

Systems Modelling and Simulation (9)



Analysis of Supply Chain System Environmental Aware Manufacturing and Systems Design

Papers Design for Recycling and reclaiming materials and components from disposed products:

Simolowo EO, **Mousavi, A.** (2013), Developing an imaging software for automated recycling processes (phase 1), *Advanced Materials Research*; **628** pp. 292-297

Simolowo, E. and **Mousavi, A.** (2011), "Integrating Image Sorting and Product Classification in Demanufacturing Processes: An Overview", *Journal of Computer Integrated Manufacturing*, Vol. 24, No. 10, pp. 900–914.



Today's discussions

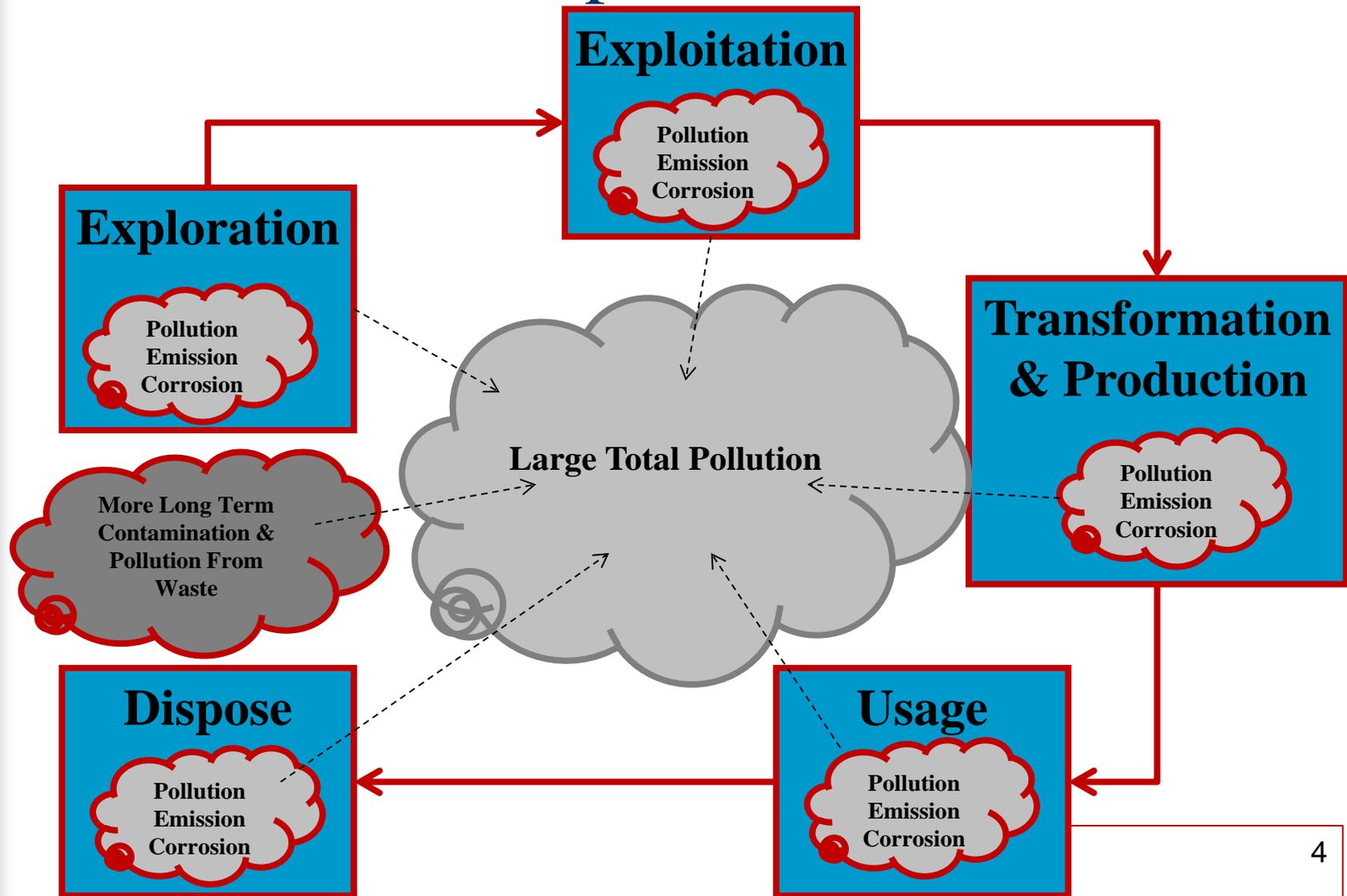
- Responsible Industrial Systems
- Logistics and Reverse Logistics
 - **Definition**
 - **Product Life Cycle**
 - **Types of RL with respect to supply chains**



