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Innovation at 3M Corporation (A)

On the evening of October 23, 1997, Rita Shor, senior product specialist at 3M, looked across the conference room at her team from the Medical-Surgical Markets Division. She wondered when to draw to close the intense ongoing debate on the nature of the team's recommendations to the Health Care Unit's senior management. A hand-picked group of talented individuals, the team had embarked on a new method for understanding customer needs called "Lead User Research." But this initiative to introduce leading-edge market research methods into 3M's legendary innovation process had now grown into a revolutionary series of recommendations that threatened to rip apart the division.

While senior management wanted the "Lead User" team to execute a manageable project involving surgical draping material to protect surgery patients from infections, the team now wanted to rewrite the entire business unit's strategy statement to also include more pro-active products or services that would permit the *upstream containment* of infectious agents such as germs. This went against the incrementalist approach that for so long had pervaded 3M. After all, as Mary Sonnack, division scientist and an internal 3M consultant on the new Lead User methodology, noted "3M gets so much revenue from incremental products . . . like a blue Post-it note instead of just a yellow one."

Outside the window, the late autumn breeze rippled through the tall Minnesota grass—a seasonal reminder that it had been a year since the group first embarked on the Lead User process (see **Exhibit 1**). The method, including training, had called for less than six months dedicated to the entire process. But the lengthy commitment from participants as well as 3M senior management might just pay off if it took the Medical-Surgical Markets division from a stagnating business to a reinvigorated enterprise. Clearly, however, unless the team came up with successful product ideas and effective positioning, the new methodology for product innovation would die with the winter frost. And so might the entire business unit.

History of 3M Corporation[1]

In 1902, on the banks of Lake Superior, five investors got together to excavate what they thought was high-quality corundum, a mineral almost as hard as diamond that manufacturers used for producing abrasives. What they dug up under the banner of the Minnesota Mining and

[1]Much of the information on 3M history comes from G. C. Nicholson, "Keeping Innovation Alive," *Research-Technology Management*, vol. 41 (3), May/June 1998, pp. 34-40 and 3M Annual Report, 1998.

Professor Stefan Thomke and Research Associate Ashok Nimgade prepared this case. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

Manufacturing Company, however, turned out low-grade and worthless. After filling one $20 order, the venture folded up its mining operations and turned instead to the sandpaper business. Here, disaster struck again: the abrasives they had imported from Spain refused to stick to the sandpaper.

Research and development (R&D) then at 3M, as the company became known, took place in a primitive laboratory so small the sole technician had to back out to let the boss in. The young technician figured out the problem after plunging some sandpaper into water and noting an oil slick. Follow-up investigations revealed that during shipment from Spain, an ocean storm had caused olive oil to leak into the abrasive material. This insight allowed for fixing the sandpaper problem while also establishing the emphasis on technology and innovativeness at 3M.

By 1916, survival assured, the company started paying stock dividends. The firm, now headquartered in St. Paul, Minnesota, initially stayed close to abrasives, developing the world's first waterproof sandpaper in the early 1920s. 3M technicians began bypassing purchasing agents in order to better understand product needs. Often, they walked into factories and workplaces and talked directly to workers, an unheard of practice that yielded unexpected dividends.

While visiting an auto-body shop in the 1920s, for instance, Richard Drew, a young lab assistant, heard a torrent of screams and curses. Workers had apparently just ruined a two-tone paint job when paint peeled away as they removed glued newspaper strips used as masking materials. Back in the lab, while working with a new and crinkly backing material for sandpaper, Drew came up with the idea that would provide the world with masking tape. To spend the long hours needed to perfect the new tape, however, he had ignored a direct order from the company head to put all his efforts into improving a preexisting product. Drew's success helped spawn the legend of the subversive 3M inventor and the 3M aphorism: "It's better to seek forgiveness than to ask for permission." It also helped inspire a "get-out-of-the-way" attitude on the part of management toward product developers. At the same time, Drew had opened up another "core technology" for 3M. A few years later, in fact, Drew went on to also invent Scotch® brand cellophane tape, which would help the company prosper through the Great Depression.

Over the decades, 3M enjoyed national and global growth as well as a reputation for remaining a "hothouse" of innovation. "We'll make any damn thing we can make money on," stated a past 3M president, Richard Carlton.[2] According to the International Directory of Company Histories: "Observers and outsiders frequently describe 3M in terms approaching awe. 3M earns such respect because of its improbable, almost defiantly non-corporate nature. The company is gigantic, yet it is as innovative and as full of growth potential as though it were a small venture."[3]

3M inventors did not share directly in product royalties; rather, the firm hoped that individual love for discovery would drive innovation. 3M sought to encourage innovation through a variety of means including awards for innovation as well as in-house grants for innovative projects. The company also allowed all staff to spend 15% of their time to explore new ideas outside of assigned responsibilities. Post-it® Notes were developed on the 15% time scheme by 3M inventor Art Fry, who first used a weak adhesive to produce convenient hymnal markers for his music recitals.

3M also employed a "dual ladder" approach that allowed senior, technically inclined individuals with attractive career opportunities to advance, without having to switch to management. In addition, the company held internal showcases for products and ideas to help encourage inter-

[2] St. James Press, Chicago/London, 1988, vol. 1: 499-501.

[3] Ibid.

departmental cross-pollination or "bootlegging" of discoveries. As a result of these steps, 3M employees tended not to move to other companies.

The 3M model of expansion involved splintering off decentralized units based on new key product areas that were sufficiently different from prior key technologies. The first core technology from the 1920s had been adhesives and sandpaper. By the late 1990s, however, over 30 key technologies existed at 3M. Much market growth for 3M also came from finding new twists to existing product platforms: for instance, digital "Post-It Software Notes;" or the use of 3M's Thinsulate®, first introduced in 1978 for apparel, in reducing sound in automobiles.

In the 1990s, 3M operated with four objectives: producing 30% of sales from products that did not exist four years earlier—an attempt to accelerate away from the incrementalism that had served as an engine for growth in the past few decades; greater than 10% annual growth in earnings per share; greater than 27% return on capital employed; and 20-25% return on equity. It also sought to change the mix of new products to emphasize products truly new to the world, instead of line extensions, which typically had provided two out of three new-product sales dollars.

To achieve high rates of innovation 3M placed a heavy emphasis on R&D. In 1997, it employed 4,500 scientists, engineers, and technicians in the United States, and another 2,000 overseas. On average, 3M spent 6.5-7.0 cents of every sales dollar on laboratory-based R&D, which amounted to just over $1 billion in 1997—not including process engineering and quality control expenses. In 1997, 3M companies operated in more than 60 countries, and overseas businesses generated half of the firm's $15.07 billion in revenue and half of its $2.7 billion in operating income. 3M employed 75,000 workers, of whom with 36,000 were outside the United States. (See **Exhibits 2** and **3**.)

