

## Breakthroughs to Order at 3M

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3M correctly prides itself on being an innovative, technology-based company, and they have an excellent track over the years with respect to innovation. But they always want to do still better. Internal thinking about 3M innovation practices by top management revealed patterns with respect to what they did well – and areas where improvement was needed.

Basically, 3M was found to be in very good shape with respect to fundamental, technology-driven innovation. 3M has very deep technological strengths in its areas of expertise, and it also has a strong internal culture that promotes bottoms-up concept generation by its employees. For example, 3M company policy encourages all technical or marketing employees to spend up to 15% of work time on a project of their own choosing. During this time, developers work on new ideas both as individuals and as informal teams, and bring them to the point where they can be considered for formal support as a product or service development project. The company was also judged to be in very good shape with respect to timely development of incremental improvements to existing product lines. They have very good pipelines to carry customer request information quickly from sales to product developers, and development and manufacturing are generally able to respond quickly to bring a desired improvement to market.

Where 3M innovation was found to be lagging, however, was in the area of innovations driven by insights into novel, unarticulated market

needs. (“Unarticulated needs” is 3M’s term for needs that customers have not yet found a way to express - often because they are very novel or rapidly-evolving – but that customers would be very pleased to have solutions to nonetheless.) This finding was not too surprising to 3Mers. The company has traditionally regarded itself as being technology driven, rather than marketing driven, and it actually employs very few professionals in marketing or marketing research, relative to the number of specialists employed in R&D and sales. Management, however, regarded the problem as a serious one. It felt that there were major opportunities for growth in the “white space” between the areas covered by existing 3M Divisions. It also judged that it would be important to enter such areas with novel technologies and deep insights into newly evolving customer needs – 3M did not want to try to enter new markets with “me-too” solutions.

But how could this be done? 3M’s insights into the needs of the markets currently served were mainly derived from many years of working with customers in those markets. Obviously, this approach could not be applied to markets not yet entered. A search by 3M of established market research methods was not encouraging. Marketing research methods generally address quantifying needs that are already established in a marketplace, rather than identification of novel, evolving needs. A search of established idea generation methods was also not encouraging. Idea generation is often referred to as the “fuzzy front end” of the innovation process, because it is not clear how to do this task well. Yet high quality idea generation or identification is essential to the success of any innovation process. After all, without high quality ideas as inputs, the quality of innovation process outputs must be low: In the elegant phrasing of our friends in computing, “Garbage in, garbage out!”

At this point, the traditional, bottoms-up innovation process of 3M took over. Various need identification methods were experimented with by a few 3M divisions, and a few employees tried their hands at developing new methods from scratch. No clear winner emerged, however, and the problem continued to worry 3M management. Eventually, Mary Sonnack became interested in the matter. Sonnack was a Division Scientist in the Commercial Office Supplies Division. She was a chemist by training, and had no background in marketing research. However, during her career she had pioneered the successful introduction of several important new processes to 3M, such as QFD, and was interested in that type of activity. She knew she could get a better method for identifying unarticulated customer needs successfully introduced into 3M everyday practice – if only she could find a good method out there somewhere.

Sonnack took a different approach to the method search problem than had others at 3M. Instead of exploring the marketing literature for candidate methods, she began reading in the new field of management of technological innovation. Fairly quickly, she found articles by von Hippel at MIT. Von Hippel had spent a number of years studying the sources of innovation for new products that had been major commercial successes in a number of fields. In essence, he had found that many of these commercially important products had been first thought of and prototyped by product users at the “bleeding edge” of a field of application – lead users – rather than by product manufacturers. He had also found that this was especially true for products that address functionally novel needs rather than simply providing improved solutions to known problems (see sidebar). This latter finding was especially important to Sonnack, because this meant that von Hippel had potentially found a way to solve the problem of identifying important

unarticulated needs that might give 3M access to previously unsuspected new markets.

In essence, von Hippel's research had found that needs that are unarticulated for ordinary users in a target market might well be clearly understood, clearly expressed – and perhaps even solved via a user-developed product or service prototype - by users who lived at the leading edges of that market or functionally similar ones. This meant that the daunting task of finding unarticulated needs might be transformable into a somewhat easier one: learning to identify and learn from lead users.

