Project Number: ZAZ E101

Reduce, Reuse, Recycle

A Major Qualifying Project Report:

Submitted to the Faculty of the

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

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August 20, 2010

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Acknowledgements

Thank you to Professor Amy Zeng for all her hard work throughout the project process both in the United States and China. This project would not be possibly without her valuable feedback. From Nypro Inc. we thank Ronald Alciati and Sunshine Xia for being generous hosts during our stay in China and we are grateful for the experience they were able to provide for us.

Abstract

The goal of the project was to reduce Nypro's impact on the environment by facilitating the company's recent "Reduce-Reuse-Recycle" initiative. Through multiple site visits, extensive interviews, and process analyses, the project team identified numerous internal opportunities within Nypro facilities in China as well as the external ones from selected Nypro suppliers. The effects of the opportunities with the highest interests are then evaluated by monetary savings and the amount of reduction in carbon emissions and waste materials.

Chapter 1 Introduction & Company Profile

At a time when it is becoming increasingly imperative to improve sustainability development in a company to both diminish the harmful effects on the environment and decrease costs a new strategy to reduce, reuse, and recycle (3R), is being implemented at Nypro Inc. facilities in China. Various areas and methods for improvement that will both motivate and nurture internal and external changes were determined. These areas were chosen to result in a reduce Nypro's impact on the environment as well as a cost savings of at least 75,000 USD.

The first step in designing a 3R strategy is to determine the opportunities, internal and external, within Nypro. These opportunities were discovered through a variety of methods including carbon footprint and waste analysis. Then for several identified opportunities a before and after process map was created. Each of these chosen opportunities went through a cost analysis in which the cost of implementing the 3R strategy was weighed against its possible savings to determine the feasibility of each opportunity.

Nypro set an explicit goal of cost reduction of at least 75,000 USD through 3R strategies as well as a decrease of its carbon footprint. This however, was just one objective at which to aim or even surpass, rather than the ultimate or ideal goal. Success would be achieved only if this number was surpassed.

Nypro Inc. was founded in 1955 by Fred Kirk and Nick Stadtherr under the name Nylon Products Inc. The original name for the company came from its expertise with the plastic material nylon. However, as time went on and the company began using many other plastic materials in addition to nylon the name was change to Nypro Inc. in 1977. In 1998 the company became one of the largest employee owned companies in the world.

Nypro’s mission is to:

> "To serve our customers with integrated, innovative and environmentally sound manufacturing solutions, built on Nypro's global plastics leadership, creating value for our team members, communities and shareholders."

Nypro has recently reorganized from divisions that were geographical to newly formed and concentrated Global Business Units (GBU). These new units are the Healthcare, Consumer & Electronics, and Packaging GBU. The focus of this study was primarily on the Consumer & Electronics, specifically on the three manufacturing plants located in the cities of Shenzhen, Suzhou, and Tianjin in China. These plants are staying true to Nypro’s mission by searching for environmentally conscious solutions by developing a 3R strategy.

Nypro has established a place for itself within the global plastics manufacturing community by providing a number of services including precision injection molding, soft touch and high gloss painting, in-mold decorating, paint laser etching and in-mold labeling. These are just a few of the services that Nypro can provide.

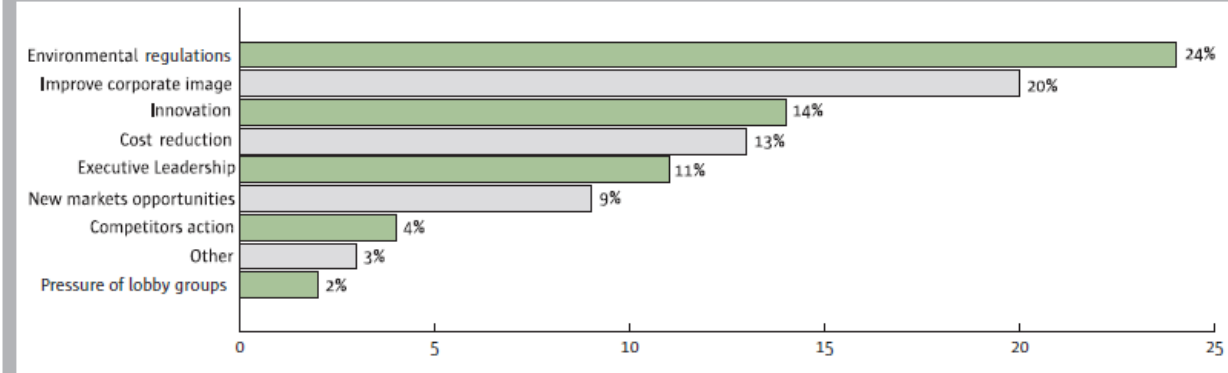
Chapter 2 Literature Review

The development of a reduce, reuse, and recycle program in Nypro's Consumer & Electronics GBU is necessary in this time in which environmental concerns are on everyone's minds. The drivers for green initiatives are well developed among many firms and so are the benefits of the firms that have switched. The 3R concept is part of a waste hierarchy that develops ideas on how to minimize the amount of waste and the associated benefits. To further develop the 3R principles a brief analysis of cradle to cradle design is introduced to illustrate what can be achieved when long term goals are kept in mind. The DMAIC process is also introduced to form a guideline on how to solve the problem.

2.1 Green Supply Chains

"The Green Supply Chain is an approach which seeks to minimize a product or service's ecological footprint". (BearingPoint, Inc.)In recent years there has been a growing importance placed on the environmental impact human civilization has on the earth. Many firms thus also take into account their own impact on the environment. In a recent report on the green supply chain 83% of those surveyed said that their firm takes environmental concerns into account when making strategic decisions. (BearingPoint, Inc.)

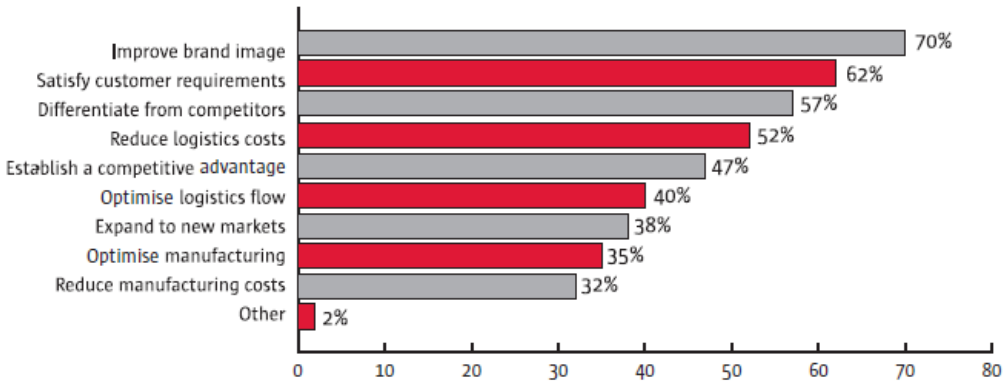
Figure 5: Main business drivers behind importance of environmental issues



Source: 2008 Supply chain Monitor "How mature is the Green Supply Chain?"

There are many drivers behind the importance of environmental issues. While environmental regulations were listed as the main driver with 24% the improvement of corporate image was listed as second at 20%. Thus firms have become aware of the concerns of the public to maintain a positive image. Nevertheless, innovation and cost reduction ranked fairly high on the list also. The placement of cost reduction so high on the list contradicts some views that going green has no benefits financially.

Figure 12: Benefits of the Green Supply Chain



Source: 2008 Supply Chain Monitor "How mature is the Green Supply Chain?"

The benefits reported by firms vary depending on what markets they serve. However, the majority of firms that have an established green supply chain reported an improvement of brand image as one of the benefits of green supply chains. In the automotive market sector the number of firms that reported savings after implementing a green supply chain was 57% in terms of reducing manufacturing and logistics costs. Consequently, there is an opportunity for manufacturers in all markets to be able to achieve a savings by reducing costs.

Putting a green supply chain into operation is no small task. 59% of companies reported obstacles in establishing a green supply chain. The largest obstacles listed were a lack of information at 36% and a complexity in implementing a strategy such as this at 18%. In spite of this the benefits of the green supply chain are established.

2.2 Waste Hierarchy

The waste hierarchy is the order from most to least favorable of how waste should be disposed of. There are several different versions however; the most widely accepted is listed below. (Finnveden, Johansson and Lind)

1. Reduce the amount of waste
2. Reuse
3. Recycle materials
4. Incinerate with heat recovery
5. Landfill

The farther down the hierarchy a disposal method is the less environmentally friendly it is. There have been several studies conducted by various countries to determine whether the hierarchy is properly constructed. In a study of the disposal of paper in Denmark (Schmidt, Holm and Merrild) it was proven that the recycling of paper is favored over the incineration and land filling. And that incineration is favored of land filling. In a similar study conducted in Sweden (Finnveden, Johansson and Lind) plastic recycling and paper recycling were also found to be more favorable then incineration and land filling.

It is then generally accepted that the waste hierarchy is a valid rule of thumb (Finnveden, Johansson and Lind). There are of course some materials that do not favor the order of the waste hierarchy such as glass (Schmidt, Holm and Merrild). Furthermore, the waste hierarchy does not consider the possibilities of composting for organic materials. Nevertheless, the waste hierarchy is a principle to take note of in the field of 3R strategies.

2.3 Cradle-to-Cradle Design

In October of 2001 Herman Miller and their Design for Environment (DfE) team decided to implement a Cradle-to-Cradle (C2C) design process to create their new product the Mirra chair (Bony and Lee). C2C is a manufacturing design that changes the focus of the design process from improving a wasteful process to be less wasteful, to create the manufacturing process that has no waste in the first place. The Mirra chair with this main idea in mind had to be looked at in a new light and because it was the first product that was being created with C2C in mind Herman Miller wanted to see all sides of C2C to look at all options, and also had to take into account how using this process would impact their own company and potential products in the future.

William McDonough, an architect, first pitched the idea of C2C to Herman Miller in 1997 as a way to integrate sustainability principals further into their systems. William's discussed the difference between his proposed manufacturing processes to that of the current day manufactures. The current day process was a "cradle-to-grave" model that took natural resources to produce products (cradle), processed them and altered them with products that could be harmful to people or the environment, then when the products were no longer useful they were discarded and that was the end of it (grave). This process put's an enormous amount of pressure on a company's ability to purchase new resources and also shows no regard for the environment.

The C2C process on the other hand looks at a products ability to "regenerate" so to speak, by using a natural resources once to create an initial product, then processing and manufacturing it in a way that allows to be recycled within the company into a newer, better product (they would call this process upcycling).

Cradle-to-Cradle is bases on two premises, eco-efficiency and eco-effectiveness. Eco-efficiency looks to intentionally adjust and improve the way an industrial system works to generate less toxic pollution and to decrease the rate that it uses resources. Eco-effectiveness on the other hand focuses on designing new industrial systems that neither generate pollution nor depletes natural resources. The process of eco-effectiveness is achieved in product cycles that upcycle. McDonough would ask, "…Instead of directing intelligence toward regulation compliance and liability reduction why not design industrial process and products so safe they do not need regulation, and direct creativity towards maximizing economic, social, and ecological benefits?"

While looking at creating and Eco-effective design the backbone of it is the idea that waste equals food, meaning when a product is at the end of its life cycle it can be either recycled through the industry or through nature without being destructive. Ideally through this process the materials would all be able to be recycled through the system converting all of a systems "waste" into food for that very system, creating what McDonough would call a "virtuous closed loop."

While trying to implement a C2C system within a company there are four key concepts that need to be focused on: Biological and technical nutrients, the Green-Yellow-Orange-Red list, disassembly and recyclability and recycled content.

Looking at the Biological and technical nutrients the focus is protecting the environment and working without waste, on the biological side that means making sure that the biodegradable material that is being used will not now or ever create a hazard for the environment after it is used or destroyed, as for the technical side a company needs to make sure that the material that they use is in a closed loop system, so they can keep the products value throughout its life cycles. An important thing to note however is to never mix the biological and technical sides, this could result in a "monstrous hybrid" where the two mix together and lose all of its benefits.

The Green-Yellow-Orange-Red list is a database that gives an easy to analyze idea about how much of an environmental impact using a product or material will result in. The color scale is as follows:

Green – Little to no risk to environment

Yellow- Low to moderate risk to environment

Orange- Not enough information to list

Red – High risk, chemical should be phased out

A company would work with their suppliers to get a log of all of the products available to them and document their Green-Yellow-Orange-Red rating to help design a product with the C2C result in mind.

The nature of C2C is the idea that a product can be beneficial after the end of its life cycle; therefore its ability to be disassembled is instrumental in its ability to be reused and recycled. Creating an easily to disassemble product helps the company reuse their products.

Finally they need to keep in mind the total recyclability and recycled content used to make their own product so that the least amount of a product ends up in a landfill or incinerator.

Keeping these keys in mind they set off to design the Mirra chair with the C2C system. They wanted to create a sensible office chair that would cost the customer around $750. Herman Miller worked with its suppliers to create a Green-Yellow-Orange-Red list for all of their suppliers' materials and made no exceptions. Each supplier was required to do so or would not be allowed to work with the company. This firm stance worked out well for the company, although it received some resistance from its suppliers who felt that their company's privacy was in jeopardy. This obstacle was handled by having Non-Disclosure agreements and having close contact with the suppliers to keep their minds at ease.

After the design of the Mirra chair had been created and a supply chain had been designed as part of the C2C process to help create an easy to disassemble chair and at the same time created one that was easy to produce as well. Some questions that still needed to be answered for their company concerned how exactly they were going to retrieve the chairs to upcycle them, they could collect the chairs themselves from customers, retailers could be required to procure them as needed or Herman Miller could hire a third party to do the work. Another option was to lease the chairs to customers as needed and when they became outdated have them returned and produce newer models from the old material and ship the new models back out.