The Medical Products Division, the first 3M division dedicated solely to health care, was founded in 1961. A decade later, the Health Care Group at 3M provided an umbrella for all health-related product divisions including the Medical-Surgical Markets Division. By 1997, 3M claimed over 10,000 health-related products ranging from surgical drapes to dental fillings to respirators to software. By 1994, Health Care sales topped $2 billion.[4]

Innovation at 3M in the 1990s

Product teams at 3M typically involved "skunkworks" teams primarily comprising technical individuals; teams also involved process engineers to help ensure that the particular product under development could be efficiently made. These engineers also provided teams with feedback about 3M's manufacturing capabilities. The entire team faced no risk if an idea flopped—indeed, there might even be a celebration. In case of failures, members of disbanded teams could go on to other projects. Although failures were often celebrated, each technical person's output over one or two years would be evaluated as a whole. The 3M mythology allowed for technical employees to take matters in their own hands—as exemplified by the Post-it notes story.

Marketing input traditionally came from current customers and sales representatives. Product developers focused on finding new angles or twists on early trends. At the same time, few market researchers worked at 3M; only one market researcher served 900 engineers. Instead, the firm hired out for market research reports from smaller market research firms. To identify market needs and trends, 3M product developers in the Health Care unit, for instance, utilized several tools:

- Data from sales representatives with daily contact with physicians or registered nurses.

[4] 3M brochure entitled "3M Health Care," 1996.

- Focus groups: for example, one business unit within the Medical-Surgical Division would gather some 30 nurses biannually from across the nation in a room to obtain reactions to proposed products.
- Customer evaluations of currently marketed products.
- Site visits by 3M scientists and technologists to observe physicians and nurses at work, with the intent to identify unforeseen needs.
- Data on risk factors for diseases.

Several disadvantages to these methods had become apparent over the years. For one, hiring out for market research created too many interfaces between development teams and customers. Another major disadvantage was that the information obtained was not necessarily proprietary. Anyone, for example, could open up a medical textbook to find key risk factors for diseases. Attempts to seek more proprietary information through, say, focus groups provided virtually no clue about market needs some five to 10 years down the road. While visiting customers provided an opportunity for Thomas Edison-type "innovations by serendipity," customers were somewhat blind about their own needs, and thus could not provide clues about developing revolutionary products.

Even these customer visits, although traditionally a part of 3M, had often become deemphasized during the past few decades of successful growth through incremental innovation. This often led to situations where, as Mary Sonnack pointed out: "Typically, one or two product developers or even marketers think of a product, then they throw it over the wall to the commercializers." As a result, thousands of 3M product concepts and inventions awaited markets and languished on drawing boards and R&D labs.

The Medical-Surgical Markets Division

Over the past century, a few medical pioneers, including Benjamin Lister and Florence Nightingale, had demonstrated that the cleanliness of healthcare providers and the hospital environment could reduce the rate of new infections in patients. Previously, patients died on account of the hospital nearly as much as because of what put them there in the first place. It took several decades, however, for the pendulum to swing from the medical establishment to ridiculing such a stress on sanitation to mandating high standards of hygiene among health professionals. As a result, surgeons and attending staff now scrubbed with an almost ritualistic devotion using antiseptic detergents and donned sterile clothing and foot covers before entering operating rooms.

What was being operated upon was also antiseptically prepared or "prepped" for surgery. Thus, operating teams carefully established "sterile fields" on the skin around the pertinent area, freeing it from microbial contamination. A key part of this process involved use of surgical drapes, which served to isolate the "field of surgery" from all other potential sources of infection including the rest of the patient's body, the operating table, the anesthesiologist's equipment, and all members of the surgical team. But the diversity of the microbial world constantly challenged this artificial fortress. As a result, medical personnel had to remain vigilant about catheters and tubes along which agents of infections could migrate into the patient.

From mid-century on, surgical operating rooms became a product developer's dream-come-true. Product categories dedicated to preserving sterility included razors and clippers for shaving hair, presurgical soaps for scrubbing hands, sterile surgical gloves and masks, drapes, handwashes,

antibiotics, lavages for washing away excess blood in a sterile fashion, sponges with or without handles, antiseptic solutions, and dressings.

The surgical drapes business unit within the Medical-Surgical Division focused largely on reducing infections from the skin through surgical drapes and surgical prepping. For 3M, the drape business represented one extension of Richard Drew's attempts to meet the needs of auto-body workshops. By the mid 1990s, 3M was highly penetrated in one niche of surgical drapes which brought the company over $100 million in yearly sales. But sales in the United States had limited growth remaining in these market niches. Overseas markets were limited by the high cost of 3M products, when converted into local currencies.

Most surgical drape products were developed using the equivalent of one full-time product developer and generated about $1 million in sales each. Occasionally, a $1-$20 million product would come along, but these big products were becoming fewer and fewer. Typically, it would take about two years to get a surgical drape product out from initial product conception to market. In the best case, this could be shortened to a year; in worse cases, it could take up to four years.

The surgical drapes section of the Medical-Surgical Markets Division had discovered the hard way that technological excellence by itself meant little. In the early 1990s, for instance, the division had spent three years developing a virus-proof gown that would let water vapor but not viruses pass through the fabric through microscopic pinholes. This manufacturing feat, however, came in just as managed care was taking hold. Although customers loved the fabric, the 10%-15% price premium banished the product into a tiny niche in the European market.

By 1996, the business unit had gone almost a decade with only one successful product. Senior management charged Rita Shor with the mandate of developing a breakthrough product within the existing business strategy. She was assigned to the task not only because of her seniority, having been at the division 11 years, but also because she was thought of as being creative and a consensus builder.

Lead User Research at 3M's Medical-Surgical Markets Division

Shor realized, at the outset, that 3M's traditional methods for understanding customer and market needs would not suffice. Market research reports provided an abundance of data but contained little useful information for conceptualizing a breakthrough product. She recalled, however, an in-house lecture given a few weeks before by Mary Sonnack, who had become increasingly involved with new product development using a new methodology termed "Lead User Research" that she had studied at the Massachusetts Institute of Technology (MIT). Shor wondered if this might provide the key to a breakthrough product.

