DryView™ Laser Imaging
The Creation of a Billion Dollar Business

By

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What creates the passion for a new business idea? The initial response might be "potential for wealth" or "a positive impact on a person's career." Those motivations alone are seldom strong enough to withstand years of challenges and setbacks. The ideas that capture the imagination, grab hold of a person's mind and soul and don't let go are more likely to come from a "eureka" moment. In that moment, one sees the possibility of doing something that almost no one believes is possible, like changing an entire industry. This is the story of my "eureka!" moment, which led me to propose, champion, and shepherd the creation of DryView™ Medical Laser imaging, one of the greatest product commercialization successes in 3M corporate history.

DryView™ revolutionized the medical imaging industry with disruptive technology that improved radiology workflow, reduced overall digital radiology exam costs, changed the basis of competition, and significantly extended the commercial life of radiology film. More than twelve and a half years after its introduction in fall of 1995, it is still a very large and very profitable business. Cumulative sales are expected to hit $10 billion in 2008.

DryView™ was also one of the most complex and challenging 3M commercialization efforts ever. It involved a team of more than 200 professionals, working for three and a half years to develop more than 20 new inventions and commercialize the technology. 3M's investment prior to market launch exceeded $100 million. It is no wonder that when the product was first announced in November of 1994, senior executives at Kodak, at that time by far the largest and technologically deep imaging company, admitted that they had not thought the creation of a product like DryView™ was technically possible.

This is the story of how that impossible dream became a reality, despite huge technological hurdles and unexpected and disruptive business reorganizations.

The Beginnings: Dry Silver

I started my career at 3M as a chemist in the Imaging Products group. My focus was a technology called photothermography, which the industry called "Dry Silver". Photothermography uses heat instead of wet chemicals as in traditional photographic processes. This processing method enables much simpler equipment for creating finished gray-scale images. (For a

more detailed description, see the sidebar, “Photothermography Technology” at the end of this article.)

While photothermography has some similarities to wet film, it also has some drastic differences chemically. Many of the unique chemical and physical mechanisms of Dry Silver were not well understood. It was not unusual to have large differences in performance from one manufacturing run to the next with no known reason. Because of these limitations, the technology seemed to have reached its peak by the mid 1980’s with annual global sales for all applications in the range of $100-200 million.

Around this time, Imaging Products merged with the 3M Diagnostic Imaging Group to become 3M Medical Imaging. Now a Quality Assurance Supervisor, I became heavily involved in the development of a major new product known as the 3M Medical Laser Imaging System. Computerized Axial Tomography (CAT/CT) scanners were just coming into wide use, and the first Magnetic Resonance Imaging (MRI) scanners were being installed. These new systems needed a high quality, reliable printing system for digital output of radiographic films. The 3M P-831 Medical Laser Imager was the first of its kind. This automated system utilized near-infrared laser diodes and infrared sensitive “wet processed” photographic film. The laser imager system was a major leap forward in image quality, consistency and reliability. It was an instant hit in the marketplace.

My work on the Medical Laser Imager exposed me to customers and the work environment in typical radiology departments. My unique combination of experiences in photothermography, laser imaging and radiology work flow was the recipe for my “Eureka!” moment: Developing a photo-quality version of Dry Silver for medical diagnostic applications.

Higher quality versions of Dry Silver, which would open much larger markets, had been discussed and debated at 3M for a long time. The idea had never really gained traction, probably because of the many technology breakthroughs needed to bring the technology to such high standards.

The Assessment & Proposal:
There had never been a thorough assessment of what work and breakthroughs were needed to meet the requirements of these new markets. In early 1986, I allocated a significant portion of my Quality Engineering group’s efforts to the task of defining the specifications for diagnostic quality Dry Silver film. I was fortunate to be working for Dean Johnston, the Medical Imaging Quality Manager. He was supportive of his people and open to new ideas. He supported my decision to assign my people to this task. He also put me on the agenda of the Division Operating Committee, which was composed of our division Vice President, Paul Pankow and his leadership team.