#### Sidebar: “Dimensions of Merit” vs Functional Novelty

Many product or service innovations provide improvements upon “dimensions of merit” known by manufacturers to be valued by customers such as cost, size, energy consumption and so on. Such innovations depend upon technological advance, and are often conceived of and developed by firms leading in the key technologies. For example, every manufacturer of computer memory chips knows that the customer wants larger-capacity chips that are smaller and faster and cheaper and more energy-efficient. And, chip manufacturers are often the developers of the concept for next-generation new chips and of the actual new chips themselves.

Functionally novel innovations are innovations that are designed to help users do new things – and users often lead in conceiving of the need for these and developing prototype solutions. We can illustrate this distinction and what is meant by functional novelty by reference

to telephone pagers. Manufacturers such as Motorola tend to lead in making pagers smaller and more energy efficient – innovations that represent improvements along dimensions of merit. In contrast, users tend to lead in finding (and prototyping) new uses that can lead to new types of paging products. Two examples:

- “With so few telephones to be beckoned to, who could have guessed that the Chinese would go bonkers over that familiar summoning device – the pager. The passion spread so quickly in China in the early Nineties that Motorola was astonished. The answer to this mystery: Resourceful Chinese use the pager not as an accessory to the phone, but as a sort of primitive substitute for it. The conventional phone system has a penetration rate of some three to four lines for every 100 Chinese, meaning that even if you find a phone, the other party might not be in a position to receive your call. Only the well-heeled business person can surmount this annoyance with a costly cellular phone. So native genius stepped into the breach. Chinese paging subscribers spontaneously developed a method of carrying code books, allowing them to interpret numeric messages flashed on their pagers: 75416, for example, might mean sell gravel at 6,500 yuan a ton or bring home a cabbage for dinner.” (“The Pager Rage” [a box from a Fortune article - I have to find the complete citation])
- “While it was once thought that portable phones would replace pagers, many people are using both devices. ... By relying on a pager for incoming messages, cellular-phone owners can avoid

interruptions from unwanted calls, which they would have to pay for if answered. They also do not need to leave the phone on to get calls, saving their batteries. ... “There are many people who have their pagers Velcroed to their phone,” said Herschel Shosteck, a cellular phone industry consultant in Silver Spring, Md. ... Universal Cellular hopes to eliminate the need for Velcro by combining the two devices. The company said the Pagerphone will be available in the spring (“The Pagerphone: Ciao Velcro,” NYT p. F9, 12-23-90).

Sonnack went to visit von Hippel at MIT and discussed his research with him. She found the research findings convincing, and also learned about real-world concept-development projects that von Hippel and others had carried out for a number of firms that had produced very good and novel outcomes. What was missing was a well-documented process and training materials that could be used to easily teach the process to project teams at firms like 3M. Von Hippel agreed that it would be worth developing such process documentation if 3M would support the work, and Sonnack went back to her management with this idea in mind.

Chuck Harstad was head of the Commercial Office Products Division at 3M (the “Post-It” Division), and was well aware of 3M’s need for an improved method for efficient identification of leading-edge needs. Mary Sonnack approached Chuck with a proposal: Send me to MIT as a Visiting Scholar for one year – I have a written invitation here in my hand. During that time I plan work with von Hippel to learn and help develop process documentation for the Lead User concept generation method. I will come back to 3M in one year with a solution to 3M’s unarticulated need

identification problem. Harstad had worked with Sonnack previously, and knew that she was worth betting on – so he agreed to continue her salary while she spent a year at MIT. Sonnack then approached Bill Coyne, 3M’s Corporate Vice President for Research and Development and asked for funds to help support the work at MIT. Bill felt strongly about the importance of the problem, and was also willing to bet: He responded with an “Alpha Grant” – the largest that had ever been authorized by that program.

