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INTERNSHIP REPORT :

LIFE CYCLE ASSESSMENT

AND DESIGN FOR LIFE (ECODESIGN)

04 – 15 OCTOBER 2004

BY:

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FOR:

THE KKEF BOARD MEMBERS

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1.0 Introduction

I was attached to the School of Environmental and Urban Engineering at Ajou University in Suwon, South Korea from 04 through 15 October 2004. My task was to learn about Life Cycle Analysis and Design for Environment or Ecodesign at the lab headed by Professor Lee Kun-Mo.

2.0 Center for Ecodesign and Life Cycle Assessment (CEL).

The lab conducts research and executes projects on LCA and Ecodesign. It has a web page of http/www//ecodesign.ajou.ac.kr and currently has 9 students as researchers.

CEL, or more affectionately referred to as the lab, undertakes projects on Life Cycle Assessment and pursues to develop tools for ecodesign application. Currently the lab has the following students as researchers:

PhD Students : Sang-Yong Lee, Junil Song, In-Tae Jong, Harnpon Phungrassami
Master Students : Byung-Hee Choi, Moon-Jung Choi, Sang-Jeon An, Yun-Hee Yang
Undergraduate Internship: You-Han Lee

The researchers have their own assigned project to be completed individually, and also work in teams for bigger more complex projects. The projects currently undertaken by the lab are as follows:

2.1 APEC project : Training Program on ISO14000 Series product oriented standards – Environmental Labels and Declaration (EL), Life Cycle Assessment (LCA) and Design for Environment (DfE)

This project undertaken for a three year period involves organising workshops on the subject matter to APEC country members. The first workshop was held in YongIn, Korea in 2002, the second in Kuala Lumpur, Malaysia in 2003 and the last one back in Seoul, Korea in 2004. This ambitious project sponsored

by APEC and the Korean government targets to train experts from APEC member countries on related standards for application. Every year within the three years, the nominated participants from the APEC forum shall be trained on the topics regarding the above.

2.2 LCI Database Development of Waste Computer Parts

The scope of the project is to develop an LCI database for the end of life stage of the PC and printers in South Korea. The completed database shall be made available for use by the industries related to computer and printer manufacturing.

The project is important as there are approximately 2 million units of computers being disposed off annually in Korea. The Korean government has imposed the Extended Producer Responsible (ERP) policy to the computer and printer manufacturers in effort to reduce the waste generation and increase recycling and reuse of the products' components. These are achieved through environmental friendly activities for the whole product life from product development processes, distribution, usage and end of life. The government wants the manufacturer to have a certain extent of responsibility to improve their activities which impacts the environmental, rather than leaving the responsibilities solely for the government and the users. Thus database development and the subsequent LCA shall provide an important information to support the industries in understanding the environmental loads and provide the necessary tools to support the industries' LCA calculations. These shall enable them to identify the weak points of their product and recommend environmentally friendly designs and determine improvement actions to their processes to address these weak points. As the target is end of life of the PC, the system boundary of the LCA database shall be up to the separation of the different component material prior the refinery for recycling; and up to the testing process to determine reusability of the component for reuse.

Currently, the computer users dispose of their computers to the PC waste collection center, owned by the government or by private companies. These PCs are disassembled to their components and further distributed to recycling or reuse collection points. Some of the parts are reused viz cards and PCB shall be used again by the computer manufacturer locally or exported out to be used elsewhere. Meanwhile the components which are not reusable shall

be recycled. These steps involved a lot of big and small companies thus it makes the activity difficult to be traced due to the many parties involved. This makes the project to be more important to establish the data for the current situation.

This 3 year project is divided into 3 phases:

- understand the scenarios of PC wastes in Korea
- collect data and develop the Life Cycle Inventory database
- conduct LCA on the database

The project is currently in the second year conducting the second phase of the project viz development of the LCI database. This phase involves gathering data where the lab issued questionnaires to 5 recycling companies to gather information and data.

