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Case Study in the Electroplating Industry

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ABSTRACT

This study carried out to investigate the opportunities for seeking ways to reducing pressures and seeking ways to overcome problems in an electroplating industry in Taiwan. Nowadays many industries rely on electroplating process. However, this industry is more hazardous to the environment and safety. There is number of regulations still heavily regulating its industry but those regulations can only restrict this hard and unique operation. So this study aimed to help to make recommendations to improve this hard situation and to save its industry's destiny.

Keywords: **Electroplating industry, Environmental management and policy,**

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Introduction

Electroplating is a plating process in which metal ions in a solution are moved by an electric field to coat an electrode (Figure 1). The process uses electrical current to reduce cations of a desired material from a solution and coat a conductive object with a thin layer of the material, such as a metal. Metals used in coatings include:

- Zinc
- Copper
- Brass
- Chromium
- Nickel
- Gold
- Silver
- Cadmium and
- Lead.

Many industries rely on electroplating process. Jewelry makers electroplate silver and gold on less expensive metals. Inexpensive gold rings cause fingers to turn green when the thin gold plate on copper wears away and exposes the more reactive metal. Similarly tin cans are made by electroplating thin layers of tin onto iron. The less reactive tin surface protects the underlying iron against corrosion by the food product in the can. (Patricia S. Hill).

Particularly, there are two type of firms operate in electroplating industry which smaller that is family oriented firm and larger firms. The larger firms diversify in the number of electroplating and finishing processes they utilized, but smaller firms tend to specialize in one or two types of finishing process. (SIC 3471)

Methodology

This study based on interview that made with Mr. Lin who is playing role in the electroplating industry in Fengyuan of Taiwan. First, I conduct comprehensive investigation of the past and current status of electroplating industry in U.S in order to get to know more about electroplating industry with processes and regulations. Then I propose a pointed case study for prompting current situations of electroplating industry in Taiwan. This approach would be

conduct by class discussion among my classmates. Finally, we examine the status and seeking ways to resolve challenges and problems together, and conclude.

The goal of this study is to identify the problems in Taiwanese workshop and seeking ways to overcome those identified issues though group discussions.

Historical and developmental procedure

The human found the method to coating a thin metal by immersing it into electrical charged solvent around end of 1700's and in the later about 1800's Alessandro Volta created the battery which is the core component of electroplating. As well as, commercial electroplating began in 1840's and the common metals were gold, silver and brass and later the nickel metals began particularly used in its industry with development of green corrosion. This was key development of its industry to plating for automobile and appliance industry. Through non-metallic materials had been electroplated since the mid-nineteenth century, this industry became increasingly important for the industry after the 1963's development of ABS plastic.(SIC 3471). After that, the electroplating is commonly utilizing in electric shielding its plastic housing of computers.

In 1990's, the capital investment was low rather than other industries and the average investment per establishment in the metal finishing industry was 83 percent below the national average for manufacturing industries. This enabled relatively easy entry into the industry and accounted for the large number of small, often family-oriented, private firms. The ease of entry into the industry made for highly competitive conditions in which small, independent companies were positioned between large suppliers of finishing machinery and materials and the large corporations for which they provided services. Smaller firms' dilemma of keeping abreast of innovative techniques was exacerbated by their need to adhere to a host of environmental regulations. This problem was deepened by the less sophisticated control procedures many smaller companies were forced to utilize due to lower cost. For example, quality finishes could only be obtained through highly sophisticated processes often unavailable to smaller firms.

However, while plating role increasing in the market, the industry has meet environmental and safety regulation in a cost-effective manner. Because

electroplating industry utilize number of toxic chemicals in its operations such as cyanide and a toxic gas with water. All of its organics' emissions have harmful impact to the environment, air, water and so on. On that account, there have being established few basic environmental and safety regulations for an electroplating industry in U.S such as Federal Water Pollution Control Act Amendments of 1972, the Resource Conservation and Recovery Act of 1976, the Clean Water Act of 1977, and the Comprehensive Environmental Response, Compensation and Liability Act of 1980.

Industry characteristic

Generally, there are two main areas of electroplating business in the metal finishing market. One provides heavy coating of hard metal such as chromium to machine parts. Others provide light coating to personal and domestic items such as jewelry, omaments, hobby items, motor vehicle parts, and electronic component.

In 1992, there were approximately 7,500 plating facilities in the United States, which was a decrease from the 12,000 reported facilities in 1980 (MRI, Work assignment, 1996). The reduction occurred in the number of smaller job shops because of the difficulties in facing waste regulations imposed on its plating processes, and growing popularity of electroless nickel-plating, the ongoing economic recession and so on. Even the difficulties are facing in this industry included increasing production cost, excessive competition and shortage of experienced employee. Such kind of the excessive competition is a slow rate of productivity growth in its industry. For example, the value added per production worker hour more than quadrupled for computers and related machines and doubled for motor vehicles and parts and household laundry equipment.

