

*Chapter 4*

**CLEANER PRODUCTION AND POLLUTION  
PREVENTION OPPORTUNITIES IN THE  
BRAZILIAN AUTO REFINISHING INDUSTRY**

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**ABSTRACT**

Auto body shops are characterized for using hazardous materials in their activities, which can have a negative impact on the workers' health, and the environment. A study performed on this micro industry demonstrated that is possible to work under more sustainable schemes. However, the first step is to identify the opportunities of putting cleaner production techniques into effect, and pollution prevention for the purpose of a program design suitable to the characteristics of the sector.

The objective of this chapter is to exhibit possible solutions, through information generated from 14 auto body shops from the city of São Paulo, Brazil. The opportunities to implement cleaner techniques are identified and evaluated; pollution prevention that forewarn, reduce and/or eliminate the occupational and environmental risks that are generated in these processes.

## **1. INTRODUCTION**

The micro industry dedicated to the restoration and refinishing of motor vehicles is characterized by using hazardous chemicals in their operations, which include isocyanates, solvents, methylene chloride, paints containing heavy metals, etc. The use of these chemicals represents a risk to the workers' health and to the environment, due to inadequate work practices, lack of control for exposure, bad management of hazardous waste, among others. There is evidence that developed countries have implemented cleaner production programs that have contributed to the prevention, reduction and/or elimination of occupational and environmental risks that this industry generates. A study in Mexico showed that in developing countries, it is possible to expand and implement a cleaner production program, as well; nonetheless, it is recommended to identify the opportunities first in order to design a cleaner production program, according to the conditions and characteristics of the country where this micro industry operates. This will help guarantee the success of the program.

## **2. ENVIRONMENTAL AND OCCUPATIONAL RISKS IN THE AUTO BODY SHOPS**

The repair processes in auto body shops have been characterized as using chemicals substances, such as paints, lacquers and primers that contain several chemical compounds that represent risks to the health, specifically those called isocyanates, which are considered the first cause of occupational asthma (Enander, R., 2003).

The most common of the isocyanates used in the phase of clear coat is the 1.6 hexamethylene diisocyanate (HDI) and its by-product polyisocyanates (Reeb-Whitaker et.al, 2012). This quickly turns to steam during the painting operations, this being the first cause of exposure by inhaling. Contamination through the skin occurs during mixing operations or product handling (Bello, D. et al., 2005). The isocyanates are highly irritating and produce sensitization with the prolonged contact (Liu y Wisnewski, 2003).

In addition to the chemical risks, workers are exposed to other risks like the noise, dust, bruising the body, cuts to the skin by metals, etc. (Bejan, et al., 2011). Since they are working in small areas that generally do not have an

organizational structure, defined working practices, or even uniforms, they are not commonly followed for monitoring by institutions or government agencies, with regards to the normative and labor laws, making them more vulnerable or susceptible to the existence of said risks (Munguía, N., et al. 2009).

Velázquez and contributors, in research done in Mexico, found that small auto body shops work under unsustainable patterns, in other words they lack effective training programs and train their workers in the use and handling of chemicals that are required in the operations, aside from not using proper safety equipment and not having administrative and engineering control (2008). It is a situation that encourages proposal, implementation, and operation of strategic Programs that follow the approaches of cleaner Production, and environmental polluting Prevention, adapted to the operative conditions and to the identified opportunities, which not only will allow the benefits of reducing health risks, but, from a point of view of sustainability, promote the implementation of actions that will allow protection of the environment (Zavala, A., Velázquez, L. y Munguía, N., 2011).