The PC waste in Korea is divided into two categories : recycle and reuse. The components segregated are as follows:

- Reuse – casing, driver, electronic devices, CPU
- Recycle – casing, driver, electronic devices, PCB, CPU

NOTE : PCB contains graphic card, memory card, sound card, mainboard

Next is understanding the different processes involved in the recycling. For example, the casing. The casing is first separated into the different material which consisted of steel, polypropylene, Acronitryl and Butadiene Styrene (ABS) and aluminium. Then the different recycling processes of each of the material is studied and process flows are developed. Inputs and outputs to each process units are identified and quantified. These inputs and outputs shall later be translated into environmental loads of the product. From there on, a functional unit is defined, here the basis is 1 kg of component, for example casing. So the functional unit is defined as 1 kg of casing having how much of a said material and the environmental load is defined based on the functional unit.

Refer to Figures 1, 2, 3 and 4 on the physical flow, definition of system boundaries and process flows for the different scenarios studied under this project.

2.3 Ecodesign Basic Technology on Hyundai Project : Case Study (Fuel Tank)

This project utilises the 12 steps of ecodesign.

The main objective of this project is to embark on ecodesign to Hyundai products and educate Hyundai personnel on ecodesign approach to designing products. The project is a 2 year project with the current status of completing 7 of the 12 steps of ecodesign. The remaining steps are management related steps which will require the manufacturer's direction and decision for implementation.

The team has to conduct ecodesign on the Hyundai automobile's fuel tank, made of High Density PolyEthylene (HDPE). This product is compared with the company's Stainless Steel made fuel tank, and a HDPE fuel tank from Corona for purposes of benchmarking the current product with the other two. The project has proceeded up to the point of conducting a simplified LCA (S-LCA) on the Hyundai's HDPE fuel tank. An S-LCA instead of a full LCA is conducted as the latter would take a lot of time, effort and resources. An S-LCA may not be as comprehensive but suffices to arrive to a reasonable evaluation.

The project commenced with understanding the manufacturing processes of the HDPE fuel tank. This involves independent research and direct feedback through questionnaires to the fuel tank manufacturer. Information which is important to the manufacturer and the customers are gathered as Voice of the Customers. These shall be translated into weightings in accordance to their importance. The parameters with impact on the environment are called environmental parameters. The data collected are processed using Quality Functional Deployment for Environment (QFDfE). This is one of the available tools for data processing which is used in the lab. A matrix of the environmental parameters and ratings are developed with weightings assigned. These are multiplied to result in scores. Environmental parameters with the highest scores would be the parameters to be looked upon for improved environmental design.

2.4 Sustainable Consumption of Korean Households

This is a PhD dissertation by Mr Sang-Yong Lee. The objective is to conduct LCA on the sustainable consumption of the Korean household. However, no discussion was able to be held with this project as all the team members were constantly occupied to complete the tasks for submission of the preliminary dissertation within the two weeks of my internship period.

2.5 LCI database for the Korean Train System

This project involves development of a Life Cycle Inventory database of the train. The first phase is the development of a Life Cycle Inventory for the body and wheel parts of the train. The project has just started its initial phase and is targeted for completion in the next 3 years.

All the above projects are worked upon in the team. Data are collected directly from the industry, government or any available resource or database. These data are then compiled and assessed using statistical methods and analysis. The researches are conducted through database only, no physical experiments were being carried out in the lab.

Amongst previous projects completed by the lab is development of the database of the Life Cycle Inventory Analysis for Electricity in Korea. This database concentrated on the production of electricity from the various natural resources viz hydroelectric, coal in South Korea. Results of the LCA has been made available for use in Korea to support LCA calculations for electricity consumption.

3.0 Life Cycle Assessment and Design For Life (Ecodesign)

3.1 Life Cycle Assessment (LCA)

LCA is a tool used to evaluate the impact of a product onto the environment. The product's life beginning from the extraction of raw material from nature, the manufacturing, the usage up to the disposal of the product is all taken into account. This is a totalistic approach to evaluate the impact of a product onto

the environment. This would eventually rate how a product ranks against the impact it has onto the environment.

The requirement of LCA is becoming more significant as the industries and consumers are getting more conscious on the impact of a product onto the environment. As such, international standards are becoming more stringent and industries are required to conform to these standards to be able to market their products.