The premise of this novel methodology was that certain consumers experienced needs ahead of other consumers and that some of the former would seek to innovate on their own. By tapping the expertise of these so-called "lead users," manufacturers could find invaluable sources of innovation. Lead users had often already created innovations to solve their own leading-edge needs—familiar examples were white-out ("liquid paper"), invented by a secretary for correcting typographical mistakes, and the sports drink Gatorade, developed in Florida with invaluable input from athletes.

3M's experience with traditional market research had been disappointing; it had not led to the kinds of innovations senior management wanted for the marketplace. As Chuck Harstad, former vice president of the Commercial and Office Supply Division and now vice president of Corporate Marketing, recalled:

> At the end of the day, we didn't learn anything from our market research department. 3M had to find new ways to identify leading-edge customer needs and develop concepts for breakthrough products and services. Traditional market research methods couldn't deliver the goods. And product developers would not assume ownership for understanding customer needs because they considered that to be the responsibility of market researchers. So we ended up eliminating the market research department to learn about customer needs!

Sonnack, under mandate from Harstad to seek out newer and better customer-focused product development processes, thought that Lead User research fit well with 3M's customer-focused philosophy (see **Exhibit 4**). In 1994, she began an unusual year-long stay at MIT to study with Professor Eric von Hippel, who had pioneered Lead User research. For von Hippel, the collaboration represented a way to develop a step-by-step methodology for practitioners and seek further validation of Lead User concepts. Since he had not charted out a "how-to" manual, he started this process with the help of Sonnack and Minnesota organizational psychologist Joan Churchill.

One of Sonnack's and Churchill's goals was to disseminate the Lead User process throughout 3M. Support for the new methodology existed at high levels within the company. William Coyne, 3M's Head of Research and Development, for instance, was fairly critical of the strategic planning process because he felt that "traditional strategic planning does not leave enough room for innovation. And innovation cannot be planned ahead of time." This view did not go unchallenged within 3M's senior management and represented a radical departure from the incrementalist approach to innovation. "Strategic planning looks in the rearview mirror and cannot keep up with the rate of change in today's markets," added Coyne. "We need to understand leading-edge customer needs to change the basis of competition." Widespread adoption of the Lead User process could help get 3M back to its roots of working more closely with customers and understanding such market needs.

Through one of Sonnack's in-house lectures, Shor first heard about the new methodology. In June of 1996, she telephoned Sonnack to say:

> Our business unit has been going nowhere. While we are number one in the surgical drapes market niche, and pull in over a hundred million in yearly sales, we are stagnating. We need to find new customer needs we haven't thought of before. If we don't bring in radically new ways of looking for products, upper management may have little choice but to sell off the business.

At the time, Sonnack's and Churchill's in-house consulting schedule was crowded. But Shor's degree of commitment appeared to match Sonnack's enthusiasm for the new methodology, and the two women agreed to meet. Were the Medical-Surgical Markets Division to focus product development based on the Lead User method, it would became one of the first divisions at 3M to do so. During their preliminary meeting, Sonnack warned Shor about the need for high level commitment from both team members and their management.

Selling the new approach to senior management would use much of Shor's time and efforts. At first, senior management had balked at such a large commitment. But Shor pointed out that an adequate human resources commitment to the new methodology might prove more cost-effective than having 10 to 15 people working disjointedly. She tactfully reminded management that far more human resources were often redeployed for attacking technical problems that developed later in the product development process: "3M can pour a hundred thousand dollars at the drop of a hat for a production problem late in the product development process, but it is not used to doing so for such an early stage." Finally, however, Shor obtained support from her senior management to assemble a

product innovation team on the basis of creativity and enthusiasm from the Medical-Surgical Markets Division. In a few weeks she was able to assemble an impressive interdisciplinary team[5].

All team members were to commit half their time to the project. But as it turned out, several team members found that their managers still expected them to perform most of their traditional duties. As a result, much of the teamwork took place on Saturdays or outside the office at restaurants. The team sought in a disciplined manner to follow a project schedule with four stages prescribed by the Lead User research methodology (see **Exhibit 4**).

Stage I: Project Planning

Stated goal in process manual: In this "homework" or scouting stage of the study, which typically lasted 4-6 weeks, teams identified the types of markets and new products of interest, and the desired level of innovation.

In September of 1996, as the first stage started, Sonnack and Churchill sat in on Shor's early Lead User team meetings to focus the process. The two co-leaders probed the team with questions like, "what do you know about this market . . . what don't you know?" "How about reimbursement policies?" "How important is the skin itself as a source of infection?" The team met for four hours each week in a conference room lined with some 20 flip charts so that ideas could be jotted down quickly. Between meetings, team members would search the Internet, literature, and their people network for information on relevant topics. Through this process, the team built up an invaluable database of information. For instance, it learned that 30% of infections occurred from the patient's own skin—a figure that highlighted the need for good surgical drapes. Stage I took the team about six weeks.

Stage II: Trends/Needs Identification

Stated goal in process manual: The ultimate goal of this stage, which typically lasted 5-6 weeks, was to select a specific need-related trend(s) to focus upon for the remainder of the study. Typically a four-day team workshop kicked off this stage.

The 3M team started Stage II with a five-day workshop intended to make sense of all the information gathered in Stage I. Through the workshop, which marked the culmination of all weekly meetings thus far, the team developed the following parameters for a breakthrough product: It should conform to the body, prove more effective than current products, be easy to apply and remove.

The team, by now, had reached a stage where secondary literature could no longer add much of value. The second half of the workshop provided a turning point for the next phase of research: identifying appropriate expertise residing in experts at the leading edge of practice. The team undertook intensive group brainstorming about identifying appropriate experts to contact for more ideas and information from analogous areas of product development. Towards this end, workshop leaders encouraged participants to "step outside the box" because the most logical person might not prove the most appropriate expert. Through the rest of this stage, team members collected information from these identified experts.

Team members started talking over the telephone to a wide range of experts ranging from veterinary sciences to medics from the U.S. Mobile Army Surgical Hospital (MASH) unit in Bosnia.

[5] The Medical-Surgical Markets Division (MSMD) team included: Rita Shor, senior product specialist; Susan Hiestand, business manager with a marketing background; John Pournoor, research specialist and team co-leader; Matt Scholz, senior research specialist; Maurice Kuypers, market development supervisor; and Mark Johnson, process development specialist, Medical Products Resource Division.

The MASH unit, discovered by team co-leader John Pournoor, had been considered a potential lead user because of its needs for portable, inexpensive, and flexible products. Product flexibility would ideally allow for low inventory; a prime consideration for a mobile medical unit. Hospitals, in contrast, could stock dozens of different product sizes and types. Interestingly, the MASH physicians did not fully realize their own need for manageable inventories since they focused on problems of communications, computerization, and telemedicine in the field; thus, they were not the lead users the team was looking for.