### **3. CLEANER PRODUCTION AND POLLUTION PREVENTION IN AUTO BODY SHOPS**

The term Pollution Prevention is defined as the use of materials, processes, and practices that reduce and/or eliminate contaminants from the source (Freeman, 1995). At the auto body shops, according to Enander (1998), Pollution Prevention should focus on three categories: change of products, improvement in the operations or improvement in the technology used; attending this, the Environmental Protection Agency of the United States (EPA), formulated the program “Design for the Environment”, whose pilot plan was developed by the City of Philadelphia. The main proposals were the use of more efficient paint spray guns that reduce the emission of chemicals into the air; the fabrication of better spray paint booths, that included filters to be changed periodically, establish more careful practices, both in the mixing room, and the operations of cleaning the paint spray gun; the use of better ventilation systems, among others (EPA, 1998).

In the state of Massachusetts, the initiative to implement pollution prevention strategies in the auto body shops emerged from Boston Mayoralty,

in collaboration with the Environmental Protection Agency (EPA), who announced the initiative to train owners and employees of 100 body shops in the city, with the objective that the members of the sector contribute to protect the environment and their workers' health (Shoemaker et al., 2003). In that same state, but in 2011, in collaboration with the Toxics Use Reduction Institute (TURI), two body shops agreed to make the change to begin using the spray paint gun, which improved the body shop's air quality with the presence of acetone by 98%, and 58% of toluene in one of the body shops, and at the other body shop the presence of acetone was reduced to 94% and toluene was reduced to 84% (Onasch, et al., 2011).

Other states also launched initiatives in this regard, such as the state of California, where the "Pollution Prevention for Auto body and Paint Shops" program, urged the auto body shop owners to use strategies of pollution prevention in order to help them meet environmental regulations by reducing emissions and proper use of hazardous materials, as well as the proper management of disposal (DTSC, 2003).

Meanwhile, the state of Delaware has implemented a program named "Compliance Assistance Workbook for the Auto Body Self-Certification Program", where 10 ways to prevent pollution were proposed. The program includes the selection of less toxic products, safe handling and material storage, reducing the use of solvents, reduction of dust exposures, the use of High and Low Volume spray paint guns (HLVP), among others (DNREC, 2004).

While in the states of Wyoming, North Dakota, South Dakota, Colorado, Montana, and Utah, there is a program named "Body Shops Pollution Prevention Guide" which includes, among other items, the proper management of waste generated (P2Rx, 2006). The most common plastics of an automobile, like polypropylene, polyethylene, polyurethane and polyvinyl chloride, represent 41% of all the plastic in automobiles that can be easily recycled (Gomma and Abbas, 2013). In this sense, the American auto industry has supported collaborative initiatives, which have demonstrated that the integration of environmental and occupational health can more effectively address the control and reduction of chemicals emitted and hazardous exposures in the workplace, a synergy that should advance strategies for future collaboration (Enander, 2003). However, much of the focus of exposure prevention in this industry has turned to painting operations, reducing attention to other activities such as those related to paint removal – either through sanding or by chemical removal, where there is also the risk of exposure to

dusts and fumes containing elements such as lead and methylene chloride (Enander, et al. 2004). There are also environmental risks for emissions, discharges, and waste generation (Velázquez, et al., 2008), so in order to focus on prevention, attention should be aimed at all potential sources of risk. The study carried out in Mexico emphasizes the importance of identifying opportunities to design a program based on the approach of Cleaner Production and environmental Pollution Prevention, but adapted to the operating conditions and opportunities identified in their body shops (Munguía, N., et al., 2009).

#### **4. CASE STUDY IN THE BRAZILIAN AUTO BODY SHOPS**

In this section, we explored in detail the current practices in occupational and environmental health carried out in the auto body shops of the city of São Paulo, as well as its implications for the health of the auto body workers, the environment, and its impact to the community in general, which will assist in the design of a program for cleaner production and pollution prevention. This plan will be based on the results found in the study of the 14 participating auto body shops. We applied the research tool called Survey for auto body shops, which was applied to the owner, to the manager, or to the person in charge of the auto body shop. This research tool was used in a previous study by the Research Group of Sustainable Engineering, from the University of Sonora, to evaluate practical operations in an auto body shop, and the conditions under which they are held. The questionnaire covers the practical operations, personal safety equipment, engineering controls, characteristics, amounts of the products used, and questions about environmental and occupational legislation.

