NEWMOA

NORTHEAST WASTE MANAGEMENT OFFICIALS' ASSOCIATION

A Pollution Prevention and Lending Case

HUBBARDTON FORGE
Immediate Environmental and Efficiency Returns

EXECUTIVE SUMMARY

Hubbardton Forge, located in Castleton, Vermont, combines 100-year old blacksmith forging techniques with state-of-the-art powder coating technology to produce high quality wrought iron lighting and fireplace accessories for retail, wholesale and contract markets. The company was founded in 1975 by two college friends whose commonalities in metal sculpture, perseverance, and values outweighed their business acumen. Although it took the partners ten years to turn a profit, the twentieth anniversary of the company was marked by financial success, sustained growth in sales, and a proactive approach to management of workplace and environmental issues.

In early 1991, the company investigated the use of an electrostatic powder coating system to address a variety of problems caused by its use of a solvent-based lacquer spray to coat the wrought iron parts of the products. Market demand for better quality finishes, excessive rework due to handling damage, process control issues caused by summer humidity, and environmental concerns related to storage and use of solvents and VOC emissions all pointed to the need to switch to a different finishing technology. After trying out a small pilot system in 1993, Hubbardton invested in an automated line and a large process oven, funding half the project cost internally and securing the balance from its bank. After almost two years of operation, the powder coating system was responsible for an array of environmental, quality and efficiency gains:

- elimination of VOC emissions & improved air quality within the plant
- elimination of 98 percent of toxic material and waste generation
- improved product quality due to more uniform and durable finish
- increased productions speeds
- better transfer efficiency
- lower heating costs

This case was written by Sam Perkins, P2 Researcher, under the direction of Terri Goldberg, Pollution Prevention Program Manager at NEWMOA. They are indebted to the owners of National Chromium for their assistance in providing information and reviewing drafts. The case was developed as part of an initiative, funded by a grant from the US EPA, that examined issues involved with the financing of pollution prevention projects. A summary of this case appears in the booklet, ***Pollution Prevention and Profitability, A Primer for Lenders***, that NEWMOA developed to assist lenders understand the benefits of pollution prevention.

While the financial condition of the company and the economics of the project were more than sufficient to justify the loan, the loan officer did understand and appreciate the environmental benefits and some of the longer-term, less tangible advantages of pollution prevention. Most importantly, he recognized that, given banks' potential exposure to the liability risks of its borrowers, it made sense to pay attention to the environmental strategy of company management. He saw that a forward-looking, proactive approach was an indicator not simply of good environmental management but of good management generally.

BACKGROUND

Company Founding

Hubbardton Forge was founded in the mid 1970s by George Chandler and Reed Hampton who met while they were students at the University of Vermont. With a shared interest in metal sculpture and a common distaste for the pursuit of a corporate lifestyle, they decided to set up a forge and start a business in an abandoned farmhouse owned by Chandler's family in Hubbardton, Vermont. While waiting for divine afflatus to inspire their product and marketing strategy, the two entrepreneurs engaged in construction work and other seasonal employment to subsidize the forge operation. Eventually small forge jobs began to trickle in, giving the partners the opportunity to improve their technical forging skills. Finally in 1976, Hubbardton Forge launched its first hand-forged product lines: lighting fixtures, fireplace implements and candle stands, supported by an ad campaign in such retail magazines as *Yankee* and *Colonial Home*.

Early Financing

The success of the construction business enabled Hampton and Chandler to borrow $40,000 from a bank in 1978 to build a studio and fund working capital needs for the forge. Financial success, however, proved elusive as 1980 sales of $30,000 were dwarfed by expenses of $40,000. Without cash to pay-off an additional bank note of $10,000, the partners turned to 'angel' venture capital financing in the form of a family friend named Jack Kleinoder, the owner of a successful tool-and-die operation. In addition to $50,000 capital, Kleinoder infused Hubbardton Forge with the even more important ingredients of improved technical knowledge and basic business discipline. In spite of solid progress and the development of a 20-page business plan, the partners were unable to convince Kleinoder to lend an additional $10,000 in 1980. As a last resort they turned to their fathers for $5,000 each to finance their first large wholesale order through a catalogue - Country Loft. Persistence and tenacity overcame that catalogue's eventual demise, which at one time accounted for 70 percent of Hubbardton Forge's volume, and by 1984 Chandler and Hampton paid off Kleinoder and turned a profit.