Although the MASH physicians would not be able to collaborate more intimately with the 3M Medical-Surgical Markets Division, this stage turned up other experts—from the theater make-up business to veterinary sciences to oceanographers—who would contribute to later stages. Stage II took the team about six weeks.

Stage III at 3M: Preliminary Concept Generation

Stated goal in process manual: In this stage, which typically lasted 5-6 weeks, Lead User groups acquired a more precise understanding of market needs in the selected areas of focus. The teams began to generate preliminary concepts involving ideal attributes and features that would best meet customer needs.

By casting a wide net for product concepts, the division's business unit rapidly realized it knew precious little about the needs of customers outside the developed world. While sanitary conditions in the developed world had long since moved infectious disease down the roster of major killers (below causes such as cardiovascular and cancer), in the developing world infectious diseases were still major killers. If 3M hoped to find a breakthrough infection control product here, however, the team quickly realized it should visit several emerging market sites. The majority of new growth opportunities might lie here, even though disposable products were not popular or affordable.

Through December 1996 and January 1997, the team broke up into groups of two and traveled to hospitals in South America and Asia. Shor and Pournoor visited Malaysia, Korea, Indonesia and India. This was the first time the Medical-Surgical Markets Division had sent product developers, rather than marketers, to visit potential customers. It allowed the 3M team members to see how operating room personnel coped with infection challenges of extreme environments. According to Shor:

> While we saw some excellent, world-class hospitals in India, we also observed hospitals in which surgeons operated barefoot and even we visitors had to take off our shoes. For surgical field preparation, these teams used cloth (often with holes) that provided no resistance to fluids migrating to the wound itself! Sometimes, surgeons would use pieces of raincoat to cover over the patient's groin and other dirtier areas to keep microbes from migrating. Some surgeons used antibiotics wholesale, since these seemed cheaper to them than disposable drapes. . . . Often, only in side-conversations would surgeons reveal that surgical infection was a problem. We also quickly realized that many other nations did not care about labor-savings from our products. Labor was inexpensive and unlikely to be replaced or reduced. As a result, we realized we should not over-engineer our products for these markets.

The international fact-finding trips lengthened the expected duration of Stage III almost four-fold. While they yielded invaluable information about extreme environments and international market needs, they turned up no experts on lead use in terms of product efficacy.

With an eye toward bringing the project to a useful culmination, individual team members, under Sonnack's and Churchill's guidance, continued searching for appropriate lead users that might actually help develop product concepts. Team members continued talking with customers,

academics, industry experts, as well as searching through refereed journals and the Internet. The team found no single lead user with the exact set of specifications that the proposed 3M breakthrough product or products would need. Instead, a variety of lead users were found with expertise about different relevant attributes.

Commenting on the often painstaking search for an appropriate expert, Pournoor felt, "It is like finding a partner for marriage." Some experts came from traditional backgrounds—for instance, an expert on infection control that consulted with the U.S. Center for Disease Control. Sometimes experts were found in the least likely places. During the premiere of the *Lion King* show in Minneapolis, for instance, a team member ended up chatting backstage with one of the make-up artists. As it turned out, the artist's husband, himself a make-up artist, had consulted with an orthopedic products firm. This make-up artist possessed specialized knowledge about the application of materials to the skin, which the team eventually felt would prove useful for developing breakthrough products. At the end, stage III took the team about six months—about four times as long as the process manual had recommended.

How to pool together the combined knowledge and talent of this diverse array of knowledge to develop product concepts would prove the challenge of the final project stage.

Stage IV at 3M: Final Concept Generation

Stated goal in process manual: In this stage, which typically lasts 5-6 weeks, Lead User teams take preliminary concepts developed in Stage III toward completion and also seek to ensure that all possible solutions have been explored. This stage centers around a workshop with invited lead users.

In the summer of 1997, bad luck struck the team in the form of a change in senior management. Thus far, the team had kept upper management apprised of the team's progress because "that way, when you make recommendations and submit proposals, there are no surprises."[6] The new division manager, Sam Dunlop, was one of the rare managers to come with a traditional market research background. His vision was aligned with the old 3M strategy of incremental growth in high margin products. Dunlop had accepted the new post against his will, with the mandate to "stop the hemorrhage of profits and reconsolidate the division." He was close to retirement, and over the past few years none of the units he headed had thrived.

In an initial meeting with team leaders, Dunlop stated more than once, "We must not tax the current operating income!" Although he recognized the need for departing from traditional product development, the focus on finding "wild-eyed" lead users made him uncomfortable. His marketing training had stressed logic and quantifiable data, which could be collected and analyzed in a predictable, linear fashion. The Lead User methodology, in contrast, collected qualitative data from people, with new questions leading to new concepts, which in turn started up a new cycle of questions that begged further answers. Where the process would ultimately lead was never known with full certainty at the project's start. As a temporary compromise, Dunlop reduced the Lead User team by one member and made his opposition to the project quite clear.

Shor and her team had to sell the program starting from scratch, reminding the new managers about how inefficient the old ways of developing products had been. One tactic was to invite some of the business managers to join several team brainstorming sessions. This, according to Pournoor, "got them out of the box," and made them more receptive. Nonetheless, team members remained uncomfortably aware of the watchdogs of corporate profitability nipping at their ankles.

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[6] "Teamwork with a twist helps 3M'ers think differently," *3M Stemwinder*, April 15, 1998.

The Stage IV Workshop: Learning from Lead Users

Even with the project's green light blinking anemically, the team finally decided to center the Stage IV workshop around the bold question, "Is there a revolutionary approach to infection control?" In deference to management's concern with the near term bottomline, however, the team decided to focus specifically on product efficacy and cost. Rita Shor expressed the workshop goals to 11 3M personnel (see **Exhibit 5**) and 11 outside experts (see **Exhibit 6**) that had gathered on August 8 at a St. Paul hotel:

> By the end of the workshop, we want at least three product concepts that could dramatically improve microbial control in the surgical setting of today and tomorrow, with significant cost savings for surgeons in the United States and in the rest of the world. We seek breakthrough innovations that range from being so big as to render obsolete the current system, or, alternatively, so simple that they would use our existing technologies in a new ways.

All assembled experts signed intellectual property rights to 3M, but received modest financial remuneration in the form of an honorarium. The workshop lasted two and a half days, a period, described by Lead User team co-leader John Pournoor, a veteran of many product development focus groups, as "not too long and not too short." This length of time allowed for two to three iterations of concepts.