According to the U.S. Census Bureau, the total value of shipment for the U.S. electroplating (including plating, polishing, anodizing and coloring) industry was 7,183 million in 2007. The industry employed an estimated 59,759 people with a total payroll of over $2,118,696.

The electroplating process

Electroplating is the process that is coating metals through reaction of the electrical conductive and chemical organics. However, some specific techniques such as coating with metallic-loaded paints or silver-reduced spray can be used to make nonconductive surfaces, such as plastic, electrically conductive.

The electroplating process divided into 2 major parts including chromium plating and others which are depending on materials and dedications.

Chromium plating and anodizing operations include hard chromium electroplating of metals, decorative chromium electroplating of metals, decorative chromium electroplating of plastics, chromic acid anodizing, and trivalent chromium plating.

Hard plating is used for items such as hydraulic cylinders and rods, industrial rolls, zinc die castings, plastic molds, engine components, and marine hardware. *Decorative plating* is used for items such as automotive trim, metal furniture, bicycles, hand tools, and plumbing fixtures. *Chromic acid anodizing* is used primarily on aircraft parts and architectural structures that are subject to high stress and corrosion.

But **other types of plating** include brass, cadmium, copper, gold, indium, iron, nickel, palladium, platinum, rhodium, ruthenium, silver, tin, lead, and zinc are most common used in engineering and industrial applications.

Figure2 illustrates a process flow diagram for an electroplating operation. Parts are plated using several types of equipment. In barrel plating, smaller parts are loaded into a perforated container which is rotated during processing. Barrel plating is good for high volume plating of smaller parts. In rack plating, the parts are hung on hooks or clamped into fixtures and sent through the plating line. Rack plating is used for larger parts. pieces with more complex geometries, or those which cm be damaged easily. A third, less common form of plating is called "reel to reel" in which an unplated material is unwound from a feed coil, plated, then rewound. Reel to reel plating is an automated process whereas both barrel and rack plating can be accomplished manually or
with automated operations (Mark Haveman).

Electroplating processes for all types of decorative and technical plating applications will continue to find new applications as manufacturing capabilities expand into emerging global markets (Metal Arts Specialist, 2002).

Environmental policy design

Electroplating industry is heavily regulated under numerous environmental statutes, including Water Pollution Control Act, Resource Conservation and Recovery Act, Clean Air Act Amendments and additional state and local authorities. According to the Environmental Protection Agency (EPA, 2002) report totally $173 million of penalties assessed to the Department of Justice of U.S.A in 1996 and it is indicating that pollution abatement continue to be a key issues for electroplating industry.

Particularly, plating process uses highly toxic or cyanide, and carcinogenic ingredients those are difficult to destroy and dispose of in environmentally sound manner. So issues of environmental concerns fell into following categories (MRI project, 1996):

Chlorinated hydrocarbons and halogenated solvents are commonly used materials in surface preparation to clean and degrease the part before the plating process. These materials caused air pollution through evaporation and may have undergone chemical changes in the atmosphere affecting smog creation, ozone depletion and global warming potential.

Acids and caustics are very commonly used in plating operations that are utilized in the surface preparation stage to remove oxides in preparing the part for plating. Acid is high-level of organic which used to rework of improperly plated or out of specification parts and used to adjust wastewaters prior to discharge.

Metals, it is primary materials in plating operation and it differed in its relative degrees of human and aquatic toxicity.

All of above factors are reasons to limit electroplating process by classified regulations. Therefore, as time progressed, regulations in all these areas increased both in scope and complexity (Mark Haveman, 1996).

Let's see briefly main regulations in the electroplating industry that were explained by Mark Haveman.

Wastewater discharges; from plating facilities were regulated under two sets of guidelines (Table1). These regulations included concentration limits and alternative mass-based limits for discharge of metals, cyanide and total toxic organics. The mass-based standards based on production as measured by area of parts processed.

Land Disposal; Electroplating operations generated large volumes of wastewaters which were treated resulting in a residual sludge. The Resource Conservation and Recovery Act regulate its hazardous wastes. But this regulatory approach is not triggered by the direct activity of the waste generator but rather by the special characteristic of certain metals which were metals and cyanide.

Air Releases; The Clean Air Act Amendments were to be regulated as hazardous air pollutants. Issues affecting the air regulation profile included the amount of emissions, type of processes, sizes of operation, even operations that were new or existing. As well as, the aim of its pressure is to reduce or eliminate solvents and to restrict the production or use of ozone-depleting chemicals.