Sustained Growth

Through the mid and late 1980s Hampton and Chandler transformed Hubbardton Forge from a part-time start-up into a solid business, clearly defining its market niche and operational philosophy and growing at an average 30 percent a year. In 1988 a bank loan financed the sweat-equity construction of a 10,000 square-foot facility, equipped with scavenged and rebuilt machinery, located at a new site in Castleton, Vermont. Sales boomed in 1989 and 1990, rising 40 percent and 60 percent respectively. In 1990 Hubbardton merged with Vermont Industries, a blacksmith company of similar size owned by a couple who practiced a far more corporate management style than did Hampton and Chandler. The great promise of the merger on paper was soon crushed by the clash of the competing philosophies. After months of wrangling and the near-fatal last-minute collapse of bank financing, Hampton and Chandler bought out their new partners. The buy-out arrangement and the financing package were largely the product of Don Merkle, a small business consultant whom the partners had hired to help salvage the company from the misfortunes of the merger. By 1992, Merkle bought-in as a third partner, and the business was growing with sales reaching over $2 million and a 10 percent pre-tax profit. With growth projected to continue at a 20 percent annual pace, financing needs loomed on the horizon to fund plant expansion.

Current Business: Products, Markets, Competition

Starting in mid-1980s Hubbardton Forge focused principally on the decorative lighting market, a niche with few competitors and growing demand. In 1994, lighting comprised 70-80 percent of the company's sales volumes, with the balance made up of fireplace accessories and other wrought iron household instruments and decorations. Hubbardton sold its products through three channels:

- Wholesale accounts serviced through the company's in-house telemarketing staff and supported by a showroom in Dallas, Texas, the lighting capital of the world according to Hampton,
- Retail catalogues such as LL Bean and Orvis, and
- Direct commercial work for hotels, motels, convention centers, and others for which Hubbardton designed and forged large custom chandeliers and also supplied wall sconces.

Wrought iron's increasing popularity since the mid 1980s boosted growth but also encouraged more competition as lighting manufacturers expanded their product lines into the rustic, wrought-iron niche. More challenging than simply the increased number of competitor products, however, was the fact that many manufacturers sourced the basic components off-shore. Because hand forging requires minimal capital investment and is widely-practiced in the third-world, there are numerous low-cost sources of ironwork, and manufacturers were able to source lighting fixture bases at a price far below the cost of fabrication in the States.

The iron pieces were often imported in an unfinished state and then the finish applied and electrical lamp elements and shades added in this country. Unable to match the price of low-cost competition, Hubbardton Forge differentiated its products by focusing on quality and customer service, especially important elements in servicing the higher-margin custom commercial customers.

