultimately completed with the collaboration of nine labs.

Nonwoven Fabrics

The journey from having a revolutionary idea to developing it into a product is not flat. Ideas in their infancy in particular require the manager to hold back on criticism and provide persistent nurturing. However, given that not all ideas will necessarily lead to a finished product, sometimes even official projects will have to be halted. Deciding whether or not to continue a project that has not produced results by its deadline requires experience and judgment.

This example may be a little dated, but between the 1930s and 1940s, Al Boese and his colleagues spent more than 10 years conducting research on using new nonwoven fabric materials in electrical insulating tape. However, their research failed to turn into a finished product, and finally, at the end of the 1940s, he received notice that their research would be cut in two years. He was further pressured to apply their research to a saleable product within three months. In desperation, based on the suggestion of a salesman, Boese hit upon developing a decorative ribbon. The product recorded reasonable sales, so a decision was taken to invest in facilities for manufacturing nonwoven fabrics and to explore other new products. From there, the “Scotch-Brite” line was born, and a series of other products was also developed, including floor mats, dust masks and surgical masks.

Overseas Expansion by 3M

Fifty-four percent of 3M’s sales are generated overseas. 3M has local subsidiaries in 63 countries outside the United States, employing 32,000 people, or 43 percent of its total workforce. Of these, less than 300 are workers dispatched from 3M’s corporate headquarters in the United States. Conversely, a far greater number of people are dispatched from overseas subsidiaries to the company’s US corporate headquarters.

3M’s overseas expansion of business operations began in 1951. Rather than low labor costs, the conditions of expansion focused on how many talented local researchers could be attracted to 3M. At first, only a small number of local personnel were recruited, and over time, they got to know 3M’s way of doing things. Numbers were then gradually increased. 3M’s merchandise is comprised of many niche products, and not having to recruit large numbers of people all at once helps with introducing a new culture. Once the local subsidiary has a good grounding, researchers and engineers get to experience doing research in the United States for about 6 to 12 months. By doing it this way, on returning to their respective countries, they will be able to continue promoting research and development internationally while building up their own personal networks.

Sixty-five percent of management has experience working overseas, and this percentage is projected to increase further. 3M is also working to increase opportunities for employees of different cultural backgrounds to engage collaboratively in problem solving. For instance, if adhesive products were developed only by US personnel, while the products would be easily applied to furniture and office supplies, they may not reflect many needs of the automotive industry or the electrical machinery industry. 3M hopes that Japanese will participate in these areas.

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