Also there are numbers of international programs which help to enhance implementation of its environmental policies. For example, one of those helpful programs is "Environmental Pollution Prevention Project (EP3) that is supported on United States Agency for International Development (USAID) has aimed to address urban and industrial pollution and environmental quality in developing countries. The goals of EP3 project are to identify environmental pollution prevention opportunities, and implement its program to manage industrial waste and pollution, even training for environmental professionals. Because most of industries support on toxic raw and related materials, especially electroplating industry consist of numerous type of processes to plating and it tends to create pollution problems and to generate wastes to varying degrees.

Workforce resource

Electroplating industry has labor intensive nature and comparatively low technology and skill requirement. However, most of employers don't care about their employee's welfare. As for this reason, people don't want to work in this industry for longer. Therefore nature of electroplating itself very harmful for employee's health because of chemical emissions, hard work loads, and so on. As well as, most of cases (employee's comments) say that people who work in the electroplating shops have low-wages, and poor "welfare" matters, even very dirty workplace conditions.

HSE Inspectors (1996) has illustrated most common problems in the electroplating plants which have direct hazards to the employee's health and safety. Those are wet floors, dirty toilet/ washing facilities, dirty wall, floor, surface and inadequate ventilation, lighting, too high or too low temperatures of their workplace.

In electroplating plants, the likely exposure to hazardous substances with a risk of ingestion is an obvious risk. Also there were amount of times frequency of physical work to move numbers of metals from preparation process to finishing processes.

Case study of electroplating in Taiwan

This case would be present about Company A which play role in the electroplating industry in Taiwan for 37 years. This case will prove above characteristics very clearly that how environmental regulation impact to the small medium enterprises, and workforce resource challenges.

Case study in the Electroplating Industry

Introduction

The company A is a family oriented company which has played 37 years in the electroplating industry. This company is technological and chemical based SME, which business idea and strategic technological plan of activity focus on industrial equipment coatings and advanced surface treatments.

The owner Mr. Lin is born 1956. The company opened by his father who was just an ordinary blue collar. He let his three sons manage the company but two of them went to the army so only the youngest one was in the business. The youngest brother spent 14 months to learn the nature of its industry and processes but only worked for 14 days in the plant, then he had went to the army too. So the company shut down a year in 1974. After when Mr. Lin got back home from army he took the business and learned how to plate and coat metals at the same time while he worked. It was not hard for Mr.Lin, because he learned Electricity engineering when he was young. From the beginning of small hardware store till now high tech shops like AUO. The way he drives the business is to keep the profit high, but also high quality for customers. It means corporations or customers who care more about their product would rather than spend little a bit more cost but they will get really good quality from Mr. Lin rather than other low cost companies. He attracts new customers by showing his products in public from other companies. People and his own products are the best commercials.

He manages his staffs well by giving relative annual bonus. Mostly depends on attendance and effort they put. There are not many staffs inside the company compare to the works they have to do. There are only 10 permanent employees and most of them are very good skilled and experienced which means older. The reason of lack of staffs is environment is messier which does not really attract young people to come. Where the plant located is in industrial district Fengyuan that is also has very pollution environment. That cause another mainly problem in the business which is pollution cost of business. So factories like him become less and less, and enterprises start to move which interrupt his from extending the company.

There are numbers of rivals run same operations however Mr. Lin has already differentiated from them and became well-known in its industry. Because he usually coating metals again free if his performance has low-quality. That's why Mr. Lin very proud that what he does and what he's done. For him, money is most important of all in this business, as long as he satisfied the request of customers, they should pay. He doesn't really want to build a intimate relationship with his customers, because it would be hard for him to raise price from time to time. His customers don't get upset easily as long as he explained the situations.

SWOT analysis of Company A

Strength

- Enough orders from their clients.
- Company A has well skilled and experienced employees /Talented team/
- They provide high quality for their customers. They recoat stuffs again without any fee if there are low quality products, or unsatisfied customers for their performance.

Weaknesses

- Strong competition. Numbers of family oriented small companies play a role in this industry. Most of them have same operation, same service.
- Lack of employees in Company A. it impacts negatively to the productivity process.
- Productivity rate is largely dependent from employees and their performance.
- Often absenteeism of employees.
- Frequency of physical work influence negatively to the employees and they get pains called "**Arthralgia"**

Opportunity

- Extend their business to the another market.
- Increase their productivity rate by hiring people from low-wage countries

Threats

- Environmental and safety tight regulations cause pressures to their operation
- Government officers often check up their process and give them large amount of penalties
- Company A pay graded tax to the government too.
- Very risky environment influence negatively to their future business plan. If this condition still existing in the later, they will face more and more problems, even they will close its business.