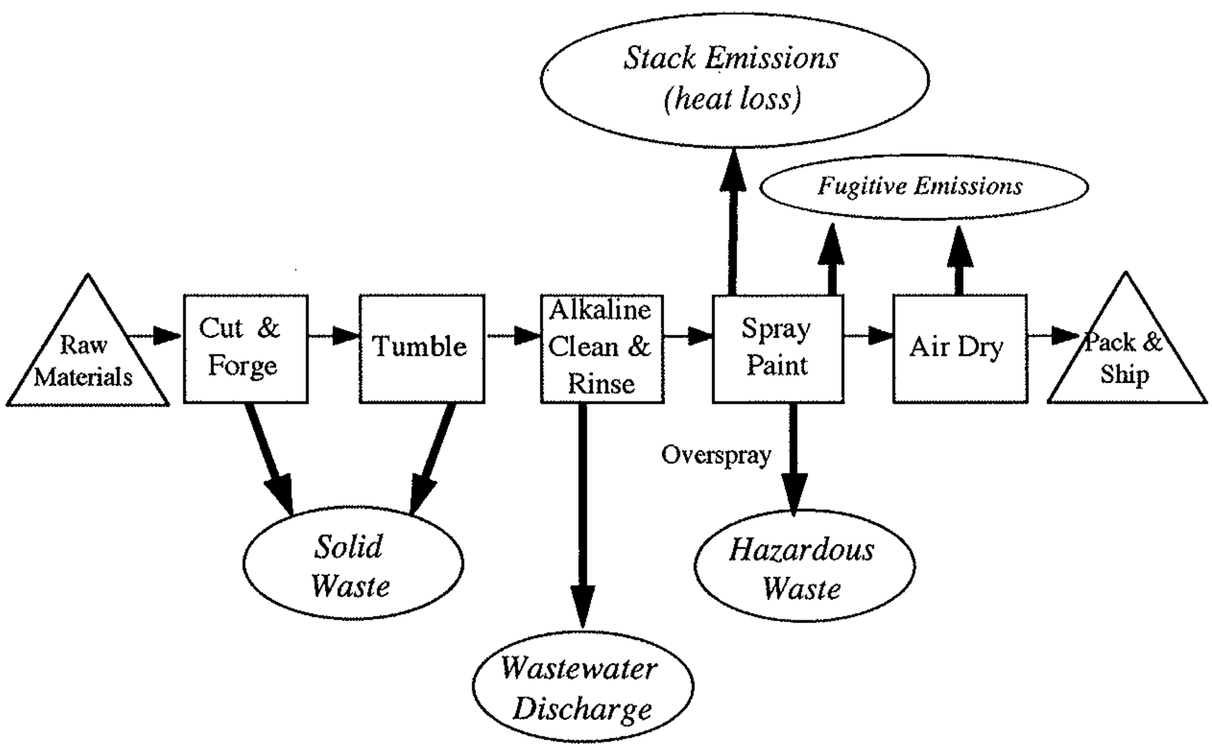
PRODUCTION PROCESSES

Fabrication

Wrought-iron products begin as lengths of flat, round, or iron square bar stock, and securing these raw materials in the desired quality, shapes and sizes has been an on-going challenge for Hampton. The stock is cut and forged to create the shapes for lighting fixtures and other products (Figure 1). This stage of production uses both hand forging and equipment dating from 1888, including a foot-treadle-operated trip hammer that replicates the actions of hand forging. Some designs require that parts be welded through a forge process that fuses pieces of wrought iron together at 2800 degrees Fahrenheit. The forged parts are then "tumbled" in a slowly-turning barrel filled with a mixture of ceramic stones and abrasive to remove mill and forge scale and to eliminate burrs and rough edges. The final stage of the fabrication process is a rinse in an alkaline bath to remove residue that may be left on the parts after tumbling.

Figure 1

Solvent-Based Lacquer Spray System



Finishing

Following fabrication, tumbling and alkaline rinsing, iron parts were coated with a finish for both aesthetic and protective purposes, as uncoated iron rusts very quickly. Until 1993, Hubbardton Forge coated its forged parts with solvent-based nitrocellulose lacquers, predominantly in colors of black, blue-gray, clear and "natural". By that year, two spray booths, operating full time, were necessary to handle the volume of parts. Originally, the company had used conventional spray guns, but in 1988 it switched to high-volume, low-pressure (HVLP) spray guns to reduce overspray wastes and increase transfer efficiency. In spite of the substantial improvements of the HVLP guns, the spray coat system and the use of solvent-based lacquers continued to pose a variety of operational and environmental problems for Hubbardton:

1. **Process Control**: Solvent-based nitrocellulose lacquers do not adhere well under conditions of high humidity, which are common during Vermont summers. For several weeks at least each summer, humidity levels at the plant disrupted the finishing process, impairing product quality and sometimes forcing the coating line to shut down.

2. **Quality:** The quality of the finish, which was critical to customer perceptions of product quality, was also negatively affected by the susceptibility of the lacquer finish to nicks and mars. Following the finishing process, parts for lighting fixtures required a significant amount of handling to attach electrical components and shade mounting brackets. Parts were often scratched and needed to be returned to the spray-coating booths for touched-up, a handling process that itself increased the chances of damaging the finish.