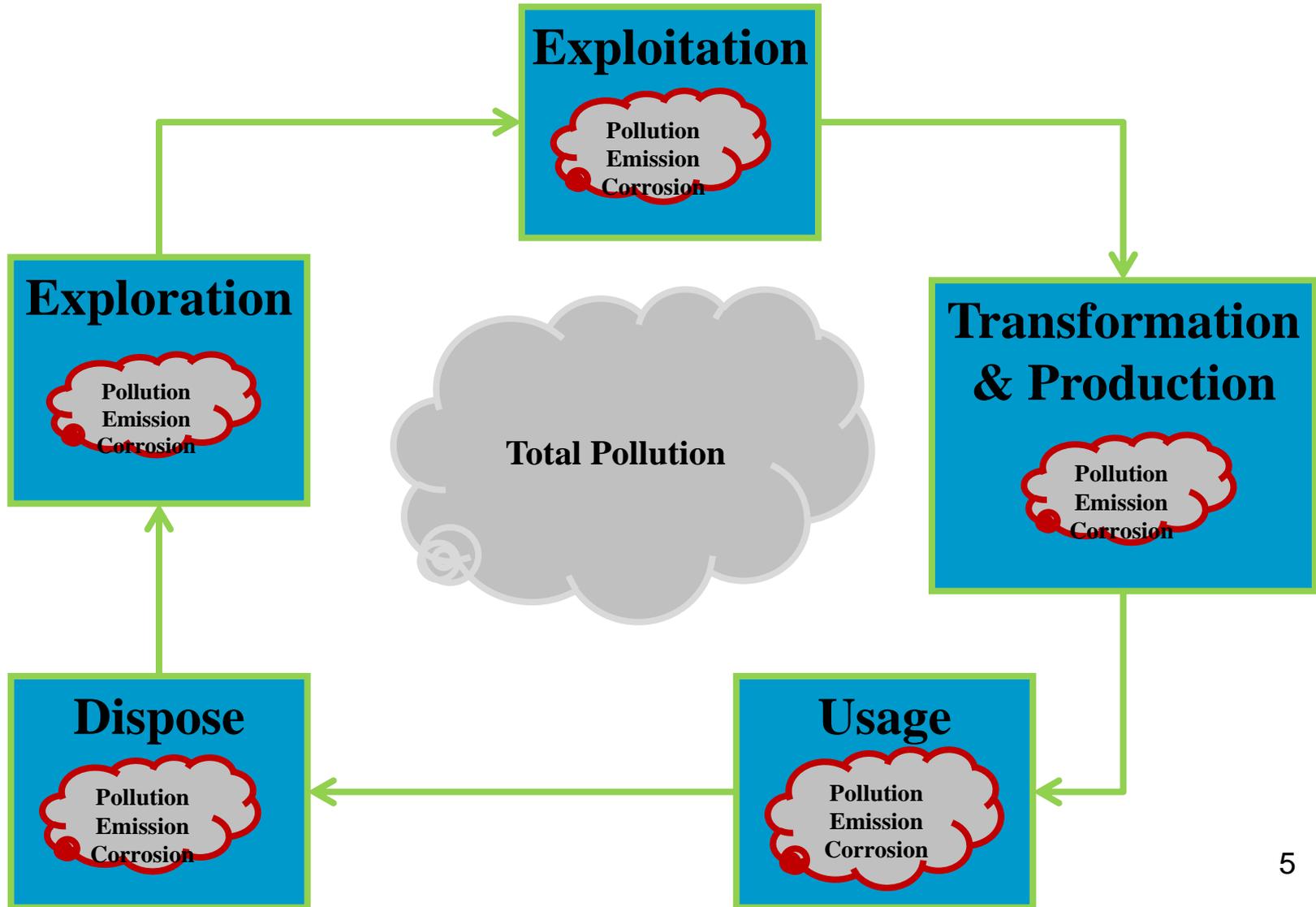
Facts about the environment

- Viable systems strategy (reminder):
 1. **Adapt**
 2. **Prosper**
 3. **Maintain Prosperity**
- Resources in the world limited and depreciable
- Effect of industrialisation on the environment (exploration, exploitation, transformation, production, usage, and disposal)

Irresponsible Manufacturing Process & Environmental Impact



Circular Manufacturing (Environmentally Aware)