The Cradle-to-Cradle design process opens many doors and opportunities that are often overlooked. By initializing the cost and resource saving techniques in the design stage of the new product development process it saves time money and effort later on down the line. Products that

are designed to be reused for future products kill two birds with one stone; they save the company money on resources as well as protect the environment by reducing the amount of waste that ends up in landfills and in the incinerator.

2.4 DMAIC Process

The DMAIC process is one of the key methodologies of Six Sigma a business management strategy developed by Motorola in 1981 (Tennant). DMAIC is a acronym for define, measure, analyze, improve, and control. These are the five phases used to guide the improvement of existing processes.

The define phase is used to define the problem at hand. In the manufacturing of printed circuit boards (Li, Al-Refaie and Yang) (Tong, Tsung and Yen) the solder paste height is identified as a critical to quality characteristic that can cause problems if not properly monitored. The solder paste height is critical because if there is an insufficient amount of solder paste there may be an open circuit, but too much can lead to bridging between different solder pads and resulting in a short circuit. Thus, the problem to define here is how to accurately be able to place the correct amount of solder paste to prevent both issues.

Gathering data to address the problem takes place during the measure phase. In the printed circuit boards example measurements of the solder paste height are taken from five different location on each printed circuit board. These measurements were logged and then used to create statistical process control charts.

Analysis of the gathered data occurs during the analyze phase. The statistical process control charts in the printed circuit board example were reviewed. After reviewing all the data and calculating relevant measurement figures it was determined that one of the machines being

used in the manufacturing process was responsible for the lower quality in the printed circuit boards.

The improve phase is used to implement a solution to the defined problem. In the printed circuit board example the machine that was responsible for the quality issues under went further testing to diagnose the specific problem. After it was identified that the settings on the machine were responsible for the issues the machine was experiencing they were adjusted and retested to ensure they were now on par with the other machines in the manufacturing process.

The implementation of the control phase ensures that similar issues with quality do not occur again. In the printed circuit board example, after all the issues were resolved with the unsatisfactory machine measurements did not stop. Statistical process control charts were regularly created and reviewed to help ensure that any further issues with quality could be quickly identified and address appropriately.

Chapter 3 Methodology

3.1 Internal Team Methodology

Within Nypro the project team has developed a four step process in order to identify the best opportunities to implement at Nypro's facilities located in Shenzhen, Suzhou, and Tianjin. These four steps consist of observation, discussion, distinction, and ranking. Each stage serves to further rank each initial observation and sort out which observations would best fit with the objectives and scope of the Reduce, Reuse, Recycle program within the Nypro facilities.

Step One: Observation

The first step of the internal method consists of in depth observation and data collection within different locations and departments in each Nypro facility. All observations are recorded as seen, and may include data if available at the time; however it is not necessarily needed. This first step served as a pool of information as the project move forward to determine which opportunities best fit the objectives and scope of the project.

Step Two: Discussion

After the initial observation gathering from the various departments and areas the information was compiled for discussion between the project team and the team supervisor within Nypro. This process served to guide the project team into deeper analysis of observations that could be completed within the limited time available for the project. These observations were then considered to be opportunities for improvement. More data was then gathered on these opportunities. The opportunities were categorized into High Interest Opportunities or Standard Opportunities. The High interest opportunities were the opportunities that would further be investigated or recommended to be investigated.

Step Three: Distinction

After the High Interest Opportunities were determined at each facility they were further filtered into a list of the most valuable environmentally and monetarily for Nypro. These opportunities were given the moniker, "1st Phase Opportunities" because these opportunities were considered to create the most positive impact if implemented, while at the same time would face minimal resistance during the implementation process.

Step Four: Ranking

The Nypro project team ranked all of the "First Phase Opportunities" based on three different factors. Environmental impact, monetary impact, and ease of implementation, these rankings (1-25, one being the most favorable, 25 being the least) were then used in conjuction with a weighted averages mathematical model to provide a total value score, one number on a scale from 100 (the most favorable) to 4 (least favorable). Based on the objectives of the projects the weights of each rank were chosen to be: 50% based on the environmental rank (ER), 35% based on the monetary rank (MR), and 15% to be based on the ease of implementation or implantation rank (IR). $\frac{.50(26-ER)+.35*(26-MR)+.15*(26-IR)}{25} * 100$

The total value score given by the weighted averages formula allowed the Nypro project team to easily determine which opportunity would give the most value back to not only the company but also the world.

3.2 External Team Methodology

The external team was tasked with motivating external change by helping suppliers identify 3R opportunities within their own firms. The external team met with suppliers individually for meetings scheduled for three hours.

Each meeting began with a presentation that introduced the project team members and a description of the project. Along with a project description several examples of 3R opportunities that Nypro had already implemented or will be implemented soon at their facilities was included.

After the presentation each supplier was invited to give their own presentation or brief company profile. These introductions were helpful to the team members from outside Nypro who had lacked previous knowledge on what each supplier provided for Nypro.

Following the supplier's company profile they were asked about their manufacturing process. The description of the manufacturing process would help build more understanding and possibly lead to discovery of some opportunities.

At this time suppliers would inform the project team of currently implemented 3R projects. The items reported on from suppliers would be noted to possibly ask other suppliers. The list of items reported would combine with the action item list that would be generated at the end of every meeting.

General discussion would follow with the hope of identifying more opportunities. The items discussed were introduced in no particular order. The environment during the meeting remained informal to deter any pressure the supplier may feel from Nypro. Nypro wanted to encourage change, but recognized that pressuring suppliers to any specific activities may only

lead to inaction. Only opportunities that the supplier had agreed to would be noted in the action item list created at the end of every discussion.

Near the conclusion of the general discussion in latter meetings the suppliers would be introduced to the list of opportunities and action items that had been agreed to previous suppliers. As Nypro had only requested each supplier to implement two opportunities the list was used mostly to generate further ideas that were of ranging difficulty to be implemented.

At the conclusion of the general discussion an action item list was created. This list was a summary of the opportunities that the supplier had agreed to act on. This list would be recorded and then emailed subsequently to every supplier along with a thank you note for attending the meeting.

Chapter 4 Internal Analysis Results

4.1 1st Phase Opportunities NSZ/NSU/NTJ

(For continuity purposes we use a currency conversion rate of 6.7 RMB = 1 USD)

Reusing Packing Foam (NTJ)

Rankings:

Total Value Score: 91.20

Environmental Impact – 1, Monetary Impact – 3, Ease of Implementation – 11

Description:

Nypro used foam sheets between plastic trays in order to better protect the manufactured items. These foam sheets were one time use items where they protect a product as it moves from one station to another within the company, and upon arrival the foam sheets would be collected and thrown away while new ones are bought. Nypro Tianjin alone uses 13,540,000, 38 cm by 61 cm foam sheets.

Resolution:

The foam sheets that were used in many cases were disposed of while they were still in pristine condition. The recommendation to Nypro is to collect these foam inserts and use them again internally provided they meet the specifications necessary for their products. If this allowed Nypro Tianjin to reuse each insert once, it would reduce their consumption by a quarter saving them, 3,385,000 foam layers a year, reducing their carbon footprint by 88,450.05 kilograms a year, and saving them 128630 RMB (~19,198.51 USD)

Reducing Energy Usage from Air Conditioning (NSZ/ NSU/ NTJ)

Rankings:

Total Value Score: 90.20

Environmental Impact – 2, Monetary Impact – 1, Ease of Implementation – 14

Description:

At Nypro Suzhou there were individual air conditioning controls in separate areas that could be turned on and off manually and also controlled the specific temperature for the area. This system for air conditioning while allowing for a higher level of comfort for the workers within the facility also created an opening for human error that in the end has an impact on not only our environment but also Nypro's bottom line. On multiple occasions air conditioning units were left on, in areas that were completely vacant, including one room that had 5 air conditioning controls all of which were on and set to 15°C (59°F) that was never observed to be in use. This opportunity was visible at each of the Nypro location and if monitored could result in large savings.

Resolution:

The Recommendation to Nypro was to create a consistent temperature setting at each individual Nypro facility as well as looking into motion sensors that would be able to automatically shut off the air conditioning when no one was in a given area. The kind of savings that this could create are huge, if Nypro Shenzhen alone, increase its office area's temperature by one degree Celsius the total savings would be 619,964 kW of electricity and a total of 681,080.4 RMB (~101,653 USD).

Reducing Energy Loss from Molding Machines (NSZ/ NSU/ NTJ)

Rankings: 80.80

Environmental Impact – 3, Monetary Impact – 2, Ease of Implementation – 24

Description:

During the time of observation for Nypro Suzhou there were 83 molding machines that were in use at the facility. Each one of these machines used energy to heat resin in order to eliminate the water that may be in it before the injection molding process. Due to the high

temperature that is needed for this process the molding machines barrel would heat up and radiate the heat used in this process. The heat that is expelled from the machine was costly waste from the process, as the machine would in turn then need to use more energy to create heat to make up for the loss.

Resolution:

In a response to the heat being lost it is recommended to Nypro that they invest in barrel blankets for their molding machines. A barrel blanket wraps around the bulk of a resin dryer (picture) and acts as insulation. Each barrel blanket is estimated to take four to six months to pay for itself in saved energy costs. In Nypro Suzhou 83 molding machines are used, if each one was equipped with a barrel blanket the energy savings would be 191,232 kW per year, the total savings by means of energy reduction each year is 210,355.2 RMB (~31396.30 USD).

Recycling Paint Thinner (NSU/ NTJ)

(For more information please see the case study section)

Rankings:

Total Value Score: 76.20

Environmental Impact – 5, Monetary Impact – 5, Ease of Implementation – 18

Description:

Paint thinner was used within each of the painting facilities at Nypro to clean the paint spray guns when changing the paint that would be used on the painting lines. The thinner would be collected and Nypro would pay a third party to dispose of.

Resolution:

Nypro Tianjin and Suzhou was recommended to follow in the steps of Nypro Shenzhen where the collected thinner was given to a recycling plant where the thinner was treated and cleaned and sold back to Nypro at a discounted rate. Since these numbers can vary at each

facility based on suppliers and usage, exact savings is difficult to estimate, however Nypro Shenzhen was able to purchase their recycled thinner at half the cost of virgin thinner.

Reducing Internal Shipping Label Size (NSZ)

Rankings:

Total Value score: 69.40

Environmental Impact – 7, Monetary Impact – 13, Ease of Implementation – 4

Description:

Nypro would keep their WIP goods in boxes throughout the manufacturing process, each box would have individual labels stating what the product was, it's part number etc. These internal packing labels would be printed on a full sheet even though they would only take up half of the paper, and on top of that the printed information was larger than necessary. Nypro Shenzhen makes 100,000 of these labels annually to be shipped internally.

Resolution:

Due to the waste that was created by the internal shipping labels it is recommended that Nypro change the size of the information to be printed on 1/3 of an A4 sheet of paper. This would decrease the amount of waste by 1/3 and save 3068.6 RMB (~458 USD) and nearly 67,000 sheets of A4 paper, reducing 10,050 kilograms of carbon dioxide from going into the atmosphere.

Reducing Product Information Sheet Size (NTJ)

Rankings:

Total Value Score: 68.20

Environmental Impact – 8, Monetary Impact – 12, Ease of Implementation – 5

Description:

While each product was being manufactured each stage of the assembly process would be given informational sheets that would detail what defects the workers should be aware of to look for. This information would be printed on A4 size paper even though the majority of the printed paper would be empty.

Resolution:

It is recommended that Nypro adjust the layout of these information sheets to be able to fit on A5 sized pieces of paper which would save 50% of the paper being used for this process amounting in a 7% reduction in total paper usage, as well as saving Nypro 4320 RMB (~644.78 USD).

Reducing Phantom Electricity Loss (NSZ/ NSU/ NTJ)

Rankings:

Total Value Score: 68.00

Environmental Impact – 10, Monetary Impact – 8, Ease of Implementation – 8

Description:

Phantom electricity loss refers to the electricity that plugged in appliances continue to use regardless if they are on or not. This energy loss can account for 10% of the total energy bill and all of that is an unnecessary expense to Nypro.

Resolution:

To resolve the issue of phantom energy loss, Nypro is recommended to implement a policy that would require all appliances and electronics in office settings to not only shut off after hours and when not in use, but also unplugged from all outlets as well.

Reusing Graywater (NSZ/ NSU/ NTJ)

Rankings:

Total Value Score: 67.20

Environmental Impact – 6, Monetary Impact – 7, Ease of Implementation – 25

Description:

Graywater is water that contains no potential toxins (such as synthetic chemicals or human feces) as it leaves a building through a drain. Graywater, specifically from hand washing, was being drained out of the building and into the sewers, when that same water could have been used for a second purpose. By installing a system for collecting graywater Nypro would be able to use this water a second time as toilet water.

Resolution:

The recommendation to Nypro is to install a system that would reuse the graywater for toilets and would save 22.06% of clean water that was being used to flush toilets, and replace it with graywater that was going to be put to waste.

Reducing Bottled Water Usage (NSU/ NTJ)

Rankings:

Total Value Score: 60.80

Environmental Impact – 13, Monetary Impact – 11, Ease of Implementation – 3

Description:

Nypro Tianjin as well as Nypro Suzhou provided bottled water to customers and suppliers when they would visit the facilities for meetings. Although very hospitable, it is also very costly to Nypro and the environment. One response to this issue that Nypro Shenzhen implemented was using water coolers and paper cups for suppliers, which eliminated their need to purchase bottled water.