3. **Process Efficiency**: Problems with humidity and the quantity of rework from nicks and scratches reduced the efficiency of the finishing process and increased average throughput time. These inefficiencies increased labor hours and drove up product costs.

4. **Environmental Concerns**: Although the HVLP guns increased transfer efficiency over the prior system, efficiency was still fairly low, in the range of 20 percent. The over-spray was collected and disposed of as a hazardous waste, with the attendant costs of collection and recordkeeping. Of greater concern to Chandler and Hampton, however, was the level of volatile organic compounds (VOC's) released during the spraying operation. As much as 90 percent (after thinning for spray) of traditional coatings consist of solvents that are emitted to the atmosphere during the spray process or as the coating cures. The fugitive VOC emissions affected the air quality of the work environment, filling the plant with fumes that, while not malodorous to all - "sort of like fresh paint" - were certainly not beneficial to the employees. Moreover the partners were concerned that VOC emissions might come under much stricter regulation in the future. Additionally there were the risks associated with storing, using and disposing of the solvent-based lacquers, the greatest of which was the risk of fire from the highly flammable substance, adding incrementally to the cost of insurance.

According to Hampton, any of these four concerns individually might have been sufficient to justify a switch to an alternative coating system; together they presented overwhelmingly compelling reasons for doing so. In April 1994, after much investigation and a year's testing through an extensive pilot project, which began in 1993, the company installed a semi-automated, electrostatic powder-coating line and process oven to handle virtually all the coating work. This eliminated the need for three multi-shift conventional spray booths.

Powder Coating Technology Process

The powder coating process uses the principle of attraction of oppositely-charged ions to cause coatings to adhere to metal. The electric charges in effect function as the transfer medium, taking the place of the solvent or water media used by conventional coatings. Electrostatically charged powder is blown through an air gun toward the wrought iron part, which has an opposite charge and thus attracts the powder. The powder may be charged either before or after it leaves the spray gun. Commonly, the charge is supplied by a high voltage, low amperage electrode, though in some spray guns, known as tribo-electric charging guns, the charge is supplied by the friction of the powder against a solid insulator or conductor[1].

Two types of powder coatings - thermoplastic and thermoset - provide different functional properties. Hubbardton Forge uses a thermoset coating, which is typically used for applications where a thin coating is desired primarily for aesthetic purposes. When heat is applied to the thermoset coating, the resins melt, flow, and chemically cross-link to form a high molecular weight coating that is chemically different from the resin. Once cured, these coatings will not remelt. By contrast, thermoplastic coating retains the same chemical composition upon cooling as it had as a resin, and the coating may be remelted if heat is reapplied. Thermoplastic coatings are used where thicker, functional coatings are required.

Powder coating technology requires clean, dry air and a clean coating area to achieve a quality finish, which can also be affected by humidity and contaminated coating material. Humidity reduces the consistency of the powder, causing it to clump and affecting its discharge from the spray nozzle, which in turn can prevent uniform coverage and wrap around. Contaminated powder, from an unclean work environment, reuse of coating material, or from a contaminated air supply, can also lead to blockages in the spray equipment. Coating is vulnerable to damage during the period between application and curing, as it is with traditional wet application coatings. If such damage is noticed prior to curing, however, the powder can be blown off and reapplied.

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[1] Miller, Emery, ed. (1987) User's Guide to Powder Coating, 2nd Edition. Prepared by AFP/SME Powder Coating Division, published by the Society of Manufacturing Engineers, Dearborn, Michigan. p. 74.

