

Unit-II, sustainable Waste Management Techniques(MEOE03)

Sustainability:

Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. The concept of sustainability is composed of three pillars: economic, environmental, and social—also known informally as profits, planet, and people.

How Sustainability Works

Sustainability encourages businesses to frame decisions in terms of environmental, social, and human impact for the long-term, rather than on short-term gains such as next quarter's earnings report. It influences them to consider more factors than simply the immediate profit or loss involved. Increasingly, companies have issue sustainability goals such as commitment to zero-waste packaging by a certain year, or to reduce overall emissions by a certain percentage.

These companies can achieve their sustainable needs by cutting emissions, lowering their energy usage, sourcing products from fair-trade organizations, and ensuring their physical waste is disposed of properly and with as small of a carbon footprint as possible.

Challenges Around Sustainability

The push of sustainability is evident in areas such as energy generation where the focus has been on finding new deposits to outpace the drawdown on existing reserves. Some electricity companies, for example, now publicly state goals for energy generation from sustainable sources such as wind, hydropower, and solar.

10 reasons for business to become sustainable:

Government Regulations

Chances are that federal, state and local governments will enact additional regulations to protect the environment. Companies that are not in compliance could find themselves excluded from government contracts. Furthermore, the regulations may apply to every business in the supply chain. Establishing a sustainability strategy helps ensure your company will be able to meet changing regulations in a timely manner.

Public Relations

Although not every consumer cares about environmental issues, more consumers are paying attention to the sustainability policies of the businesses from whom they make purchases. Social media and the Internet mean that consumers can spread the word about a company's environmental responsibility, or lack of it, instantly.

Attracting Employees

Top-caliber employees, particularly younger ones, might be reluctant to cast their fates with companies linked to an ecological disaster. Few people want to have their names linked to a company that allows its toxic waste to seep into the groundwater or whose safety procedures result in a massive oil spill. In addition, some employees may display higher morale, productivity and loyalty to a firm they believe to be socially responsible.

Increased Sales

The trend has been for more large corporations to go public with their sustainability strategies. Companies such as IBM, Walmart and Kaiser Permanente examine suppliers' sustainability commitments when determining which supplier receives a contract. If your company can provide proof of your commitment, you will have an edge over suppliers who have yet to implement a sustainability strategy.

Attract Investors

Like consumers, many investors prefer to choose an environmentally responsible company in which to invest. Their motives are not altogether altruistic. Investors want to earn a profit. A company that is at risk for a large government fine or a massive cleanup effort will likely not be as profitable. Investors might also perceive an environmentally conscious company as one that is more innovative and therefore more competitive.

Reduce Operating Costs

Even small changes can reduce your expenses. Choosing recycled toner cartridges and energy efficient lighting may lower your costs. Opting for laptops over desktops and multifunction machines over stand-alone printers, faxes and scanners will reduce your energy costs.

Encourage Creativity

When you encourage your employees to find a better way to do something, it is seldom a one-time occurrence. Once you engage their creative side, it tends to remain engaged. While considering a method to reduce energy costs, for example, an employee may find the inspiration to a better manufacturing process.

Improve Productivity

Targeting one area might lead to benefits in another area. For example, you might decide to map your delivery routes in an effort to reduce fuel costs, but then discover that the streamlined routes also reduce labor and maintenance costs. In addition, you might find that your customers are receiving their orders sooner.

Risk Reduction

Reducing your risk of lawsuits and fines may benefit you in multiple ways. You may be able to reduce the number of attorneys you keep on retainer. Your insurance company may be able to assign you to a lower cost pool.

Brand Loyalty

Historically, certain brands have given consumers confidence in a company or its products. The consumer's perception can determine whether a product or line sells. Once a brand is tarnished, however, it is difficult to recover. Branding your company as one that is committed to sustainability is easier than removing the public perception that you are environmentally irresponsible.

Typical forms of wastes:

Source	Typical waste generators	Types of solid wastes
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes.).
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes.
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Institutional	Schools, hospitals,	Same as commercial.

	prisons, government centers.	
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants.	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge.
Process (manufacturing, etc.)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing.	Industrial process wastes, scrap materials, off-specification products, slay, tailings.
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms.	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g., pesticides).