The different steps of LCA involves the following:

- definition of targets and goal
  This is the most important step of the LCA as this will dictate how the whole process proceeds. The user needs to understand what is the purpose of the study, define the objective, develop the system boundary for the scope and identify required data for collection
- conducting the Life Cycle Inventory Analysis
  Inventory analysis involves a few stages. Firstly understanding the details of the product which includes process details, identifying inputs and outputs to the processes, conducting data gathering and calculation of environmental loads for the inputs and outputs of the processes. A process tree is developed and from there on, a Life Cycle Inventory Database (LCI DB) is generated. This database shall list down all the substances taken from or contributed back to the environment and quantified in a defined unit. This data shall cover the whole product life and the end result would show the environmental load. The environmental load parameters that can be considered are as follows: crude oil, coal, iron ore, CO2, CH4, CFC11, BOD, CO, VOC, NOx and SOx
- assessment of the Life Cycle Impact (LCIA)
  Once the inventory has been completed, the results are evaluated to gauge its impact onto the environment. The loads are classified into the potential impacts which consists of global warming, eutrophication, acidification, photochemical oxidant creation, abiotic and biotic resource depletion, ozone depletion, human toxicity, ecotoxicity and solid waste, hazardous and radioactive waste. The step can be further extended to characterisation, normalisation and weighting.
- interpretation of the results according to standards and guidelines
  This step basically looks back at LCIA results by identifying the main issues, reviewing of data and concludes the findings with

recommendations in line with the available standards and guidelines

All the above are summary of the steps required to conduct LCA. However, extent of the LCA steps depends on the objective of the study. Some of the steps may not be relevant if it does required for the objective.

There are 4 ISO standards specifically developed for LCA:

- ISO 14040 - Principles and framework
- ISO 14041 - Goal and Scope definition and Inventory Analysis
- ISO 14042 - Life Cycle Impact Assessment
- ISO 14043 - Interpretation

Refer to Figure 5 : Cycle of Life of a Product or Service.

3.2 Ecodesign

Ecodesign or Design for Environment is a combining the environmental aspects into product or services development. It covers the whole life stages of the product from extraction of raw material making up the product to its end of life where it is disposed, reused or recycled. The main intention is to reduce if not eliminate the detrimental impact of the product onto the environment. Ecodesign also takes into account the requirement of the manufacturer and user of the product and how to ensure these requirements are met without ignoring the environmental aspects of the product. Various tools are utilised in implementing Ecodesign viz Environmental Quality Function for Design (EQfD), Life Cycle Analysis (LCA), Life Cycle Inventory Analysis (LCIA), etc

When the weak points in the product have been identified, improvement steps are introduced to overcome this weakness. For example, a product's environmental weak point is not able to be recycled due to disassembly problems. Ecodesign approach recommends that this product be redesigned for easier disassembly. Product development shall have to introduce modification to the product design to result in a product being able to be disassembled. When the product can be disassembled, its ability to be recycled exists. Thus the environmental load at the product's end of life due to the product being landfilled is now reduced as it can now be recycled.

First of all, a product's function needs to be clearly defined. This shall allow the assessment to clearly concentrate on the main intent of the product. Next the stake-holders' requirements of the product needs to be considered. This step requires gathering of information both from the manufacturers and the customers on what are their expectations of the product and whether the product has met those expectations and requirements. Data and information for this can be sourced through interviews, surveys, questionnaires, etc. These data shall be analysed using statistical analysis tools viz EQfD, Monte Carlo, etc. Next the product is compared with a similar product by a competitor. This step is to benchmark the product to evaluate how it stands in comparison against the same stakeholders' requirements and expectations. Then only the Life Cycle Analysis is conducted on the original product. This step will identify the weak points of the product, environmental wise. When the weak points have been identified, strategies shall be developed towards improving the product. This is where LCA tools like ECODESIGN and PILOT is utilised. The tools shall consider the whole life cycle of the product and shall be able to produce recommended strategies at the required phases of the product life.

The next phase is the implementation phase where the strategies for improvement are realised physically. Creative sessions shall be held with the designers to translate the ideas into implementation plans. This shall generate design concepts which shall be evaluated again against certain assessment criteria. Finally, the idea will only be implemented if it is deemed feasible.