Sonnack transferred to MIT for one year starting in September, 1995. A psychologist who specialized in the development of training materials, Dr. Joan Churchill, was identified and invited to join the team. By Spring, 1996, an initial Lead User project had been carried out at 3M, and the work of process documentation was well underway. At the end of the academic year, Sonnack moved back to 3M, and work was continued at both 3M and at MIT. In 1997, two projects were completed using draft training materials. In 1998, eight projects were underway simultaneously, and a how-to-do-it book plus coaching materials on the Lead User method had been completed. In 1997, Sonnack moved to Corporate Marketing. By the end of 1998, 3M management was well-pleased with the outcome from its investment, and word was getting around 3M that ‘Mary has something that really works!’ (see sidebar)

Sidebar: The Value of the Lead User method to 3M

Marc Adams, Corporate VP of Marketing, and Bill Coyne, Corporate VP of Research and Development, have been following the evolution of Lead User methods within 3M, and feel that the method can offer a major competitive edge to its users. (Coyne, along with Chuck

Harstad, then VP of the Commercial Office Supplies Division, were the original corporate sponsors who financed and encouraged Mary Sonnack to pursue her interest in Lead User methods.)

Bill Coyne reports that: “Evidence to date suggests that the Lead User method as we practice it at 3M is the system we have been looking for to identify and capitalize on very novel needs. Lead User projects to date have identified major new application areas for Divisions that have tried the process, and are also uncovering major new strategic directions for some Divisions. Corporate management is very enthusiastic about the process – and the line of 3M Divisions interested in learning the method from Sonnack’s Lead User Research and Training Group now extends out of her office door and around the block!”

### Conceptual Underpinnings of Concept Generation with Lead Users

Not all users are created equal with respect to the development of commercially-important innovations and innovation prototypes. Research shows that almost all user-developed ideas and prototypes of general commercial interest tend to be developed by “Lead Users” – that is, users that: (1) expect to get high benefit from an innovation and so have a strong incentive to innovate and; (2) that are ahead of a target market with respect to one or more important trends. For example, Glen Urban and von Hippel studied innovations in the process software used to design complex printed circuit boards. In this field an important and continuing trend in the market was and is the steadily decreasing size of printed circuits. This meant that an important leading edge of that market was involved in designing the very

densest circuits possible. When Urban and von Hippel studied the lead users in the target market who (1) were very dissatisfied with their present software and (2) were at the leading edge of that market with respect to shrinking circuit size, it was found that more than 80% of those lead users had developed novel software on their own – while only 1% of non-lead users had done this.

The point is, if you want to find users that are actively exploring and testing new ideas, it is a waste of time to survey users in the center of the target market. Instead, you must develop methods to seek out users that are at the leading edge with respect to needs that are important to that market – even if such lead users are rare and hard to find - because that is where interesting user idea generation and innovation is concentrated. For example, if an auto company wants to find innovative ways to improve car braking, it should surely search among automobile users who are at the leading edge with respect to this need – say, auto racers. But it should also go on to search for innovative ideas in other fields that have a high need for “stopping things in a hurry” such as aerospace. (Indeed, aerospace is where innovations such as ABS braking were first developed: military and commercial aircraft users have a very high incentive to stop their vehicles before running out of runway!)

Sidebar: User vs manufacturer innovators and innovations

It is important to note that “users” and “lead users” are not just individual consumers. User-developed innovations are novel products or services developed by individuals or firms that expect to benefit from using them. Manufacturer-developed innovations are those

developed by individuals or firms that expect to benefit from making and selling them.

An innovating user firm can be as large or larger than an innovating manufacturer. For example, an auto company that develops an novel machine tool because it has a use for it is typically much larger than a machine tool manufacturing firm.

A single firm may develop both user innovations and manufacturer innovations. For example, when Boeing develops a new process machine that it will use to help build airplanes, it has developed that innovation as a user. In contrast, when Boeing develops an innovative new aircraft to manufacture and sell, it has in that case developed a manufacturer innovation.

There is often a multi-link supply chain between manufacturer and end users. When this is so, different attributes of a product may have different users, which in turn gives rise to different classes of user-innovators. For example, a home light switch is installed by electricians, but used by homeowners. The electrician would be the user of the “easy wiring” features of that switch, while the homeowner is the user of the in-home functions of the switch such as on-off and lamp dimming.

These research findings set the basis for an idea identification and generation method that finds new ideas among lead users, and that then selects and combines some of these with manufacturer insights and capabilities to create significantly new products and services. This approach differs conceptually from other approaches to idea generation in an important way. All idea generation processes collect some information from

users and then employ that information to generate or refine further within the product or service manufacturing firm. However, methods vary in terms of how much of the “idea” they seek to obtain from users versus how much they attempt to generate within the manufacturing firm.