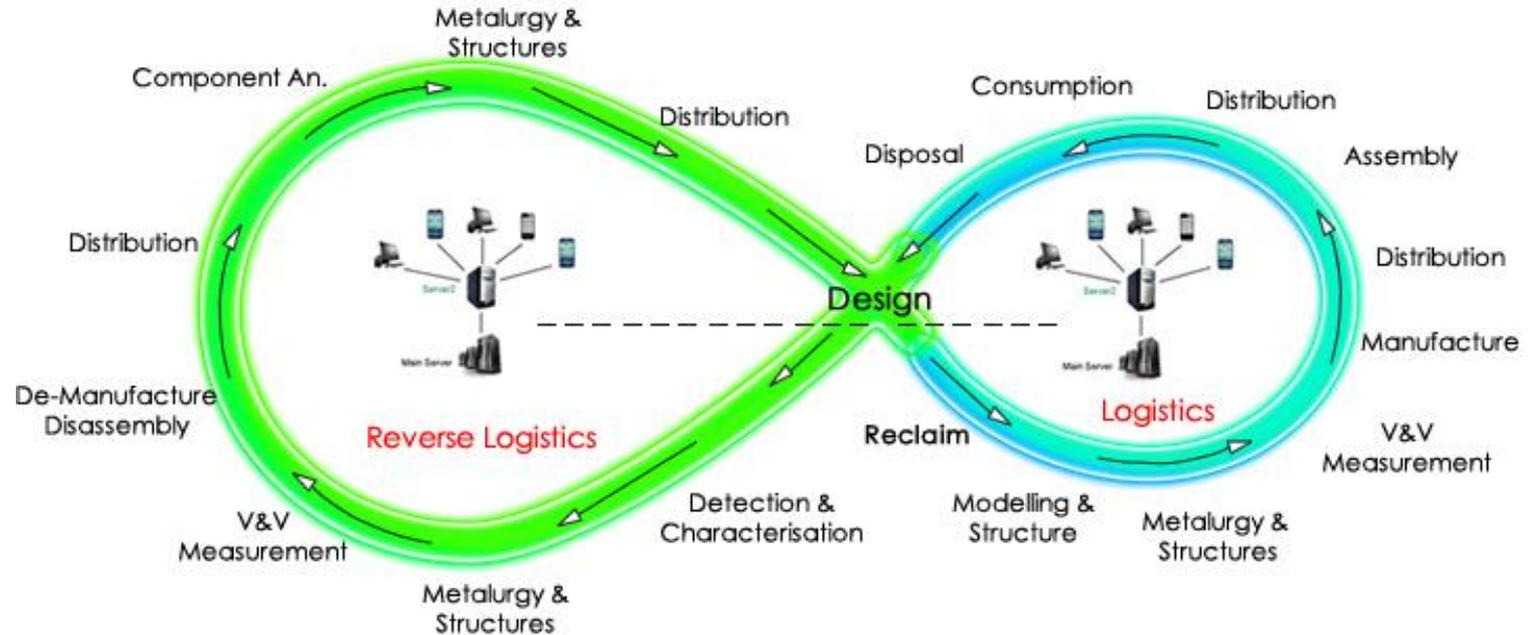


Initiatives

- Better usage of energy
- Reduction of emission of hazardous material
- Renewable energy
- Improved methods
- Recycling of material

SUSTAINABLE LOOP-INFINITE MANUFACTURING (SLIM)