3.3 Ecolabeling

Products which have utilized these environmental tools and have incorporated ecodesign into their features needs to be communicated to the consumers. This is done through Ecolabeling which basically classifies the types or extent of measures of ecodesign approach taken on the product development. The labels established in ISO are as follows:

- Type I

  This is the Ecolabeling program as defined in ISO 14024. This label refers to the more than average environmentally friendly products which are conformed to voluntary by manufacturers for consumers' choice. This label requires a third party certification. Examples of the labels are: Blue Angel (Germany), Nordic White Swan (Nordic countries), Ecomark (Japan),

Environmental Mark (Korea), Environmental Choice (Canada)

- Type II
  This is a self-declared environmental claim as defined under ISO 14021. This labeling is for average environmentally friendly products where the manufacturer declares environmental aspects of the products for increase in market shares for environmentally conscious consumers. This labeling does not require a third party certification, thus standardisation is an issue.
- Type III
  This label is an environmental declaration using preset category of parameters as outlined in ISO 14025. The environmental load of a product is determined from the Life Cycle Analysis and the results are presented according to the preset category of parameters. This label is focused on business to business (intermediate) products, not finished products.

3.4 Ecodesign Tools

One of the tools used for ecodesign is PILOT – **P**roduct **I**nvestigation, **L**earning and **O**ptimisation **T**ool for Sustainable Product Development. This software facilitates to identify the environmental parameters with the highest score and recommends standard improvement steps for the product. These recommendations would have to be interpreted specifically for the product later.

I had the opportunity to use the tool myself and found the software to be very helpful in executing ecodesign. It is a very user friendly software with guides (Learn icon) and explanation for each of the strategies and measure recommended.

The software requires user to input data on the raw material, manufacturing, distribution, usage and end life stages of the product. Data like material used and energy consumption are key factors in the evaluation. Upon processing the data input, the software shall evaluate the product and classify, in which phase of its life that it has the most impact onto the environment. Based on the classification, the software shall recommend the improvement strategies in a prioritized order. The user can work further on these strategies by going through the available checklist and the recommended measures to keep track of the implementation of the measures. The user is required to rate the importance of the measure in Weightings and the Assessment ratings based

on the guided questions for each of the measure. These Weightings and the Assessment shall be multiplied and result in scores for the Priorities. Measures with the highest Priorities scores shall be the ones to be concentrated on for product development. In summary, the software helps the user to identify the product category, recommends the suitable improvement strategies and required measures to address the issue and produce a scoring system for prioritisation of measures to be taken up as actions.

This software can be accessed through the following website: http://www.ecodesign.at/pilot/ONLINE/ENGLISH/PDS/INDEX.HTM.

4.0 LCA and Ecodesign Related Visits and Trips

4.1 Korean Electronics Show 2004

On 07 October 2004, I had the opportunity to visit the Korean Electronics Show 2004 held at the CoEx in Seoul. This annual event is held to exhibit the advancement of the Korean Electronics industry and introduce new technologies to the public. The giants of Korean electronics industry like Samsung, Hyundai and LG dominated the exhibition with products like plasma television, telephones, MP3 players, home appliances, etc. There were also exhibition the small scaled industry and from technical institutes of higher learning.

One of the more interesting booth was from the Electronic Industries Association of Korea (EIAK). This is a group of representatives from the industry like Samsung SDI, LG Electronics, IBM Korea, Orion Electric, Itronics, etc which pursues on keeping the industry competitive internationally. One of its' activities is to strengthen the overall competitiveness of the Korean electronics industry. The booth featured products which had incorporated environment friendly features or utilising ecodesign into their product development. Among the items exhibited were refrigerators, semiconductors and microchips. These products has incorporated environmental friendly design inputs into their products, either by having conducted LCA or even has ecodesign implemented on the manufacturing processes to reduce the environmental impact during manufacture or use of the product. One of

the process modification example was substituting lead with silver in the manufacturing phase of a semiconductor, while another has completely discarded usage of lead in its soldering process.

In conjunction with the exhibition, seminars were also organized to discuss on issues relevant to the electronics industry. I had the opportunity to attend a presentation by Professor Lee on EU sanctioning of LCA and Ecodesign in the afternoon. There was a full house response showing the public's interest of the issue and the consciousness on requirement of eco friendly products.

4.2 Environmental Consultant Company

On 11 October 2004, I had the opportunity to visit Ecosian, a company which specializes in environmental consultancy and related IT support requirement. The company conducts consultancy work in environmental management, advises on development of environmental strategies and policies, develops environmental related software and computing system, and provides technical data and international databases to parties of interest like the industries or academicians. The main advantage of this company is that it integrates their expertise in environmental consulting with IT, which allowed them to venture into development of software and systems for environmental related requirements.