Insert figure here

On the far left of this spectrum (see figure) are brainstorming-type methods. These methods are based on the assumptions that, (1) new product and service ideas are generated within manufacturing firms and (2) that the key to generating them is to help in-house developers to more creatively use the information about user needs and solutions that they already possess. Thus brainstorming methods focus on techniques such as generating “out of the box” analogies to a problem being studied to help free up developers’ thinking.

Most conventional idea generation processes fall into the middle of the spectrum shown in the figure. Here, the assumption is that the role of the user is to provide need information, and the role of the manufacturer is then to combine that need information with solution approaches known to the manufacturer to create new product and service ideas in-house. Methods for collection of need information can range from the conventional, such as focus groups, to the sophisticated, such as the ZMET method of Gerry Zaltman and the Empathic Design methods of Dorothy Leonard. The Lead User method falls to the far right on our spectrum, in that it is designed to collect both need and solution information from lead users. In other words, in the lead user method, the emphasis is more on finding prototype product

and service ideas that have already been generated by lead users than it is on generating those ideas in-house.

There are two major reasons why it makes sense to focus on the identification and collection of innovative ideas generated by lead users rather than on the collection of user need information followed by in-house idea generation. The first is that user need information can very “sticky” – very complex and poorly encoded, and so very hard and costly to transfer from users to the manufacturer. When this is so, and when it is relatively less costly to transfer solution information from manufacturer to user than it is to transfer need information the other way, it can make economic sense to locate the problem-solving work of idea generation at the site of the sticky need information – the user. (The logic here is the same as that used by mining firms when deciding where to locate their ore refining facilities: In cases where ore is very bulky and costly to transport, it often makes sense to locate that processing facility right at the mine.) Research has shown that these conditions often do hold, and that it often does make sense to have concept development and initial prototyping carried out by users rather than manufacturers.

The second reason that it makes sense to search for ideas and concepts among lead users rather than focusing on in-house idea generation is that there are often many more innovating users thinking about a problem than there are manufacturer-based developers, and these users are thinking about and testing a lot of different ideas. For example, it has recently been argued that some user-developed software products such as Apache web-server software are better and more advanced than are commercially-developed servers by Microsoft and other commercial suppliers. In one sense this is not surprising. There are over half a million sites that use Apache software,

and thousands of users who participate in developing and supporting Apache. In contrast Microsoft's team of in-house developers focused on servers totals no more than one hundred.

A similar contrast was recently described in the case of video game development. A web site recently set up by Sony to support computer "hacker-users" interested in developing and playing games on the Sony Playstation quickly attracted 10,000 active participants. In contrast, Sony devotes the efforts of only about 50 in-house and contract developers to developing games for the Playstation. Conceivably one might argue that each of the in-house developers is in some senses better than any user-developer. But can one realistically argue that 100 in-house developers can develop more and more original new product ideas than can 10,000 user-developers? Sony's VP of third-party R&D, Phil Harrison, thinks that the user-developers he has gained access to will come up with "...some radically new forms of creativity [that will] break the conventions that are holding the business today." (J.C. Herz, "Under Sony's Wing, Novel Games Incubate" NYT, p. E4 5-28-98.)

### Two Key Activities in Lead User Studies

As presently implemented at 3M and elsewhere, the Lead User method has two unique core activities that are linked to sequences of more conventional development and market analysis activities. The Lead User core activities are, first, identification of lead users with potentially interesting ideas and, second, working with selected lead users to transfer their insights to firm product and service development teams.

Tracking down especially promising Lead Users is a core requirement for the Lead User method. This is so because the lead user method is based

upon the premise that information on needs and solutions is very non-uniformly distributed in the population, and that the best information on any topic is held by only a few lead users and lead use experts.

Development of a simple method that can efficiently find lead users among a large population of users was a very difficult task. Screening surveys, such as those conventionally used by market research firms were tried first, and were found to not be efficient. Lead Users with the most interesting information were simply too rare to be found by screening methods in a reasonable time and at a reasonable cost. Ultimately a method based on networking was developed that proved very effective and efficient. This method depends on the fact that people with a serious interest in any area or problem tend to know people who know even more about it than they do – these are the people they turn to for help and advice when facing a particularly tough problem. Lead User project teams are now taught to use telephone interviewing to track these network links from person to person until they – quickly – reach the top experts in the field of interest. The process is similar to that practiced in investigative journalism, and it involves two important activities that go on simultaneously. At the same time as top experts in the initially-framed question are being identified, the nature of the most important question – and therefore the identity of the most relevant expertise and experts - is being constantly revised as the interviewing and networking progresses.