Resolution:

It was recommended that Nypro start by reducing the usage of water bottles in Nypro Suzhou and Nypro Tianjin by half to test and see how the suppliers respond to this change. By

reducing bottled water usage by half Nypro would save 8160 plastic bottles and, 12,240 (~1826.87 USD).

Eliminating Tax Exempt Stickers (NSZ/ NTJ)

Rankings:

Total Value Score: 60.80

Environmental Impact – 14, Monetary Impact – 10, Ease of Implementation – 2

Description:

Packages leaving Nypro Shenzhen and Tianjin would be labeled with a tax exempt sticker these stickers varied in size from 11 cm. by 4 cm. to 5 cm. by 2.3 cm. and also included smaller (roughly 1 cm by 3 cm) labels that looked printed out and taped on to boxes. On a yearly basis Nypro Shenzhen and Tianjin combine to use 400,000 of these stickers.

Resolution:

It is recommended to Nypro that they move away from using any stickers for labeling their boxes, but move to using a stamp. This would not only save the stickers but also the paper that the stickers are held on before use, adding up to 920 square meters of paper, and 16,000 RMB (~2388.06 USD).

Eliminating Runner Bags (NSZ)

Rankings:

Total Value Score: 57.00

Environmental Impact – 15, Monetary Impact – 4, Ease of Implementation – 19

Description:

Nypro Shenzhen used 108,300 large plastic bags per year to collect runners that were being used to collect runners that were created in the molding process, and the expelled as waste from the molding machine. These bags would be collected periodically and brought to a

warehouse for storage before they were brought to the regrind area of the plant to be broken down and resold.

Resolution:

The recommendation to Nypro is to eliminate these bags used at Nypro Shenzhen in favor of using reusable plastic bins that would collect the runners and when full, would be dumped into a larger collection bin in the warehouse (a reused gaylord possibly) that would then be moved up to the regrind area, eliminating the need for the larger plastic bags. In total by eliminating all of these plastic bags Nypro would save 54.15 kilograms of carbon dioxide from going into the atmosphere and 47316.27 RMB (~7,062.13 USD).

Recycling Waste within Assembly Lines (NSU)

(More information on this opportunity in the case study section)

Rankings:

Total value Score: 56.60

Environmental Impact – 4, Monetary Impact – 23, Ease of Implementation – 12

Description:

Within Nypro Suzhou in an assembly line, there were two boxes, both 2.5 feet wide and long, and 3 feet deep. These boxes would be filled twice a day and thrown away. Within these boxes 85% of the material could be reused or recycled in one form or another, there were 5 different forms of plastic trays, as well as cardboard containers, and 150 foam protective layers.

Resolution:

By creating a better recycling station in the assembly line 85% of the material in the box could be recycled or reused, reducing the waste that would have otherwise end up in our environment. Per year these boxes created 17,863.1 kilograms of carbon dioxide.

Elimination or Reduction of Trash Liner Waste (NSZ/ NSU/ NTJ)

Rankings:

Total Value Score: 55.80

Environmental Impact – 16, Monetary Impact – 6, Ease of Implementation – 13

Description:

At each location there was a huge use of plastic trash bags or liners as they are called. These were mostly used in office locations however they could also be found in assembly lines, warehouses, and conference rooms. Where ever there were people and waste there would be these plastic trash liners. Usage did however vary depending on facility, in total however Nypro Shenzhen, Suzhou, and Tianjin used 231,800, 108,000, and 67,000 respectfully.

Resolution:

Nypro is recommended to eliminate or reduce their use of trash liners. This can be done multiple ways. Ideally if Nypro would create a system where the office workers would only use their personal trash bins for "clean" trash (that is trash that will not leave residue in the trash, i.e. non-recyclable paper, clean food covers, etc.) which would not necessitate a trash liner. Then for the "dirty" trash (food cores, food containers, etc.) could be disposed of in a centralized trash receptacle located in each office. These savings would amount to 28,476 RMB (~2350.15 USD) per year, and save 406,800 bags per year, a total carbon footprint reduction of 40.68 kg.

Reusing Shrink Wrap Cores (NSZ/ NSU/ NTJ)

(For more information please see the case study section located in the appendix.)

Rankings:

Total Value Score: 54.20

Environmental Impact – 11, Monetary Impact – 16, Ease of Implementation – 9

Description:

Shrink wrap is a thin, translucent, plastic sheet that is used to wrap objects as well as help secure boxes on pallets, something along the line of industrial strength saran wrap. The shrink wrap itself would be wrapped around a cardboard core that is half a meter long, and 10 cm in diameter. Nypro Suzhou alone uses roughly 3000 rolls a year, and when the shrink wrap would be used up the core would be thrown away or sold to pickers at the Nypro site for .4 RMB (~.06 USD).

Resolution:

After looking at the process it was discovered that the supplier could reuse these cores and was interested in buying the cores back from Nypro for .6 RMB (~.09 USD). If Nypro recycles all of their cores in a given year it would add 6000 RMB per year and save over 1.5 km per year of cores. This initiative also spurred the supplier to talk to his other customers about doing the same process. It is recommended that Nypro look into discussing this opportunity will all of their shrink wrap suppliers.

Eliminating Paint Can Labels (NTJ)

Rankings:

Total value Score: 47.40

Environmental Impact – 9, Monetary Impact – 19, Ease of Implementation – 20

Description:

Nypro Tianjin purchased 70,000 cans per year these paint cans included a 20cm by 20 cm label on the front made of a plastic non biodegradable material. The information on the label was needed however the way the information was presented on the can could be altered.

Resolution:

The best solution to eliminate the paper used for the paint can labels, is follow a practice that is already used at Nypro Shenzhen and Nypro Suzhou that is to no longer have the paint

supplier use paper labels and instead print the information directly onto the paint can. This reduction in paper labels totals to 2800 square meters of paper.

Eliminating Molding Line Plastic Bags (NSZ)

Rankings:

Total Value Score: 44.80

Environmental Impact – 17, Monetary Impact – 9, Ease of Implementation – 21

Description:

Nypro Shenzhen had 34 assembly line stations on their molding floor that would have workers remove runners on manufactured pieces before they were packaged and sent off to be used at other parts of the factory. These workers would remove the molded piece package it then throw the runner into a plastic bag. These bags filled with runners would then be collected in a warehouse and eventually moved to the regrind area of the facility to be broken down and resold, at that time; the bags would be disposed of.

Resolution:

It is recommended that Nypro eliminate the use of these bags by using reusable plastic bins at the assembly line stations to collect the runners, and have a larger container (the same container that would be used to collect the runners straight from the machine) to collect the runners in the warehouse and to be moved to the regrind area. This adjustment in the process would save approximately 43,500 bags per year, keep 21.75 kilograms of carbon dioxide from entering the atmosphere and generate a cost savings of 19,005.15 RMB (~2836.59 USD).

Reducing Calendar Waste (NSZ/ NSU/ NTJ)

Rankings:

Total value Score: 36.20

Environmental Impact – 12, Monetary Impact – 24, Ease of Implementation – 17

Description:

Nypro received free calendars from suppliers with their shipments as gifts. These calendars although a nice gesture, created a large impact on the environment. Nearly every person that worked in an office at each of the three Nypro facilities that were visited had one or more paper calendars on their desks, many of which were the same ones that were given to Nypro as a gift.

Resolution:

Nypro is recommended to send a letter to all of their suppliers and customers that historically send them calendars that they respectfully decline the calendars in order to better protect the environment. This act would save more than 600 Calendars within Nypro save savings of 4,694.76 kilograms of Carbon Dioxide from going into the atmosphere.

Reusing Dry Erase Marker Casings (NSZ/ NSU/ NTJ)

Rankings:

Total Value Score: 34.80

Environmental Impact – 14, Monetary Impact – 20, Ease of Implementation – 16

Description:

Similar to the disposable highlighters, Nypro Tianjin, Suzhou, and Shenzhen combined to use 8,492 dry erase markers per year. These Dry erase markers would be disposed of after they were used creating a total of 169.84 kilograms of plastic waste.

Resolution:

By using refillable highlighters would keep two-thirds of that plastic from being disposed of. In total this savings for Nypro comes to 113.227 kilograms of plastic which equates to reducing their carbon footprint by 5.651 kilograms.

Reusing Toner and Ink Cartridges (NSU/NSZ)

Rankings:

Total Value Score: 33.20

Environmental Impact – 18, Monetary Impact – 15, Ease of Implementation – 23

Description:

The Nypro facilities use 1044 toner and ink cartridges per year, and although it is possible to refill ink cartridges and reuse them multiple times, which extends the life of each plastic container, lowers the cost of ink cartridges and helps keep plastic out of landfills Nypro Shenzhen and Suzhou had not utilized any form of refill method. Although Nypro Tianjin started refilling toner and ink cartridges, 60% of their toner and ink cartridges were purchased new.

Resolution:

The recommendation to Nypro is to further look into the opportunity of refilling toner and ink cartridges at each individual facility. The different locations of each facility are under different governmental jurisdictions and should be further looked into to ensure Nypro is following all necessary regulations. If all the locations started recycling half of their ink cartridges that would save 522 toner and ink cartridges from ending up in landfills and would also create a monetary savings as well.

Eliminating Shrink Wrap Covers (NSZ/ NSU/ NTJ)

(For more information please see the case study section.)

Rankings:

Total Value Score: 31.40

Environmental Impact – 22, Monetary Impact – 20, Ease of Implementation – 1

Description:

Further looking into the shrink wrap process we found that each individual shrink wrap roll was packaged in an individual plastic bag, put in a cardboard box, and then shipped to Nypro Suzhou. With the nature of Shrink wrap and how it was stored in the facility we determined that the process of putting the rolls of shrink wrap in the plastic bags before packaging was an unnecessary and environmentally costly step.

Resolution:

When this idea was discussed with the supplier they were also highly interested, the supplier purchases the bags and by removing them it helps his bottom line as well as the environment. By removing these plastic covers Nypro is saving 3000 plastic bags from ending up in landfills. The supplier will also discuss the opportunity to implement this process with their other customers as well. It is recommended that Nypro discuss this opportunity with all of their shrink wrap suppliers as necessary.

Reusing Highlighter Casings (NSZ/ NTJ)

Rankings:

Total Value Score: 29.20

Environmental Impact – 21, Monetary Impact – 17, Ease of Implementation – 15

Description:

Nypro Shenzhen, Tianjin combined to use 360 highlighters per year. Each of these highlighters after being used was disposed of, which created a total of 12.24 kilograms of waste a year.

Resolution:

By using refillable highlighters instead of disposing of the whole highlighter only the ink container would be disposed of saving two-thirds of the waste created by this process. In total

this change would save 8.16 kilograms of plastic from being put into landfills and save a carbon footprint of .408 kilograms.

Eliminating Plastic Garment Bags (NTJ)

Rankings:

Total Value Score: 24.60

Environmental Impact – 25, Monetary Impact – 18, Ease of Implementation – 7

Description:

When a non-worker would visit the Nypro Tianjin or Shenzhen manufacturing facilities they would be required to put on a hairnet, shoe covers, and an anti-static gown first. These protective items would be given to a visitor in a disposable plastic bag. While at Nypro Suzhou they would be given these items in reusable static free bags which eliminated the plastic waste.

Resolution:

We recommended that Nypro Tianjin and Nypro Shenzhen convert to a plastic free system by also using reusable ant-static bags for all visitors to their manufacturing facility.

Recycling Bin Identification (NSZ/ NSU/ NTJ)

Rankings:

Total Value Score: 23.60

Environmental Impact – 23, Monetary Impact – 22, Ease of Implementation – 6

Description:

At the Nypro Shenzhen, Suzhou and Tianjin, locations they had recycling bins that are in place in designated areas around the facility. These recycling bins, however, were being disregarded and used interchangeably as garbage bins. Although there was a system in place that consisted of having a written list of what should go in each barrel this form of labeling was being

disregarded and resulted in all of the recyclable material and non-recyclable material to be thrown away together.

Resolution:

The recommendation to Nypro was to create easy to follow pictures on the recycling bins so that they can be used correctly. Pictures would be necessary for the most common forms of waste in each location, (such as finger clots, paper, food waste, etc.). By creating easier to follow identification on the recycling bins it will allow Nypro to recycle the materials that they want to and not have to throw out the contaminated material when the bins are used incorrectly.

Eliminating Water Jug Wraps (NSU/NSZ/ NTJ)

Rankings:

Total Value Score: 23.40

Environmental Impact – 19, Monetary Impact – 21, Ease of Implementation – 22

Description:

In a previous effort to reduce the waste created by providing water bottles to customers and suppliers Nypro Shenzhen started providing water coolers and paper cups in each meeting room. This change created a new opportunity in itself. The water jug would be filled at the bottler, put into a plastic bag for protection, and then delivered to Nypro, where each plastic bag would be removed and thrown away before the water jug would be used.

Resolution:

After discovering this opportunity in Nypro Shenzhen the water distributor was contacted and this process was discussed. The distributor stated that this change was not a problem, and would no longer use the plastic bags in the shipments to Nypro Shenzhen; they continued to say that they will discuss this change with their other customers and try to limit the total number of plastic bags that are being used from their facility. Nypro Shenzhen, Suzhou, and Tianjin

combine to use 24,875 water jugs a year, by eliminating all of the bags the cover these jugs we keep 7.46 kilograms of Carbon Dioxide from entering the atmosphere.

Reusing Die Cut Reels (NTJ)

Rankings:

Total Value Score: 15.00

Environmental Impact – 24, Monetary Impact – 25, Ease of Implementation – 10

Description:

At Nypro Tianjin plastic covers to protect materials come from a die cut supplier that provides a reel of these die cut items. When all of the die cut materials are used the reel is discarded.