One of the most impressive achievements by Ecosian was the development of the LCA simulation software called **PASS** – **P**roduct **A**ssessment for **S**ustainable **S**olutions. This software is currently being used by government agencies, industries and universities in Korea. This simulation software has the ability to store raw data into database for LCI and even perform LCA on the completed database. The software has separate sub-sheets for references to standards such as ISO 14040 to ensure correct references are made when conducting the assessment. It also has links to local and international databases for support ie LCI of Korean Electricity, etc which may be required to support a total LCA of a product or service.

One of the major projects handled by Ecosian was the development of a solution database of an Environmental Management System support for

onsite data. This project involved collecting data from a current process into a database and links them up with the relevant environmental management tools like Environmental Impact Assessment (EIA), Life Cycle Assessment (LCA), Environmental Performance Evaluation (EPE) and Environmental Report (ER). This allows the user to constantly monitor the environmental aspects of their production and introduce continuos improvement actions through the environmental tools made available through the links in the software as outlined by ISO14001 and ISO 14004 with the Environmental Management System's Plan, Do, Check and Act steps. Another application used is SMART – **S**mall and **M**edium Sized **A**pplicable and **R**easonable **T**ool for the Environmental Management System. This system facilitates the user to develop the Environmental Management system according to the regulated limits and relevant ISO standards. Other major projects completed by Ecosian were Intershifting between LCA and ERP, Eco-product System Build up and Green House Gasses Emission Estimation Program. We were also given a brief on the application of SMART and PASS.

It was certainly a good opportunity to have a first hand look on the application of LCA in the industry from a consultant's point of view. It was also an interesting experience to have a look at the other environmental tools available in the market and is currently being utilised in the industry. The development of such softwares makes evaluation of environmental databases more efficient and standardized according to the governing regulations and international standards. Personally, I find Ecosian's effort to be very innovating and their advantage of the IT integration keeps them at the frontier of the field.

4.3 Samsung Electronics

On 13 October 2004, I had the opportunity to visit Samsung Electronics in Suwon. It was one of the seven Samsung Electronics complexes in South Korea, the others being Giheung, Hwaseong, Onyang, Cheonan, Gumi and Gwangju. The Suwon Complex produces televisions, refrigerators, and handphones.

First we were led to the Exhibition Hall which exhibited all Samsung's latest products from handphones (Anycall), semiconductors, refrigerators

(Zipel), MP3 player (Yepp), televisions (Liquid Crystal Digital, Plasma Digital Projection), computers, audios to total home appliances control (Homepad). Next we were brought to the Museum where the roots of Samsung was displayed. The word Samsung itself has a meaning: Sam - three, Sung - stars; combination of two forms Samsung means three stars which was actually used as the company's logo up to the 1980's. However, the company has since stopped using the label and is now using the blue oval background label with the Samsung word in the middle. The museum exhibits the starting point of Samsung from the first venture of producing semiconductors in 1969 to its rapid development of becoming an international electronics manufacturer within a 35 year period. One very interesting exhibit was the Time Travel where Samsung's products were showcased according to years they were used. The different models of television were displayed according to the year they were used playing the popular series during that time, against a backdrop of significant events of the year. First models of handphones and lap tops were displayed with previous models of washer machines and data processors. The museum also showcased the various advertisements and sport sponsorships Samsung had over the years plus Samsung's community services both locally and internationally.

The highlight of the day was the introduction to Samsung Electronics' Product Environmental Technical Team. Samsung Electronics announced its Environment Related Guideline in 1992 and Green Management in 1996 towards developing environmental friendly products. Its' Green Management System pursues to develop and produce environmental friendly product designs throughout the whole life cycle of the product and endeavors to develop new technologies for cleaner production. To put these in action, Samsung Electronics established an Environment / Safety Management Committee headed by the Chief Executive Officer consisting of a Secretariat and the following ecodesign subcommittees: Eco-device, Lead-Free Soldering, Green Production, Eco Product and Eco-design. This set up supports the local and international Samsung Electronics production.

