NEWMOA

NORTHEAST WASTE MANAGEMENT OFFICIALS' ASSOCIATION

A Pollution Prevention and Lending Case

NATIONAL CHROMIUM CO., INCORPORATED
Renewed Profitability Through Pollution Prevention

INTRODUCTION

In 1988, National Chromium Co., Incorporated, a chrome and nickel plating company in Putnam, Connecticut, faced an uncertain future. Its antiquated operations were located in an assemblage of added-on structures that incorporated the barn where the company got its start in 1939. More than five decades of continuous use had made the facility one of the older undisturbed chromium-contaminated sites in the United States. Although production and waste disposal practices had improved over the years in line with stricter environmental regulations, decades of minor spills and plating rack drips onto plank-covered dirt floors had produced severe, though contained, site contamination. No control systems impeded the venting of a thousand kilograms of chromium emissions into the air, and even the method of wastewater treatment and discharge, which had been in compliance since the mid-seventies, was suspect to state regulators. The potential environmental impacts of these emissions to ground, air and water were magnified by the plant's proximity to a wetland, located a hundred feet downstream of the plant. Although demand for the company's plating services was strong and growing, the cost of site remediation, compliance with new Clean Air Act regulations and the fundamental condition of the facility threatened the existence of the enterprise. Without major investment in new process equipment and treatment and control technologies, the business most likely would not survive. Because of the condition of the site and the fact that the Connecticut Department of Environmental Protection (DEP) had filed suit to bring the company into compliance, access to financing to make the necessary investment was cut off.

In mid-1995, National Chromium neared completion of a new 10,000 square foot addition, engineered and designed by the owner, Whitby Ellsworth and his architect son Campbell Ellsworth. The facility, scheduled to house all the plating operations by the end of the year, was based on a comprehensive pollution prevention strategy that incorporated numerous design and technical features to minimize waste, reduce costs and facilitate

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compliance with environmental regulations. Additionally, new equipment that included larger plating tanks and hoist systems enabled the company to expand the size and range of parts it could plate, creating new market opportunities to better serve existing customers and to secure new business.

Whitby Ellsworth's prevention-based approach to managing the existing and ongoing environmental challenges at National Chromium had enabled him to enter into a consent decree with the Connecticut Department of Environmental Protection to remediate the site and attain regulatory compliance. That agreement, in turn, enabled him to secure financing from Citizens National Bank (CNB), a local institution with whom Elsworth had developed a strong business relationship. CNB provided the financing on the basis of collateral in land and equipment and sufficient cash flow. Yet, because of the condition of the site and the need to fulfill the terms of the decree, the bank also clearly placed significant weight on the competence of Whitby Ellsworth.

Whitby, himself, felt very certain about what had enabled the remarkable transition from 1988 to 1995:

> (A) limited number of people in the Connecticut Department of Environmental Protection along with this small town bank were willing to try something that had never been done before with a company that had a good record but had a lot of problems. There has been substantial flexibility throughout the project by all people to change it and adjust it and modify it as time went on.

BACKGROUND

Plating Industry

National Chromium falls within SIC code 3471, defined as metal finishing through the use of chemistry, a sub-group of a larger category that includes all processes - chemical, painting, coating - that "finish" raw metal parts prior to their incorporation into final products. Chemical finishes are applied either for aesthetic purposes, such as a chrome bumper on a car, or for wear resistance and lubricity, such as on a bearing shaft. The chemical plating industry is fragmented and includes numerous small job-shops serving local customers and large in-house or "captive" shops that service the production needs of large corporations. Prior to the advent of environmental regulations, the costs of starting a plating business were minimal. Many shops were opened by employees of existing establishments who gained enough knowledge and experience to strike out on their own. All that was required to get into business were a tank, some chemicals, an old garage and a few borrowed customers. The number of small plating businesses, especially in New England, have been in decline for the past two decades, however, due to several trends: stricter environmental regulation, increased use of outsourcing, substitution of non-ferrous materials, and a regional decrease in manufacturing activity.

Because of the toxicity of the plating process and its contribution to contamination in all three media - ground, air and water, the plating industry is one of the most highly regulated in the United States. During the 1980's and 1990's, the costs of complying with increasingly stringent environmental regulations raised the price of entry and forced many small shops out of business. Their volume of sales was insufficient to support the investment in upgrading and/or adding new equipment to achieve regulatory compliance. Many large companies that had relatively small in-house plating facilities decided to outsource the work and eliminate the costs and headaches of dealing with such a regulatory-intensive operation. Additionally there has been a general secular trend away from metal parts that require plating, as companies substitute other materials, such as plastics for car parts, to reduce weight and cut costs. In the Northeast manufacturing has been in a state of decline since the 1970's, reducing the total volume of fabricated parts that require plating.