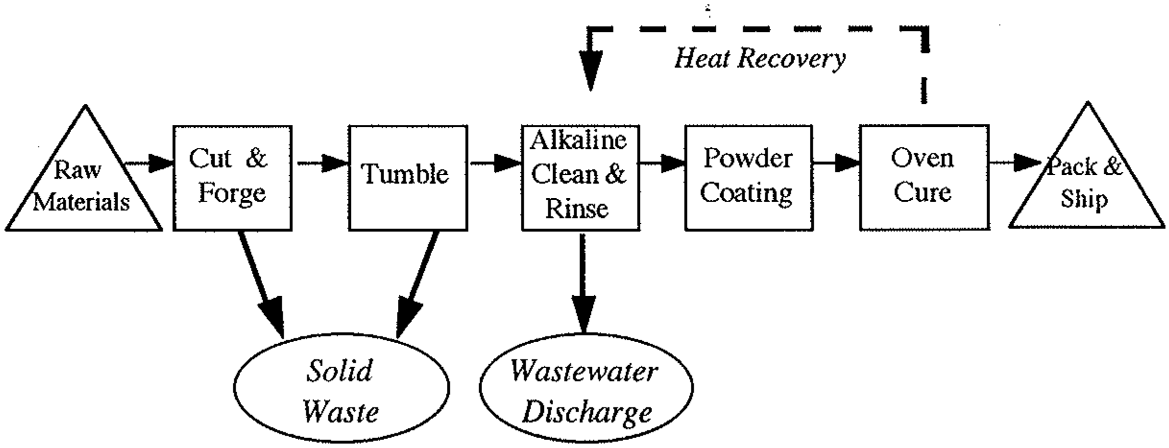
Powder Coating Line Process

While much of the powder coating process at Hubbardton Forge is automated, Hubbardton relies on a human operator to apply the coating. Pre-cleaned wrought iron parts are hung on an overhead conveyor that moves slowly through the spray booth area, where the powder is applied manually. Hampton considers a well-trained operator to be central to the success of its powder coating process. The contact between the hangers on the conveyor and the parts being coated must be kept free of excess coating material in order to maximize transfer efficiency. Hubbardton Forge uses a Bayco furnace to burn the built up coating off the racks and remove coating from parts that have defects in their finish. This furnace has been permitted under the stringent requirements of the Vermont Air Pollution Control Division.

After leaving the coating booth, the conveyor moves through the curing oven, where the parts are heated to 400 degrees Fahrenheit for twenty minutes in order to fuse the coating. Maintaining proper oven temperature is crucial - too high or low a temperature (+/- 5 percent) will cause the coating to deteriorate. Parts leave the oven with a surface temperature of 200 degrees Fahrenheit. The coating remains soft for approximately 15 minutes then hardens and is completely cured.

Figure 2

Powder Coating System



BENEFITS OF POWDER COATING

Electrostatic powder coating provides a durable, quality finish that not only addresses all of the shortcomings of the lacquer spray system, but does so at a lower cost.

1. **Process Control:** Although high humidity can affect the application of powder coating, its impact is significantly less than with conventional "wet" spray. The coating line does not have to shut down during periods of high humidity in the summer.

2. **Quality:** Powder coating improves product quality for several reasons:
   - Application of coating is more uniform,
   - The cured coating is more durable and resistant to scratches

3. **Process Efficiency:** Powder coating enabled significant increases in the efficiency of the coating process due to:
   - Automation of the line: One to two pounds of powder coating equal the same coating that could be obtained from one gallon of liquid paint. Overspray is recycled with virgin, providing 98 percent yield.

   - Reduced coating time: The transfer efficiency and the excellent wrap around effect of powder coating assists in eliminating much of the effort traditionally required of the spray gun operator and allows a reduction in the number of passes that must be made to obtain adequate coverage. Only a single pass with the spray guns is required with the powder coating to achieve the same coverage provided by two passes of liquid paint.

   - Reduced re-work and touch-ups: The more durable and scratch-resistant coating translates into greatly reduced need to touch-up parts.

4. **Environmental Concerns:** Powder coating is nearly ideal from an environmental standpoint, addressing all the issues associated with the use of the solvent-based lacquer.
   - VOC emissions: Hubbardton Forge has virtually eliminated its VOC emissions, enabling easier compliance with the Clean Air Act. Solvent paint use is less than 1/2 gallon per month.