In the introductory session, group members introduced themselves and discussed how their backgrounds might pertain to the task on hand. The group of experts, varying in age from 35 to 79, came from disciplines ranging from dermatology to make-up artistry to veterinarian sciences (see **Exhibit 6**). The workshop was divided into exercise sessions lasting several hours each. For each session, participants divided up into smaller groups of three to five individuals. Although groups constantly changed, "An element of competition among groups developed," according to Pournoor. "This reminded me of my old work at Boeing, where we'd have two different teams working in parallel on the same project."

Group members and facilitators faced at least four major challenges. The first arose from the lack of structure found in many corporate meetings. As a result, some groups tended to "flounder" during much of the exercise sessions. In a surprisingly large number of sessions, however, teams adhered to a strict schedule, which served to shepherd them toward solutions in the last few minutes.

A second challenge came from introverted and extroverted participants. Initially, for instance, the make-up artist, according to Pournoor, "felt intimidated by all the big words being thrown around, and I think he began to wonder what he was doing there. As time went on, however, his expertise and our needs converged. He contributed more and more." By contrast, the surgeon tended to squash all new ideas that arose early in the session. During a break, however, the veterinarian took him aside, saying, "Do you remember how during your training you were under someone's thumb? Well, that's what you're doing to us." After reflecting upon these words, the surgeon actually stayed up much of that night searching the Internet for new information, and thereafter went on to encourage other team members' contributions.

A third challenge came from finding ways to marry very creative ideas with technical feasibility. A rare nexus of lead user need and technological reality occurred following a period when the veterinarian stopped to reflect on his view of the ideal operating room:

> I—and probably most surgeons—want to focus on only one area on the operating table. I don't want to see anything except what I'm focused on, especially when I'm tired or under

stress. With this in mind, could we create a material that we could quickly pull out of the wall or a box and place directly over the patient to create an infection barrier? Such a material should ideally draw the surgeon's attention to only the area being operated upon. This would prove valuable because time is of the essence, and surgery is a waltz that must be performed correctly every single time.

Subsequent brainstorming identified a preexisting material found in 3M's current line of products as possibly capable of bringing the veterinarian's needs to product reality. This exchange of ideas ended up forming the basis of one of the workshop's key product concept recommendations.

The fourth challenge lay in navigating a sea of facts. Here, an intricate interplay of questions and answers between experts from a diverse range of interrelated disciplines helped keep the entire product development process afloat. For example, one participant asked, "How do we make all these antimicrobial materials stick to the patient's body?" The make-up artist, heretofore in the background, pulled open his large binder of dozens of pre-fabricated/pre-made concoctions of skin-adhesive materials that 3M would have otherwise missed. By the end of the ensuing discussion, he ended up sketching a product concept for layering on materials onto surfaces with smooth contours that could be shown to the other participants.

In the course of several sessions, the invitees successfully rose to the challenges facing them and generated numerous product concepts. In the final session, the group met as a whole to rate and prioritize all concepts on the basis of commercial appeal and technical feasibility. Finally, team members agreed upon the next steps for refining the leading candidates (see **Exhibit 7**). The external experts ended up rating the workshops highly, from an A- to A+ largely because, in Shor's words, "They'd been in brain-storming sessions where everybody tossed out ideas, but this time, they got to turn the ideas into concrete concepts. . . ."[7] (See **Exhibit 8**.)

After the lead users and other invitees had left town, the product development team from the Medical-Surgical Markets Division met to decide upon its final recommendations to senior management. The team felt the following "metrics" should be used for ranking the product development concepts that had arisen from the recent workshop:

- Customer preference for the new products.
- Creation of new growth for the division, with the goal of double-digit annual growth. Creation of new businesses and industries that could change the basis of competition for the business unit.
- Boosted global presence of the division.
- Higher growth for the rest of 3M through, as much as possible, incorporation of proprietary 3M technology with patent protection.

The team ended up with three product recommendations that involved an "economy" line with a strong focus on cost, a "skin doctor" line, and an antimicrobial "armor" line (see **Exhibit 7**). The first two recommendations represented straightforward linear extensions of existing 3M product lines. The last, the team thought, represented a departure from past activities, and might thus open the door to new business opportunities. The team felt solidly confident in presenting these three recommendations to senior management, especially given the scope for synergy with 3M's existing activities and business unit strategy. For instance, all these proposed product lines could potentially

[7] "Lead User Research picks up the pace of 3M innovation." *3M Stemwinder*, September 24, 1997.

boost sales from preexisting 3M products that helped reduce microbial contamination. As another example, the first proposal could also draw from a preexisting line of 3M drapes.

It was the fourth recommendation, however, that divided the team and formed the basis for a long, heated discussion among the team members.

The Fourth Recommendation: Evolution or Revolution?

Over the past few months, the product development team had become increasingly aware of a gaping hole in medical knowledge involving infection containment. Discussions with lead users and associated experts indicated that the medical community still groped for ways to prevent infections and was easily swayed by any report that appeared credible. No health care company had yet stepped in to take leadership in the area of early intervention in the disease process. Thus a vacuum existed in which 3M could find a new growth area.

For the fourth recommendation, therefore, the product development team had begun thinking about re-writing the business unit's strategy statement to include *upstream containment* of infections or, in other words, to keep infections from happening by precautionary upstream measures. Entering the area of upstream containment, however, meant becoming adept at a new set of skills and knowledge. It meant, for example, being able to track early contamination and its possible consequences in a health care facility—not only detecting specific contaminants but also identifying and, depending on their risk-level, targeting individuals for interventions.

The new approach thus called for much more sophistication than the traditional industrial viewpoint, which held one patient just as deserving as the next of the latest surgical drape or the newest handwash. With the new approach, for instance, a malnourished patient might be targeted for nutritional interventions in addition to standard interventions, and diabetic patients might be identified for extra antibiotic coverage.

At 3M, such sophistication called for combining technologies from more than one core area or from areas in which 3M lacked depth. In particular, the product development team recognized the need to combine technologies from its Medical-Surgical division with diagnostics. But because the term "diagnostics" held a negative connotation at 3M—following the brief and unhappy acquisition of a small diagnostics company in the 1980's, the team diplomatically substituted the word "detection" in wording its recommendations.

The very need for diplomacy with phrasing of recommendations brought home the ramifications of a shift in direction. "While traditional product development team members at 3M face no immediate consequences for failures," according to Pournoor, the polymer chemist, "we were actually thinking about challenging the entire business strategy. We were crossing boundaries. . . . I think this resulted from using the Lead User methodology, which, in addition to allowing us to gather and use information differently than before, also provided emotional support for change. Team members no longer felt like `lone-rangers' as they might have under the traditional regime."