At the May 1986 3M Medical Imaging Operating Committee meeting, I made the formal proposal to develop a diagnostic quality or photo grade Dry Silver. Paul Pankow, who was a visionary leader with many years of experience in the medical imaging industry, was enthusiastic about the idea. He agreed to let me pull together a cross functional team, do a full assessment and develop a plan of how to make this idea a reality.

A few months after the assessment team was formed, Paul Pankow left Medical Imaging. He was replaced by a new Vice President, one without any experience in the industry. The final proposal, which laid out the many technological hurdles to be overcome and the efforts required, was shot down by the new VP despite the support of several other Operating Committee members.

That could have been the end. But after the meeting, the head of Medical Imaging R&D, Roberto Oggioni, pulled me aside and told me that he believed in the idea. Despite the decision just made, he authorized a small effort to begin working on the technology development.

"Skunkworks"

A while later another stroke of good fortune occurred: Jim Philip, the brilliant young chemist who was the primary inventor of the wet process laser imager film, asked to be a part of this new effort. Eventually this small "skunk works" research team became visible but was allowed to continue its efforts.

In the summer of 1991, the team made a film pilot coating. The images, while still far from the precise standards of diagnostic film, demonstrated for the first time that the concept was possible. These images were shown to senior management at 3M and got their attention. Near the end of 1991, the decision was made to aggressively pursue this opportunity. Brad Sauer (now the head of 3M Health Care) was brought in as the Business Manager.

I had moved on in my career to other management positions but Roberto Oggioni, remembering my passion for this idea, asked me to come back and lead the team that would develop the technology, commercialize the film, and manage the rebuilding of the film factory. These tasks eventually encompassed about two-thirds of program spending, $65 million. Finally I had the opportunity to make my dream - now the dream of many - a reality. I accepted.

The Plan

The Dry Laser Imaging team, as it was known, was assembled in early 1992. It was made up of my team, known as the SY-3670 team, and 3 hardware teams. The program leadership began the assembly of talent and resources. Emphasis was placed not only on individual skills but also on how capabilities complemented one another. We also developed the initial program assessment and project plan. This plan, which eventually grew to over 3000 tasks, was critical to the

success of the program. It outlined the extensive interactions among the four separate teams working on the project and allowed for the massive parallel effort required to compress the time to market.

That initial plan summarized both the great potential and the enormous challenges facing the project. Here is a summary of the program assessment:

Market Size Projections: $1 billion growing to $2 billion+ in 5 to 7 years

Resources Needed: (prior to start of sales)
• Significant portions of 200+ professionals (mostly scientists & engineers) for 3 + years
• Eventually a $100 million investment, including $65 million in the film development and factory upgrades.