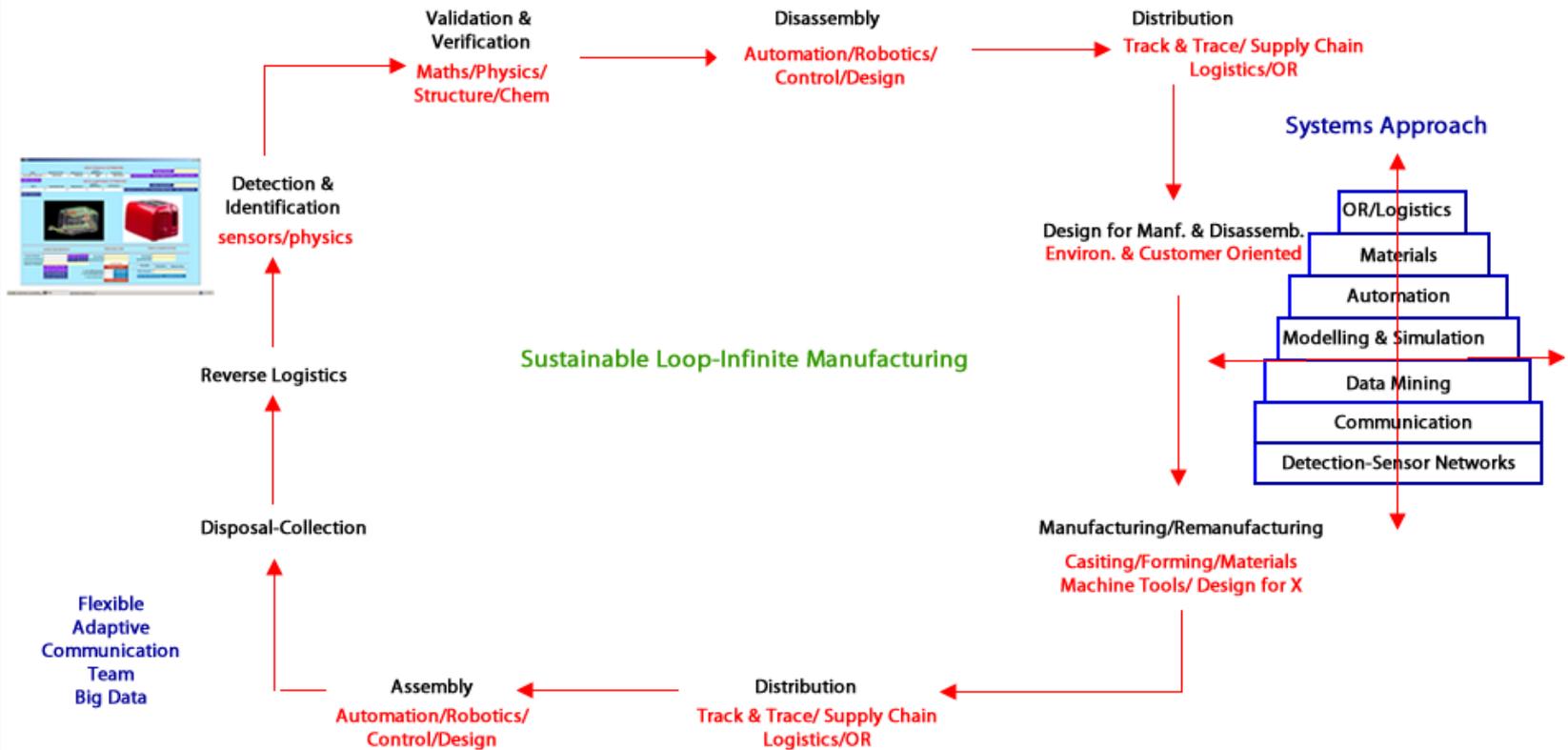
Sustainable Loop-Infinite Manufacturing (SLIM)



Systems Engineering Research Group (SERG)