For example, in a Lead User study of medical imaging, it was known that a major trend in that field was towards efforts to detect smaller and smaller features – very early-stage tumors, for instance. A lead user team began to work in that area, and initially framed the problem as “How can you increase the resolution of medical images?”Networking in the field of

medical radiology very quickly identified a few radiologist-users working with the most challenging imaging problems in the medical field. These radiologists had created some interesting innovations in the field that were in advance of commercially-available products.

But, equally or even more interesting to the lead user team, these lead users in the target market had links to lead users outside of the target market – some of whom had very different approaches to the problem. For example, lead users in the military and elsewhere have long worked on computerized “pattern recognition” methods for clarifying and recognizing features in cases when increased resolution was not attainable. These non-medical lead users had a very strong need to answer questions such as, “Is that a rock lying under that tree? Or is it the tip of an ICBM?” and they had developed very innovative methods for finding answers. Information they provided changed the nature of the questions the Lead User team was asking, and changed the outcome of their study as well.

The second core activity in the Lead User method is transferring key information from Lead Users to the commercializing firm. That is, after the most promising Lead Users have been identified via networking, the next step for the Lead User team is to understand the lead user problem formulations and solution approaches, and to think about whether anything from these might be transferred with profit to a product or service for their target marketplace – or perhaps to some novel marketplace suggested by the nature of the Lead User activities observed.

Sidebar: Why will lead users talk to your team?

Managers often ask whether lead users with advanced and potentially commercially valuable information are really willing to

talk to a manufacturer – and under what terms? The answer we have found via actual field practice is that most lead users are very willing to transfer detailed solution information to inquiring manufacturers – and they are generally willing to do it for free. The reason for this willingness is rooted, we think, in the relatively low competitive advantage gained by lead users from exclusive possession of an innovation that they may have developed, coupled with the relatively high cost of protecting intellectual property and transferring it at a price.

With respect to the first point, consider that lead users in semiconductor imaging or military pattern recognition will not experience a competitive loss if medical imaging companies adopt some of their innovative techniques. They might want to shield some very new techniques not known to their competitors in their own field. But much of what they know that is of potential value to the medical field will probably already be known to their key competitors, and so there is no competitive cost associated with revealing it. With respect to the second point, a number of innovative ideas and solutions from lead users are usually combined into the new product concept developed by the lead user project team. It would be hugely cumbersome to try to isolate the contribution of a given lead user and put a price on it even if – as is seldom the case – the user has taken steps to protect the innovation via patenting or trade secrecy.

Lead User teams are always instructed to reveal to lead users they interview that their firm may have a potential commercial interest in the ideas being discussed. Interviewees who express any hesitation

in discussing their ideas are urged not to do so – and the team will then move on to other lead users who do not have such concerns.

Lead User project teams use two basic information transfer methods. First, they use interviews with and site visits to individual lead users that they have identified. Second, they invite a few lead users (6 to 8) who appear to have very promising ideas and insights to participate in a joint problem-solving workshop with members of the (multidisciplinary) lead user project team. Such workshops typically run for 2 to 3 days. During that time, lead users and firm product developers and marketers and manufacturing people all join in the problem-solving work of designing one or more product or service concepts (and/or new markets or new strategies) that precisely fit the sponsoring company's needs. Lead users who participate in these workshops do it primarily for the joy of challenging intellectual work with peers. Prior to coming to the workshop they have signed an agreement that any novel outputs from the workshop belong to the workshop sponsor. Outside participants are offered a small honorarium, when this is acceptable to their employers.

More conventional activities that have been put into place around the core of the lead user method include methods for gathering of support for a project among key stakeholders, methods for building collaboration among team-members drawn from multiple specialties, interviewing methods, contextual inquiry methods and the like. Team members must have good skills in these areas to carry out a high-quality lead user study, and some training is often required, we find.