Resolution:

These Die cut reels are reusable and it was recommended to Nypro to work with the die cut suppliers to work out a method collection for these reels to eliminate the impact they have on the environment.

First Phase Opportunity Summary

Through the twenty-five first phase opportunities identified, if all implemented could save a total of over 130,134.9219 kilograms of CO_2 from being released into the atmosphere. To put the numbers into perspective, through these opportunities we would save enough paper to cover two professional soccer fields, almost 390,000 plastic bags, and enough foam layers that if they were laid end to end could reach from Hong Kong to Beijing and still have 150 kilometers to spare. The opportunities also provide Nypro with a total bottom line increase of at least 1,203,482.42 RMB (~179,624.24 USD).

4.2 High Interest Opportunities

After processing the observations the Nypro project team classified the information to determine what opportunities would be of interest to Nypro and could be further investigated by either the Nypro project team or Nypro. These "High Interest Opportunities" that were seen at Nypro Plants all were all considered potential environmental and monetary saving possibilities. 25 of these 53 observations were looked in to further as "First Phase Opportunities" and can be read about further in the First Phase Opportunity chapter, this section will focus on briefly summarizing the remaining 28 opportunities that also can make a difference for the world that we live in.

Pass/Fail system

Nypro's pass fail system at Nypro Shenzhen consisted of paper labels that were applied onto the packaging of products that both pass and fail the various QC points. This process should be looked at to eliminate or lower the amount of paper label used, or to adjust the system to be electronic.

Training Manuals

Nypro had printed out training manuals for their employees, this opportunity should be looked into to determine if an electronic training manual would be a reasonable substitution.

Paper Cup Waste

Nypro Shenzhen's process of reducing water bottle waste by using paper cups and water coolers increased their paper cup waste. This waste could further be lowered by encouraging refillable water bottles to be used by their employees, potentially giving each office worker one to use to overall reduce the cost of cups.

ID's

Nypro used ID tags to identify their employees, these ID's were held in a plastic protector and put on a lanyard. Other options for this process include replacing the plastic protector and instead laminating the ID itself and punching a whole for the lanyard to hold on to. Another further reduction in waste could be accomplished by eliminating the lanyards used in favor of clips that would fasten directly to clothes.

Nylon Bindings

Nypro used a nylon rope material to hold stacks of trays during the assembly and delivery process, this process should be looked into for alternatives that are also reusable.

Shoe Coverings

Nypro used disposable shoe coverings to minimize dirt and static in the manufacturing and assembly lines of their products. Recyclable or reusable options should be looked into to lower waste.

Noise Pollution

Due to the nature of Nypro's business, the amount of noise pollution and the ways it should be addressed should be addressed.

Batteries

Nypro had already implemented a battery recycling program at their locations but had not looked into reusable batteries as an option. This change could save money as well as waste.

Employee Used Cars/Vans

Nypro used company cars and vans to transport managers to lunch and various other locations, an analysis should be conducted for the most efficient number of cars and vans that Nypro should employ at each location.

Extra Resin Bags

Nypro purchased extra empty resin bags for the potential occurrence that a process would need an amount of resin smaller than the standard bag of resin. These bags would then be addressed like a standard resin bag and either disposed of or used to hold regrind. It should be looked into to see if these bags could be replaced by reusable plastic buckets to eliminate the waste.

Packaging efficiency

Nypro's suppliers sent their products to Nypro in various sized cardboard boxes, Nypro would be encouraged to work with various suppliers of non-package specific products, (such as hairnets, shoe covers, etc, products that can fit in any size box with little to no difference in packaging requirements), to work to use larger boxes that would use surface area of each box more efficiently to lower the waste create by cardboard boxes. (For example using an 8" cubic box is more efficient then a 6" cubic box because of the volume it provides for the amount of cardboard it takes to make it).

Lighting Efficiency and Control

Moving towards better lighting regulations regarding which standard of lights that are used within Nypro would help reduce energy costs. Nypro also had multiple areas where a whole assembly rooms would be on but only half of the room was in use, by using multiple light switches to control different parts of the room Nypro could reduce the amount of unneeded energy that is being used in their plants.

Evaporators

On the roof of Nypro Shenzhen there are evaporators that are used while cycling water to lower the temperature in the building. These evaporators while using water to transport energy and release it, need to be refilled with water because the sun and the nature of their purpose

causes it to evaporate. Nypro should look into some form of water collection through reduction of evaporated water or rain water collection.

Day Off Requests

Nypro Shenzhen uses paper requests from its employees to ask for days off. This process has already been moved to an electronic system in Hong Kong and should be looked into at other locations.

Double Labels

Nypro Shenzhen would on occasion use one package to transport two different products to a company. These packages would have two sets of labels (one for each product) on the boxes. If a double label could be designed to reduce the amount of paper used, it could save 50% of the paper on these boxes.

Pallet Labeling

Nypro uses pallets to transport their goods to other companies as well as internally, on these pallets each of their boxes would be individually labeled with product details. Nypro should look into lowering the number of labels on a pallet if all of the materials are identical to reduce waste.

Raw Material Labels

Resin that would come into Nypro Shenzhen would have extra labels on it to describe the product. Nypro should look into asking the suppliers to print the labels directly onto the bag instead of using paper.

RoHS Stickers

RoHS stickers are put on every box that Nypro uses for its products, these stickers should be replaced with stamps and ink that would perform the same service with minimal waste.

Paper Waste

In Nypro Suzhou's office 90% of the trash in the garbage cans was paper. Nypro could reduce the paper waste by implementing a stronger recycling program within the office (at the time of observation there were only two recycling bins in the main office area).

Staple-less Stapler

In an effort to reduce cost and waste from staples Nypro should investigate the use of staple-less staples in their offices. (These staplers use a paper punch and fold method to bind up to 5 pieces together without introducing new materials.)

Pen Usage and Recycling

Nypro Suzhou's office workers would have multiple pens on their desks, my implementing a pen recycling program where each worker get's one pen, and can only get a new one by return the old one to be refilled, it would reduce the cost of pens and the waste that comes along with it.

Urinal Efficiency

At all of the Nypro locations the urinals would flush as you approach as well as when you leave. This extra flush doubles the amount of water used and can be changed to be more efficient to reduce water usage and cost.

Solar Panel Roofing

Adding solar panels to roofs of the manufacturing buildings could significantly reduce energy costs over time.

Escaping Air

Nypro Suzhou uses a system to pressurize air within their molding floor to keep non conditioned air out. Air escapes through pipes in the floor used for the injection molding runners. These pipes force the room to process more air to keep the pressure and sanitary conditions that

are necessary. Nypro should look into possibilities such as using caps on pipes that are not in use that would reduce the energy needed to keep the room in the necessary conditions.

Plastic Mask Efficiency

Plastic masks are used on the painting lines to protect the parts of the products that aren't to be painted. Further research needs to be done on possible ways to increase the amount of times each mask can be used and the ideal number of times a mask can be used before it should be regroup for QC purposes.

Paint Waste Water

Water is used in the paint lines to collect the stray paint that is expelled during the paint process. This water is handled differently at most plants. Research should be done to find out the most environmentally and cost efficient option.

Finger Clots

Finger clots were prevalent at each Nypro facility; however there was no process in place for recycling or reuse of these products.

Increased Recycling

Recycling within Nypro, although it was available at many locations, still needed to improve within offices, manufacturing, and assembly lines.

Chapter 5 External Analysis Results

5.1 Resistances

Though the project team met resistances in the meetings it should be noted that overall the environmental discussions were hugely successful. The points of view that were represented during the meetings were as vast as China itself. In spite of the different points of view, the meetings all ended exceeding expectations some more so than others, but the need for change is being introduced very well.

For many of the suppliers this was their first formal discussion into environmental policies and they were excited to participate. Out of the twenty-one meetings that were scheduled only two were cancelled gauging that for the most part people do want to participate in environmental discussions and to contribute results. Though there were several suppliers that did poorly on generating ideas several just took off and kept thinking and opening their minds.

The resistances encountered by the external team stemmed from various issues. Some suppliers did not understand what the project was trying to accomplish or other environmental issues surrounding such topics. Some of those that attended the interviews were disinterested in the subject and lacked passion on the issue. Many suppliers also had concerns that were not particularly relevant to the discussions that took place during the meetings. Unwillingness for the execution of opportunities also contributed much to the resistance that was faced.

Lack of understanding for the project and the environment is a culmination of several problems. At the outset, various suppliers were unaware of how polluted their environment is. Others had no concept of or previous knowledge of 3R. Suppliers would often come unprepared for the meetings. This unprepared also extended into a lack of understanding of their own

operations. Also many were under a misconception that an environmental project would lead only to additional costs.

Suppliers were uninformed about the conditions of their environment. Most of the suppliers were aware of the need for action in environmental terms. However, those that attended the meetings were not always those that had received the initial invitation. A superior inside the supplier's company would often send someone in their place and unfortunately some of those that were sent to attend meetings in their place did not share similar views. Discussion on possible solutions that could be implemented or other opportunities that could be identified was hampered at times, by the refusal of one person because they did not acknowledge a problem with the environment.

Acknowledging a problem is only an initial step, but some were not conversant in various environmental initiatives including 3R. One would have to be naïve to expect any given person to be experienced with every single possible environmental solution that has been proposed, but being unaware of the topic that is guiding discussion added difficulty to achieving the objectives of every meeting. After explaining the topics of 3R and similar material the discussion could continue.

A lack of preparedness added difficulty to the majority of meetings. As stated earlier those that received the initial invitations were often not those that attended the meetings. Since those did arrive often did not see the initial invitation they often were unprepared of what to expect and what was expected of them. A few suppliers thought they would be attending a seminar about 3R which would explain why some of those that attended may not have know much to begin with as they may have expected to be educated about the topic. Another

misunderstanding was that the discussion was to be an environmental audit to gauge what the supplier has accomplished to reduce its own impact on the environment. Thus, the information that was gathered if it had been gathered was ineffective in continuing conversation.

Similar to the lack of preparedness was a general lack of knowledge in how their companies operated. Most meetings were attended by fairly experience company representatives and could answer most questions during the course of the meeting. A few however, were much less experienced with how their companies conducted business. For example, one supplier had sent a personal assistant that was unfamiliar with the manufacturing process and could only answer questions about the office area inside their facility. The discussion that followed proved to be difficult, but the objects for the meeting were still met.

There was a general misconception about the cost of introducing environmental policies into their companies. Many if not all the suppliers were under the illusion that an environmental project would cost them additional funds to complete. However, as one of the studies reviewed in the literature section show if conducted appropriately an environmental project can save money. The opportunities that were discussed may or may not have an initial investment associated with them, but they would all potential generate savings.

Another barrier to resistance that was faced was a lack of passion or interest. The lack of interest came from some suppliers that expressed difficulties in participating in the discussion. Furthermore, some suppliers cited the standards of the industry for their inaction.

There was a lack of participation from the suppliers in some of the discussions. The suppliers were tasked with identifying opportunities for their companies to implement. While some had no qualms in identifying problems themselves others expressed a lack of creative and

were just searching for ideas to implement. One of the reasons suppliers were not just presented with a list and asked to choose was it was believed that if the opportunity was identified internally it would be met with less resistance than if Nypro had just dictated responsibilities.

Unfortunately an environmental project proves to be an exception than a standard among this business community currently. This has created an environment where many of the suppliers do not see the need to change and to take environmental policies seriously because their competitors and companies they do business with do not see the need for change. A simple statement that asks why should we change the way we operate and conduct business when no one else sees the need. This hinders the passion or interest that can be generated.

The suppliers had numerous concerns on various topics. They had concerns for cost stemming from a lack of understanding about potential savings. The suppliers were worried over the leaking of potentially confidential information about their manufacturing process or product specifications. They were also concerned that certain opportunities were dismissible because of current customer requirements. Many of these concerns could be substantiated quite easily; however some would use them as a means for not pursuing further investigation.

The concern for cost was cited numerous times of the opportunities that were agreed upon. To combat many concerns of these concerns the focus was placed on opportunities that would have little to no initial costs of implementation, but may be able to generate a cost savings. In addition to cost savings the primary focus on this project was on the environment so the project team would maintain focus only on opportunities that could produce a clear environmental savings. For those opportunities that had initial costs suppliers would discredit them without proper analysis to see if implementation could generate savings. The suppliers

operated on a basis of assumption and not mathematics. Some suppliers would also cite that the potential savings were too modest to pursue further discussion.

Confidentiality was treated very seriously throughout the completion of this project. The supplier names are withheld because of the issues over confidentiality and the suppliers had their own issues over confidentiality as well. We did enquiry into their manufacturing process, but if they did not feel like expressing further information because they were worried over a possible leak the supplier was not further pressed. Conversely, some suppliers would use issues over confidentiality as a possible excuse for not further discussing topics. While respecting the subjects dealing with manufacturing very seriously, it was difficult to believe how expressing, for example, whether or not the supplier used plastic trash liners would affect confidentiality requirements. It is important to protect company secrets when possible, but it appeared some would use this as a shield to not further discussion.

Customer requirements are very serious in all aspects of business. If there was a requirement for a specific product it would not meet much questioning. Suppliers though were quick to assume there was a customer requirement when there may not be one at all. For example, when asked about the size of the labels that were being used on the cartons sent to Nypro a supplier responded that there was a requirement from Nypro about the size of the label. The supplier was given the benefit of doubt for the duration of the meeting. Afterwards though the project teamed met with supervisors from quality control and purchasing departments to ask whether if there was a specific size, style, color, or anything else that was required. The supervisors from those departments all responded with a similar reply stating that as long as the carton that was received was labeled so that all needed information could be easily read there were no specific requirements about how large any of the labels or quality control markings had

to be. Thus, the supplier assumed that the reason they perform a certain task was because of the customer, not because that is what their own company had decided upon.