Industry 4.0 Initiative

Industrie 4.0 Initiative



Green Design

Usage & Disposal

Tracking and traceability, recycling info

Distribution - Supply

**Operational research, management
Tracking and traceability**

Assembly

Manufacturing Systems

Design & Manufacture

**Env. & Customer Oriented Design
Design for Manf., Disassb, Society**

Distribution - Supply

**Operational research, management
Tracking and traceability**

Disassembly & Demanufacturing

Process Planning, Automation, Robotics

Validation & Verification

Analytical and Numerical methods

Measurement & Tracking

Measurements, integrity, traceability

Detection Technology

Sensors, detectors, pattern , BOM



Logistics

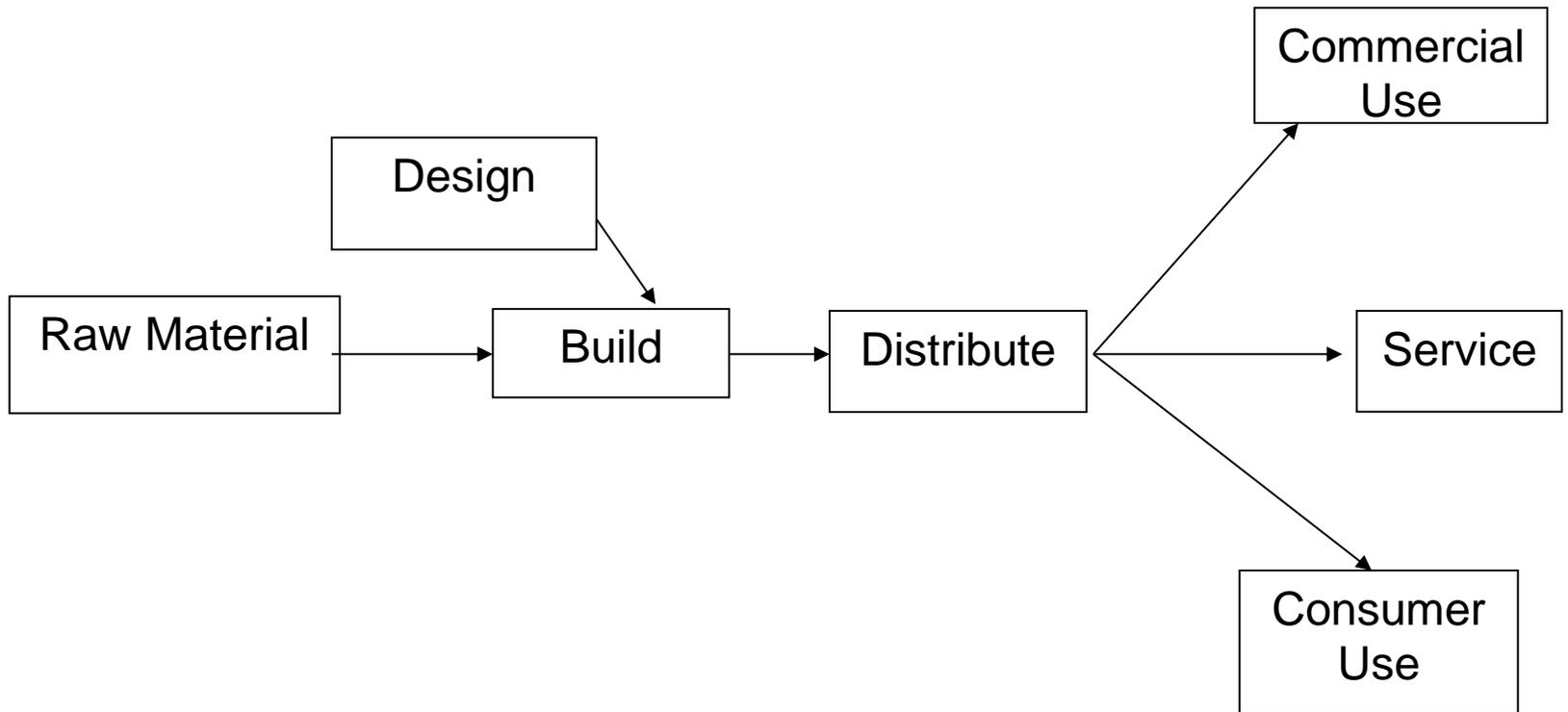
“The process of efficient planning, implementing, and controlling of cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements.” [The Council of Logistics Management]



Logistics and Reverse Logistics (RL)

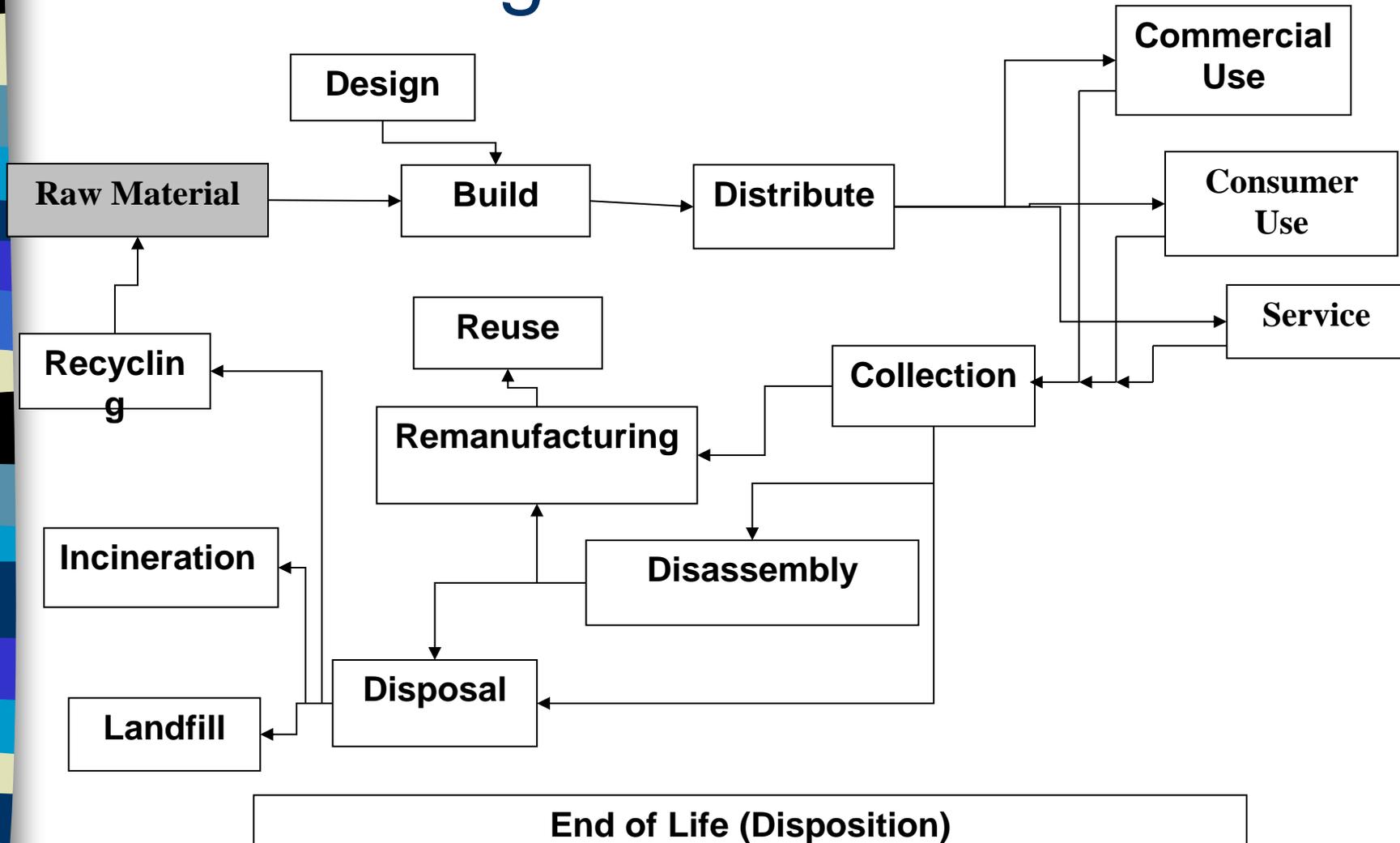
- Logistics is mainly concerned with optimising the flow of product from the point of origin to the point of consumption
- Reverse Logistics (RL) is the movement of goods from consumer towards producer in a channel of distribution