Table 1 indicates that 100% of the shops surveyed do not have air conditioning in the working area. Only 21.42% have ventilation in the mixing room, while 28.57% have an extractor in the mixing area.

Table 2 indicates that the auto body shops studied lack some methods of necessary equipment to minimize risks to health and to the environment. 85.72% do not have a solvent recycling system; and 92.86% do not have a closed system for cleaning the spray paint gun. However, 92.86% use the High and the Low Volume spray paint gun (HLVP).

**Table 1. Ventilation systems used in the body shop**

		Total	%
Air conditioning (Working area)	Yes	0	0 %
	No	14	100 %
Fans	Yes	6	42.85 %
	No	8	57.14 %
Mixing room ventilation	Yes	3	21.42 %
	No	11	78.57 %
Extractor in the mixing area	Yes	4	28.57 %
	No	10	71.42 %
Ventilation for the tool area	Yes	3	21.42 %
	No	11	78.57 %
Filtering system	Yes	10	71.42 %
	No	4	28.57 %
Other ventilation (outdoors, wind exhauster)	Yes	9	64.28 %
	No	5	35.71 %

**Table 2. Body shop equipment**

		Total	%
Solvent recycling system	No	12	85.72 %
	Yes	2	14.28 %
Closed system for cleaning the spray paint gun	No	13	92.86 %
	Yes	1	7.14 %
Type of spray paint gun	HVLP	13	92.86 %
	Other	1	7.14 %

As shown in Table 3, 100% of the shops use respirators; the most common being the half-face mask and dust mask with 100%. Also, 100% were said to have a respirator with Activated Carbon (AC) for the painting work. 71.42% have not been trained for respirator use. Only 28.57% of the workers have received some kind of training to use respirators properly. Formal programs about respirator protection and communication about hazardous materials are rarely implemented in the shops. This is derived from reports that 100% of the shops said that MSDSs were not available at the shop, and 57.14% responded that containers were not properly labeled. 57.14% of shops have safety signs and use toxic materials. 100% of workers use gloves to perform their duties; 92.86% use latex gloves, and 100% use leather gloves. Latex gloves are used

by workers to mix and paint, and leather gloves are generally used for mechanical or body work. The result for use of gloves is shown in Table 4.

**Table 3. Respirators and protection programs**

		Total	%
Use of respirator	Yes	14	100 %
	No	0	0 %
Type of Respirator	Dust mask	14	100 %
	Mid-face	14	100 %
	Full face	0	0 %
	With air	0	0 %
Respirator with Activated Carbon	Yes	14	100%
	No	0	0 %
Respirator training	Yes	4	28.57 %
	No	10	71.42 %
Written program about respirators protection	Yes	3	21.42 %
	No	11	78.57 %
Written program about risk communication	Yes	4	28.57%
	No	10	71.42 %
Safety Data Sheets (MSDS) (FISPQ)	Yes	0	0%
	No	14	100%
Labeled Containers	Yes	6	42.86 %
	No	8	57.14 %
Safety Signs	Yes	8	57.14 %
	No	6	42.86 %

The result in the use of overalls, uniforms, and protective eyewear are shown in Table 5. 0.0% use long sleeve uniforms. 100% use eye protection, and 100% use hearing protection.

The impact to the environment produced by the auto body shops is mainly through the emissions of solvents, as well as the generation of hazardous solid waste, among which saturated solids stand out (burlap, flannel, materials with oil, filters) and chemical containers. As shown in Table 6, on average, they use about 1,475 liters of solvent per year, and estimate that 142 liters of waste per year is generated; twelve of the fourteen participating companies have a management company responsible for the disposal of waste solvents.