Other suppliers expressed some unwillingness to execute discussed topics. They did not want to consider certain ideas because they believed that the current employees were to accustom to the current processes and would not change. A few suppliers feared that a possible change would result in jobless for others. Though some problems encountered for unwillingness may be alleviated easier than others. For example, those that attended meetings had their own responsibilities to attend to and feared that if they were tasked with environmental concerns they would be overwhelmed and produce poor quality work. In line with those apprehensions were anxieties over various opportunities that would require both Nypro and a supplier to work jointly together. Joint opportunities can produce benefits for both involved, but that are many difficulties to working together.

Assumption over employee habits hampered the number of opportunities identified because of the views of those that attended the meetings. The project team viewed all opportunities large or small as possible areas for improvement as any change is better than no change at all. However, when dealing with opportunities that appear trifle would appear not worth the effort. Such as, with the reuse of stationary items, pens, markers, a supplier would reply that the opportunity was too small and their employees would ignore any refill policies in place and continue with their regular routines. This problem could be easily rectified with proper implementation and execution.

A fear of job loss was also used to account for why some opportunities would be met with reluctance. The while some opportunities recorded are procedural others may have an

impact on the possible employment of others. Those present during the discussion though took it upon them to ensure that everyone currently employed would continue to have a job. While it is expected that a coworker may worry over the possible employment of a friend it may not hurt to step back and look at a bigger picture.

Unfortunately of the suppliers that were met none of them held a position in their own company that was specific to the environment. Hence, if they were to be placed in charge of current environmental projects or future environmental projects that would have to be on top of their regular workload. A sentiment expressed by many of the suppliers is that an environmental policy change would require more attention than they are able to give. However, due to the size of some of the suppliers most believe that they are too small to have an individual in charge solely on environment topics. By recognizing the demand of environment change it can be seen that many supplier would intend to take it very seriously.

Joint opportunities represent many difficulties because of the need for two distinct firms to work together. A joint opportunity would require coordination for something such as the reuse of packaging. For example, whether a supplier would arrange for packaging to be picked up or would Nypro have to arrange a shipment. There would also be a sharing of savings that would have to be negotiated. The joint opportunities that do get implemented can clearly reduce the impact on the environment.

The challenges that were faced seemed prevalent, but it should be noted that the project team was able to exceed expectations. The resistances that were represented in the discussions with suppliers may also appear internally within the ranks of Nypro. A company as large as Nypro cannot expect that all of its employees will be in accordance with all company policies.

The resistances can be used as a guide of what to expect from any future environmental discussions. In the following section how the resistances were halted is documented.

5.2 Overcoming Resistance

The external team used mainly one of two strategies in overcoming resistances that they faced in supplier meetings. The first strategy was to inspire the supplier into determining opportunities they could implement at their own firms. How the external team inspired the supplier was mainly through one of two methods. One method was to give them opportunity ideas and to nurture their thinking along the lines of one of the opportunities. The other method was to challenge their thinking on processes and items that they have grown accustomed to. For example, the external team would ask them to observe some of the items inside the conference room and ask them what they could do without or how they could alter an item or process that normally takes place in the conference room to be more environmentally friendly. The second strategy was to provide concrete examples of how certain environmental changes may appear to generate a cost, but actually provide a cost savings if properly implemented.

The inspiration of suppliers was crucial to the goal of them arriving at opportunities that they could determine and implement themselves. The goal was for every supplier to establish opportunities for themselves and not for the external team to assign a to-do list for every supplier. Thus, the emphasis was placed on creating unique opportunities among the suppliers instead of having every supplier agree to implement the same two or three opportunities.

The first method for inspiring ideas was to nurture positive thinking. Every supplier meeting would begin with a presentation introducing the project and its objectives. The last portion of the presentation was dedicated to the nurturing of ideas that the suppliers might have.

At the end of the presentation there would be a list of several opportunities that Nypro or some of its suppliers has implemented or will implement recently. These examples provided at the end of the presentation would provide a scope for what type of opportunities or similar ones that could be implemented. As the suppliers that were interviewed ranged a wide variety of categories it would be impossible for them to implement every opportunity show at the end of the presentation.

In some of the meetings opportunities were introduced outside of the presentation to nurture thinking and discussion. The external team created a list comprising of opportunities that may face little resistance if introduced. The goal was to be able to use this check list to break down resistance and build momentum in the thinking of the suppliers that was interviewed. Several suppliers would use these opportunities as a fuel for more creative thinking to arrive at other possibilities.

However, those less inclined to participate often would experience the opposite effect. During the presentation to the suppliers every supplier was told of an expectation that they should implement at least two opportunities by the end of the calendar year. The goal was made so that there was something to measure and account the supplier against, not to limit them as it happened with several of the suppliers. Thus, if the external team introduced an opportunity and a supplier agreed to it as their possible second or third opportunity they would often limit their thinking. Their view was more in the lines of that the goal was accomplished so there is nothing more to add. The continuation of this method seemed unfruitful because if they agreed to more of these opportunities they seemed even less inclined to generate original ideas.

Inspiration through the challenging on current processes has mixed results as well. For some suppliers it allowed them to question certain processes that they have grown accustom to. This questioning may lead to a realization of how a process can be accomplished in a more environmentally friendly manner. On the other hand, some suppliers were blind to other possibilities. They had grown so accustom to certain processes that they do not question why they take place, but instead accept them without any thought.

The suppliers that responded well to the challenging of certain ideas were generally more accepting of environmental policies. Those that took the exercise in stride would often quietly think to themselves and suggest an opportunity. There would be a feeling of a sense of accomplishment from the supplier and from the external team. For example, the external team asked about the objects that are inside the conference rooms where most of the meeting were held. A simple example was to point out how their water was being served. Nypro would often choose to serve its guests water in paper cups from water coolers then to give every supplier a plastic bottle filled with water. The supplier would then be asked if they find anything else in the room that they themselves could change.

Those less incline to participate would often struggle or just not even make an effort. The suppliers would often sit in silence for only a few moments and say they cannot think of any opportunities. Others would go more along the lines of denying that such opportunities exist. Responses such as this would require a change in strategy or method to try to salvage the meeting.

5.3 Opportunities

Compiled below is the collection of opportunities that the external team gathered during the course of their interviews. By the end of the project the external team conducted interviews with

19 different suppliers. From these interviews there were 35 unique opportunities identified and over 110 opportunities identified in total. These opportunities were separated into five different categories, Utilities, Office, Warehouse, Production, and Other these categories were the themes for which all subsequent opportunities would be placed under.

5.4 Utilities

The Utilities opportunities focus around topics such as reducing electricity consumption and indirect materials that may be used anywhere in the facility. Operating costs are one of the highest in manufacturing and the opportunities below find ways to lower operating costs and reduce the impact on the environment.

Reduction in Electricity Use by Lighting Solutions

Suppliers Interested: 3, 5, 6, 7, 11, 12, 13, 14, 16, 17, and 18

The supplier has not implemented any energy efficient lights and or has limited lighting controls and or has limited lighting policies. By implementing more efficient lighting and or more light controls and or more limited lighting policies, the supplier stands to reduce its impact on the environment and reduce its energy consumption. Energy efficient lights have higher overhead costs, but are usually able to recuperate the cost before they need to be replaced. The use of lighting controls is the simplest method for reducing the amount of electricity used. Currently, with the design of certain manufacture areas or office spaces it is difficult to light only individual areas. For example in certain assembly lines there are only two switches one to control the workstations on either side of the line. Therefore, if the line only had one or two operators on a side the whole side would still have to bet lit because there are no controls at each individual work station. Poor lighting policies in which lights maybe left on during lunch hours in the assembly areas when no operators are present lead to unnecessary waste. All employees of a firm

must be mindful in how much light is needed in their work areas and to shut off lights in areas where there are currently no occupants.

Reduce Electricity Use by Restricting Air Conditioner Use

Suppliers Interested: 2, 7, and 13

The supplier will better enforce air conditioner control to keep temperature at or above 26°C to reduce the use of electricity and comply with a government mandate. The current government mandate restricts the setting of central air conditioning units below 26°C. A simple solution for this is to appoint an employee in every area in which there are air conditioner controls to be responsible for ensuring that the air conditioner is not set below 26°C. Most electricity produced worldwide is not from renewable sources. By reducing the amount of electricity used we reduce the amount of carbon that will be released into the environment.

Reduce Electricity Use by Purchasing More Efficient Air Conditioners

Suppliers Interested: 17

The supplier currently uses air conditioners throughout their facility that are on the fifth degree of energy efficiency and should switch to a first degree air conditioner. In China electricity consuming devices are rated on a five degree scale from best to worst with the best being on the first degree and the fifth degree being the worst. First degree devices consume the least amount of electricity, thus also are the most environmentally friendly. Though energy efficient devices such as this are generally more expensive they will often generate a savings over the course of their lifetime because of the lower operating costs.

Reduction in Plastic Trash Liners

Suppliers Interested: 8, 11, 13, 14, 15, and 18

The supplier will remove the plastic trash liners in the waste bins located throughout their facilities where possible to reduce the amount of plastic used. For example, plastic trash liners that are inside waste bins inside of offices are wasteful as they should contain no liquid or food wastes. Plastic trash liners would be limited to break rooms or similar areas that may contain liquid or food wastes. Employees can continue to enjoy beverages and snacks at their own desks if that is the current policy, but would be asked to dispose of them in the waste bins located in the break rooms.

Recycling Waste Information Sheets

Suppliers Interested: 3, 7, and 10

The supplier currently has a recycling system in place, but some of their employees do not recycle. Information sheets informing employees on what can be recycled will be placed near garbage and recycling bins. There is a need from everyone on the earth to help to reduce the impact on the environment so that we do not destroy it.

Rechargeable Batteries

Suppliers Interested: 6, 10

The supplier does not use rechargeable batteries and will explore the possibility of switching to rechargeable batteries to reduce the impact on the environment that disposing of these batteries has. Batteries contain highly toxic acids that can damage the environment and reduce the amount of metal that will also find its way into the environment.

Recycle Batteries

Suppliers Interested: 14

The supplier currently does not recycle disposable batteries. Government regulations in most areas require batteries to be recycled instead of being disposed of in regular trash bins. The

chemicals in batteries are very harmful to the environment and every effort should be made to prevent their entrance to the environment.

Reuse Cotton Gloves and Masks for Cleaning

Suppliers Interested: 19

The supplier will use cotton gloves and masks to remove oil from their machines instead of using separate dusters. The reuse of the cotton gloves and masks prevents the use of separate dusters which is of both an environmental benefit and possible cost savings. Cotton gloves and masks can only be cleaned and reused so many times, but even after they are unable to perform the task they were designed for they may still be able to be used as scrap rags for maintenance purposes.

5.5 Office

The Office opportunities focus around topics such as reuse of stationary items and reduction of paper use. As many of those interviewed spent the majority of their workday in office areas they were able to help identify opportunities for their companies.

Reuse Stationary Items

Suppliers Interested: 3, 6, 8, 9, 10, 11, 12, 13, 15, 16, and 17

The supplier will investigate the use of stationary items that are refillable to reduce the amount of plastic waste generated by one time use stationary items. Markers come in plastic housings and some models can be refilled and reused. By reusing markers there is a restriction on the amount of plastic that enters the environment. Furthermore, the supplier will purchase refills for pens to decrease on the amount of waste that they produce. By purchasing just refills there is also a potential cost savings. Similar to the reuse of markers, pens also only need the ink to be refilled and not the whole pen.

Reduce the Amount of Office Paper Waste

Suppliers Interested: 2, 3, 5, 6, 7, 8, 9, 10, 17, and 19

The supplier will print non-confidential documents and data sheets on both sides of paper sheets to reduce the amount of paper used. In the same vein, the supplier will add a message to the signature in all their emails reminding recipients to be mindful of the environment before printing. Having hard copies of an email may be helpful for meetings and other activities, but the paper use is wasteful is an email can just be edited and stored electronically. Limiting the amount of paper used will help reduce the need for deforestation.

Reduction of Plastic Water Bottle Waste

Suppliers Interested: 1, 2, 3, 5, 6, 7, 10, 13, and 14

The supplier would be looking to switch to paper cups and water coolers for guests to cut back on the amount of plastic bottles used. It is well know that plastic takes far longer to degrade than paper in the environment if it is not recycled. By switching to paper we hope to reduce the amount of plastic waste that finds its way into the environment.

Reduction of Plastic Bags

Suppliers Interested: 3, 5, 6, 13, and 14

The supplier will ask for plastic bags to not be placed onto water coolers for delivery. The supplier currently uses water coolers. The plastic bags on these water coolers are of limited to no benefit.

Reuse Printer & Toner Cartridges

Suppliers Interested: 19

The supplier currently does not reuse printer and toner cartridges and will work to reuse these products. Much like stationary items the containers that the ink is stored in is capable of

continuing to function, but is limited by the amount of ink it can store. By reusing printer and toner cartridges they will be able to limit the amount of plastic waste produce.

Recycle Printer & Toner Cartridges

Suppliers Interested: 3

The supplier currently does not recycle cartridges after they are unable to be reused again. Recycling cartridges helps to protect the environment and is mandatory under current government regulation. After several times of being reused the cartridge can no longer be refilled and must be disposed of. By recycling there will be a reduction in the amount of plastic waste that will enter the environment.