Schematic View for Logistics



Source: Grenchus E., Johnson S., McDonnell D. (2001), Improving the environment performance through reverse logistics at IBM, Global Asset Recovery Services, IBM Corp.

Reverse logistics





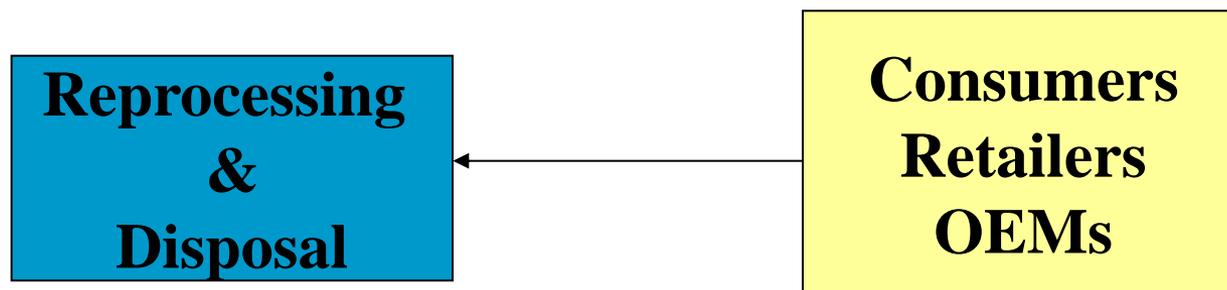
Types of RL

According to Blumberg et al (2003):

1. Basic RL
2. Closed Loop supply Chain: Integrated Direct, RL and repair service for high tech products
3. Closed Loop supply Chain: Independent Direct, RL and repair service for standard low tech products
4. Consumer-oriented Closed Loop supply Chain