In the evening before the final recommendations were to be presented, the team met to resolve a deadlock over the fourth recommendation. Maurice Kuypers, the market development supervisor, sparked the debate by stating, "We don't want the Lead User methodology to be viewed as a means for fomenting revolution. We already have three great product recommendations. If the team proceeds too quickly with the fourth recommendation, senior management may pull the plug on everything: the product recommendations as well as the Lead User method itself."

Mark Johnson, the process development specialist, countered, "When I started with this method, I thought we were just going to develop new products. But now, talking with these lead user experts has shown me that what we were planning was not too effective anyway. We should seriously question our unit's business strategy."

Susan Hiestand, the business manager, chipped in: "Wasn't our mandate to find break-throughs? We were warned that with the Lead User method we will never be able to predict the final outcome or the path we will end up taking. Well, here we are with our breakthrough: It's not a product you can drop on your foot; it turns out to be a process or a service!"

"I think in the back of his mind," John Pournoor warned, "Dunlop would not mind seeing this process fail. Let's not give him any excuses for scrapping everything we've worked and sacrificed for, with our extra hours of hard work on this process. Let's focus on the first three recommendations, plant a few seeds about infection prevention, and draw the managers into making the intellectual leap themselves. Let them become the revolutionaries... or 'corporate visionaries.'"

Rita Shor looked at her watch. In less than an hour she would have to draw the discussion to a close and seek consensus. She recalled how in the final workshop, the sessions often floundered until very close to the end, when miraculously the group would arrive at consensus. But that—as invaluable to fostering creativity as it had proven—now seemed like playing a board game on a rainy day. Today's decisions would ripple through the very real world of business, with the future of a sizable business unit at stake.

Exhibit 1 Important Milestones

1902	Minnesota Mining and Manufacturing founded.
1948	3M Steri-Drape® Surgical Drape introduced.
1961	Medical Products Division, the first 3M division dedicated solely to health care, founded.
1993	
May	Eric von Hippel at MIT contacts Mary Sonnack to see if 3M would help test Lead User methodology. Sonnack would spend the entire next year to learn and help formalize the Lead User methodology and initiate the involvement of psychologist Joan Churchill in the later part of the year.
1996	
June	Rita Shor given task of finding breakthrough products for Medical-Surgical Markets Division. Shor approaches Mary Sonnack after hearing Sonnack lecture internally at 3M about Lead User methodology.
September-October	Stage 1 of Medical-Surgical Markets Division Lead User project starts. Shor's product development team meets with Mary Sonnack.
End of October	Stage 2 starts.
December	Stage 3 starts. The product development team decides to search internationally for breakthrough ideas on surgical draping.
1997	
January-March	Medical-Surgical Markets Division team visits South America and Asia for breakthrough ideas on surgical draping.
April	Lead user meetings/workshops result in several concepts. Team starts search for appropriate lead users.
June-July	New management in Medical-Surgical Markets Division seeks justification for Lead User process and wants accelerated outcome. The team convinces new management to maintain support. Stage 4 starts.
August	Large 2.5-day Lead User workshop with 11 outside experts and 11 3M insiders.
October 27	Scheduled date for Medical-Surgical Markets Division team's presentation to management concerning recommendations generated from Lead User process.
November	Medical-Surgical Markets Division management's deadline for resource allocation for product concepts generated from Lead User process.

Source: Case interviews.

Exhibit 2 Selected 3M Financial Data (dollars in millions, except per-share data)

	1995	1996	1997
Sales	**13,460**	**14,236**	**15,070**
Cost of goods sold	6,861	7,216	7,710
Gross profit	**6,599**	**7,020**	**7,360**
Selling, general, and administrative expenses	3,440	3,646	3,815
Depreciation, depletion, and amortization	859	883	870
Operating profit	**2,300**	**2,491**	**2,675**
Net income (after taxes)	**976**	**1,526**	**2,121**
Other Data:			
EPS (primary)—excluding extra items and discontinued operations	3.11	3.63	5.14
Dividends per share	1.88	1.92	2.12
ROA (%)	9%	11%	16%
ROE (%)	19%	24%	36%
Market value	27,791	34,597	33,212
R&D expenses	883	947	

Source: 3M Financial Reports

Exhibit 3 3M Revenue by Classes of Products/Services ($millions)

	1995	1996	1997E	1998E
Tape products	$2,042	$2,096	$2,215	$2,370
Abrasive products	1,220	1,270	1,375	1,510
Automotive and chemical products	1,328	1,460	1,620	1,800
Connecting and insulating products	1,470	1,564	1,688	1,850
Consumer and office products	2,272	2,460	2,672	2,925
Health care products	2,221	2,356	2,545	2,775
Safety and personal care products	1,220	1,301	1,385	1,505
All other products	1,687	1,729	1,835	1,980
Total	**$13,460**	**$14,236**	**$15,335**	**$16,715**

Source: R.P. Curran, "Minnesota Mining & Manufacturing Co.—Company Report," *Merrill Lynch Capital Markets*, New York, July 11, 1997.

Exhibit 4 Description of Lead User Research Methodology

The Lead User method provides a means to unearth product development opportunities that are not immediately obvious by traditional methods. It allows for accurately forecasting market opportunities by tapping the expertise and experience base of "lead users," the individuals or firms that experience needs *ahead* of the market segment in which they operate. Lead users may lead in either the *target* or *analogous* markets. Some lead users may be involved with just one or more of the important *attributes* of the problems faced by users in the target market.

Ideally, Lead User methods allows new product development to flow out of a sensitive understanding of product features that matter most to customers several years later. Specific benefits of Lead User methods include: richer and more reliable information on the needs of emerging customer needs; better products and service concepts since these come out of better data on quality needs; and acceleration of the product and service development process.

These benefits, however, come only after substantial commitment of resources on part of the sponsoring firm. Research indicates that three elements remain necessary for success in the Lead User process: *supportive management*, use of a *cross-disciplinary team of highly skilled people,* and a clear *understanding of the principles of Lead User research*.

Success of the study relies heavily on selecting a talented core team. Typically, the team consists of four to six people from marketing and technical departments, with one member serving as project leader. These team members typically spend 12 to 15 hours per week for the entire project on a Lead User project. This high level of immersion fosters creative thought and sustains project momentum.