As the number of platers declined, some remaining competitors have sought to become stronger by focusing on fewer plating processes, rather than trying to handle a large variety of work. By specializing in only a few core operations and reducing the number of chemicals they use, plating companies have reduced the regulatory burden and associated environmental compliance costs and developed better defined market niches.

Company Origins and Business

National Chromium was founded in 1939 in a wooden barn over and around which succeeding structures were built to accommodate expanded production. The current majority owner, Whitby Ellsworth, purchased the business in 1975, just before the swell of environmental regulation hit the industry. Over the twenty years of his stewardship, sales increased from $260 thousand to $2.4 million and the number of employees from ten to fifty. In the early 1990's Whitby formalized an ownership and management succession plan with John Miller, who started working part-time for the company in 1980. Miller functioned as the Chief Operating Officer of the business, concentrating on customers and general management issues, while Whitby focused on the environmental and technology challenges in completing the new facility and bringing the operation into compliance.

In spite of the regional decline in the manufacturing base and the smaller number of potential customers with plating needs, the company has expanded by taking advantage of opportunities created by other industry trends and by attention to its own competitive strategy. National Chromium has gained business as other smaller operations closed shop and has also benefited from the trend of large companies to outsource their plating requirements. For example, Worcestor-based Norton Company, a manufacturer of abrasives, closed its in-house chrome finishing and now sends all its work to National Chromium, which had formerly handled only Norton's overflow business. The move was good for both companies, according Whitby Ellsworth: "We gained a steady customer and Norton no longer had the environmental headaches from being in chrome plating". Whitby expects to secure more business from these trends:

> I have a good friend that has a business twice the size of this, but the chrome portion of it may only be around 5 percent of his volume. Before he spends $50-80 thousand to upgrade to meet the new round of environmental regulations, he's probably going to get out. He can send the business down to me and take an override on it, and he can still service his customers. It just doesn't become worth it at that scale to try to stay in the chrome business.

National Chromium itself followed the same strategy in leaving areas of its plating business that were too small to justify the time and expense required to maintain the knowledge and equipment to achieve environmental objectives. In the early 1990's National exited cyanide-based copper and cadmium plating, choosing to focus solely on chromium and some nickel. While the plating processes are very similar, different chemicals each have their own set of regulations and environmental issues.

National Chromium performs specific jobs to meet individual customer orders from across a very wide and diverse market, including hand tools, machinery and equipment, small appliances, and work for local machine tool and mold shops. Some of its business is on a production scale, such as a small part for a home kitchen appliance that is at the rate of about two million parts annually. At the other end of the spectrum in terms of size and profit margin are large single pieces, such as 8-foot pistons and journals for industrial applications. A substantial portion of National's work involves replating worn parts to increase their useful life. Usually the cost advantages of replating are significant: a large gear mechanism, which might cost $10,000 dollars to manufacture, can be replated and reground for ten percent of the cost of replacement. One long-term customer sends molds that are twenty years old to National for reconditioning at a considerable savings over the cost of new equipment.

COMPETITIVE STRATEGY

National Chromium has succeeded and grown in a shrinking market by pursuing a customer-focused approach that emphasizes quality and responsive service. As Ellsworth stated, the differentiating factor of his company was:

> Quality and experience to do difficult jobs. Some of my managers often complain, 'Jeez, we never get anything but the difficult jobs in here.' But that's good. That's good because anyone can do the easy jobs. So quality is by far the most important thing. We also have a great sensitivity to delivery requirements. We have very good working relationships with our customers and can provide quick delivery for them in many cases and that's very important. A machine that's out of operation and needing repair, a late

scheduling problem, a screwup in another part of their production process: in all of these situations cost is not as much a consideration as is the ability to turn it around quickly and deliver it when promised.

Most of National's customers are from a 100-mile radius and nearly 95 percent are repeat business. Ellsworth estimated that a quarter of the current customers have been with the company since he took over in 1975. By stressing quality and service, National has sometimes lost business in the small-part, low-margin end of the plating market to competitors that have undercut its price. Frequently however, that business has returned because of unacceptable quality or service. National Chromium has also been able to keep some lower-margin business by developing long-term partnerships with customers who are willing to invest in dedicated tooling at National in return for a commitment to hold prices steady over a multi-year contract . As Ellsworth stated: "if you give us an opportunity to run a volume of parts over a period of time we are very inventive in bringing the price down. So repetitive jobs in many cases can be done less expensively here even though we are not pricing them cheaply."