**Table 4. Gloves used in the operations of the auto body shops**

		Total	%
Gloves are provided	Yes	14	100 %
	No	0	0 %
Type of Gloves	Latex	13	92.86 %
	Nitrile	1	7.14
	Leather	14	100 %
Gloves used in welding	Yes	6	
Gloves used in mass polyester	Yes	0	
Gloves used for primer	Yes	1	
Gloves used in sanding	Yes	0	
Gloves used in paint mixing	Yes	4	
Gloves used in painting	Yes	5	
Gloves used in miscellaneous	Yes	0	

**Table 5. Overalls, uniforms, and face protection**

Use Overalls	Yes	3	21.42 %
	No	11	78.58 %
Use Short Sleeve Uniform	Yes	14	100 %
	No	0	0 %
Use Long Sleeve Uniform	Yes	0	0 %
	No	14	100 %
Use eye protection	Yes	14	100 %
	No	0	0 %
Use hearing protection	Yes	14	100 %
	No	0	0 %

**Table 6. Quantity of solvents used in the body shop**

	Average	Maximum	Minimum	Mode	Total
Liters of Solvents per year	1475	3600	200	200	20651
Liters of solvent waste per year	142	20	360	20	1998
Solvent available	Hired Company				12
	Other				2

Table 7 corresponds to environmental and occupational regulations, and indicates that 78.57% of the people responsible for the auto body shops ignore the environmental and occupational laws that apply to their business. 57.14% do not have the Alvara Operating Permits (permit required for an auto body shop in Brazil), and 57.14% do not have the AVCB (another permit required to operate an auto body shop in Brazil).

Moreover, the results show that only 21.43% of the neighbors have expressed some disagreement with the establishments. The chart also points out the main suppliers of the participating painting body shops. Likewise, it should be noted that 100% of participating body shops would be willing to participate in the cleaner production program and pollution prevention.

**Table 7. Permits and relevant regulations**

		Total	%
Know the environmental/occupational regulations relevant to the business	Yes	11	21.43 %
	No	3	78.57 %
Alvara operating permits*	Yes	6	42.86 %
	No	8	57.14 %
AVCB*	Yes	6	42.86 %
	No	8	57.14 %
Neighbor Disagreement	Yes	3	21.43%
	No	11	78.57 %
Paints and Solvents Salespeople	PPG	3	
	BASF	1	
	Ink BR	1	
	Ink House	2	
	TJ Inks	1	
	Ink corner	1	
	Roman	2	
	Bangu	1	
Participate in a PP program	Automobile	1	
	Yes	14	100 %
	No	0	0 %

## **5. AREAS OF OPPORTUNITY**

The study of the body shops from the city of São Paulo revealed several areas of opportunity. With one or more interventions, progress can be generated towards sustainable production in this important micro-industry, through the realization of a Pollution Prevention program that will allow to reduction and/or elimination of occupational and environmental risks generated by the auto body shops (Munguía, N. et al., 2009). There is not a unique and simple formula so that organizations or companies can establish a program of this nature; nonetheless, there are some basic steps that should be considered and adopted to create an individual approach to pollution prevention. The objective of the program will be defined by each organization, but generally would seek to develop and establish ongoing strategies to reduce the waste generated, defining the procedures that allow reduction of operational costs, its best image to the community, workers' protection, and the environment (Case, 1998; Rossi, 1991).

The opportunities defined what could allow this clean production program to be developed in the Brazilian auto body shops. They are listed below:

### **Support from the Administration**

The support and commitment from the administration is essential for the development of a Pollution Prevention program (Zavala, 2011); however, it should also consider developing an achievement plan for each of the units that structure the company, and a periodic review and update of the program to reflect the conditions that have changed (Case, 1998).

In this case, 100% of the participants in the study are willing to participate in an advisory program in relation to practices on occupational safety and pollution prevention, especially because 78.21% of the auto body shop owners who visited expressed their lack of knowledge in regards to the occupational and environmental legal requirements applicable to their business, but are willing to accept guidance or advice to fulfill said requirements.