Biases towards waste:

Given the general susceptibility of Contingent Valuation Responses to different kind of biases, a very important aspect of this survey is to verify the reliability of the predicted willingness to pay (WTP) in terms of bias decomposition and control. The paper concentrates on three specific biases, viz., hypothetical bias, anchoring bias and shift bias where the first one is rooted in the incompleteness in framing of the market, the second one in the start bid and the last one in the repeated bidding. Here the household level responses on WTP collected before introduction of an improved waste management program in Bally Municipality, India have been compared with that collected after program initiation to isolate these biases and to assess appropriateness of alternative estimation techniques in terms of their built-in flexibility to accommodate such biases. This paper demonstrates that better information dissemination for the project components is likely to ensure substantial mitigation of all such biases when the estimation is carried out by applying Composite Error Bivariate Probit (CEBVP) method. This has important implications for the policy planners in developing world who are keenly attempting to involve private players in the provision of public amenities and utility services. Our study indicates that if the initial

framing of the commodity to be valued is faulty, then subsequent partnership is unlikely to be sustainable in the longer run.

4 steps to achieve sustainability:

Designate a Goal

While the goal of “make our business 100 percent sustainable” may seem like a logical place to start, that statement is vague. Nothing interferes with accomplishing a goal like not having a road map.

Having a specific set of goals will help your company move toward sustainability faster and more efficiently. Goals will vary based on the industry; however, there are a few business model innovations that most companies can reasonably adopt. These include transitioning your business from physical to virtual operations, researching innovative product financing such as leases, and finding and supporting local producers to supply your business.

Assign a Person (Or People)

Every company needs a sustainability cheerleader. While this should, in theory, be the entire team, advocating for sustainable business practices can start with a single person. A sustainability team lead or corporate social responsibility staff member will be the person who takes your goals and communicates them with the rest of the staff and community.

Once you’ve designated a goal, make sure it’s embedded in your corporate culture. As the head of a sustainability department, an effective leader should be able to advocate for the role of sustainability to everyone from the entry-level workers to the CEO.

Allocate Resources

Just as with any company goal, increasing your company’s sustainability will require both time and money.

While you may have a single person working toward completing sustainability surveys by a certain deadline, it isn’t this person’s sole responsibility to ensure this process goes smoothly. Reporting requires a lot of information, and much of it will need to be obtained from members of your team, especially project and property managers.

Ensure the right people are told they may be contacted by your sustainability team. Then, make sure they have the time and capacity to step aside from their daily work to take part in your company’s new pledge to sustainability.

Look Out for Improvements

Once you've mastered sustainable practices within your own team, consider other places sustainability can factor in.

Businesses rarely operate in a vacuum and are constantly interacting with others in their vertical and horizontal networks. This is where your next opportunity may lie. Suppliers make up a big part of any company's sustainability footprint. Make sure part of your resource planning includes keeping a pulse on your supply chain and working with partners to achieve more sustainable procurement.

Businesses can see significant benefits, both economically and socially, from incorporating sustainable practices. When selling your team on the tenets of corporate sustainability, remember that even if steps seem small at first, those efforts can build to produce tremendous results.

Stahel's ratio of manpower to energy use in production and close loop materials:

A 'circular economy' would turn goods that are at the end of their service life into resources for others, closing loops in industrial ecosystems and minimizing waste (see closing loops). It would change economic logic because it replaces production with sufficiency: reuse what you can, recycle what cannot be reused, repair what is broken, remanufacture what cannot be repaired. A study of seven European nations found that a shift to a circular economy would reduce each nation's greenhouse-gas emissions by up to 70% and grow its workforce by about 4% — the ultimate low-carbon economy.

The concept grew out of the idea of substituting manpower for energy, first described 40 years ago in a report to the European Commission by me and Geneviève Reday-Mulvey while we were at the Battelle Research Centre in Geneva, Switzerland. The early 1970s saw rising energy prices and high unemployment. As an architect, I knew that it took more labour and fewer resources to refurbish buildings than to erect new ones. The principle is true for any stock or capital, from mobile phones to arable land and cultural heritage.

Circular-economy business models fall in two groups: those that foster reuse and extend service life through repair, remanufacture, upgrades and retrofits; and those that turn old goods into new resources by recycling the materials. People — of all ages and skills — are central to the model. Ownership gives way to stewardship; consumers become users and creators. The remanufacturing and repair of old goods, buildings and infrastructure creates skilled jobs in local workshops. The experiences of workers from the past are instrumental.