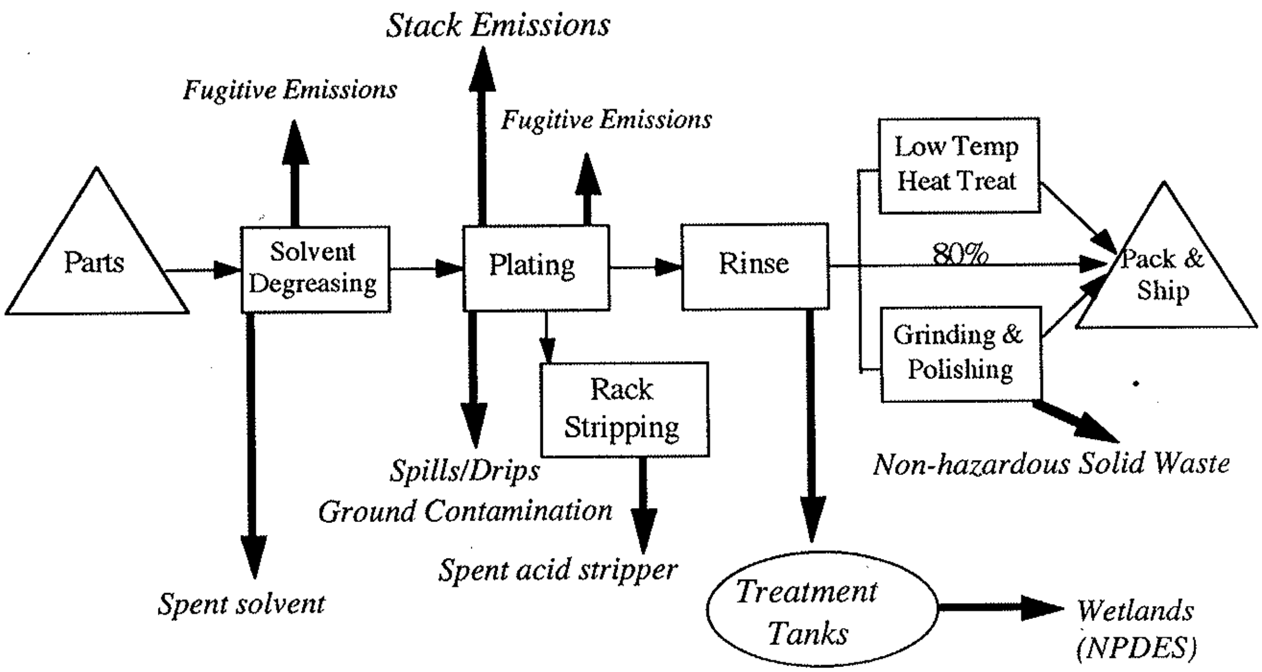
In addition to plating, National Chromium provides additional finishing to a relatively small volume of its business either through tumbling, polishing, heat treating or grinding. While Whitby Ellsworth has considered further expansion into these areas, the economics and the additional environmental regulations have dissuaded him from pursuing those opportunities. To handle parts too large for National Chromium's in-house capability in heat-treating and grinding, Ellsworth has developed strategic alliances with outside heat-treating and grinding firms in order to provide seamless service to customers. Heat-treating usually has to be performed within several hours after plating, and thus there needs to be considerable coordination between National Chromium and its downstream partners to ensure that parts are packed, delivered, accepted and treated on time.

HARD CHROME ELECTROPLATING PROCESS

Approximately 90 percent of National Chromium's work in Putnam (Connecticut) consists of hard chrome electroplating. Prior to 1993, this basic plating process included the steps illustrated in Figure 1 and described below. Table 1 summarizes the environmental impacts and regulatory oversight of plating.

Figure 1

Process Flow Diagram - Old Plant (pre-1993)



1. **In-bound Parts**: Metal parts arrive from customers and are unpacked and organized for plating. The raw metal parts have been coated by the customer with a layer of oil to protect them from oxidation and rusting.

2. **Degreasing:** The protective oil coating is removed prior to plating. Depending on size and shape, the parts are degreased either in a tank of solvent or by hand. Until 1993, National Chromium used 1,1,1 trichloroethane (TCA) for degreasing. In 1993 the company switched to an aqueous-based solvent. TCA is subject to RCRA, CFC labeling requirements and is reportable under TRI.