   - Indoor air quality: The air quality within the plant has improved. Although the use of solvent-based coatings has not been entirely eliminated, the odor associated with the use of these materials has been greatly reduced. Management sees this as having a positive impact on employee health.

- Solid and Hazardous Waste: The volume and toxicity of the wastes generated from the coating operations have been significantly reduced. Mr. Hampton estimated that waste paint generation as a result of overspray has dropped from as much as 80 percent to approximately 2 percent. The company now recovers and reuses virtually all of the overspray. Air drawn through the filter pulls the powdered coating material against the filter surface. At a timed interval a back pulse of air knocks the paint powder off the filter. The powder drops to the floor of the booth where it can be collected, squeegeed out and reused. The majority of the coating waste is generated from powder that is inadvertently knocked off the parts after they have left the spray booth area. Once the powder has fallen onto the floor the company considers it to be contaminated and unfit for reuse. Employees cure the waste powder in the curing oven and dispose of it as inert solid waste, or it is saved and used for in-house utility painting purposes.

- Reduced risk: Significantly reducing the volume of solvent stored on site has reduced the risks of a plant fire.

Pollution Prevention

Many of the benefits described above could be categorized broadly as pollution prevention or waste minimization. In addition to the explicit environmental gains in reducing waste and emissions, the process improvements significantly reduce the volume and toxicity of the raw materials used. Other efficiency/pollution prevention benefits include reduced heating requirements during the winter months. The heated air generated from the use of the curing oven contains no VOC's and thus may be directed back into the building and used as a source of heat during the winter. Additionally, the decrease in the use of solvent reduces the need for venting and thus reduces the amount of make-up air, which needs to be heated in the winter. Although not strictly a health issue, the volume of make-up air tended to make the plant less comfortable in the winter.

While many of these pollution prevention benefits started almost immediately, others were seen as the proactive management of potential longer-term problems. As described by Merkle and Chandler:

> We looked at the environmental situation and said: 'OK looking ahead 5 or 10 years there will be a ruling that is going to reduce the volatile emissions that people can put into the air. Do we want to wait until the last minute and then hustle or do we want be proactive?' In our payback analysis we didn't put a dollar amount on that, and I don't how you would because you don't know when it will happen, but we just knew it was sort of like money in the bank that will pay a dividend at some point in the future. We also figured that we

> wanted to grow a certain amount every year, and we didn't want these problems and their associated costs and risks compounding.

In addition to avoided liability risk, the powder coating system enabled Hubbardton to address growing stakeholder concerns about environmental issues and to position itself as a "green" company. According to Hampton:

> One of the other benefits (of the change to powder coating) is that we are able to market the company as green. It is a small facet but a nice one. It is also important to the surrounding community. Word spreads that the place is clean and nice and that's certainly a plus.

FINANCING

The entire automated powder coating system cost Hubbardton Forge approximately $80,000 in direct equipment costs and in-house engineering work and installation labor. Though a significant investment for the business, it was only half of what the system would have cost to purchase from a vendor on a turn-key basis. Hubbardton kept costs low by purchasing second-hand equipment from a manufacturer in southern New England and by using company staff, supervised by Hampton, to disassemble the unit, transport it to Castleton and reassemble and install it according to a revised design and lay-out appropriate for the work configuration of the business.

Figuring that they could finance half the total cost through internally generated cash, the partners approached their bank, First Vermont Bank, to provide the other half. Hubbardton had done business with First Vermont for most of its twenty year existence, initially as a depositor and eventually a borrower for capital purposes. Vermont Industries had also been a bank customer, and the combined entity had gradually increased the amount of its borrowing to finance plant and capacity expansion. At the time of the powder coating project, Hubbardton had about $200,000 in outstanding loans of various maturities with the bank.