Samsung Electronics wants their designers to incorporate ecodesign into their design ideas. In doing so, Samsung Electronics started using LCA in 1995 with its microwave ovens, and expanded the utilization to other

products. It also adopted the Design for Recycle / Service / Disassembly / Assembly – DfX (DfR/S/D/A) in 1995 on the washer machines and refrigerators and has also expanded the usage on all other products in 2002 in line with EU's recycling regulations. The ecodesign approaches should be material saving, energy saving and environment friendly materials.

Samsung Electronics also adopts an Eco-Product System (EPS) which consisted of LCA, Eco-design, Green Purchasing, Green Accounting and Customer Service. This is a total environmental tool to evaluate the products' in adherence to the relevant local and international laws and regulations and also to improve the product compositions towards being more environmental friendly.

Samsung Electronics' effort in ecodesign gained momentum with the enforcement of **R**estriction **o**f the Use of Certain **H**azardous **S**ubstances in Electrical and Electronic Equipment (ROHS). This directive requires all waste electrical and electronic equipment to substitute using hazardous substances with safe or safer material and restricting the use of these hazardous chemicals. The hazardous chemicals referred to were heavy metal and flame retardants as follows: Cadmium, Lead, Mercury, Hexavalent Chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE). In complying to the directive, Samsung Electronics has to ensure its suppliers are also adhering to the directive. Thus Samsung Electronics set up an Eco-partnership Certification whereby the suppliers are required to asses their environmental management system, production processes and facilities to conform to the directive. Only suppliers who conform to the directive's requirements shall receive the certification and continue to do business with Samsung Electronics while those who do not shall need to improve their Environmental Management System towards fulfilling the requirements.

Among the success stories from Samsung Electronics' Green Management efforts are as follows:

- Lead Free Solder for HDD (Victor rev 3.0), printer (SCX5312), monitor (BU150 MP1.1) and DVD / CDRW combo drive (SM348B)
- Semiconductors free of Lead and halogen

- Produced Hard disk drives (PL40) which is free of all the 6 hazardous substances specified under RoHS in 2003
- Replacement of CFCs refrigerants and blowing agents with the following:
  - Refrigerators – using alternatives HFC-134a and isobutene (R-600a) as refrigerants and cycle-pentane as blowing agents
  - Air conditioners – HFC as refrigerants like R-407C and R-410A
- VCR – SVK811 – this printer uses paper cushion, utilises lead free soldering process, has halogen free circuit boards and packing material, and uses vegetable based ink. This product received the Green Marketing Grand Award 2003
- TFT-LCD Monitor (NB21BS) contains limited cadmium, lead and halogen, has easy removable mercury lamp and common material for recycling. This product acquired the TCO'03 certification from Sweden which evaluates environmental, ergonomics and safety, etc features of a product
- Optical Disk Drives with reduced weight and components from the previous model, uses paper-based disk packaging, lead free soldering. This product acquired the first Korea Environmental Declaration of Product (EDP) label for optical disk drives

4.4 International Symposium of Remanufacturing and Eco Design

On 14 October 2004, I had the opportunity to attend the International Symposium on Remanufacturing and Eco-Design, at the COEX InterContinental Hotel, Seoul. This symposium was jointly organized by the Korea National Cleaner Production Center (KITECH) and the Korean government's Ministry of Commerce, Industry and Energy (MOCIE). The objective of the symposium was to share with the Korean businesses the international status on remanufacturing and eco-design and encourage Korean businesses to work towards the same direction. The requirement of remanufacturing and eco-design has become more emphasized at present with the introduction of new directives and legislations and increasing demand from customers on environmental friendly products. Korean businesses have to keep abreast with these requirements to remain competitive both in the local and international markets.

The first paper on remanufacturing session focused on the status of the

remanufacturing industry in the United States. The paper gave an introduction of remanufacturing, explained the difference with rebuilt, the sectors involved in remanufacturing, types of remanufacturing industries and the challenges faced. The second paper elaborated the applications of remanufacturing technologies with the applications in Single Use Camera and Xerox's toner reconditioned auto parts. The last paper presented the status of the remanufacturing industry in Korea. It studied the current situation, the problems associated and recommendations to promote the activity. Research showed that the remanufacturing industry in Korea is small compared with those of United States and Japan. However, the number of companies involved in the industry is a lot more in Korea as compared to Japan. The main problems faced is no legislative basis for the industry, only small businesses are involved, underground business of remanufacturing, lack of public awareness and misunderstanding on the whole remanufacturing concept. The paper proposed that these small remanufacturing businesses be clustered and development of technologies to support these remanufacturing activities.