3. **Plating:** Hard chrome electroplating is the process of using electricity to force chromium ions to adhere to the surface of a raw steel part. The parts are attached to plating racks and suspended in a plating bath - a tank filled with a heated solution of water and dissolved chromium ions. A high amperage, low voltage direct current runs through the bath from a series of anodes that are arranged on either side of the parts to be plated. The electric current deposits the positive chromium ions onto the metal parts as chromium. Depending on the size of the part and purpose of the plating, the process may range from a few minutes to several hours. In cases where large parts are plated to protect against wear, the chrome may be built up and then later ground down to attain the specified tolerance.

The plating operation has several environmental impacts. Because the plating baths are heated, the solution evaporates quickly. Hoods along the sides of tanks are equipped with strong negative air pressure to draw the evaporating solution and toxic fumes into a system of ducts that vent to the outside. The strength of the air flow through the venting system removes virtually all fugitive emissions at National Chromium, but the volume of exhaust does require substantial make-up air that needs to be heated at least seven months of the year. The exhaust system in the old plant had no filtering or scrubbing components, permitting all the chromium fumes to be discharged to the atmosphere. Such emissions were subject to the Clean Air Act and TRI reporting.

Because the old plant floor was constructed of planks laid on top of dirt, the plating operation caused considerable ground contamination. Plating racks were manually carried between different plating and rinse tanks, allowing plating solution to drip onto the floor and eventually to soak in to the earth below. The ground contamination was subject to RCRA and state site remediation regulations.

4. **Rack stripping**: Chrome build-up on the plating racks after several plating operations hinders effective use of the racks and needs to be removed. The racks are dipped into a rack stripping tank filled with an acid solution. The spent stripper, a hazardous waste under RCRA, is sent to an external recycler for treatment.

5. **Rinsing:** After plating, the parts are rinsed in tanks to remove excess solution. Prior to 1993, the water was piped to treatment tanks in the basement and then discharged to a near-by wetland under an NPDES permit.

6. **Finishing:** Approximately 20 percent of the parts that go through the plating operation are ground, polished or heat-treated prior to being packed and shipped. The metal grinding dust is too fine a consistency and too small a quantity to merit reuse. Although it usually does not need to be classified as a hazardous waste, the 200 pounds that are collected annually are disposed of along with the hazardous waste. This method is easier than spending the time to perform additional sampling and testing and to set up a separate collection and disposal protocol.

7. **Pack and Ship:** After plating (and other finishing if specified) parts are packed and shipped either directly back to the customer or to another shop if further fabrication or assembly is required.

Table 1
Summary of Environmental Impacts of Hard Chrome Plating Operations

Process	Waste	Disposal/Treatment	Regulations
Degreasing			
Pre-1993	1,1,1 Trichlor (TCA)	Recycling	RCRA & TRI
Post- 1993	Aqueous Solvent	Neutralization	
Plating			
Solution Evaporation	Fumes	Stack Emissions	CAA, TRI
Solution Evaporation	Fumes	Fugitive Emissions	CAA, TRI, OSHA
Spills and Drips	Chrome Solution	Ground Contamination	RCRA
Rack Stripping	Spent Acid Stripper	External Recycling	RCRA
Counter-Current Rinsing	Wastewater	Wastewater Treatment	NPDES
Grinding/Polishing	Metal Dust	Solid Waste	RCRA
Heat Treating			CAA

ENVIRONMENTAL COMPLIANCE

As environmental regulations expanded and became increasingly stringent during the seventies and eighties, National Chromium faced significant obstacles in trying to bring its discharges to air, water and soil into compliance. In fact, the inability of the former owner to comply with the Clean Water Act contributed to his desire to sell the business in 1975. Ellsworth was able to achieve compliance under a NPDES (National Pollution Discharge Elimination System) permit within a short time after purchasing the company, though the State of Connecticut had never been entirely comfortable with his solution. Rinsewater, contaminated with chromium, which had been discharged directly to the wetlands, was collected in tanks and treated with various chemicals prior to discharge. The soil and air problems remained unaddressed, however, as the age and design of the facility and the extent of the soil contamination precluded incremental approaches to preventing continued contamination or to remediating the site.