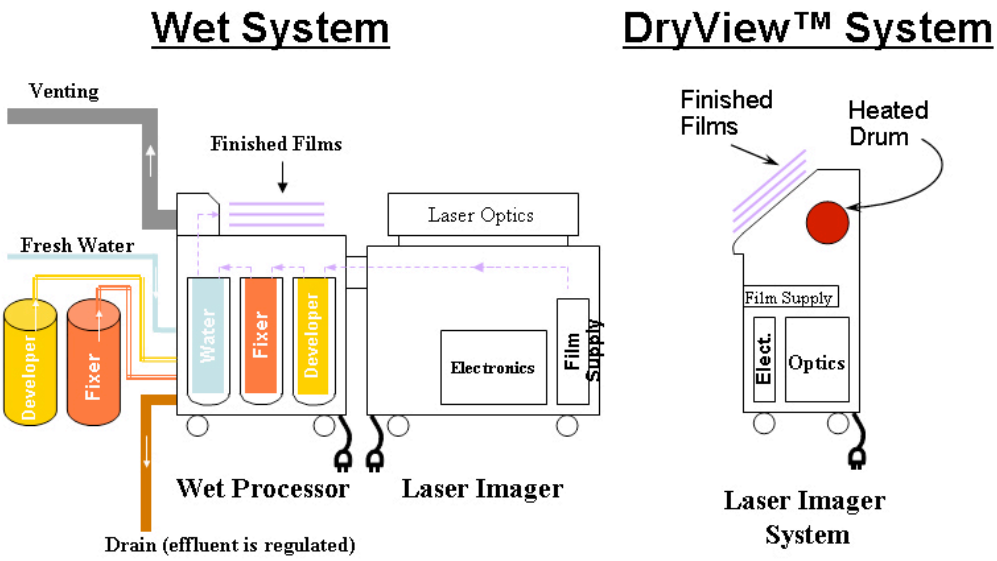
Risks:
• 20+ inventions (nearly all in the film and processor) were required, with the overall technical probability of success rated at 50%
• Complexity – the huge number of tasks requiring successful completion, massive parallel efforts, and extensive new technology development.
• To compress time, the capital investment would have to be made in parallel with the R&D efforts before some inventions were in hand
• Competitive response & timing was uncertain
• Customer acceptance of the performance tradeoffs verses traditional product was unknown
• Customer acceptance of higher prices for the dry film was unknown

Estimated Payback:
• Revenue growth of $50 - $75 million / year for the first 5 years
• Net Present Value: $200 + million (for 5 years of sales)

While 3M was already a $14 billion company, the majority of its businesses were built on smaller, more incremental investments. The decision to move forward with the investment was considered significant and would be made ultimately by the Board of Directors of the corporation. At this time 3M Medical Imaging was losing market share to larger competitors such as Kodak It was apparent to senior management that going ahead with the project was a significant risk, but not moving ahead meant the business would likely have to be harvested. They decided to take the risk and invest.

This diagram shows how the new dry film technology impacts the design of the laser imager hardware. All of the functions of the wet system processor are replaced by the heated drum shown in red in the DryView™ system diagram. The equipment size is roughly to scale, so there is significant space savings as well:

Laser Imager System Comparison



Development & Commercialization:
The critical path for the program was the development of the film and processor technology. This is where nearly all of the inventions were required and where the majority of the program risks resided. The film construction was quite complex.

A major challenge facing the film commercialization team was how to schedule inventions. The scientists argued that it couldn't be done. As a scientist, I understood the difficulties. As a manager, I knew that success depended on finding solutions to difficult technical problems in a predictable manner

We adopted a methodology that took into account the uncertainties of invention. Applying the team's best judgment, we assigned probabilities to the approaches to solve certain problems. If the probabilities were too low, one or several additional paths to solving the problem were identified. Typically, separate individuals or teams were put in place for each approach. The effort to find the solution then became a competitive exercise. The total probability of success went up with the additional solution paths.

This methodology embodied my central beliefs about the most effective way to approach major technology decisions. An autocratic

leadership approach is never productive in a creative activity. On the other hand, a good manager knows when it is time to move the team toward buy-in to a conclusion. When that time came, I would assemble the team, let everyone make their case, and then arrive at a consensus (or, at least, a majority decision). Once the decision was made, everyone had to "get on board." Individual/private agendas were unacceptable and detrimental to the team's success, and team members had to let them go or leave the team.

Another of my key contributions was maintaining a clear vision of the strategic goal while assessing and prioritizing numerous tactical changes. It is a process I compare to aligning the sides on a great Rubik's cube - except that the cube is invisible and it lacks the color-coding that lets you know instantly when you've arrived at the right combination.

During the commercialization effort, the film development was continuously on the program critical path. The inventions required were not just in the film formulation but also in the process of coating and manufacturing the film. Unlike traditional wet photographic film, DryView™ was coated using organic solvents. Coating the film at high speeds with the extreme uniformity required had never been done with this type of coating.