10 ways to reduce waste at home:

1. Shop eco-friendly with reusable bags

With cities like Montreal banning the distribution of plastic bags in stores, reusable grocery bags are already commonplace across Canada. Further more, they can significantly help reduce the number of plastic bags collecting in our landfills.

2. Ditch disposables in the kitchen

Sure, plastic wrap, tin foil, paper towels and plastic zip bags may be convenient – but they create a lot of waste. Try using a silicone baking sheet in place of tinfoil or parchment. When cleaning, swap out paper towels and single-use wipes for microfibre cloths you can wash and reuse. Reusable lunch containers and washable snack bags will keep your food just as fresh and will minimize the amount of trash coming from your household on a day-to-day basis.

3. Say so long to single serve – bulk up instead

Items like snack packs, coffee pods and disposable cutlery save a little time and effort, but the packaging generates a lot of unnecessary waste. Try sticking to foods that have zero packaging or take your reusable containers to the bulk store and stock up – and save time and money on your shopping!

4. Say no to disposable water bottles and coffee cups

Contrary to popular belief, disposable coffee cups are *not* recyclable, due to the inside coating they have. For coffee on the go, use a travel mug. It's just as convenient, and it can save you money too. And why not try a double-insulated bottle that can handle both your hot and cold beverages.

5. Reduce food waste

Did you know Canadians waste food every year – and 47% of it is produced in the home? Before putting food to the trash, Indians waste around 30% cooked food every day. Ask yourself if it is so far gone that you really need to throw it out. Take the habit of noting the expiry dates of food in your fridge and planning your meals accordingly. If food goes bad, compost it! Composting transforms organic waste into nutrient-rich soil.

6. Join buy-and-sell groups

Did you know Canada's second-hand economy is alive and well organized. Keep your no-longer-needed items out of landfill and make some fast cash. There are dozens of online buy-and-sell web sites. Yes, someone could be interested in that blender that you never used, the skates too tight for your kid or the pine coffee table in the basement – they'll even pick it up and pay you in cash.

7. Try a new way to buy (and sell) utility items

Need some new items. Why not check out your nearest second-hand store. And while you're at it, the items you no longer use could be perfectly useful for someone else. Try donating them to consignment, swapping items with friends, or even repurposing them as other items.

8. Find a new home for old furniture

Why not give your old furniture a new home? Donate it to a local charity, put it on the curb with a "free" sign on it, or post an online ad to sell it or give it away. Some donation centres even offer pickup services for used furniture.

9. Dispose of e-waste responsibly

Old computers, TVs and other devices are placing an increased burden on landfills. These devices have components that can contain potentially harmful chemicals, so before you put your e-waste at the curb, find out if the manufacturer has drop-off programs.

10. Choose paperless billing

Paying bills can be fast, easy and paper-free. Why not spend an hour switching all your paper statements to electronic delivery sometime this week. Enter your invoices' due date on your online calendar or set up automated payments so you don't have to worry about missing a payment.

10 ways to reduce waste at workplace:

1. Go (nearly) paperless

While recycling is helpful, the biggest impact comes from using less paper in the first place. With programs like Google Docs that allows you to write, edit, and collaborate for free online, and Dropbox, a free service that makes it easy to sync and share files, it's easier than ever to eliminate the amount of paper you use in the workplace. Consider adding a "think before you print" message to the bottom of your emails as a friendly reminder to coworkers.

2. Keep a paper recycling bin within arm's reach

People recycle when it's convenient. At ISCG, every trashcan has a small recycle bin attached so that it's visible and doesn't take any extra effort. Make it easy for employees to recycle by meeting them where they already are (at their desks) with a bin.

3. Print smarter

Sometimes printing is necessary. Save up to 50 percent on paper costs by having employees set their defaults to print double-sided, and ask employees to use the “Print Selection” function, which encourages them to only print what they need and reduces wasted sheets of paper.

4. Provide real dishes and silverware

Instead of spending money on wasteful paper plates, harmful Styrofoam cups, and flimsy plastic utensils, invest in real dishes and silverware for your office café. You’ll save on the cost of purchasing and disposing these items over time, and real dishes are much nicer to use. Make everyone responsible for cleaning their own dishes, and if you can, spring for a dishwasher to make it even easier.

