New Avenues for Improving Supply Chains: Product Recovery, Waste Management and Sustainability

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New Avenues for Improving Supply Chains

The dramatic rise in oil prices, over the past six months, is having a debilitating effect on supply chain performance.

This coupled with increasingly shorter life cycles, acceleration of product introductions, the competitive imperative to maintain product availability and the need to be environmentally responsible has brought to fore a *new set of avenues* whose characteristics and effects need to be understood and managed if the supply chains are to be improved and made sustainable.

Product recovery

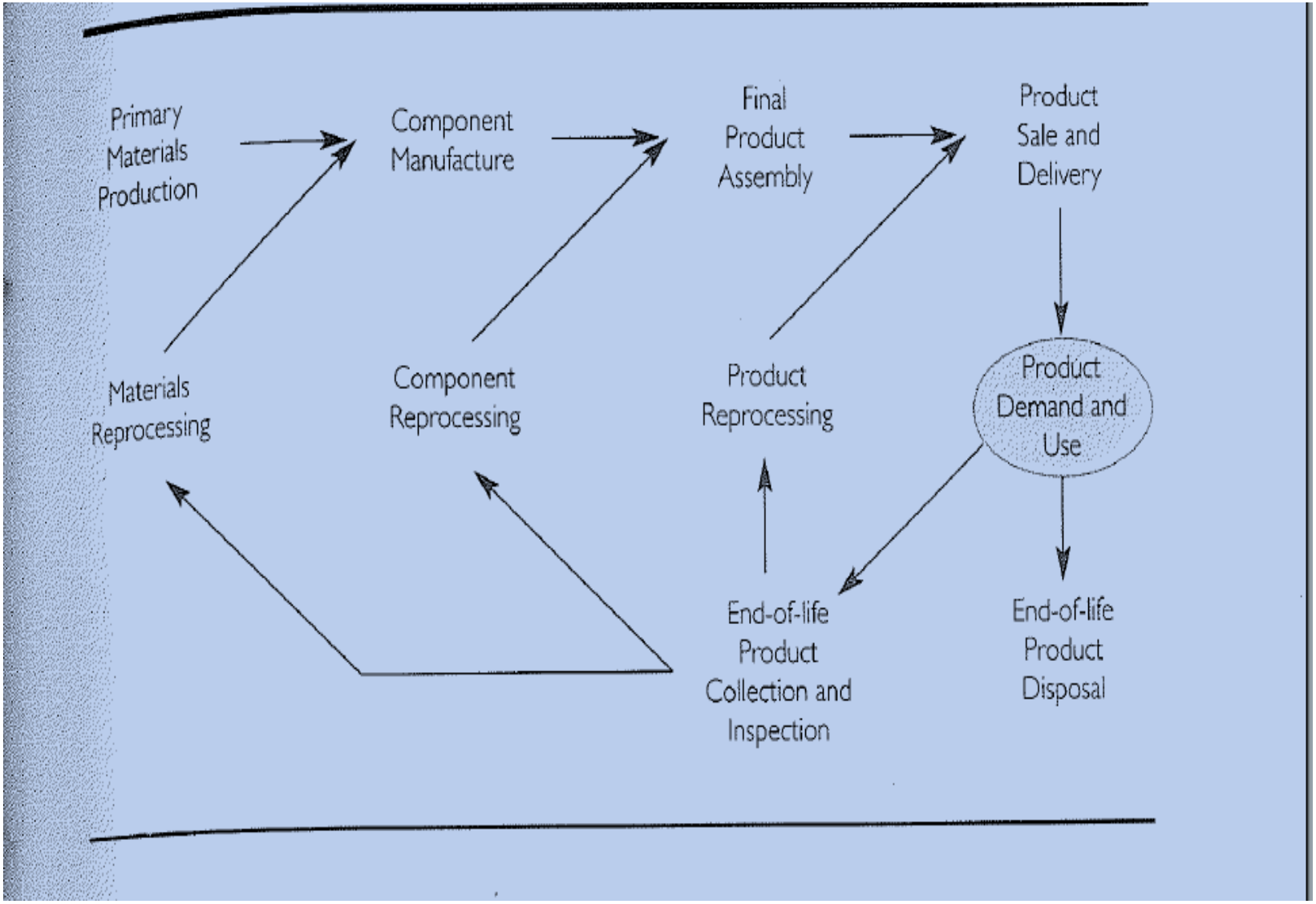
The future belongs to firms whose End-of-Life (EOL) product management strategies creates both environmental and economic value, a *win-win* opportunity.