The fact that 100% of participants in the study agreed to participate in the implementation and operation of a program of this nature represents the biggest and best opportunity to promote the implementation of cleaner practices in Brazilian auto body shops.

## **Product Labeling**

For purposes of applying the approach to pollution prevention, it is important to have an adequate and effective labeling system that allows control of expiration dates, and use of instructions; but above all, to avoid mixing chemicals, which could react and cause accidents. This would reduce to a minimum the probability of risk to the workers' health or the community's (P2RX, 2013). This is especially important, considering that 57.14% have voiced that their products are not labeled.

## **Contingency Plan**

In spite of the fact that the percentage of auto body shops that have voiced not having signs is less than half (42.86%), it is important that an establishment, with the characteristics of these auto body shops, has at least minimum safety signs. Moreover, 100% said that the "MSDS" are not available in the establishment and 71.42% reported not having a written hazard communication program.

In a Pollution Prevention program, the plan of actions is contemplated in writing in case of emergencies, as well as having safety equipment and first aid available in the business, which helps to reduce the impact of a spill, accident, or explosion that could happen.

## **Training**

The study revealed that the owners and workers should have necessary training in this micro-industry in order to prepare them to take successful actions that eliminate the risks to which they are exposed or at least reduce them to a tolerable minimum.

According to Zavala and colleagues, it is important to involve local authorities, non-governmental organizations, and educative institutions in training programs for workers who belong to the micro-industry; on topics of Pollution Prevention it is a good strategy to train employees (2011).

## **Improving Operations**

A Pollution Prevention program considers that this is achieved through effective improvement in the operations and methods involved in the process, as well as having effective equipment maintenance (Rossi, 1991).

## **Spray Paint Gun Cleaning**

In the specific case of the auto body shops studied, 92.86% of the auto body shops studied did not have a closed cleaning system for the spray paint gun. A Pollution prevention program recommends using an automated cleaner for the spray paint gun, since it saves money and reduces the risk to the environment. Enhanced use of solvents, reducing the amount of waste, and avoiding direct employee contact with the solvent is recommended (DTSC, 2012). Cleaning the spray paint gun is done with solvent. It is recommended to disassemble it and place the parts in a closed cleaning system, and one should always wear protective equipment such as gloves and a mask (Sparer, 2004).

## **Personal Protective Equipment**

The most common gloves used to mix the paint are latex gloves, with a frequency of 92.86%. Only 7.14% used nitrile gloves, although these gloves are recommended for use with solvents and paints. 100% of employees surveyed affirmed having glasses and hearing protection, but they were not seen using them during their working hours.

## **CONCLUSION**

Approaches to Cleaner Production and Pollution Prevention represent one of the best tools to prevent, reduce, and/or eliminate environmental and occupational risks generated in a workplace.

Approaches to Cleaner Production and Pollution Prevention represent one of the best tools on which to base the design of a program that encourages the participation of the microenterprise area formed by the auto body shops, with a purpose of developing the ability to identify, eliminate, or reduce occupational and environmental risks that are generated in these working places daily. The

literature puts forth how it has been economically feasible to design and implement programs of Cleaner Production and Pollution Prevention in auto body shops.

The chapter specifies, step by step, how several areas of opportunities were identified at the auto body shops from the city of São Paulo, in which a program can be applied based on the approach of Cleaner Production: administration support, labeling products, contingency plan, training and improving operations. Support from the administration is emphasized since 100% of participants in the study agreed to work with a program that will guide them and help them to reduce occupational and environmental risks generated by their business, therefore, it is possible to achieve these opportunities. The auto body shops should promote, implement, and use cleaner production techniques, which will set the pattern for extrapolating these same actions to other economic areas, with similar operational characteristics, so that they will not expose their workers to occupational risks and generate environmental risks.

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