5. Get rid of the K-Cup machine

Those millions of little plastic cups can’t be recycled and go straight to the landfill. K-Cups may seem economical because you can make one cup of coffee at a time, but they are much more expensive than coffee beans. A pound of K-Cup coffee goes for roughly \$50, while Starbucks is \$12 per pound, and Dunkin is only \$9 per pound. Invest in a machine that grinds the beans to make one cup at a time, and buy coffee beans in bulk to save money.

6. Buy in bulk

Coffee beans aren’t the only thing you should buy in bulk for the office. Purchase items like sugar and creamer, snacks, cleaning supplies, and Kleenex in bulk instead of individually packaged to lower the cost per unit and reduce the amount of packaging you throw away.

7. Reuse binders and file folders

Provide label stickers so employees can write over and reuse binders and file folders instead of throwing them away after one use.

8. Create a recycling center

Make a small recycling center by providing bins to put returnable bottles, non-returnable bottles, and paper. At ISCG, we have these three bins and a trash bin hidden in two large pull-out drawers in the kitchen. Money from the bottle deposits is money in your company’s pocket.

9. Provide filtered water

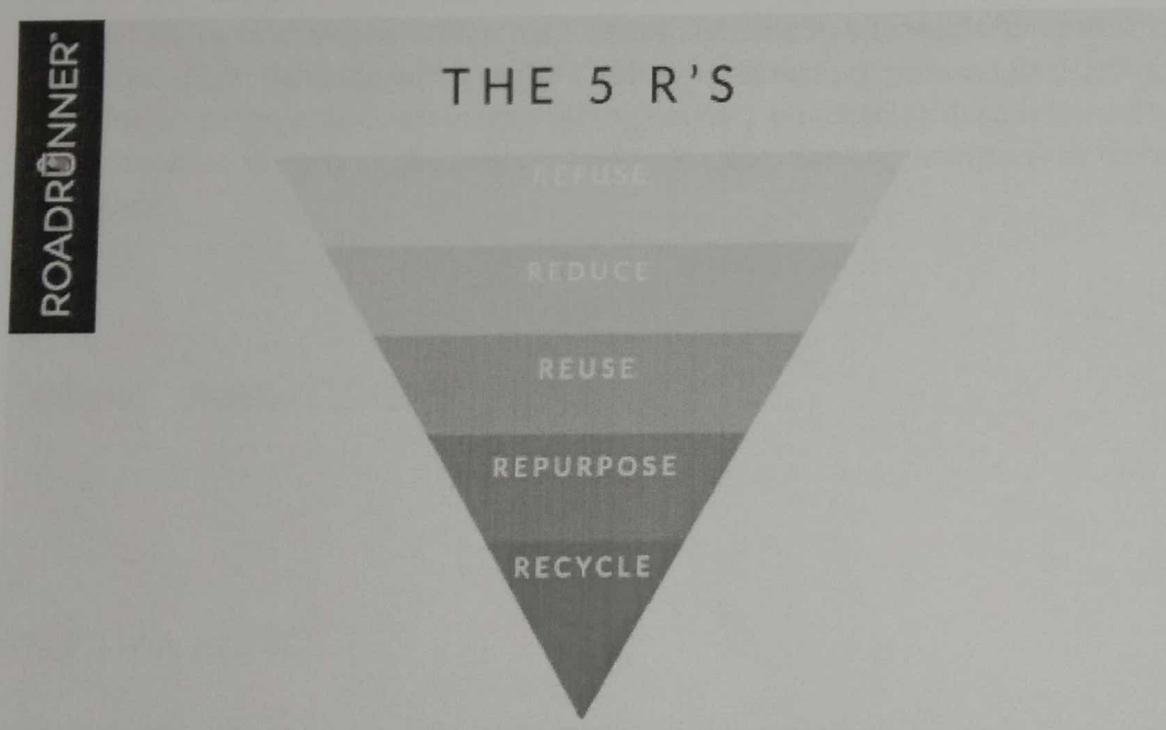
Install a filtered water tap or keep a large Brita pitcher in the fridge so employees can pour a glass of water instead of grabbing a disposable plastic water bottle. Your company will save money on bottled water, and landfills will be spared of more plastic.