Supply Loops are EOL product management strategies that satisfy two criteria. *First* they divert EOL products from landfills and incinerators by collecting and reprocessing them for economic value recovery.

Second, the secondary resources that result from reprocessing replace the primary resources in the forward supply chains. Thus supply loops address the environmental issues caused at both the front and back end of the production-supply chains.

Supply Loops

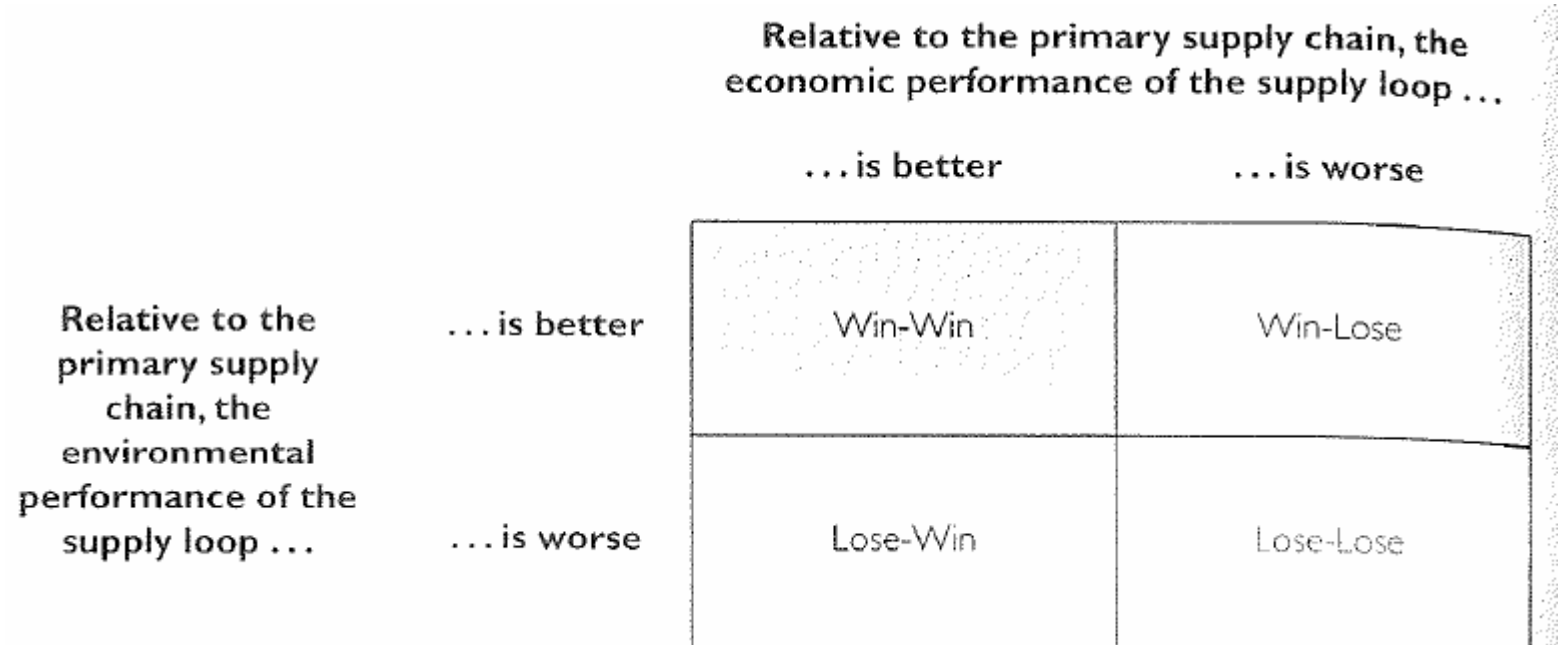
Source: Geyer & Jackson, California Management Review, Winter 2004



Supply Loops -- Examples

Mobile phones are a case in point. Greener Solutions in UK collects the EOL phones and either *refurbishes* the entire phone, or retrieves valuable components (such as ICs) for *reuse*, or pass on the phones to specialist *recyclers* who recover the precious metals they contain.

Xerox remanufactures EOL products, reuses their parts or recycles their materials in its "*Waste-Free Products*" program.



Supply Loop Performance

In designing Supply Loops, the firms should seek out performance strategies that deliver both economic and environmental benefits. (*win-win*)

A *win-lose* supply loop has better environmental performance than primary production route but needs support in the form of legislation, subsidies, investor interest to change the economic returns.