Lead User projects typically take five or six months, in which time the four to six people involved spend up to a third of their time on the project. In conducting a Lead User study, four stages are involved, as described below, with typical time commitments provided in parentheses:

- *Stage I: Project Planning (up to 4-6 weeks)*. In this "homework" or scouting phase of the study, the team identifies the types of markets and new products of interest, and the desired level of innovation. For instance, does the company seek a "breakthrough" product or does it wish to merely extend current product or service lines? At the same time, the team identifies key business constraints. The team typically starts Stage I by informally interviewing industry experts, including customers, suppliers, and internal company managers, to get a feel for current trends and market needs. This lays the groundwork for developing strategies for future data collection and for helping focus on key market trends.

- *Stage II: Trends/Needs Identification (up to 5-6 weeks)*. The ultimate goal of this stage is to select a specific need-related trend(s) to focus upon for the remainder of the study. Typically a four-day team workshop kicks off this stage. In this workshop, members digest the information collected during Stage I to get a sense of the "conventional wisdom" relating to trends and market needs. Thereafter, the focus shifts to finding top experts, through querying experts, telephone "networking," scanning literature, and consulting with in-house colleagues. Thereafter, telephone interviews can start. Three or four weeks into Stage II, the team generally develops a good understanding of major trends and is now positioned for the vital task of "framing" the customer need that can be addressed by a new product or service. These initial ideas are reworked and refined throughout this stage.

- *Stage III: Preliminary Concept Generation (up to 5-6 weeks)*. In this stage, the group acquires a more precise understanding of the needs it has selected as the area of focus. The team begins to generate preliminary concepts involving ideal attributes and features that will best meet

customer needs. The team also seeks to informally assess business potential for the product or service being conceptualized. The team continues interviewing lead user experts for technical knowledge that pertains to concept generation. Toward the end of Stage III, the team meets with key managers involved with implementing concepts after completion of the entire project to confirm that identified needs and initial concepts fit well with important business interests.

- *Stage IV: Final Concept Generation (up to 5-6 weeks)*. In this stage, the team takes the preliminary concept developed in Stage III toward completion. Participants in this stage seek to ensure that all possible solutions have been explored. Activity in Stage IV centers around a one- to two-day Lead User workshop with invited lead users to improve and add to the preliminary concepts. Typically, 15 to 18 people attend this workshop, of which a third may come from the project team and from in-house technical or marketing divisions. In these workshops, subgroups comprised of in-house personnel as well as invited experts discuss independent parts of the problem to generate alternative product concepts. Thereafter, the entire group evaluates the concepts in terms of technical feasibility, market appeal, and management priorities. Finally, the entire group arrives at consensus on the most commercially promising concepts and develops recommendations for further steps to refine them.

After the workshop, the team refines the preliminary concept on the basis of knowledge gained from the workshop. At a meeting with managers, the team presents the proposed products or services, covering design principles. The team comes prepared with solid evidence about why customers would be willing to pay for them. For any concept chosen for commercialization, at least one member of the Lead User team should remain involved in further steps needed to take the concept to market. This helps fully leverage that the vast body of knowledge captured through the Lead User method.

While Lead User methodology stresses qualitative probing of the right questions over the traditional focus on quantifiable questions, ongoing studies seek to compare performance of the new method with traditional methods.

Source: E. von Hippel, J. Churchill, M. Sonnack, *Breakthrough Products and Services with Lead User Research* (Cambridge, Mass. and Minneapolis, Minn.: Lead User Concepts, Inc., 1998, forthcoming Oxford University Press). For a detailed discussion and description of Lead User research, see also S. Thomke and A. Nimgade, *Note on Lead User Research* (Harvard Business School Case No. 699-014).

Exhibit 5 3M Staff Participating in the Stage IV Workshop

Lead User Team Members:

- Rita Shor, Senior Product Specialist, Medical-Surgical Markets Division (MSMD) and Lead User team co-leader
- Susan Hiestand, Business Manager, MSMD
- John Pournoor, PhD, Research Specialist, MSMD, and Lead User team co-leader
- Matt Scholz, Senior Research Specialist, MSMD
- Maurice Kuypers, Market Development Supervisor, MSMD
- Mark Johnson, Process Development Specialist, MSMD

Lead User Team Consultants

- Joan Churchill, PhD, Clinical Psychologist
- Mary Sonnack, Division Scientist and Internal 3M Consultant

Other 3M Staff Members Involved

- *Microbiologist:* Joanne Bartkus, PhD, Clinical Studies
- *Business Development Manager:* German Chamorro, 3M Latin America
- *Synthetic Chemist:* John Dell, PhD, Senior Research Specialist
- *Organic Chemist:* Roger Olsen, R&D Manager
- *Marketing Manager:* Nicola Stevens
- *Product Designer*: Joy Packard

Source: 3M

Exhibit 6 Outside Experts Participating in the Stage IV Workshop

Expertise on Advanced Methods for Understanding Bacteria

- ***General surgeon and chemist*** *(MD, PhD),* possessed considerable experience in minimally invasive surgery with very ill patients as well as epidemiological expertise. *Area of innovation:* understanding surgical contamination.

- ***Dermatologist/surgeon*** *(MD),* had worked on laser excision of skin cancer and possessed expertise on skin infection. *Area of innovation:* surgical wound healing.

Expertise on Methods for "Fast Track" to Market

- ***Antimicrobial pharmacologist*** *(PhD),* had chaired the Food and Drug Administration's Antimicrobial Committee for pharmaceutical drugs and had worked with skin care and pharmaceutical products for 30 years. He had worked on a similar product focus group that had led "tortuously" to the anti-cold medication Nyquil. *Area of innovation:* antimicrobial agents.

Expertise on Advanced Agents to Kill Bacteria

- ***Disease control expert*** *(MS),* a water-purifying expert who had worked for the Centers for Disease Control (appearing here as a private consultant) and had a background in epidemiology and hospital staff-mediated infections. *Area of innovation:* expertise in controlling infections in wet environments as evinced by getting a flood-stricken hospital back in operation with antiseptic systems working within six days.

- ***Antimicrobial chemist*** *(PhD),* with training in synthetic organic chemistry, held over 50 patents in better delivery of antiseptic solutions and had also researched synthetic materials used to make artificial skin. *Area of innovation:* delivery of antiseptic solutions.

- ***Biologist*** *(PhD*), had started out researching meat industry infection but ended up appreciating the need for preventive medicine through "looking upstream" for the earlier sources of infection involving livestock. *Area of innovation:* study of the relationship between different microorganisms; development of light and reduced fat cheese.

- ***Biochemical engineer*** *(PhD),* a university professor who worked in the areas of tissue engineering and sterilization. *Area of innovation:* tissue engineering and sterilization.

Expertise on Ease of Application to Skin

- ***Broadway make-up artist***, had served as a consultant to an orthopedic products firm. *Area of innovation:* application of materials and cosmetics to the skin.