10. Give employees a reusable water bottle

Surprise and delight employees with a reusable water bottle with your company's logo on it. There's a small cost associated, but ultimately you'll save on plastic water bottles, promote wellness, and get free advertising when they carry it outside the office.

There are countless ways to reduce waste in the workplace. Try these suggestions to see how easy it is and how much money you can save. And if you're ready to create a more sustainable workplace overall.

The 5 R's: Refuse, Reduce, Reuse, Repurpose, Recycle



Recycling is usually number one on our list, but today, it's last...

According to the 5 R's, four actions should be taken, if possible, prior to 'recycling': **refuse, reduce, reuse, repurpose, and then recycle**. Incorporating this methodology into your business' waste reduction and recycling efforts will minimize landfill waste and help take your recycling program to the next level. In this post, we explain each of the 5 R's and the benefits of putting them into practice at your business.

HOW TO APPLY THE 5 R'S

Applying the 5 R's to your business' waste management and recycling strategies can positively impact the outcome of your program by significantly reducing the amount of waste your business generates. In the 5 R's hierarchy, remember to treat recycling as a last resort after attempting to refuse, reduce, reuse, or repurpose. Before disposing of your waste, walk through each of these steps in the following order:



STEP ONE: Refuse

Refuse: the first element of the 5 R's hierarchy. Learning to refuse waste can take some practice, but incorporating this step into your business' strategy is the most effective way to minimize waste. Talk to your procurement team about refusing to buy wasteful or non-recyclable products. When working with vendors, refuse unnecessary product packaging and request reusable or returnable containers. Making smarter purchasing decisions and setting standards and expectations early in the process makes it easier for organizations to "refuse" waste in the first place.



STEP TWO: REDUCE

Reduce the use of harmful, wasteful, and non-recyclable products. Reducing dependency on these kinds of products results in less waste materials ending up in landfill and the associated negative environmental impacts. We recommend always using the minimum amount required to avoid unnecessary waste. For example, when printing a document, print double-sided to cut your waste output in half. Other commonly used items businesses can focus on reducing include single-use plastics, plastic packaging, organic waste, and Styrofoam cups.



STEP THREE: REUSE

Single-use plastics have created a "throw-away" culture by normalizing consumer behavior of using materials once and then throwing them away. The rate at which we consume plastics has become unimaginable, and the plastic crisis has become one of the world's greatest environmental challenges. In an effort to reduce waste, reuse items throughout the workplace instead of buying new ones. Begin by focusing on one area of your business at a time, like the break room. Replace all of the single-use eating utensils, Styrofoam cups, water bottles, and paper plates with compostable or reusable alternatives. Once you master one area, prioritize reuse for other products in your facility like packaging peanuts, printer cartridges, cardboard boxes, food containers, and rechargeable batteries.



STEP FOUR: REPURPOSE

For every item that can't be refused, reduced, or reused, try repurposing it. Many people in the green community refer to this method as upcycling. You may be surprised to learn how many common office products serve more than one purpose. Sometimes it requires using some creativity, but the possibilities are endless. Try using wasted printer paper for scrap paper, cardboard boxes for storing supplies, binder clips to hold power cords and chargers in place, and even mason jars, coffee mugs, and tin cans for holding pens and pencils. Designate an area of your office as an Upcycle Station for collecting and storing supplies. Encourage your colleagues to add items to the station they no longer need and to check there before purchasing new supplies. We'd love to hear what products your business repurposes!



STEP FIVE: RECYCLE

Last but definitely not least: recycle. Once you've gone through all of the other R's, recycling is the most environmentally friendly waste disposal method. If your business doesn't already, start collecting cardboard,

mixed paper products, commingled materials (plastics, aluminum, glass) and organics. Most companies we speak with are surprised by the amount of waste they reduce by establishing an effective recycling program. Click for a round-up of the best resources we've created for launching a successful recycling program.