A recent example is the deposit that German retailers charge for single-use beverage containers, which favors multiple-use containers with take-back.

Lose-win supply loops are profitable but pose severe environmental problems. For example, common use of sewage sludge instead of chemical fertilizer in agriculture.

Why Product Recovery?

1) Reduction of Production Costs: OEMs such as Xerox, Benz, Ford generate large savings by disassembling their EOL durable products and substituting the recovered parts for virgin parts.

2) Project the image of Environmental Responsibility: Kodak and Fuji initially introduced their single-use cameras as “disposables” or “throwaways”. But quickly in the face of pressure from environmental groups they introduced *take-back* programs that recycles 90% of these cameras and reversed the product’s poor environmental image.
Wal-Mart and Home Depot accept free of charge used fluorescent and incandescent light bulbs at their stores.

Why Product Recovery?

3) Customer Demand: Moderns customers demand OEMs have mechanisms in place for product recovery.

Dell collects EOL PCs from their commercial customers in the US as a service associated with a new sale.

Retailers of mattresses, household appliances provide such services to differentiate themselves from competitors.

4) Aftermarket: These refer to markets for parts and accessories to maintain or enhance a previous purchase. Not only does product recovery provide benefits but it also protects OEMs from independent remanufacturers.

HP provides its customers prepaid envelopes to return the toner cartridges.

Lexmark offers “prebate” discount for returns as a way to protect its brand image.

Why Product Recovery?

5) Pre-empting Regulation: Responsible Care Program developed by Chemical Industry is one way to reduce the pressure of regulation. Major power tool manufacturers in Germany voluntarily take back their EOL products from the customers at no charge.

Regardless of the motive to engage in product recovery, firms face a *strategic choice*. Should they contract with recyclers, establish joint ventures with recyclers, form a consortia with competitors, vertically integrate into product recovery or simply promote recycling market?

Three management theories – *transaction cost* analysis, *capability* analysis, *resource dependence* analysis – provide guidance to the firm in making this choice.

How to Structure Product Recovery?

Transaction Cost Analysis provides guidance to OEMs on how to structure – vertically integrate, rely on third parties (market), or develop hybrids such as consortia, alliances or joint ventures – product recovery activities.

1) When EOL product recovery requires transaction-specific investments, hold-up risks are larger and they can be mitigated by joint ventures or vertical integration than by relying on markets.

Example: Signature Analysis Technology facilitates the comparison of a remanufactured Xerox machine to the firm's new product quality standards. This investment has high transaction specificity resulting in Vertical Integration.

How to Structure Product Recovery?

On the other hand investments that are not transaction specific such as disassembly technologies that can be used across a range of products does not pose any hold-up risk and hence markets can be relied on.

For example, SpectraCode's Polymer Identification System can be used to identify polymers used in a wide variety of electronic products. So both OEMs and Independent Recyclers purchase this technology on the open market.

How to Structure Product Recovery?

Reverse supply chains associated with product recovery are subject to *more uncertainty* than forward supply chains. Primarily, this is due to uncertainty i) in timing and quantity of returns ii) in material recovery iii) in processing times iv) in availability of components etc.

Remanufacturers may be able to reduce variability by having price schedule across various quantities and qualities. *Dell* and *ReCellular* provide such schedules. Others such as *Bosch* install electronic data logs in their power tools to record their usage history.

Benz keeps a log of all maintenance activity on the vehicle which allows them to determine the trade-in value.

How to Structure Product Recovery?

The above uncertainties coupled with lack of control of the return recovery process makes *independent* recyclers highly *unreliable*, (that is, forecasts of return availability tend to be grossly inaccurate) and costly for the OEMs especially when the latter operates on a JIT basis or on Lean principles.

2) *Thus the additional costs and risks may convince OEMs to structure the recovery process as a joint venture or vertically integrate so as to gain better access to information and thus mitigate hold-up risks.*

Leveraging Resources, Capabilities and Competencies (RCC) for Product Recovery

To leverage RCC effectively, it is critical for firms to fully understand the capabilities necessary for product recovery while assessing how closely they *align* with the capabilities the OEMs already possess.

Lack of skills in identifying bad cores (EOL product) means that disassembly investment is not offset by the recovery of enough good parts.

Thus firms with extensive manufacturing, service and repair experience may be more likely to vertically integrate into product recovery.