In the late 1980's the State of Connecticut began to exert substantial pressure on National Chromium to come into compliance with soil and air regulations and to improve its method for treating wastewater. Given the extent of the work to remediate the site and the condition of the existing plant and equipment, the effort promised to require a major investment in facility improvements. Securing funds to make those investments, however, was problematic. Although the business was operating profitably, it could not generate enough cash to finance the necessary improvements internally, and it was also cut off from external sources of funding. No bank would lend the company money because of the contaminated nature of the property and the fact that it was being sued by and hit with continuing citations by the State. Remarkably, according to Ellsworth, National Chromium was not even able to access funds from a State remediation fund: "I was denied money from the site remediation fund because the site needed remediation. I'm dead serious".

Faced with intransigence and mistrust of the regulators, tired of spending money on lawyers to respond to State lawsuits, and unable to raise the capital necessary to bring the operation into compliance, Whitby Ellsworth had few options left.

> So I told the State that unless we found a joint resolution to these problems, I would close the plant. I told them that I was not going to spend any more money on lawyers and that they either stop suing me, or I would close the plant and at that point we would file Chapter 7 bankruptcy. This plant is valid as long as it is running but not once it's closed. They would then have had a hazardous waste site on their hands and no recourse whatsoever. If they didn't help me they suddenly would acquire a piece of contaminated property that they didn't want. In addition to which I brought the politicians in. They were about to lose forty jobs, which were important to this town. All the State had to do was be helpful.

Consent Decree with Connecticut DEP

In May 1988, tired of dealing with the threats of the litigious lawyers in the State Attorney General's office, Ellsworth took his case to the office of the DEP Commissioner. They had some familiarity with both National Chromium and Whitby and the parties were able to forge an agreement that would allow Ellsworth the time and enforcement flexibility to develop a comprehensive approach to the compliance issues. After the proposal had gained the Commissioner's consent to proceed, oversight of the agreement was turned over to a DEP Director who, according to Whitby Ellsworth, "took a special interest in the case because he thought that we could do it."

The first step in implementing the agreement was to reach consensus on the general scope of the undertaking and the willingness of both parties to work together on the challenge of remediating the site and bringing the company into full compliance. That accomplished, Ellsworth hired Environmental Risk Limited, a respected and experienced Connecticut consulting firm, to develop an overall plan, which was approved by the state and served as the basis for a consent decree, eventually signed nearly two years after Ellsworth first approached the State. The consent degree included both a remediation plan for the site and a conceptual engineering plan for a new facility. Although the term "pollution prevention" was not specifically used, the clear intention of the plan was to include "best management practices" and current proven technology to address the emissions and other environmentally-related practices. The decree envisioned a four-year timeframe for completing the work on a new facility, which was projected to cost in the range of $1 million to $1.3 million, and a multi-year time frame to remediate the ground under the old plant.

FINANCING THE NEW FACILITY

While in the process of working out the details of the consent decree, Whitby Ellsworth approached "every large and small bank in the State of Connecticut", none of which were interested in lending to the company until the agreement had been finalized. With the consent decree in hand, Ellsworth returned to Citizens National Bank (CNB), whose president, Bob Silva "had given us more support and more encouragement" than any of the other institutions. Citizens National was a small bank, based in Putnam, with about $100 million in assets and four branches, all within a ten mile radius of its main office. Owned principally by local businessmen, the bank took a very local perspective on its lending activities. About a third of its loans were to retail establishments, a third to consumers and a third to area manufacturers.

Although Silva was initially supportive of Ellsworth's efforts, he was unable to make a commitment on the Putnam facility until the agreement with Connecticut DEP had been consummated. With the agreement in place, Citizens provided National Chromium with a comprehensive 20-year loan package for $600,000 that was to cover the construction of the new plant and purchase of equipment. When a new opportunity arose shortly after this, Citizens loaned National Chromium an additional $450,000 to acquire a going electroplating business in Rhode Island. As a condition of the loan agreement, National Chromium cleared its books of other loans, enabling Citizens National to take a first mortgage on the land and buildings and a first security position on the equipment, receivables and inventory. According to bank Vice-President Andy Andrews, the loan was relatively easy to make because of the success and growth of the business, its cash flow and financial condition, and the available equity in the assets. The bank treated the loan essentially as a commercial real estate loan, and loan documentation did not specifically mention pollution control equipment or prevention components. According to Andrews:

> The cash flow was there. The collateral was there. It was immaterial that we were financing pollution control equipment. We didn't differentiate between the different types of new equipment going into the facility.