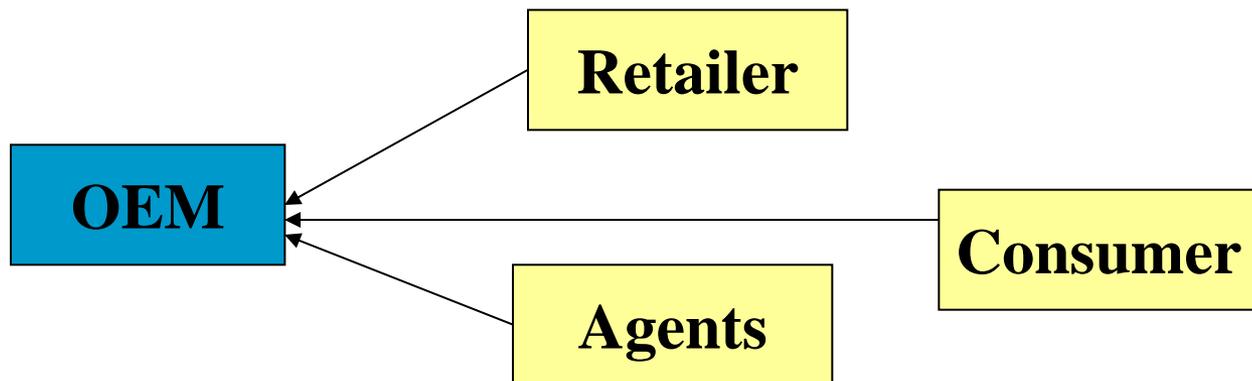
1. Basic RL

- Deals with unwanted returned products or materials to a central place for processing and disposal
- Operates independent of the direct supply chain
- Emphasis on the economic disposal of waste



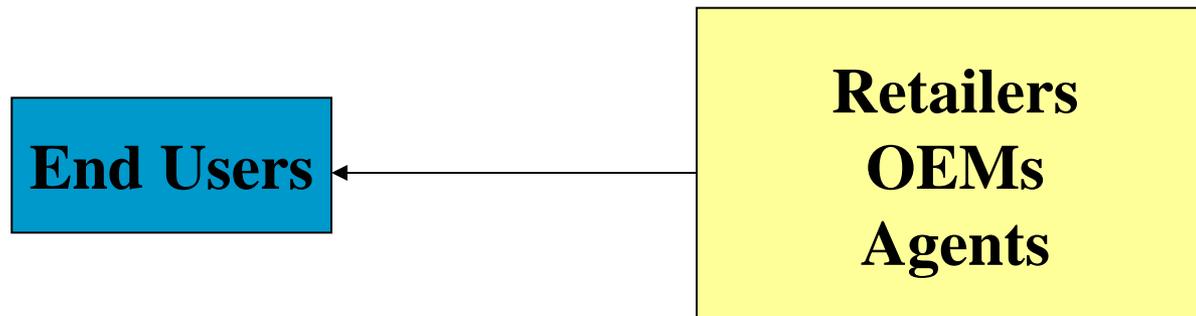
2. Closed Loop supply Chain high tech products

- The original equipment manufacturer (OEM) is responsible for the RL process
- The entire flow is controlled by the OEM
- The RL flow to depot will be to repair/reconfigure and re-supply or full disposal to secondary markets



3. Closed Loop supply Chain for low tech products

- The RL is normally controlled by the end user as opposed to the OEM
- In this model the buyer or user is a large organisation and has its own maintenance, service and supply chain in supporting its activities
- The end user takes most of the responsibilities of repair, reconfiguration, disassembly and recycling
- Independent supply chains



4. Consumer-oriented Closed Loop supply Chain

- Primary interaction is between the retailer and the OEM
- Handling of returned products (either by consumer or unsold products)
- Typical of consumer goods and recall processes





Interest in RL

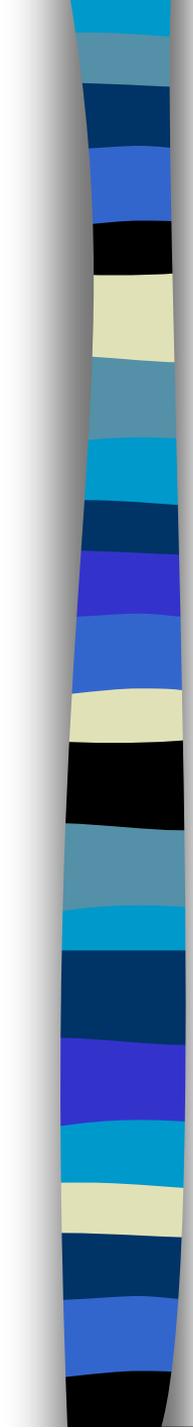
- Executives, managers and operational personnel involved in supply chain and reverse logistics
- Logistics and support organisations
- High tech companies that need to provide evidence of good environmental and business practice
- Consumer-oriented manufacturers, wholesalers , dealers, and retailers concerned with growing cost of inventory
- Enforcement of environmental laws and regulations on green practice
- Supply chain researchers and practitioners
- Technology developers, system modellers that need to control and manage such complex systems



Savings of up 3% of total revenue

By maximising inventory value through:

- Rapid returns to manufacturer for reuse
- Ability to liquidate products, parts and subassemblies with value in secondary markets
- Controlled recycling and disposition within environmental regulations
- Ability to efficiently process returns back into the original direct supply chain