According to Kirke Hart, Vice President of First Vermont in its Rutland office, the loan to Hubbardton Forge for the powder coating equipment was a fairly straight-forward deal. From his perspective, the overriding justification for the change to powder coating was improved product quality through enhanced durability of the finish in response to clear customer demands. Process efficiencies seemed less important than the opportunity costs of lost revenue if Hubbardton was unable to satisfy market demand for higher quality wrought iron products. Although the concept of pollution prevention did not explicitly come up during the loan discussions, in the course of explaining the project to Hart, Chandler and Hampton did describe many of the efficiency and environmental benefits, such as a cleaner work environment, less risk from stored solvents, and reduced VOC emissions. While these benefits were seen by Hart as less important than the quality and market issues, they did provide strong support for his confidence in the business and in the competence of the partners.

> Bankers are very sensitive about polluting industries. If we have to go in and work with this business in a liquidation scenario, we want to know what the machinery and equipment and the land and buildings are going to be worth. So site pollution is a big issue. When you go into a factory and it's clean, that's a big plus. Seeing the company focusing on the issue and envisioning a completely self-contained process, which is going to be reducing or eliminating toxic chemicals is encouraging. There's not going to be barrels of solvents sitting around the floor that could end up in the back lot. While that wasn't a driving aspect from our analysis it certainly was a little "star" that goes on the view of this thing.
>
> It is important because it measures your feeling about management and their capacity for taking a long-term perspective on the business. If you go into a shop, a factory and it's clean, as a banker you feel a lot more comfortable. You can see it from when I started banking until now, the factories are getting cleaner and cleaner, there's less junk lying around. It used to be you'd go into a factory and there's trash all over the place or barrels behind the factory. You don't see that any more. For a company where you don't see that progression, you get concerned. At a company like Hubbardton it is happening , boom, boom, boom, boom. I know Reed and George are on top of this thing, you don't even have to think about it with them. They are taking care of it.

Ultimately, given the success of the business and its prospects for continued growth, its cash flow and financial strength, and the size of the loan request relative to total indebtedness and sales, the purpose of the loan was secondary to its approval.

SAVINGS AND ECONOMIC BENEFITS

Line Item Savings

Most of the pollution prevention benefits and process efficiencies generated by the powder coating line translated into immediate cash or opportunity cost savings for Hubbardton Forge. Table 1 presents the most significant operational savings, as well as the increment costs, for Year 2, the first full year of operation. Table 2 summarizes the reasons for the savings.

Table 1

Item	Spray Process Costs	Powder Coating Costs	Savings
Incremental Savings:			
Raw Materials	31,000	12,000	$19,000
Labor	60,000	40,000	20,000
Heat Loss	3,500	0	3,500
Sub-total			**$42,500**
Incremental Costs of Powder Coating:			**Costs**
Oven Heat (net)	0	4,600	4,600
Sub-total			**$4,600**

Table 2

Item	Reason for Savings
Raw Materials	Powder is slightly more expensive than solvent-based lacquer, but due to the increased transfer efficiency, the process uses less than 20 percent of the volume of raw material.
Labor	The 50 percent reduction in coating labor is due both to the increased efficiency of powder coating and to the reduction in touch-up work. Prior to its implementation, the finishing operations at Hubbardton Forge required two "wet" spray booths with two full time operators. Although output has increased nearly 40 percent, and six new jobs have been added elsewhere in the plant, the entire coating operation is now performed by two operators
Heat Loss	The venting of the VOC fumes required make-up air that had to be heated in the winter.
Oven Heat	The cost to heat the oven ($5,000) is reduced somewhat ($400) by savings from oven heat recovery.

Financial Impact

Hubbardton Forge originally estimated a 3.5 year payback on its investment in the powder coating equipment. However, the savings from reduced labor and raw materials, and the gains from increased efficiency and throughput reduced the estimated payback period to 2.5 years. Exhibit 1 shows the company's calculations of cash flow at a point about halfway through the three-year process. Using the same three-year horizon, which arguably understates the actual useful life of the project, Exhibit 2 uses the cash flow figures from Exhibit 1 to generate a discounted cash flow analysis. At a 15 percent cost of capital, the project generates a $15,000 net present value (NPV) and has a 24 percent internal rate of return. By any measure, and especially if the economic life were set at a more realistic seven to ten years, the powder coating line is an extremely attractive investment.