Although pollution prevention per se did not play an explicit role in the loan approval process, the strategy of proactive environmental management, grounded in the concept of prevention, did play an intrinsic part in establishing the conditions under which CNB was willing to make the loan. It also played a role in the bank's assessment of and confidence in management's ability and competence. In spite of the assertion that the first liens on the property and other assets made the loan a "no brainer", the bank was clearly aware of the potential risks associated with a loan collateralized in large measure by a piece of property that had chromium contamination, a toxic substance. As a small bank lending to a local customer, CNB was able to place substantial weight in its confidence in management's ability to follow through on the agreement with the state.

> If the business closed tomorrow and management couldn't be found anywhere, and the state came in and said: 'we want this cleaned up right now', then, yes, we'd have a problem with our loan. We don't anticipate that being an issue, but I wouldn't want a whole portfolio of loans like this with that type of risk factor in the background.

Whitby Ellsworth attributed the bank's willingness to make the loan to the completely open nature of the relationship the parties had developed, based in large measure on the quality and frequency of the information he had provided, as well as on the particulars of the cash flow and collateral issues. In spite of the strength of those criteria, he did believe the bank "stuck their necks out a bit" in taking on the degree of environmental risk entailed in the first mortgage.

> They took a local position on it. I am forever grateful that they did. The large, Hartford-based banks would not touch us. Even the State Department of Economic Development refused to help us. I mean the P&L [profit and loss statement] and the balance sheet are wonderful but then you look at the liability and what happens if.....

POLLUTION PREVENTION

Initial Steps

Although most of the pollution prevention equipment and techniques were incorporated into the design of the new facility, some were implemented prior to moving production in order to respond to particular customer requirements or business needs. The major pollution prevention features are described below.

Parts degreasing: All parts arrive with a coating of oil to protect them from rust. Prior to 1993, National Chromium removed the oil with 1,1,1 Trichloroethane (TCA), a solvent that has been the subject of numerous pollution prevention initiatives. The spent solvent was shipped to an offsite recycler. Although sharply escalating taxes on the solvent had become more costly than the solvent itself, the principal impetus behind National Chromium's elimination of the TCA was the Ozone Depleting Substance (ODS) labeling law scheduled to become effective on January 1, 1994. Although there were questions about how far down the manufacturing value chain the law would apply, the regulation required that all products made with ozone depleting substances had to bear on ODS label. National Chromium's customers, concerned about the potential market impacts of such a label on their products, put pressure on all their suppliers to change their processes.

A year before the labeling law was scheduled to go into effect, National changed to an aqueous cleaning solution, eliminating the use of TCA. Because the aqueous solution was less effective at removing certain types of oils, the change required more than simply substituting one material for another. National Chromium worked closely with its customers to change the type of oil they used to protect their parts. Although most of the customers were very cooperative and helpful in making the switch, occasionally National has had to send parts back because they were coated with an oil that was incompatible with the aqueous system. According to Ellsworth, on balance the switch will cost customers more. The raw materials and disposal costs of the aqueous cleaner are less than the solvent, but the new cleaning system requires substantially more labor and is less flexible.

New Facility

The new facility, housed in a 10,000 square foot steel frame building, achieves environmental protection through a combination of approaches that includes structural design, appropriate building materials, pollution control equipment, production equipment and process techniques that minimize input and maximize internal recycling. Although some subsidiary aspects of plating are susceptible to front-end pollution prevention approaches, such as solvent substitution in the degreasing operations, there are no environmentally benign substitutes for hard chrome plating itself. As an aesthetic finish and as a wearing surface, chrome remains the metal of choice for many finishing jobs. Thus process control and end-of-pipe control technology played important roles in reducing chrome emissions to the air, water and ground in the new facility. The company's prevention strategy, however, made those controls as efficient as possible by minimizing the volume of waste they process. While there are numerous examples of financial savings and process efficiencies generated by the changes in plant facilities and operations, it is difficult to quantify those savings precisely for every element of the operation. The number of changes, the move to a new facility, and the growth in plating volume make it difficult to isolate components of the system and look at them discretely.

Building Structure

Environmental protection was designed into the structure of the facility, starting with the layout and placement of the equipment. The plating equipment sits in containment pits, which are lined with a geo-textile, plastic liner, and protective flooring. The pits, three-feet deep for one line of equipment and one-foot deep for another, always contain a few inches of water so that any spill of concentrated chromium is almost instantly diluted. The concrete floor around the equipment is coated with an epoxy. All drips or spills from the plating operations either land directly in the pit or on the floor, which can then be washed down into the pits. The pits themselves are washed down on a regular basis and pumped out to a wastewater treatment system. As an additional precaution against pollution, the joints where all concrete pours meet were designed with a integral lip and built with a special material, bentonite, to reduce the chance of liquid seeping through openings created by normal foundation shifting. These seams have also been sealed externally with a flexible, chemical-resistant sealer.