5.6 Warehouse

The Warehouse opportunities focus around topics such as the packaging of products and the logistics of the shipments. The transportation of goods is very important in conducting business at a time when JIT is becoming the standard if it is not already.

Reduction in Paper Label Amount and Size

Suppliers Interested: 1, 3, 4, 5, 6, 9, 12, 13, 14, 15, 17, and 18

The supplier will print or stamp the Restriction of Hazardous Substances (ROHS) label directly onto the box or datasheet if their customers are satisfied with the change. Currently, some suppliers print ROHS labels separately and then attach them to the cartons and packaging. Some suppliers would attach as many as three separate ROHS labels to every carton. By stamping or printing the ROHS label there can be a reduction in the amount of paper used. The supplier has also expressed interest in minimizing the size of their labels or datasheets attached to packages to decrease the amount of paper that is used. Some suppliers would print their labels onto A4 sized paper sheets. There is no need for such a large label that can be read from as far

away as five meters. Thus, if the labels are minimized more labels can be printed on every sheet of paper and in turn reduce paper use.

Recycle Carrier Labels

Suppliers Interested: 3

The supplier will investigate the possibility of recycling the carriers that the labels arrive on. After the supplier has removed the paper label from its carrier the carrier will be disposed of. The supplier will try to incorporate a new strategy to limit the amount of waste that will enter the environment.

Reuse Paper Waste to Create New Labels

Suppliers Interested: 9

The supplier will investigate switching to reused paper labels or using other scrap paper for labeling purposes if the reused paper labels meet their customer specifications. Reusing labels will reduce the amount of paper waste generated. The supplier will take certain paper waste and print information normally found on a label onto this waste paper and attach it to packaging that they send out.

Reuse Packaging

Suppliers Interested: 3, 5, 13, 16, and 17

The supplier has expressed interest in reusing packaging sent to its customers if they are able to receive the packaging back. Currently the supplier has to purchase new packaging material for every shipment made. If they were able to receive packaging material back they would be able to reduce the amount of paper used. There may be a cost savings realized by both the supplier and customer however, this may prove difficult to arrange.

Reuse Roll Cores

Suppliers Interested: 16, 18

The supplier has expressed interest in reusing roll cores sent to its customers if they are able to receive the roll cores back. Die cuts are manufactured in several ways, but if the supplier uses a rotary machine the die cuts will be stored on a plastic core. This plastic core currently is disposed of when received by the customer, but it is still capable of storing die cuts if it was returned to the supplier. Similar to the reuse of packaging this may prove to be difficult to implement.

Change in Materials

Suppliers Interested: 4

The supplier will investigate a change in materials in the packaging materials they use for their shipments. By considering other plastic materials or various packaging styles they may be able to reduce the amount of plastic that is released into the environment as well as be able to ship more products in every cardboard carton reducing the amount of paper used.

Reduction in Carbon Emissions

Suppliers Interested: 4, 17

The supplier will explore the use of different transportation methods if their customers allow it. Currently the supplier has to transport numerous amounts of product through air freight which produces very large amount of carbon emissions. The supplier will explore the possibility of switching to more environmentally friendly transportation methods such as rail freight if the products can reach their customers by their deadline. The supplier should also review the logistics of their delivery activities to ensure that delivery trucks that are used are able to maximize their capacities.

5.7 Production

The Production opportunities focus around topics such as direct and indirect material use in the manufacturing of goods. Due to the confidentially of many of the production processes used by the suppliers the opportunities cannot be more product specific.

Recycle Finger Cots

Suppliers Interested: 3, 6, 7, 10, 13, 15, and 17

The supplier currently does not recycle finger cots used by their employees. By collecting the finger cots for recycling they will reduce the amount of waste produced by their firm and may be able to receive a discount from their supplier for returning them. Some finger cot suppliers have said that they would give a one to two percent discount on future orders if they are able to receive used finger cots. Some suppliers may experience difficulty in recycling finger cots because of the materials that the finger cots come in contact with will change the finger cots classification into hazardous waste. These suppliers however have still expressed interest in possibly recycling them as long as it complies with a government mandates.

Reuse Cotton Gloves, Hair Nets, Shoe Covers, Cloth Dusters

Suppliers Interested: 3, 10, 11, and 12

The supplier will investigate using a laundry service to clean used cotton gloves, hair nets, shoe covers, and cloth dusters to determine if there is an environmental benefit. Instead of disposing gloves, etc. and having to purchase new gloves the supplier could collect and wash them. However, it is uncertain whether the chemicals used in this process to wash the cotton gloves, etc. will cause more harm than if the items were just disposed. A possibility to reduce the amount of chemical waste released is to filter the water and reuse it, but this may not be possible for all suppliers.

Recycling of Waste Water

Suppliers Interested: 7

The supplier will implement a waste water recycle system to be able to reuse water throughout some of its production processes instead of continually disposing of water. Water that has been filtered can still be used to capture dust and paint particles throughout the various production process used in the development of consumer electronics. Recycling water is of both environmental and financial benefit.

Recycling of Chemicals

Suppliers Interested: 1, 7

The supplier currently uses sodium hydroxide and sulfuric acid or other chemicals in their production line as cleaning agents. The supplier will investigate whether it is possible to recycle any chemicals they currently use. An example of a recycled chemical is paint thinner. The supplier has expressed interest in testing recycled paint thinner, to see if the recycled paint thinner meets quality assurance standards. By using a recycled chemical product, the supplier will reduce the waste produced by their firm. The recycled thinner that is currently in use in Nypro is also purchased at a much lower price than the virgin material. Recycling chemical agents is a good example of a 3R opportunity that helps the environment and reduces costs.

Combining of Production Processes

Suppliers Interested: 13

During an onsite visit the supplier was asked about combining some of their production processes to reduce the amount of internal packaging materials consumed. After several steps in the production process the product would be packaged internally to be brought to the next workstation. If the processes could be combined at some workstations the need to use packaging

materials in between these steps would be eliminated; thus, saving packaging material from having to be disposed of after it is no longer considered suitable.

Reduce use of Indirect Materials

Suppliers Interested: 13

During an onsite visit the supplier was ask about the materials used based on individual tendencies of the operators. When observing a workstation the supplier was questioned about the different methods each operator used to complete a given task. It was visibility observable that several of the operators used substantially less indirect material then others based on their technique of performing the given task.

Reduce Production Waste

Suppliers Interested: 13

During an onsite visit the supplier was asked about the specifications of some of their products to see if the amount of waste could be minimized. The amount of material used for the process in question seemed to generate excessive amounts of waste. The supplier was asked to confirm if the amount of waste could be reduced.

Reclassification of Production Wastes

Suppliers Interested: 2, 17, and 19

The supplier is looking to expand their garbage classification system to encompass industrial waste that is produced. Currently the supplier does not classify waste as recyclable or non-recyclable so all industrial waste produced by the supplier will find its way into a landfill. By classifying certain wastes as recyclable they will be able to reduce the amount of waste that finds its way into landfills and provide opportunities for paper and plastic products to be recycled.

Waste Separation

Suppliers Interested: 5

The supplier will investigate the feasibility of separating paper and plastic waste so that it may be recycled. The supplier produces scrap waste that contains both paper and plastic bound together with a light adhesive. The supplier will determine if the waste can be separated easily so that it can recycle the materials without impeding production.

5.8 Other

The opportunities listed under the Other category did not really warrant themselves to any of the other categories, nor did they justify having their own category. Additionally, in this section there were several opportunities suggested by suppliers for Nypro to implement.

3R Internal Meetings

Suppliers Interested: 17, 19

The supplier will begin holding regular 3R meetings within their own organization to continue to look for opportunities in which they can reduce the impact that their firm has on the environment. The products that the firm produces may change over time so there must be a constant vigilance to ensure that every step is being taken to account for the waste that is produced.

3R Supplier Meetings

Suppliers Interested: 17

The supplier will try to incorporate their own supplier or other firms that they do business with into future 3R discussions. The current environment situation was not created by the actions of a sole entity. Thus, the more organizations that are considering the environment the more

likely that a change can be made in the way business is conducted in regards to environmental policy.

"Reduce, Reuse, Recycle" Rewards System

Suppliers Interested: 7

The supplier currently has a rewards system in place that rewards employees with bonus pay for identifying opportunities in which the supplier can reduce its impact on the environment and save costs. The supplier has agreed to share information about the rewards system to see if a similar system could be implemented in Nypro. By giving the employees incentives to determine solutions for problems they face they may work without fear of repercussions for objecting current methods. As management is not always present on the manufacturing line it is important to receive input from the people who spend most of their time there. By working together everyone can help to realize environmental and monetary benefits.

Carbon Filter

Suppliers Interested: 1

The supplier uses carbon filters to help reduce the amount of pollution in the air that their workers inhale and that is spread to the outside environment. The supplier will share this information with Nypro. Health and safety is a priority in Nypro and the added environmental benefit is of great benefit as air pollution has become a highly discussed topic in China.

Cell Unit

Suppliers Interested: 2

The supplier introduced the cell unit production model for Nypro reference. For example: in an assembly line in F company they were able to re-design the assembly process from individual process per person to multi-process per person which saved them about 30% labor.

Though this may appear to be only a cost savings any reduction in human activity is a reduction in the amount of carbon released into the environment.

Chapter 6: Recommendations and Conclusions

6.1 Internal Recommendations and Conclusions

The potential presented by instituting environmentally friendly practices at Nypro is astounding. The Nypro project team was able to recognize 53 internal opportunities in six weeks that would help the environment and Nypro in one way or another. If Nypro uses more if its resources towards identifying and implementing these practices it will benefit their bottom line and reduce the waste within their company.

Nypro is recommended to identify either an employee or group of employees (the environmental team) who will be in charge of spearheading the implementation of 3R programs within each facility, (Nypro Shenzhen, Nypro Suzhou, and Nypro Tianjin). This group would be required to keep up to date records of what environmental initiatives have been implemented and their monetary and environmental impacts. These individual databases would be put into a report at the end of each year and presented at a meeting that would include each of the Nypro facilities environmental teams to facilitate communication between all of the teams.

Each Nypro facility will be required to implement two new 3R opportunities each year to further benefit the environment and Nypro. These opportunities for the first few years should be focused on helping create a mindset within Nypro that implementing 3R opportunities has a positive effect for the company that cannot be ignored. For this reason we recommend that the opportunities that are chosen are taken from the first phase opportunities that are provided, but if other opportunities present themselves the ones that are used for implementation should have clear results that are measurable and significant.

Each Nypro facility will also be required to identify two new 3R opportunities each year to keep the amount of potential 3R opportunities up and the keep the 3R mindset fresh. These

two new identified opportunities should also be presented at the environmental team meeting each year to help share opportunities between facilities.

If Nypro focuses on increases communication between facilities and embracing the 3R production mindset the impact on the environment as well as their bottom line will be significant. Furthermore it will provide convincing evidence that implementing 3R opportunities evolves a company into a more efficient less waste system.

6.2 External Recommendations and Conclusions

Nypro takes environmental concerns very seriously. This is made evident by sponsoring the current project team among other activities that it has already accomplished in China and elsewhere in its facilities worldwide.

On the other hand, Nypro's suppliers have not been as successful in introducing environmental reforms. For some suppliers this was their first experience working on an environmental project. Hopefully, it was an enjoyable experience for the suppliers that were involved so that they can continue the work with great excitement. The changes that are needed may require strong resolve.

Change is needed. Unfortunately, those that were involved needed to be pushed for answers. The project team strongly recommends that Nypro continues to push suppliers for implementations plan and to confirm with suppliers that their words are transformed into actions. When Nypro conducts audits on its suppliers environmental policies should be taken into account. Without pressure, it is uncertain whether certain opportunities will be implemented. By enforcing change there is hope to achieve lasting results.

As of now there is no simple solution to the current environment situation. A company cannot just sit by and say we did our part in the last fiscal year. Any strategies that are to be put into operation will have to be long term changes. Without consideration for future generations any differences that have been made currently will peter away.

The project team thus wishes that projects such as this one will continue. Any solutions that achieved cannot be implemented in the short term. Metaphorically, if the environment currently has a cold we cannot just take a few days off from work and alleviate the problem. There needs to be a lifestyle change among all of those that populate the environment. Any change that one does to improve the conditions of the environment is a change for the better.

Continue to keep the suppliers involved and add more to future programs if possible. If every supplier can agree to do one thing differently than the amount of people performing good deeds for the environment is multiplicative. The more changes that can be made the better the situation will become. If the suppliers keep with the ongoing it will be possible to achieve a cultural change. A change in which people are more conscious of the decisions they make and what effects they have on the environment.

The environment encompasses the scope of the entire scope of the earth. It is difficult to imagine for many people that how humans can change the environment when it is so large in scale compared to the size of a person. However, people have been defying the impossible for quite some time. Man has no wings, yet we fly every day. If one looks at the accomplishments of ancient civilizations in terms of architecture such as the ancient Egyptians and the constructing of the pyramids it is apparent that people have had the capacity to change their environments on

massive scale. Much time has passes since then and technology has improved much so why is it so farfetched to believe that the earth as a whole can be changed.

Accordingly, civilization has to revert some of the changes that have been made. By continuing processes such as this project small changes made by individuals can amass to something much larger than any one person can accomplish. The current problems with the environment today are too large for anyone person to handle or for anyone one country to handle only by working together can a lasting difference be made.

As Nypro continues to conduct business it is the project team's hope that they will always keep the environment in mind. A company as large as Nypro can build momentum to change the way business is conducted so more people are aware of the sacrifices that have been to arrive at this point in time.