With an investment of this size and risk, the financial projections, including investment costs and five-year sales projections, were critical. Significant effort from the program leadership team went into these projections and making sure the assumptions were solid. Having this information enabled smarter program management decisions.

Even with the large investment costs and the conservative assumptions used, the financial model indicated a Net Present Value (NPV) of > $200 million. The value of time was also estimated to assess the financial impact of a delay or an acceleration of the schedule. This was estimated to be $2 million/week, which turned out to be conservative.

Development of intellectual property was essential for keeping competition at bay once the product was introduced. In addition, it was critical that competition not get word of what the team was doing, which would cost 3M Medical Imaging some of its timing advantage. The program management team approached security of information with an intensity bordering on paranoia. With a team of 200+ persons and involvement of other supporting organizations as well as customer advisors, the challenge to keep it quiet was great. The need for security was emphasized over and over again.

The product was announced in November of 1994 at the Radiological Society of North America (RSNA) annual conference in Chicago. This is the largest radiology industry conference and trade show in the world. The product was projected to ship 10 months

after this show. Since medical laser imagers are typically part of a hospital's capital spending budget, the early announcement was important not to delay sales.

To celebrate the team's success, we bussed 100 of the team members to McCormick Place. Entering the building minutes before the trade show opened to the public, they were greeted by the song "We Are the Champions" piped through the sound system.

The Dry View system did not require plumbing, so it was possible for 3M to print large format 14"X17" films on the show floor – a first at RSNA. Radiologists and hospital management packed the booth the entire week. DryView™ was the hit of this massive trade show.

In October of 1995, the first DryView Laser Imager systems began shipping. Demand greatly exceeded expectations. Sales representatives for Medical Imaging confided that they felt more like "order takers" than sales reps since customers were calling them to place orders. This new and, to many customers, unproven technology instantly dominated the industry and overwhelmed the competition. Over the next twelve and a half years, the DryView™ business grew to nearly $1 billion in annual sales, with approximately three-fourths of the sales in film.

All of this success has occurred despite the fact that just one month after the product launched, 3M announced that its Medical Imaging business would be spun-off into Imation. Senior management offered buy-outs that included key contributors and professionals with product know-how. Many of them left the organization at this time, risking the viability of the business. Two years later, Imation sold the Medical Imaging business to Kodak, again causing great turmoil in the business. In 2007, the business was sold to an investment group in Canada and is now known as CareStream Health.

Despite all of this turmoil, underinvestment, and business decisions by leadership from Imation and Kodak, the business has been a huge success. A conservative estimate is that it has been used in over 1 billion radiology exams worldwide).

While I was a primary instigator in making DryView™ a reality, there are many others who deserve significant credit for their contributions, only a few of whom are mentioned in this story. Without the great set of talent that was assembled this program would not have been successful against all odds.

DryView™ has truly revolutionized the medical imaging industry.

Brian Rembish

Sidebar: Photothermography Technology

The very first Dry Silver products were invented in the 1960's by David A. Morgan and other 3M scientists. Successful products were developed in the 1960's, 70's, and 80's, for simple, low-cost imaging applications. Some common applications included AP wire photo systems for transmitting news images to newspapers, computer output microfilm (COM), and reader printer paper for COM readers. In the 1980's, 3M was the world leader in photothermography technology. Eastman Kodak was the only other company with any significant business utilizing this technology.

The technology in the Dry Silver media was complex and not well understood. Photographic media in general are some of the most complex non-biological chemical systems. It is not uncommon for photographic media to contain 30-50 chemicals with most being interactive. Photographic coatings that require precise uniformity also have extreme sensitivities to impurities. As little as parts per billion of some impurities cause total failure of a product. It has taken many thousands of research-years for scientists to unlock the secrets of wet processed photographic media mechanisms since they were first invented over 150 years ago. This research enabled the precise control of these complex chemical systems required for consumer camera film and medical imaging/radiographic applications as examples. Prior to the Dry View development effort, photothermography science had only a very small fraction of this kind of research.