1. Repairing: The most logical approach to closing the loop on product use is simply to repair and extend the product's life. However, whilst this is intrinsically a simple concept, its practice is low and little research has been undertaken to understand this closed loop option. Repairing is simply the correction of specified faults in a product. Generally, the quality of repaired products is inferior to those of remanufactured and reconditioned alternatives. When repaired products have warranties, they are less than those of newly manufactured equivalents. Also, the warranty may not cover the whole product but only the replaced component. Empirical research has shown that appliance ownership within the UK increased by around 60% over a 5-year period. In addition, consumer decisions during the 'use' phase of a product whether to repair, pass on or throw items away accordingly affect product life spans (and thus the rate of waste generation). The E-SCOPE survey found that 68% of respondents cited cost as a reason why they did not get items repaired; a factor borne out by the fact that whilst new washing machine prices increased by only 40% during the 1980s-1990s repair costs over this period increased by 165%. Throughout the UK, the sustained existence of jumble sales and charity shops show that there is a supply and demand for second hand goods. However, by law they are not allowed to sell electronic equipment unless they have had it reconditioned. Products go out of use for essentially two reasons: functional obsolescence (they physically fail and need repair) or fashion obsolescence (they lose their appeal due to new products appearing in the market with different/additional features). Planned obsolescence is one way in which capitalist markets generate a demand for new sales; B Earl Puckett, former head of Allied Stores Corporation said "We must accelerate obsolescence ... It is our job to make women unhappy with what they have ... We must make them so unhappy that their husbands can find no happiness or peace in their excessive savings. Indeed, a growing body of literature cites the fact that consumerism is the dominant social paradigm to be the fundamental cause of the world's sustainability problems. This is seen to be encouraged by a culture of individualism and a relaxation in credit controls. In contrast to this view, planned obsolescence (and the consumerism it generates) has been defended "as an engine of technological progress". Although flawed in terms of economic efficiency and environmental sustainability, the argument planned obsolescence this represents progress is often politically expedient.

2. Reconditioning: Reconditioning involves less work content than remanufacturing, but more than that of repairing. This is because reconditioning usually requires the rebuilding of major components to a working condition that is generally expected to be inferior to that of the original model. All major components that have failed or that are on the point of failure will be rebuilt or replaced, even where the customer has not reported or noticed faults in those components. The fact that a reconditioned product is clearly not new (and thus not offering the latest functionality or aesthetic styling of new product) means that it has the same market acceptance issues to products that have been repaired. The practice is well established and has created what is called a "grey goods" market where original "white goods" products such as fridges and washing machines are reconditioned after a single life and returned for sale as "grey goods". The visual image is clear that the product is not returned to its original condition but has been improved to allow extended functional use. Often such products are either sold directly to low-income families or indirectly through local government social service providers. The reduced quality of a reconditioned product allows it to be sold affordable to such social groups (Renew, 2004). Another example of reconditioning practice comes from a company named "181 Respin". This Plymouth based company

reconditions components from white goods and sells them to service agents and reconditions whole products for sale to low-income families and landlords. In each case, the reconditioned products have a lower performance specification and associated warranty than the equivalent new product (DARP, 2003).

3. Remanufacturing: is the only process where used products are brought at least to Original Equipment Manufacturer (OEM) performance specification from the customer's perspective and, at the same time, are given warranties that are equal to those of equivalent new products (Ijomah W, 2002). The reasoning here being that if a remanufactured product has quality equal to that of a new equivalent then its warranty must also be the same. Of all the current "secondary market" (used product) processes, remanufacturing involves the greatest degree of work content and as a result its products have superior quality and reliability. This is because remanufacturing requires the total dismantling of the product and the restoration and replacement of its components. Remanufacturing is particularly applicable to complex electro-mechanical and mechanical products which have cores that, when recovered, will have value added to them which is high relative both to their market value and to their original cost (Lund, 1985). The essential characteristic from an environmental aspect is that remanufacturing preserves the embodied energy (emergy) that has been used to shape the components for their first life. Lund estimates that a remanufactured product only requires 20-25% of the energy used in its initial formation (Lund, 1985). Thus, as well as reusing the material, the energy required to produce a new product is significantly lower. Although the environmental advantages are clear (and meet the requirements of extended producer responsibility legislation) there are other benefits from remanufacturing. Bras & McIntosh (1999) state that, by receiving back old products,