## Should you try a lead user study?

The Lead User method is still rapidly evolving, and if you are interested in trying a lead user study, you may find that your firm is the first to pioneer a new approach or application of particular interest to you. For example, a study recently carried out at Nestle was the first lead user study explicitly directed at strategy development. It was initiated and championed by Mary Longo, a VP at Nestle, who said, “No one has done a lead user strategy study before – but it makes sense that it should work: Let’s try!” The study ended up identifying a whole new strategy for custom food production. A key source of information for that team was lead users in the field of custom semiconductor production – not a source of expertise normally sought out by Nestle!

The Lead User approach to idea generation is applied to significant projects only – it is not a substitute for focus groups! Project teams consist of very experienced and creative people drawn from development, marketing and other fields relevant to a particular project. (At 3M, the general level of team personnel we strive for is at or just below the level of Divisional Technical and Marketing Director.) These very valuable, very busy people then commit to working on a Lead User project for one-third to on-half of their time for a period of four to six months. Clearly, this is not a minor investment!

Lead User projects can be hard to do – especially the first time you try one. On the surface, it sounds easy –finding some attractive lead user innovations and putting them into production doesn’t sound so difficult! But, only rarely will a Lead User project team decide to adopt a solution developed by a single lead user as the basis for a commercial product or strategy. Lead Users are too different from routine users in a target market

for this approach to work very often or very well. More frequently, your team will have to creatively combine and build upon a number of lead user need and solution insights in order to come up with a winning breakthrough that precisely suits your firm and your intended target market.

A recent 3M Lead User study illustrates the “out of the box” sources of information that often prove to be the most valuable, and that must be analyzed and combined to yield a breakthrough outcome. The study involved finding new approaches to controlling infections contracted during surgical operations. (This problem is becoming steadily more important as the effectiveness of many antibiotics fades.) Some of the Lead Users outside of their target market that the project team’s investigations led them to:

- Leading veterinary surgeons and hospitals. Infections at leading veterinary hospitals were found to be as low or lower than those at the best human hospitals. Yet by all logic they should be higher - animals generally don’t bathe as often as people do, and veterinary hospitals cannot afford elaborate infection control techniques in surgery because most owners don’t carry health insurance on their pets. The team wondered: “What is going on here – anything very new of potential interest to us?”
- Military MASH units. Infections at MASH units can also be very low. Yet a key measure used to control infections in ordinary hospital surgical suites is frequent scrubbing of wall and floor surfaces with antiseptic solutions. What do you do when the walls and floors are fabric and may be covered with dirt from the battlefield – if they are still standing at all? (One possible answer, you create a laminar flow of sterile air around the patient, and to heck with walls and floors!)

- Leading movie make-up artists. Many materials used in this field, such as latex masks and appliances, stick to the skin very effectively, do not irritate, and then come off easily. These same attributes are very important to many surgical infection control products.

A Lead User study due to its exploratory, “out of the box” character, may not go where you initially expect it to go. At the conclusion of the 3M Lead Use study just mentioned, for example, the project team had developed unexpected new insights and radically new approaches to the surgical infection control problem. This led to the identification of major new markets by the Division, and to a major change in Divisional strategy in order to address them. (More on this example can be found in a Harvard Business School Case by Professor Stefan Thomke # --.)

A final bit of advice: Set ambitious targets for your Lead User projects. Lead User projects can produce very “out of the box” outcomes and insights – and can lead to new strategies as well as to breakthrough concepts for new products and services. However, if the project is not ambitious enough and the team does not look well beyond present-day needs and present-day users in the target market, the results will probably be disappointing. For example, we were recently contacted by a firm specializing in home video theater systems. They had studied some “lead users” who they had defined as individuals who were early purchasers of top-of-the-line home theater systems. The firm was disappointed with the level of new insights gained. “Well, duhhh!” as the children of today might impolitely put it. Lead users are not the same as early adopters of today’s products, and lead users with the best insights are probably not even in your target market. The video theater project should have been looking much further ahead, for example, to

users who were exploring and playing with virtual reality systems and so forth, in order to get worthwhile insights. In other words, if you really want to explore the future, stop looking at your feet!

If you do elect to try a Lead User project and staff it well and carry it out well, we predict that you will be pleased with the results. We also think on the basis of our experience at 3M and elsewhere that the people who are actually engaged in the project will be pleased too – good lead user projects are exciting and fun and great skill enhancers. When you have finished, feel free to write and tell us what you did and didn't do, and what did and didn't work well. We are steadily learning too, and will enjoy and learn from the exchange!