IBM and HP versus Gateway

Leveraging Resources, Capabilities and Competencies (RCC) for Product Recovery

When firms design, develop and manufacture a product they acquire *tacit* knowledge about how it is assembled.

So they are better placed to leverage this knowledge in gaining a cost advantage in disassembling EOL product than some independent product recovery firm.
For example, *Ford* maintains its Experimental Dismantling Center in Germany to benchmark design practices and materials use against recovery capabilities.

In addition, locating remanufacturing within manufacturing site facilitates transfer of tacit knowledge between the two.

Leveraging Feedback from Product Recovery

Engaging in product recovery generates know-how about various aspects of the original product its components and their durability. This can then be leveraged to redesign the product to facilitate better product recovery.

IBM evaluates the effectiveness of its design initiatives against disassembly and plastic resin identification. Similarly *BMW* operates a Recycling center to determine the amount of time and tools needed for disassembly.
It is said that firms, such as *DuPont* and *Shell*, that have well embedded TQM and Environmental programs are more likely to possess capabilities to leverage the feedback into design improvements.

Resource Dependence and Product Recovery

Firms tend to avoid depending upon other organizations for critical resources. In some cases, EOL products could become *critical* resources to OEMs if others can refurbish or remanufacture their products and thereby threaten their customer base.

Therefore, OEMs that reuse specific components from their EOL products avoid supplier dependence by developing schemes that encourage EOL products to returned directly to them.

Xerox has long relied on Leasing strategy. *HP* uses prepaid envelopes. *Kodak* pays film processors to return the "single-use" cameras directly to it.

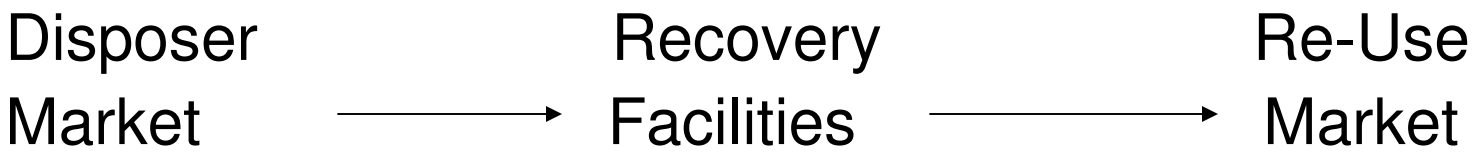
Product Recovery Networks: Some Takeaways

The following steps are common to all product recovery networks

1) Collection – take back of copiers.
2) Inspection/Separation – distinguishing between repairable and recyclable parts. Involves splitting of flows.
3) Reprocessing – nylon reprocessing from used carpet.
4) Disposal – may include land filling and incineration.
5) Re-distribution – this could involve sale of recyclables or lease of remanufactured parts.

Product Recovery Networks: Some Takeaways

Product recovery networks can be divided into 3 parts.



The *collection* in the disposer market creates large # of *converging* flows from sources of used products to the recovery facilities.
The *redistribution* involves *diverging* flows from facilities to demand points in the reuse market.
The *structure* of the recovery facilities could be simple, single level (reusable packages) or complex, multi-level (re-manufacturing).

Product Recovery Networks: Some Takeaways

Differences between product recovery networks & traditional production-distribution networks arise on the supply side.

In the traditional networks, the supply is *endogenous* in the sense that timing, quantity and quality of the *input* may be controlled to meet the production's requirements.

In contrast, the supply is *exogenous* in recovery networks and comes from a large # of sources resulting in large uncertainty which makes forecasting quite difficult.

The *demand points* in recovery networks are dependent on the *output quality* of the processing steps which creates interdependencies and hence complex network structures.

Different types of Product Recovery Networks

The recovery networks vary according to the following factors.

1) *Degree of centralization* -- # of locations at which similar activities are carried out. It represents the *width* of the network.

2*) # of levels* – refers to the # of facilities the good flows sequentially and it represents the *depth* of the network.

In a *single* level network all activities are integrated in 1-type of facility.

3) *Closed vs Open loop* – in the closed loop sources and sinks coincide so that flows cycle in the network. The open loop has a “one-way” structure so that flows enter one point and leave at another.

Different types of Product Recovery Networks

The *context* within which product recovery occurs is defined by i) product ii) supply chain and iii) facility characteristics.

These influence the design of the network.

Products with *complex* assembly structures effects the degree of centralization and the # of levels in the network.

Similarly economic value (junk vs valuable waste), *recovery option* chosen (repair or recycle) affect network design.