manufacturers can obtain feedback on reliability and durability information and can also resell into lower-priced markets, typically costing 60% of the original production cost. Ijomah describe current remanufacturing activity by the following activities:1.Receive the "core", that is the parts of the product to be remanufactured. The term "core" is used, as typical remanufactured parts are larger core items of the product.2.Strip and clean the core into individual elements. As the used parts may be dirty, they are dismantled and appropriately cleaned. A visual inspection would discard badly damaged elements.3.Estimate & quote remanufacturing costs. As many remanufacturing companies are subcontractors to the OEMs, the cost of remanufacturing is often estimated on each product to determine the appropriate rectification strategy.4.Remanufacture. If the component were suitable, the appropriate machining/fabrication processes would be used to remanufacture the component to an "as new" specification.5.Build, test and dispatch. Finally, the remanufactured components are reassembled (together with necessary replacement components) to build the new product. After appropriate quality testing, the product would be dispatched for sale. Arguably the most well known (and certainly the most referred to) example of remanufacturing is that of photocopiers made by Rank-Xerox; their process is shown in figure 2 (Xerox, 2003).Figure 2: Xerox's equipment recovery & parts reuse/recycle process (Xerox, 2003)In 1987, Rank-Xerox started a new programme called "asset recovery" and created a new, wholly owned subsidiary next to its manufacturing plant in The Netherlands. Its aim was two-fold: firstly, to remove old copying machines from the waste stream and, secondly, to process these machines for resale. This was called the Asset Recovery Operation (ARO). In 1989 5% of scrapped machines were remanufactured; by 1997 this had risen to 75% of the 80,000 copiers

returned. At the beginning of 1993 landfill accounted for 41% of manufacturing waste but by 1995 this was only 21%. To encourage return, an incentive scheme was introduced in The Netherlands, and although the remanufactured copiers compete with new Xerox machines, the company claims to have saved \$65million by 1996 (Ayres et al., 1997). The company now has remanufacturing facilities in the USA, the UK, The Netherlands, Australia, Mexico, Brazil and Japan (Kerr & Ryan, 2001).Aware of the growing interest in remanufacturing within the UK, Oakdene Hollins undertook a UK-wide survey of activities to better understand what current happens and identify issues for future development (Parker, 2003). Parker, after a review of academic work, includes questionnaire/interview evidence from 14 companies and identified three key parameters that influenced the activity: intrinsic value (the value of the product being remanufactured), re-constructability (how easy it was to disassemble and the rebuild the product) and evolution rate (how quickly new product varies appeared on the market). The recommendations include changes to legislation to allow reused components in new products, further

research to enable design for remanufacture and the development of product-service systems that include upgrade/maintenance with initial purchase.

4. Recycling: Recycling is “the series of activities by which discarded materials are collected, sorted, processed, and used in the production of new products” (NRC,1999). According to the Northeast Recycling Council (NERC), recycling activity in New York in 1997 reduced energy use by 9%, sulphur oxide emissions by 12% and saved 2.7 million tons of iron ore from needing to be extracted to form new materials (NERC, 1999). Thus, it is clear that it is environmentally better to recycle materials rather than take them to a landfill site. Indeed, for aluminium, the energy saving can be as high as 91% by recycling scrap compared with the process of using the primary raw material, bauxite.

However, although it is currently the most mature waste avoidance strategy, with established rates as high as 80% for certain products, many designers are reluctant to use recycled materials because of uncertain quality or supply standards . One attempt to address the issue of quality has been to further define a recyclable material as one that can reacquire the material properties it had in its virgin state and thus to develop a measure of the “recyclability” of different materials by assessing virgin, scrap and processed economic values . In addition, whilst the materials recycled reduce virgin material use, they do still require additional energy to be used to reform them into manufactured products. Jacobs (1991) states “Wastes can't turn back into resources unless there is some external source of energy. ‘Recycling’ doesn't just happen on its own ... it has to be powered by an energy source. This is because the embodied energy used in production is lost during the recycling process. Figure 3 below presents the three operations of repair, reconditioning and remanufacturing on a hierarchy based on the work content that they typically require, the performance that should be obtained from them and the value of the warranty that they normally carry. The hierarchy of secondary market production processes

3. Discussion: which return loop is “best”.Returning to the idea of closing loops, Stahel (1994) states that the smaller the loop, the more profitable it is. Thus, according to Stahel, repairing or remanufacturing products ought to be more common (if it is more profitable) than recycling.