The next topic was of more interest – eco-design. It started off with a presentation by the European Commission on the framework for sustainable development of Energy using product. The paper gave a background on the requirement from treaties, policies, directives and legislations on it. It outlines the eco-design requirements but stressed that LCAs are not required instead Life cycle thinking should be incorporated into designs. Though the framework shall become a directive, the legislative requirements will only be available later with the implementing measures. These frameworks are still in the discussion stage and are expected to be approved for implementation in the European countries in 2006. The next paper elaborated on the role of science and technology in development. It outlines the phases of technology development and implementation of the environmental ideas towards improving the products. The paper highlighted several projects implementing this viz-industrial electronics, power transformer units, power supply units, and gold plating baths. The paper emphasised on the need to understand the stakeholders' requirements and use of ecodesign as a tool to improve the processes accordingly.

The last two papers were on industries' experiences in implementing ecodesign, Samsung Electronics and Motorola. Both companies presented their experiences with ecodesign; the development, challenges, successes and future plans for ecodesign. On top of the legislated requirements of RoHS in January 2006, Motorola has plans to establish a take back system for Motorola products in August 2005 and have all Motorola products in the European market to be 75 % recoverable and 65 % recyclable. Motorola has also developed tools to facilitate ecodesign concepts thorough Product Environmental Template (PET), Guidelines and Standards, Green Design Advisor (GDA), Life Cycle Assessment (LCA), Environmental Product Assessment and Rapid Environmental Assessment Lab (REAL). Motorola has a 15-step design process and eco design is considered in 8 of those steps. Among the products that has successfully adopted the eco design features are:

- Green Phone v.2288 Environmental limited Edition
  Has a lead free solder, halogen free printed wire board, recycled plastic housing, energy efficient charger
- IDen
  Has lead free solder
- 2 way radios
  Eric 800MHz Tetra lead free solder and halogen free printed wire board
- Mobile phones C350
  Lead free solder process, halogen free printed wire board, water based paint pilot

Motorola also needs to ensure their various suppliers adhere to the RoHS requirements. Thus, Motorola has set up Supplier Training Programs to educate the suppliers on the requirement. Motorola has set up a Material Declaration (W18) form which requires suppliers to declare all the material contents in their supplied goods to Motorola.

4.5. LG

On the last day of my internship in Korea, I was given the opportunity to visit LG in Seoul. This office is one of LG's offices in Seoul and is where the Eco-Technology group is located. LG Electronics has four manufacturing sites viz Seoul, Changwon, Gumi and Peongtek.

First of all, LG Electronics has an Environmental Policy which concentrates on product, process, organisational system, supply chain and product receiving and external relationships. However, the eco-design activities is focused only on two of the strategies - product and supply chain, and product recovery.

LG Electronics' environmental target is to establish a take back system for all its products in the world. The first two targets are the EU market in 2004 and China and US markets in 2005. Towards achieving this, LG Electronics has established its Task Team in January 2004 with focus to optimise the take back of its products in the European countries. On top of that, LG Electronics pursues to improve its recycling rate of products by developing alternatives for hazardous substances and integrates environmental aspects in product development processes. LG Electronics has its own recycling center in Chilbeo which focuses mainly on recycling of refrigerators and washing machines products. LG has developed its own recycling software with IWF Germany in 1996 called Assessment Tool for Recycling Oriented Design - ATROD. This tool takes into account 32 criteria of disassembly and recycling to optimise a products' recycling potential.

In the manufacturing, LG Electronics targets to phase out all lead soldering by 2004. The following are the products that has successfully incorporated ecodesign features into their product improvement:

- Linear DIOS Refrigerator
  Type III environmental labeling, with lead free soldering process, zero level of Ozone Depletion Potential (ODP) and Global Warming Potential (GBP)
- TROMM Washing Machine
  Type II ecolabeling, with lead free soldering
- 60" PDP television
  Type II ecolabeling, with lead free solder, minimises utilisation of hazardous substances and does not use Brominated Fire retardant substances
- LCD Monitors
  uses lead free solder, minimises utilisation of hazardous substances, led free external parts and cables, and improved recycling rates

LG Electronics has also established it own hazardous substance laboratory to concentrate on the analysis of RoHS listed substances in their products. The lab has analysis equipment such as ICP-OES, Ion Chromatography, High Pressure Asher, Furnace, Microwave Digestion, etc. However, as the required analysis standard has not been defined, they are using ASTM and EPA standards among others as methods for their analyses.