Members of the supply chain – OEMs, suppliers, users – can influence the network design. OEMs may be responsible for the set-up of the network for product and package recovery.

Different types of Product Recovery Networks

The *flexibility* (dedicated/universal) and the *costs* (high/low) of the recovery facilities influence the design.

Universal systems can handle multiple product types but may be less efficient. Facilities with high fixed costs generally require centralized operations.

Based on the above factors we can identify 3 broad types of recovery networks.

Bulk Recycling Networks: Here the concern is with material recovery from low value product: *sand and carpet recycling* Disposer and re-use markets are different. Material suppliers play an important role in the network

Different types of Product Recovery Networks

Costs are usually high due to advanced technologies. These networks use centralized, open loop network structure with fewer levels but are vulnerable to supply volume.

Remanufacturing Networks: Here the focus is on re-use of parts of a high value assembled product. Recovery is mainly carried out by the OEM since they require intimate knowledge of the product.

Copier & Mobile phone manufacturers operate such networks

They involve complex multi-level structures and most often form a closed loop and rely on the existing supply chain.

Different types of Product Recovery Networks

Reusable item Networks: These are appropriate for items such as re-usable packages.

Typically these items require only *minor* "reprocessing" steps and can lead to flat network structure with few levels or depots.

Also a closed loop chain is appropriate as there is not much difference between original and re-use.

This network is ideal for items such as bottles, crates, pallets and containers. Given the large # of re-use cycles, transportation is a big cost element. They can be operated in *decentralized* mode where depots can be close to the users.

Waste Management

Any firm can extend its current supply chain solutions to waste management. The key elements of an effective waste management system include

1. Develop a waste reduction and recovery strategy
2. Trace & Track materials to be recovered
3. Create transportation plan for waste recovery
4. Extend recovery opportunities to consumers

Note haste makes waste, so you need to have a plan in place.
Define objectives. *Reduce* i) greenhouse gas emissions,
ii) fossil resource use, and iii) landfill disposal.
Increase use of iv) renewable resources and v) recycled content

Waste Management

Trade offs exist. Increased use of renewable material could increase the use of fossil fuel if the material is heavier.

Based on the chosen tradeoff, perform a system wide waste audit with a goal of identifying the source of waste. One potential area for waste reduction is packaging.

Raymour & Flanigan, a furniture company reduced the volume of their recoverable expanded polystyrene by 10% through a process known as heat extrusion.

Trace & Track Material to be Recovered

Recoverable items should be traced and tracked just like raw materials and finished goods. RFID tags could be useful. What should be tracked? A plastic bag or Pallets or Reusable packaging for parts.
The trick is to use the Warehouse Management System as a tool in Waste Management. For example, in the auto industry, parts which are sent to the assembly plant use custom packaging which is often reusable and expensive (about $100 million packaging inventory).

By leveraging WMS and RFID, reusable packaging can be returned to the supplier without being lost (saving 4.5 million)

Leverage Transportation for Waste Recovery

Routing and Consolidation routines that are normally focused on moving material TO a destination point can also be used to collect waste FROM a destination point.

Questions to ask include: Can the trucks be used for backhauling waste?
Is consolidation of recyclables being done at the most practical location?
Can the vehicles be adapted to carry both consumer items and waste materials?

Backhaul strategies increase material flow through the supply chain which improves fleet utilization & lowers transportation costs

Leverage Transportation for Waste Recovery

3PL firms can be leveraged as part of the broader waste recovery strategy.

Example: Over 280 million scrap tires are discarded in the US each year.

Encore Tire Recovery, based in Michigan, operates a mobile tire shredding fleet aimed at car dealerships and tire retailers. Their vehicles have a capacity to shred 500 tires an hour which are later converted into environmentally friendly products.

Provide Consumers Recovery Opportunities

Involving the retailers and consumers in waste reduction is one of the most effective steps. Such involvement only strengthens consumer's ties to your brand.

Retail collection (plastic bag recycling programs) offers convenience, results in less contamination of the recycling stream, and gives the consumer another reason to visit the store.

In 2006, *Apple* recycled 13 million lbs of e-waste. A popular at-store program has been free iPod recycling program which offers safe disposal and a 10% discount on the purchase of a new iPod.

Summing it up

By developing a clear waste reduction and recovery strategy and leveraging supply chain execution and store operations, a firm can have a substantial positive impact on the environment and also produce significant cost savings.

What is Sustainability?