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Appendix

Appendix 1 Recycling within assembly lines

When looking in depth at the Nypro Suzhou facility within one of the assembly lines there were two 2.5'x2.5'x3' cardboard boxes that were filled and emptied twice a day with what was considered waste from the assembly line. Upon further inspection, the boxes contained many items that could be recycled or reused. The contents of the box were then itemized and sorted to get a better idea of how much was waste and how much could further be reused. In all there were 5 different kinds of plastic trays, 13 cardboard box halves, and 150 foam layer sheets that all appeared to be in reusable condition.

85% of the material in the bin was recyclable or reusable material, using that information, per year 15,183.635 kilograms of carbon dioxide could be kept from going into the atmosphere by implementing a recycling system. The materials may have been able to be sold back to suppliers for recycling purposes which would give Nypro not only a better relationship with their suppliers but could also positively impact their bottom line.

Appendix 2 Paint Thinner

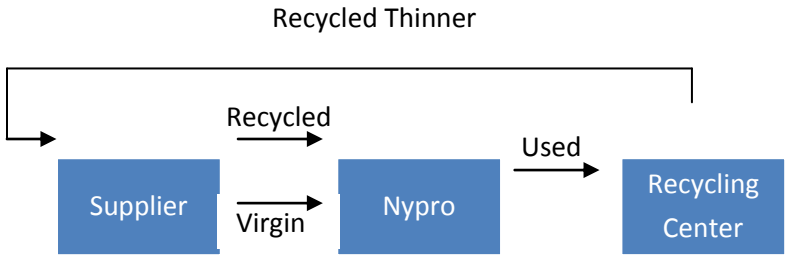
All of the Nypro painting lines used paint thinner to clean the spray guns when the paint was being changed. This used thinner would then be collected and sold to a third party to dispose of the material. Nypro Shenzhen already has implemented a paint thinner recycling program at their facility, using that as a model Nypro Suzhou's paint thinner provider was called in to discuss the same opportunity.

The process at Nypro Suzhou originally consisted of Nypro purchasing virgin material, then after it was used, they would sell the dirty material to a third party to dispose of it. Now the new process consists of Nypro Suzhou purchasing both virgin and recycled thinner, and giving

the used materials to a recycling plant, where they would in turn sell the recycled thinner back to Nypro Suzhou at a discounted rate.

Former Process

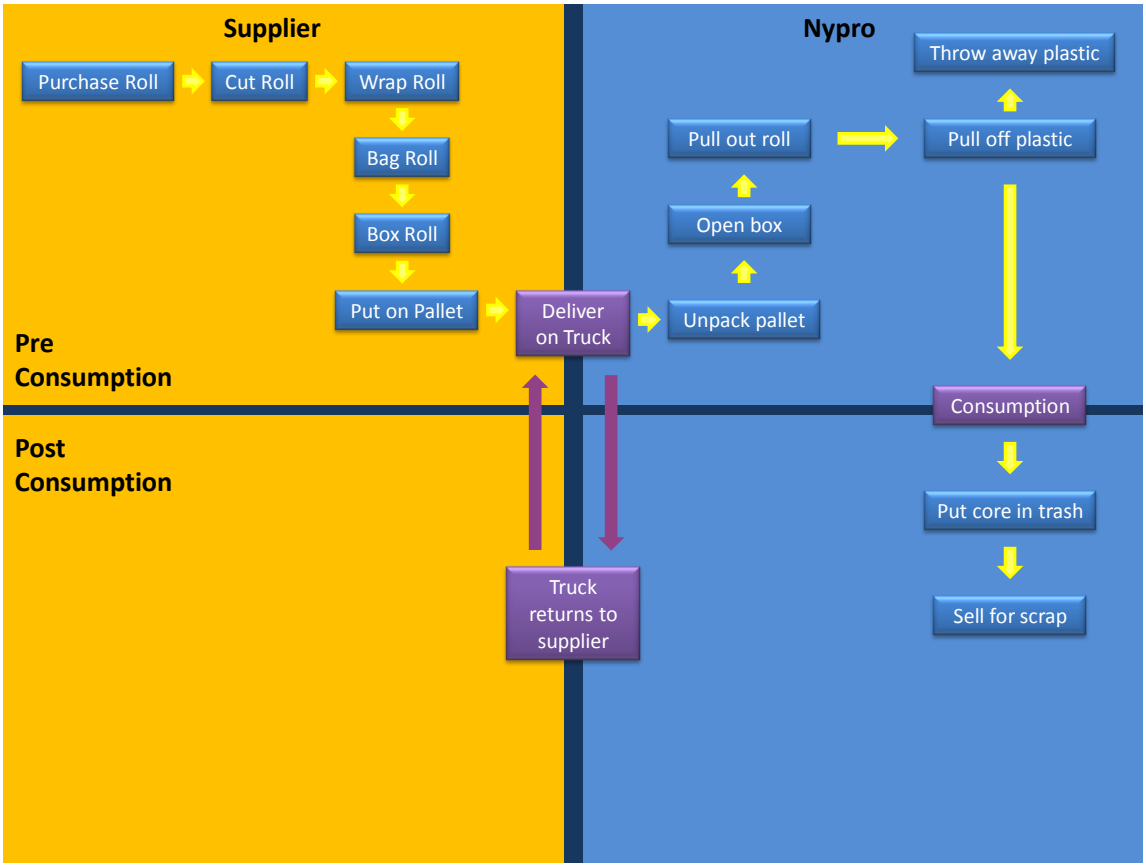
New Process



In total the change in this process based on the process that has already been put in place at Nypro Shenzhen, could provide 50% savings on thinner that is bought as recycled material instead of virgin material.

Appendix 3 Shrink wrap plastic covers and cores

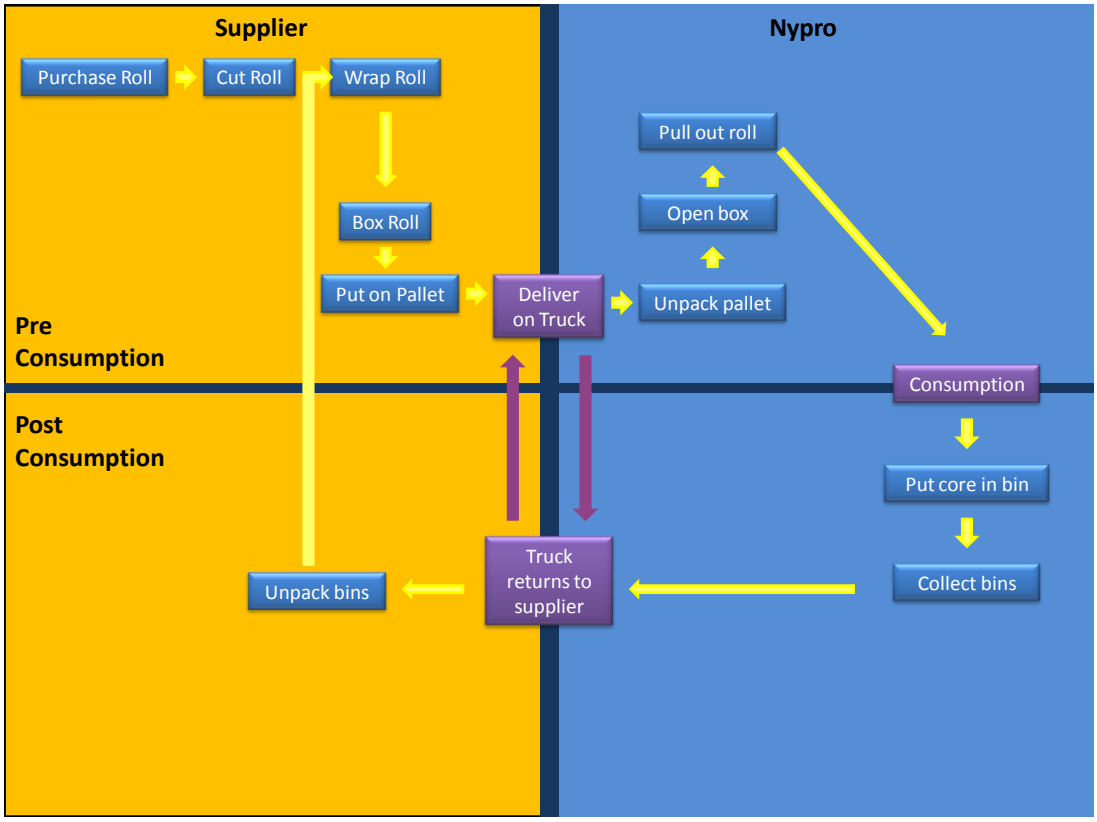
Shrink wrap, a thin, translucent, plastic sheet is used to bind and add protection to objects as they are being shipped of stored. Shrink wrap itself is rolled around cardboard cores that are .5 meters long and roughly 10 cm in diameter. Each one of these rolls was put in a plastic bag for a cover, then packaged in a cardboard box before they were shipped to Nypro. Once they arrived at Nypro they would be unpacked from the cardboard box, the plastic bag cover would be thrown away, before the shrink wrap would be used. After all the shrink wrap was used the core would be thrown in the trash where some would be sold to pickers for .4 RMB (~ .06 USD), and the rest would be disposed of.



After looking at this process at Nypro Suzhou, where they use 3000 rolls annually, the supplier was invited to visit Nypro for discussions about adjusting the process to make it more environmentally friendly. During the talks with the supplier it was determined that the plastic covers for each shrink wrap roll was removable and for then on would not be put on the shrink wrap cores to Nypro. This opportunity, although easily implemented, saves 3000 plastic bags per year from being put into landfills.

The next opportunity that was discussed was the reuse of cardboard cores, the supplier said each individual core cost them 1.2 RMB (~.18 USD) and they were very interested in setting up a procedure of picking up empty shrink wrap cores that were in reusable condition from Nypro. It was then agreed upon to split the 1.2 RMB cost savings on each core between the Nypro and the supplier, giving Nypro a .6 RMB (~.09 USD) per core returned to the supplier.

The total savings from these two opportunities combine to be 3000 plastic bags, 1.5 km of cardboard cores, and 1,800 RMB (~268.66 USD) for Nypro.



Appendix 4 Calculations

Reusing Packing Foam:

The density of foam used: .75 g/cm^3

Carbon footprint for foam inserts: .05 gCO_2/g

Price per piece: .038 RMB

- Total pieces used at Nypro Tianjin per year:
  - 13,540,000
- Roughly half for internal use:
  - 13,540,000/2=6,770,000 pieces
- Reuse each piece once (eliminates half of the new pieces):
  - 6,770,000/2= 3,385,000 pieces saved
- Total cost savings:
  - 3,385,000*.038= 128,630 RMB
  - (~19,198.51 USD)
- Carbon footprint savings:
  - Size per sheet 15"X24"
    - 15*24*2.54*2.54=2322.576 cm^2
  - Volume per sheet .3 cm thick
    - 2322.576*0.3= 696.7728 cm^3
  - Carbon footprint per sheet:
    - 696.7728*0.75g/cm^3*.05=26.12898
  - Carbon footprint for 3,385,000 sheets:
    - 26.13*3,385,000=88,450.05 kg CO_2

Reducing Energy Usage from Air Conditioning:

10*.735 = kW used per degree/ per hour for a big A/C

3*.735= kW used per degree/ per hour for a small A/C

1.1 = RMB per kW

At Nypro Shenzhen:

- Half of all A/C's in offices:
  - 45 Big A/C's in offices
  - 60 Small A/C's in offices
- kW's per degree, 8 hrs a day, 180 days a year:
  - 45*7.35*8*180= 476,280
  - 60*2.205*8*180= 190,152
  - Total kW's used: 666,792 kW saved per year
- Cost Savings per year:
  - 666,792*1.1= 733,471.2 RMB (~109,473.31 USD)

Reducing Energy Loss from Molding Machines:

Cost per kW: 1.1 RMB

- Average usage of a molding machine:
  - (24 hrs a day, 5 days a week, 4 weeks a month, 12 months a year)
  - 24*5*4*12=5260
- kW per year used by a molding machine (40 kW per hour):
  - 7200*40=230,400
- Cost per year for one molding machine:
  - 230400*1.1=253,440 RMB
- Cost per year for all of Nypro Suzhou's molding machines (83):
  - 253,440*83=21,035,520
- Cost savings of 1% per year:
  - 21,035,520/100=210,355.2
  - (~31,396.30 USD)

Reducing Internal Shipping Label Size:

- Amount of paper used within Nypro Shenzhen for internal shipping:
  - 100,000 sheets of A4 paper
- Reduce size by 1/3:
  - 100,000/3 ~ 33,000 pieces of paper needed
- Cost savings (22.90 RMB per 500):
  - 67,000/500*22.90= 3068.6 RMB
  - (~458 USD)
- Carbon footprint savings:
  - 67,000 pieces*.15 kgCO2/piece= 10050 kg CO2

Reducing Product Information Sheet Size:

Price difference from A4 to A5: 20 RMB

- Total paper usage in Nypro Tianjin per year:
  - 180*12=2160 parcels per year
- Total paper savings:
  - 50% of all paper used for paper memo's per year
- Cost savings:
  - 2160*20=43200 RMB per year
  - (~6,447.76 USD)

Reusing Graywater:

- Gallons used for hand washing: .75 gallons per use
- Gallons used for toilet flushing: 3.4 gallons per flush
- Percentage saving:
  - 0.75/3.4= 22.0588%

Eliminating Tax Exempt Stickers:

Carbon footprint for paper: .2405 gCO_2/cm^2

Each sticker is 11.5 cm^2

- Total stickers used at both locations per year:
  - Nypro Shenzhen: 100,000
  - Nypro Tianjin: 300,000
  - Total used: 400,000
- Total Cost per year (.04 RMB each):
  - 400,000*.04=16,000 RMB
  - (~2388.06 USD)
- Total Size of all stickers:
  - 400,000*11.5=460 m^2
- Including paper used for sticker backing:
  - 460*2=920 m^2
- Carbon footprint of paper saved:
  - 9200000*.2405= 2212.6 kg CO_2