LG Electronics commenced their LCA activities back in 1996 starting with their refrigerators, and moved on to 17" CRI monitors, air conditioners, CRT televisions and washing machines during the subsequent years. One example presented was the LCA conducted on their mobile phone model SD1100. The LCA objective was to identify the environmental aspect of the product and develop the LCA database. In order to conduct this LCA, the LCAs from other databases viz Ministry of Environment (Korea), MoCIE and Association of Plastic Manufacturer' of Europe (APME) was required using the TEAM software. The LCIA concluded that high environmental loads were imposed during the use phase and the production phase of the product.

LG Electronics have also developed ecodesign strategies while their Ecodesign guide focuses on 3 aspects - identification and accessibility, disassembly and recyclable material.

To support all the above, LG Electronics has developed a Green Procurement policy with the objective to procure product with low environmental impact throughout their life cycle, promote suppliers that manufacture environmentally conscious parts and comply with all laws, regulations and standards for environmental protection. These must be done to ensure that LG Electronics' suppliers supplies them with components and parts which meets LG's Electronics environmental requirements.

Following that, we were brought to the various laboratories in the facility viz the Hazardous Material lab, Electromagnetic Components, Weather Testing, Home Simulation and Packaging for an introduction on their activities.

5.0 Conclusion

5.1 The Korean Experience

This internship has opened my eyes to a very different culture. Koreans have high regard for tradition and culture. Their lifestyles are very distinct only to Koreans but their achievement are at most times at par and sometimes even superior to the western countries. Despite not being very opened to the western or even other foreign countries, their advancement in technology is impressive. This is also evident in the field of Life Cycle Assessment and ecodesign where there are significant accomplishments achieved in research, database development, and product development and manufacturing.

5.2 Conclusion

This internship has exposed me to a different culture and work environment. From the very little time I had with the lab, the exposure with the industries on the implementation, observations during the exhibition and symposium, it is evident that all the parties involved are very concerned about the environment - of how their products impact the environment and how to reduce them for sustainable consumption.

Throughout my internship period, I had the opportunity to observe how LCA and Ecodesign was being utilised by and implemented by academicians, consultant and the industries. This has exposed me to the significance and importance of both LCA and Ecodesign. Even though the short experience only allowed me to discuss the outline of how things were done and the exposure on the industries' application was only through presentations, it has thought me on the importance of a continual effort to improve a product design to meet the manufacturer, user and most of all the environmental requirement - reducing the detrimental impact the product has throughout its life cycle.

The visits to the electronic giants - Samsung Electronics and LG, and the attendance to the International Symposium of Remanufacturing and Ecodesign revealed that LCA and ecodesign is taken seriously in Korea. The manufacturers have dedicated teams to concentrate on LCA and

ecodesign towards improving their products while the government continues to support these activities by sponsoring networking sessions and continual efforts to promote awareness. Though the enforcement of international regulations and guidelines like RoHS may have catalysed the effort, the accomplishments evidenced from the improved products proves that the businesses are very committed and is determined to achieve the set targets.

We need to sustainably consume whatever elements we take from the environment as at most times, these elements are not replaceable. We need to understand how these have impacted the environment and how to improve the situation as some of them can and has even caused irreversible detrimental impact onto the environment.

Most of our daily activities have impact onto the environment whether directly or indirectly. One of the ways to minimize if not diminish the impact is through ecodesign and its application. However, while technology can do wonders to our lives, it is still back to one's attitude towards using the technology and what it provides wisely. There can be products with environmental friendly production processes, have low environmental loads throughout its manufacturing and use stage and high ability for recycling, but if our attitude does not support the product's environmental abilities (ie ignore energy saving features, do not recycle), the whole effort would be meaningless. There must be an increase in environmental awareness and supporting attitude from us the consumers / users to enable appreciation of LCA and ecodesign application towards realising sustainable consumption. The choice is always ours – choose environment!