Sustainability is generally defined as using resources to meet the needs of the present without compromising the ability of future generations to meet their own needs. (WCED, Our Common Future,1987)

This definition raises many questions which include:

- What resources will future generations require?
- At what levels can pollutants be released without having a negative effect on future generations?
- At what level can renewable resources be exploited while ensuring that these resources remain renewable?
- To what extent can market forces drive sustainability?
- What sort of policies are required to achieve sustainability?

Sustainability and Supply Chains

For any firm making profits for a while is not that difficult, but doing it in a sustainable manner is a challenge.

So a sustainable supply chain is one where

- Resource consumption dovetails nicely with replenishment patterns
- Decisions take into account impacts of long-term interruptions or outages
- Total Risk and costs continue to fall over time.
- It is beyond JUST an environmental issue

Sustainability and Supply Chains

Sustainability stretches the concept of supply chain management to look at optimizing operations from a broader perspective—the entire production system and post-production stewardship as opposed to just the production of a specific product.

Supply chains must be explicitly extended to include by-products of the supply chain, to consider the entire lifecycle of the product, and to optimize the product not only from a current cost standpoint but also a total cost standpoint.

Total cost must include the effects of resource depletion and the generation of by-products that are neither captured nor used (pollutants and waste).

Why sustainability?

To summarize

- To lower costs… through reduced energy use
- To reduce risk… of water shortages
- To reduce absenteeism.due to less toxins, cleaner air
- To improve productivity..with natural light & ventilation
- To create healthier environments.. better land use
- To Increase profits … on an ongoing basis

Redesigning Supply Chain for Sustainability

A 2008 study by Capgemini under Global Commerce Initiative, reports that a designing a new integrated supply chain should take into account *sustainability* parameters such as

co2 emissions reduction,
reduced energy consumption,
better traceability
reduced traffic congestion,

as well as traditional measures like on-shelf availability, cost reduction and financial performance.

Seven Key Innovation Areas

- *In-Store Logistics*: Improvements within the store will be necessary to add value to the consumer and reduce business costs; solutions will include in-store visibility, shelf-ready products, shopper interaction.

- *Collaborative Physical Logistics*: This will involve the sharing of physical infrastructure such as warehouse storage and transportation vehicles in order to simplify the overall physical footprint, and to consolidate flows to improve service and asset utilization.

- *Reverse Logistics*: Solutions will include product recycling, packaging recycling and returnable assets.

- *Demand Fluctuation Management*: Demand fluctuations will require new models to smooth the demand signal coming from customers; solutions will include joint planning, execution and monitoring.

Seven Key Innovation Areas

- *Identification and Labeling* through the use of barcodes and RFID tags will become more prevalent.

- *Efficient Assets*: Efforts by companies will occur to modify existing or design new equipment or buildings, to enhance their productivity and reduce their environmental impact.

- *Joint Scorecard and Business Plan*: A suite of industry-relevant tools will be designed to measure the extent to which trading partners are working collaboratively, as well as business metrics aimed at measuring the impact of that collaboration.

Seven Key Innovation Areas

A big impact on the parameters can be made when the following concepts are merged and implemented:

- Information sharing – driving the collaborative supply chain
- Collaborative warehousing
- Collaborative city distribution (including home delivery and pick-up)
- Collaborative non-urban distribution (including home delivery and pick-up)

Some examples

Xerox Corporation earned ‘chain of custody’ certification from both the Forest Stewardship Council (FSC) and the Program for the Endorsement of Forest Certification (PEFC).

These certifications confirm that Xerox paper products have been manufactured using raw materials harvested from certified sources, controlled wood sources or post-consumer reclaimed sources.

What does this mean in practice? The paper can be tracked all the way from its origin to its final use. As the pulp comes from a certified forest to a paper mill, that product is segregated and followed through every stage.

In essence, it is assured that a piece of paper can be tracked all the way back to a well-managed forest.

Some examples

- Yeo Valley Organic won the Queens Award for Enterprise in Sustainable Development for its role in developing a sustainable UK *organic dairy supply chain*.

  The company achieved this by:
- sourcing organic raw materials, in particular milk, from nearby farms.
- setting up long-term agreements with these farms and guaranteeing them a fixed price per liter of milk. This has given other farms the confidence to convert to organic methods.
- paying a marketing levy to OMSCo, to allow the *cooperative* to carry out research into the health and environmental benefits of organic farming and to produce promotional campaigns for organic milk.
- providing centralized support to the whole company from its headquarters.