From SWOT analysis I got following questions those are:

- How can a Company A increase its number of employees?
- How to motivate existing employees?
- How to reduce absenteeism?
- How should they increase its productivity rate?
- How should they take better care of employee's health?
- How to resolve a problem related to pollution cost?

The solutions and recommendation to resolve those problems are;

- To improve salary or health insurance.
- To divide annual bonus into monthly
- To reform factory's procedures into automatic producing line (with good structure)
- To modify factory's image
- Often make medical checkups for employees

Most useful recommendations are:

- To create budget that is dedicated to disappear environmental pollution cost. Therefore, they proposed that Company A need to progress social responsibility and communication. That mean's they should invest to the environmental safety with increasing social communities that is to promote own businesses activities and its contributions to the residents what Company A has doing, what they already have done to the environmental development or social welfare, then they may able to get or to support local communities for bringing workers from them.

- To link their communication with government and other agency based courses, training even universities courses which driven by government. It is very helpful approach to overcome a work force problem. / Students or trainees who are attending its course or training must to do practice in Company A.

Conclusion

Electroplating is one of the important sectors in the metal finishing industry. However, while increasing role of this industry there were a number of pressures restrict this industry destiny. It is still puzzle that this industry can hang or live? Because we need to live pure area but we need the benefit of this industry. So what should we to do? How do we save the destiny of electroplating industry? Also a number of electroplating enterprises in the world are confronted with problems like small scale, obsolete production technologies, and large amount of waste emissions as well as inefficient resources and energy utilization.

So how do drive this industry beneficial and effectively even less hazards for environment and employees? The one of the possible solutions is owners should fit their operation with environmental and safety programs. Because those programs provide them very helpful ways to identify hazards, to assess the risk or injury and control the risks by several preventing exposures

In additional, according to my classmate's recommendations, if players want to save their living source which they operate electroplating activity should obey the rules exactly in their operations. Governments already allowed them opportunities to operate business in the electroplating industry within limited scopes. However, hazards are still big headache in both government and players they can overcome those problems together if they could collaborate successful. One of the ways is to classify areas to operate activity only in permitted area.

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Figures

Figure1; Schematic of Electroplating Apparatus

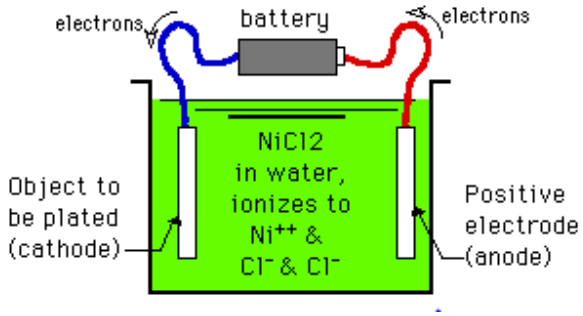
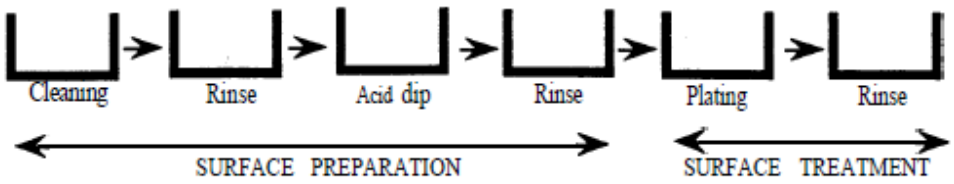


Figure2; Process flow diagram for an electroplating operation



Tables

Table 1; Electroplating Limitations

Electroplating Limitations (40 CFR 413)
all values are milligrams per liter (mg/l)

Pollutant (or Pollutant Parameter)	less than 10,000 gallons per day of regulated process flow		more than 10,000 gallons per day of regulated process flow	
	Daily max.	4-day avg.	Daily max.	4-day avg.
Cadmium	1.2	0.7	1.2	0.7
Chromium (total)	NR	NR	7.0	4.0
Copper	NR	NR	4.5	2.7
Cyanide (total)	NR	NR	1.9	1.0
Cyanide-amenable	5.0	2.7	NR	NR
Lead	0.6	0.4	0.6	0.4
Nickel	NR	NR	4.1	2.6
Silver	NR	NR	1.2	0.7
Zinc	NR	NR	1.9	1.0
Total Metals (sum CR, CU, NI, Zn)	NR	NR	10.5	6.8
Total Toxic Organics	4.57	-	2.13	-