Chrome Plating

The chrome plating process integrates several technologies to achieve air emissions compliance and to minimize the use of raw material inputs, as illustrated in Figure 2 and described below.

Ventilation system: The ventilation hoods on the plating tanks, which capture chromium emissions and vent them into a central stack, operate on a push/pull rather than simply a pull system. A stream of air is pushed out of one side of the tank and pulled in on the other,. instead of being pulled in on both sides. This method is significantly more efficient and promises to reduce the total volume of air vented to the outside by about 60 percent. The impact of this reduction generates costs reductions for a series of operating and capital expenses.

Capital costs:

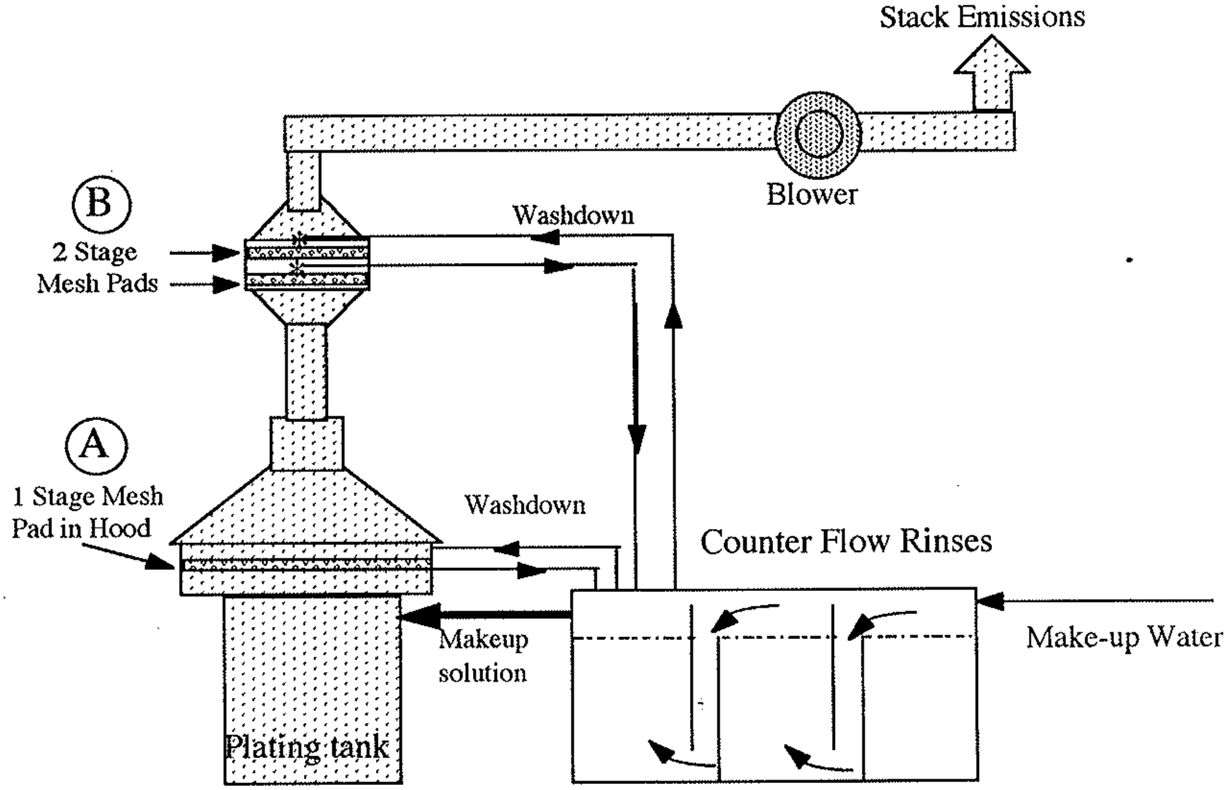
- Ventilation equipment: The reduced air flow of the more efficient push/pull system translated into reductions in the specifications for much of the ventilation equipment. The size of the ductwork and the horsepower of the blowers all shrunk.

Operating costs:

- Electricity: The smaller motors and blowers require less electric power to operate.
- Oil Heat: Make-up air to replace the air vented out of the building needs to be heated six to seven months of the year. The plating baths are heated by steam pipes that run through the solution. The reduction in vented air enables corresponding reductions in the costs of the heated make-up air and the steam-heated solution. Ellsworth estimated that the savings from reduced purchases of oil for the boiler would be in the range of $12,000 to $15,000 annually.