- ***Veterinarian surgeon*** *(DVM),* explained his presence on the panel in terms of the extreme challenges infection control in animals poses since, in his words, animals "have hair, do not bathe, and carry no insurance!" Veterinarian input, thus, could help address an extreme end of the spectrum of human infection that was traditionally neglected. *Area of innovation:*

surgical techniques and implant design, for which he had won the 1996 veterinarian "Practitioner of the Year" award.

- ***"Creative health practitioner"*** *(MD),* a psychiatrist with a BS in microbiology, also had a background in the assessment of performance of paint products. *Area of innovation:* assessment of chemical applications on hard surfaces.

- ***Polymer chemist***, who had also studied acupuncture, in addition to polymers. *Area of innovation:* study of acupuncture, polymers, and rheology (the study of the flow of matter).

Source: 3M

Exhibit 7 Excerpt from Memo on Product Recommendations

The abbreviated descriptions below are the Lead User team's recommendations for three product lines for the Medical-Surgical Markets Division (MSMD). (Note that these are the leading contenders from the six concepts that came out of the final product development workshop.)

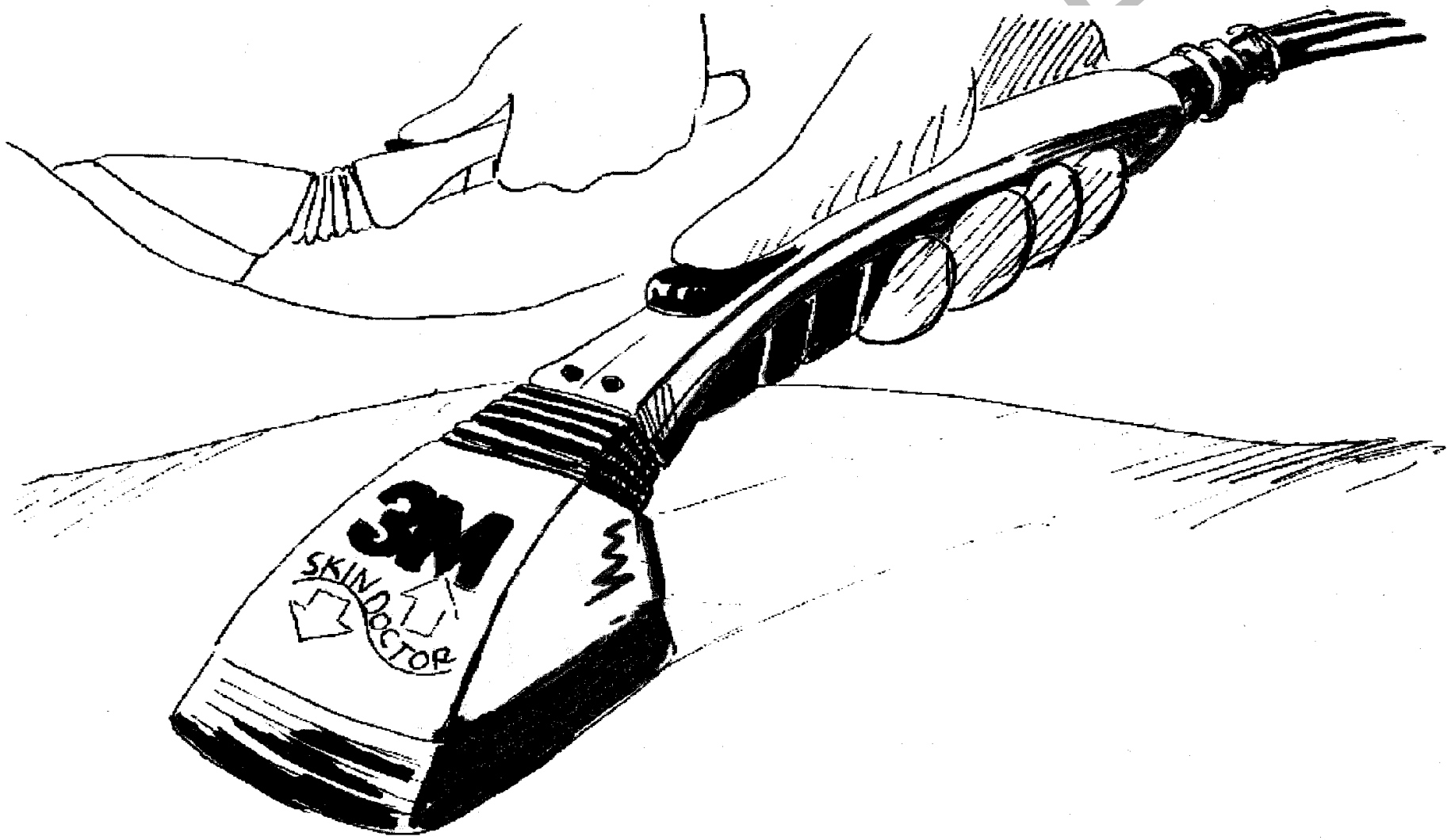
1. ***The "Economy" line.*** The MSMD should consider a line of surgical drapes using a combination of low cost materials. Preexisting 3M adhesives and fastening devices may provide a variety of ways for sticking the materials to the body. A one-size-fits-all strategy and timesaving dispensing systems will boost product acceptance in the current cost-containment environment as well as in developing countries. (Impetus for this product line, in fact, came out of the divisional fact-finding trips to the developing world.) Following the veterinarian lead user's advice, these materials should allow focus on only the part of the body being operated upon. Being based on preexisting 3M technologies, this represents an incremental proposal.

2. ***The "Skin Doctor" line*** (See **Exhibit 8**). The MSMD should consider a line of hand-held devices resembling hand-held vacuums for antimicrobial protection. These devices would layer antimicrobial substances onto surfaces being operated upon. An advanced generation of the Skin Doctor could potentially operate in two modes: a vacuum mode, which could mop up surface liquids, in addition to the original layering mode. Impetus for this came from the Lead User workshop. Being based on preexisting 3M technologies, this also represents an incremental proposal.

3. ***Antimicrobial "armor" line.*** Currently, 3M focuses on only surface infections and thus ignores other infection control markets that included blood borne, urinary tract, and respiratory infections. An armor product line would use 3M technologies to "armor" catheters and tubes from unwelcome microscopic visitors. This line would represent a breakthrough product because it is consistent with the current business strategy of reactive infection control but would provide the company entry into a new $2 billion market.

Source: 3M

Exhibit 8 Drawing of the "Skin Doctor" Product Concept Generated During the Lead User Workshop



Source: 3M