Reducing Bottled Water Usage:

Cost per bottle: 1.5 RMB

- Bottle Purchasing amounts:
  - The number purchased in Nypro Suzhou per year: 7680
  - The number purchased in Nypro Tianjin per year: 8640
  - Total purchased per year: 16320
- Total Cost if reduced by half:
  - 16320/2*1.5=12240 RMB per year
  - (~2435.82 USD)
- Environmental Savings:
  - 8160 bottles saved per year

Eliminating Runner Bags:

Cost of a large trash bag: .4369 RMB

Carbon footprint of a large trash bag .5 gCO_2/g

- Large trash bags used in Nypro Shenzhen for runner bags:
  - 108300 per year
- Cost savings:
  - 108300*.4369=47316.27 RMB per year
  - (~7062.13 USD)
- Carbon footprint print impact:
  - 0.5*108300=54.15 kg CO_2 per year

Recycling Waste within Assembly Lines:

1 cubic inch = 16.39 cubic centimeters

1 square inch = 6.4516 square centimeters

The density of plastic used: 0.91-0.94 g/cm^3 ~.925g/cm^3

The density of foam used: .75 g/cm^3

Carbon footprint for plastic: .05 gCO_2/g

Carbon footprint for cardboard: .2405 g/cm^2

Carbon footprint for foam inserts: .05 gCO_2/g

- The carbon footprint of sample A:
  - Size of stack of trays 12”X12”X12”:
    - 12*12*12=1728 in^3
  - Converted to cm:
    - 1728*16.39= 28321.92 cm^3
  - Carbon footprint of plastic:
    - 28321.92*0.925g/cm^3*.05=1.31 kg CO_2
    -
- The carbon footprint of sample B:
  - Size of stack of trays 12”X12”X2”:
    - 12*12*2=288 in^3
  - Converted to cm:
    - 288*16.39= 47020.32 cm^3
  - Carbon footprint of plastic:
    - 47020.32*0.925g/cm^3*.05=.22 kg CO_2

- The carbon footprint of sample C:
  - Size of stack of trays 12”X12”X1”:
    - 12*12*1=144 in^3
  - Converted to cm:
    - 144*16.39= 2360.16 cm^3
  - Carbon footprint of plastic:
    - 2360.16*0.925g/cm^3*.05=.11 kg CO_2

- The carbon footprint of sample D:
  - Size of stack of trays 12”X9”X3”:
    - 12*9*3=324 in^3
  - Converted to cm:
    - 216*16.39= 5310.36 cm^3

    - Carbon footprint of plastic:
        - 5310.36*0.925g/cm^3*.05=.25 kg CO_2

- The carbon footprint of sample E :
    - Size of stack of trays 9”X9”X7”:
        - 9*9*7=567 in^3
    - Converted to cm:
        - 567*16.39= 9293.13 cm^3
    - Carbon footprint of plastic:
        - 9293.13*0.925g/cm^3*.05=.43 kg CO_2

- The carbon footprint of sample F (cardboard box):
    - The surface area of the box is:
        - 14*17+2*12*2.5=3874*6.4516=24933cm^2
    - Carbon footprint of cardboard:
        - 24933*.2405g/cm^2=5.996 kg CO_2

- The carbon footprint of foam insertion:
    - Size per sheet 15”X24”
        - 15*24*2.54*2.54=2322.576 cm^2
    - Volume per sheet .3 cm thick
        - 2322.576*0.3= 696.7728 cm^3
    - Carbon footprint per sheet:
        - 696.7728*0.75g/cm^3*.05=26.12898
    - Carbon footprint for 150 sheets:
        - 26.12898*150=3.919 kg CO_2

- Carbon footprint per year:
    - Total Carbon footprint from one box:
        - 1.31kg+0.22kg+0.11kg+0.25kg+0.43kg+5.996kg+3.919kg=12.235
    - Carbon footprint per day from boxes (two boxes emptied twice a day):
        - 12.235*2*2= 48.94 kg CO_2 per day
    - Carbon footprint from boxes per year:
        - 48.94*365=17,863.1 kg CO_2

Elimination or Reduction of Trash Liner Waste:

Cost of a small trash bag: .07 RMB

Carbon footprint for 1 small trash bag: .1 gCO_2/g

- Small trash bags:
    - The number in Shenzhen: 231,800 per year
    - The number in Suzhou: 108,000 per year

    - The number in Tianjin: 67,000 per year
    - Total per year: 406,800
- Cost savings:
    - 0.07*（231800+108000+67000）=28476 RMB per year
    - (~4250.15 USD)
- Carbon footprint impact:
    - 0.1g*(231800+108000+67000) = 40.68kg CO_2 per year

Reusing Shrink Wrap Cores:

Shrink Wrap Cores used per year: 3000

Size of each roll: .5 meters

- Total length of shrink wrap cores able to be reused:
    - 3000*.5m= 1.5 km
- Previous return from selling shrink wrap cores (if all cores were sold at .4 RMB to trash pickers):
    - 3000*.4=1200 RMB
    - (~179.10 USD)
- Potential return from selling shrink wrap cores (if all cores are sold at .6 RMB back to supplier):
    - 3000*.6=1800 RMB
    - (~268.66 USD)
- Cost benefit from selling to supplier:
    - 1800-1200= 600 RMB per year
    - (~89.55 USD)

Eliminating Paint Can Labels:

Total number of paint cans per year at Nypro Tianjin: 70,000

Carbon footprint for paper: .2405 g/cm^2

- Size of label on each paint can (20 cm by 20 cm):
    - 20*20 = 400 cm^2
- Total paper used for all labels
    - 400*70,000=28,000,000 cm^2
- Total carbon footprint savings:
- 28000000*.2405=6734 kg CO_2

Eliminating Molding Line Plastic Bags:

Cost of a large trash bag: .4369 RMB

Carbon footprint of a large trash bag .5 gCO_2/g

- Large trash bags used in Nypro Shenzhen for the molding line:
    - 43500 per year
- Cost savings:

    - 43500*.4369=19005.15 RMB per year
    - (~2836.59 USD)
- Carbon footprint print impact:
    - 0.5*43500=21.75 kg CO_2 per year

Reducing Calendar Waste:

Average pages per Calendar: 14

Calendar page Carbon footprint: .5207 kg CO_2

- Total observed calendars in each facility at Nypro:
    - Nypro Shenzhen: 350
    - Nypro Suzhou: 150
    - Nypro Tianjin: 144
    - Total: 644
- The carbon footprint of one calendar:
    - 14*.5207=7.29 kg CO_2
- Total carbon footprint for all the calendars:
    - 644*7.29=4,694.76 kg CO_2

Reusing Dry Erase Marker Casings:

Average weight of dry erase marker: 20 g

Average percentage of dry erase marker that is the refill (by weight): 33%

Carbon footprint of plastic: .05 gCO_2/g

- Number of highlighters in each facility per year:
    - Nypro Shenzhen: 2,409
    - Nypro Suzhou: 4,243
    - Nypro Tianjin: 1,840
    - Total Dry Erase Markers: 8,492
- Total weight:
    - 8,492*20g = 169840
- Total weight saved:
    - 169840*(2/3)=113,227 grams saved per year
- Carbon footprint saved:
    - 113227*.05= 5.661 kg CO_2

Eliminating Shrink Wrap Covers:

Carbon footprint of one shrink wrap cover: .1 gCO_2/bag

Shrink wrap rolls used in Nypro Suzhou per year: 3000

- Carbon footprint impact if all shrink wrap covers are eliminated:
    - 0.1*3000=.3 kg CO_2

Reusing Highlighter Casings:

Average weight of highlighter: 34 g

Average percentage of highlighter that is the refill (by weight): 33%

Carbon footprint of plastic: .05 gCO_2/g

- Number of highlighters in both facilities per year:
  - Nypro Shenzhen: 134
  - Nypro Tianjin: 226
  - Total highlighters: 360
- Total weight:
  - 360*34g = 12240
- Total weight saved:
  - 12240*(2/3)= 8160 grams saved per year
- Carbon footprint saved:
  - 8160*.05= .408 $kgCO_2$

Reusing Toner and Ink Cartridges:

- Total number of toner and ink cartridges used per year
  - Nypro Shenzhen: 300
  - Nypro Suzhou: 366
  - Nypro Tianjin: 378
  - Total toner and ink: 1044
- If we refill each once, we cut cartridges by half:
  - 1044/2= 522 toner and ink cartridges

Eliminating Water Jug Wraps:

Carbon footprint of a plastic jug wrap: .3 kg CO_2/bag

- Total plastic jug wraps at each location per year:
  - Nypro Shenzhen: 10,275
  - Nypro Suzhou: 9800
  - Nypro Tianjin: 4800
  - Total used: 24,875
- Carbon footprint savings if all bags are eliminated:
  - 24875*.3=7.4625kg

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Environmental Impact

Rank	Opportunity
1	Reusing Packing Foam
2	Reducing Energy Usage from Air Conditioning
3	Reducing Energy Loss from Molding Machines
4	Recycling Waste within Assembly Lines
5	Recycling Paint Thinner
6	Reusing Graywater
7	Reducing Internal Shipping Label Size
8	Reducing Product Information Sheet Size
9	Eliminating Paint Can Labels
10	Reducing Phantom Electricity Loss
11	Reusing Shrink Wrap Cores
12	Reducing Calendar Waste
13	Reducing Bottled Water Usage
14	Eliminating Tax Exempt Stickers
15	Eliminating Runner Bags
16	Elimination or Reduction of Trash Liner Waste
17	Eliminating Molding Line Plastic Bags
18	Reusing Toner and Ink Cartridges
19	Eliminating Water Jug Wraps
20	Reusing Dry Erase Marker Casings
21	Reusing Highlighter Casings
22	Eliminating Shrink Wrap Covers
23	Recycling Bin Identification
24	Reusing Die Cut Reels
25	Eliminating Plastic Garment Bags

Monetary Impact

Rank	Opportunity
1	Reducing Energy Usage from Air Conditioning
2	Reducing Energy Loss from Molding Machines
3	Reusing Packing Foam
4	Eliminating Runner Bags
5	Recycling Paint Thinner
6	Elimination or Reduction of Trash Liner Waste
7	Reusing Graywater
8	Reducing Phantom Electricity Loss
9	Eliminating Molding Line Plastic Bags
10	Eliminating Tax Exempt Stickers
11	Reducing Bottled Water Usage
12	Reducing Product Information Sheet Size
13	Reducing Internal Shipping Label Size
14	Reusing Dry Erase Marker Casings
15	Reusing Toner and Ink Cartridges
16	Reusing Shrink Wrap Cores
17	Reusing Highlighter Casings
18	Eliminating Plastic Garment Bags
19	Eliminating Paint Can Labels
20	Eliminating Shrink Wrap Covers
21	Eliminating Water Jug Wraps
22	Recycling Bin Identification
23	Recycling Waste within Assembly Lines
24	Reducing Calendar Waste
25	Reusing Die Cut Reels

Ease of Implementation

Rank	Opportunity
1	Eliminating Shrink Wrap Covers
2	Eliminating Tax Exempt Stickers
3	Reducing Bottled Water Usage
4	Reducing Internal Shipping Label Size
5	Reducing Product Information Sheet Size
6	Recycling Bin Identification
7	Eliminating Plastic Garment Bags
8	Reducing Phantom Electricity Loss
9	Reusing Shrink Wrap Cores
10	Reusing Die Cut Reels
11	Reusing Packing Foam
12	Recycling Waste within Assembly Lines
13	Elimination or Reduction of Trash Liner Waste
14	Reducing Energy Usage from Air Conditioning
15	Reusing Highlighter Casings
16	Reusing Dry Erase Marker Casings
17	Reducing Calendar Waste
18	Recycling Paint Thinner
19	Eliminating Runner Bags
20	Eliminating Paint Can Labels
21	Eliminating Molding Line Plastic Bags
22	Eliminating Water Jug Wraps
23	Reusing Toner and Ink Cartridges
24	Reducing Energy Loss from Molding Machines
25	Reusing Graywater

Total Value Score

Rank	Opportunity	Score
1	Reusing Packing Foam	91.20
2	Reducing Energy Usage from Air Conditioning	90.20
3	Reducing Energy Loss from Molding Machines	80.80
4	Recycling Paint Thinner	76.20
5	Reducing Internal Shipping Label Size	69.40
6	Reducing Product Information Sheet Size	68.20
7	Reducing Phantom Electricity Loss	68.00
8	Reusing Graywater	67.20
9	Eliminating Tax Exempt Stickers	60.80
10	Reducing Bottled Water Usage	60.80
11	Eliminating Runner Bags	57.00
12	Recycling Waste within Assembly Lines	56.60
13	Elimination or Reduction of Trash Liner Waste	55.80
14	Reusing Shrink Wrap Cores	54.20
15	Eliminating Paint Can Labels	47.40
16	Eliminating Molding Line Plastic Bags	44.80
17	Reducing Calendar Waste	36.20
18	Reusing Dry Erase Marker Casings	34.80
19	Reusing Toner and Ink Cartridges	33.20
20	Eliminating Shrink Wrap Covers	31.40
21	Reusing Highlighter Casings	29.20
22	Eliminating Plastic Garment Bags	24.60
23	Recycling Bin Identification	23.60
24	Eliminating Water Jug Wraps	23.40
25	Reusing Die Cut Reels	15.00