Counter-current rinses, water recycling and chromium reuse: After parts are plated, they are rinsed in a three part counter-current rinse tank, moving from the dirtiest to the cleanest tank against the flow of the water. Fresh water enters the final tank and flows in a direction opposite that of the movement of parts. The first rinse stage, which becomes the most contaminated, is used as the make-up supply for the plating tanks, as the heated plating solution evaporates. The solution in this first stage is also used to clean the mesh pads in the air filter system (shown below), capturing the chromium in the pads for reuse in the plating baths. At the current operating level, the fresh makeup water entering the final rinse tank essentially equals the evaporation. The plating and rinsing system is very close to a closed loop except for the cleaning and pumping of the pits. By the spring of 1995, water usage had fallen from 47,000 gallons per day (gpd) in 1992 for a two-shift operation to 22,000 gpd. Sales increased substantially over this period, however, so the effective reduction in water usage per volume of plating was between 65-75 percent.

Figure 2
New Plating Line with Control and Recycling Technologies (1995)



Air emissions controls: As shown in Figure 2, the vented air passes through a series of filters that trap the chromium droplets. One stage is located in the hood (point A) and another two-stage mist eliminator is in the stack (point B). The old plant had no air emissions controls and vented all chromium emissions into the atmosphere, where it was caught by prevailing winds and often deposited in the wetlands.

The mesh pads are rinsed every day with the solution from the first rinse tank, which has a lower concentration of chromium than the pads. Based on the EPA standard of 10 milligrams of chromium per ampere hour, Ellsworth estimated that the old operation emitted 1,000 kilograms of chromium per year. Tests of the new control equipment indicated a 99.8 percent reduction in emissions to about 1 kilogram a year, still too high to meet the Clean Air Act compliance standard, which goes into effect in 1997, but close enough to give Ellsworth confidence that he will be able to achieve compliance within the next two years.

Wastewater Treatment

Although the plating operation comes close to being a closed-loop system, the need to handle spills and pit clean-out as well as to treat the wastewater from the aqueous parts cleaning operation necessitates a wastewater treatment system. Like the stack cleaners, this is essentially an end-of-pipe solution, though a finely-tuned operation affords the opportunity to minimize through-put and chemical treatment agents. Ellsworth purchased the entire system from a Lockheed plant in New Jersey for a fraction of the cost to purchase a new one. He oversaw its disassembly, transport and reassembly according to his design to deal with the particular wastewater constituents of National's operation. The system consists of a series of tanks, with a final filter and filter press at the end. Treated effluent is permitted by the state to flow into the town's sewer system. Theoretically it would be possible to close the loop on the wastewater system but only by purchasing extremely expensive equipment. Also, because the effluent is a higher temperature than incoming town water, it would be necessary to purchase and operate a cooler. According to Elsworth, those costs, plus the added problems of addressing increasing concentrations of salt impurities trapped in a closed loop, outweigh the financial and environmental benefits of a zero discharge operation. Portions of the plant operations do utilize closed loops, however, and Ellsworth continues to investigate opportunities to save water and other raw materials.

ENVIRONMENTAL COMPLIANCE MANAGEMENT

The new facility achieved substantial gains in the reductions of emissions to the environment (as summarized in Figure 3) and in some operating costs. The benefits did not, however, extend to savings in the time required to manage the environmental effort. Because the reduction in emissions is achieved through highly sophisticated water and air treatment systems, the oversight of those controls requires special knowledge and a significant amount of time. Ellsworth estimates that he spends half of his hours on environmental issues and does not foresee any significant reduction in that level.

> Each one of the new technologies puts a very substantial burden on maintenance and upkeep. You have to be very technically capable to keep these systems up and running. The entire staff here has to learn new skills, and they have to upgrade their skills. Each time you add another layer of control on top of the existing ones the complexity increases in something greater than arithmetic proportion. So the answer is no. None of this is easier to do. Nor will it ever be.

According to Ellsworth, however, there have been gains on the regulatory front based on the perceptions engendered by the look of the new plant.

We were always in compliance in the old plant on water discharges, but no one believed us. Because you just looked at it and you would say it can't be. Well it was, because we knew what we were doing and it was carefully taken care of. But it looked like hell. The new plant looks beautiful and is operating completely within limits and now no one doubts that. So that helps.

Figure 3
New Facility Process Flow Diagram (1995)