Maximising inventory use in a CLSC with embedded RL process

Yields significant efficiency in distribution channels such as:

- Simplifying processes of retail and wholesale return
- Reducing undesirable shrinkage and damage from returns
- Increasing recovery of value
- Improving the visibility of the product during its life cycle (Tracking and traceability)
- Reducing disposition cycle times, thus increasing cash flow

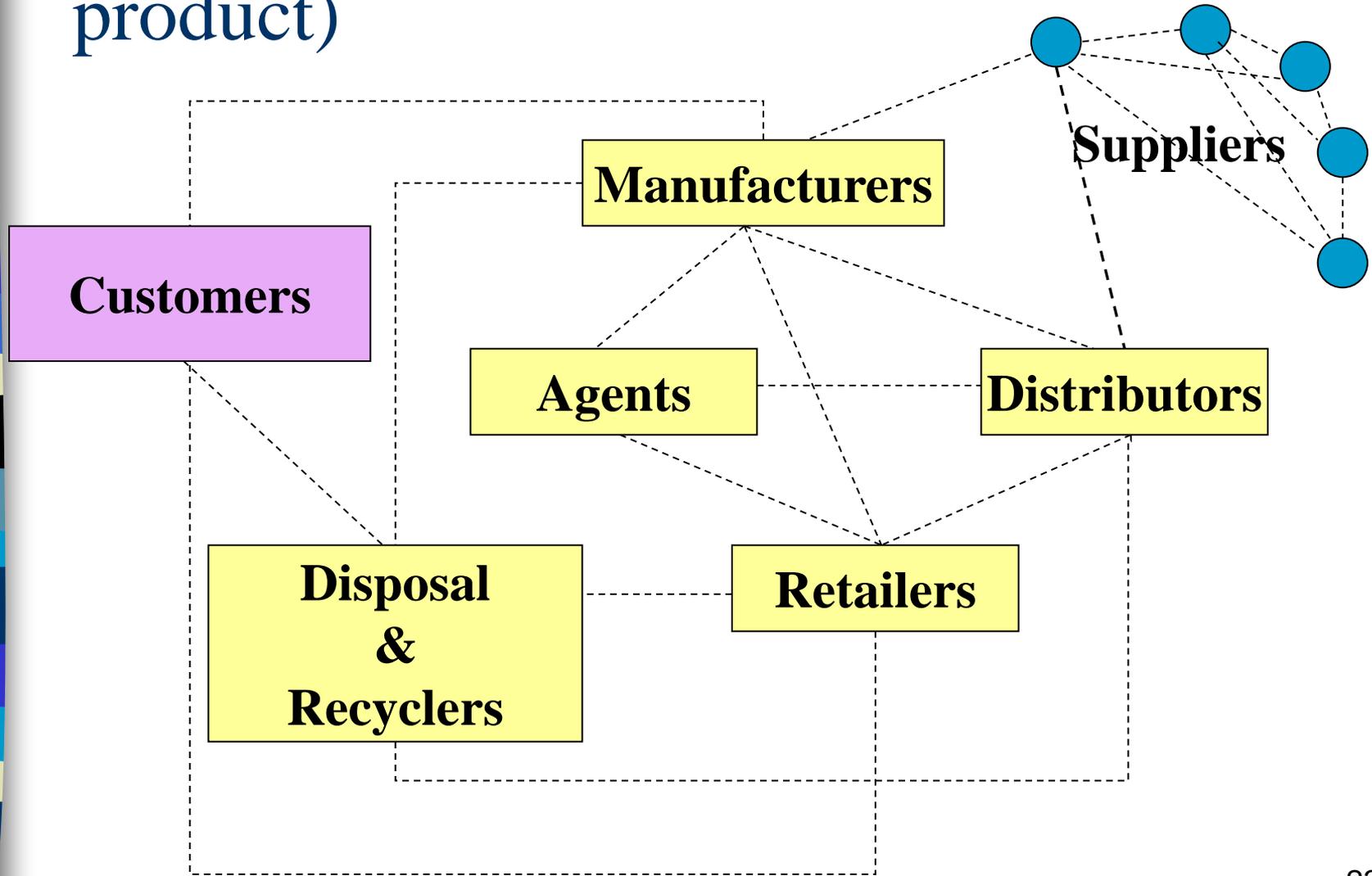


Supply Chain Management

A **Supply Chain** is a network of different organisations such as suppliers, retailers, distributors, agents, and manufacturers that cooperate (strategic or opportunist) to add value.

Supply Chain Management can be defined as a set of approaches utilised to efficiently integrate the supply chain so that the products or services can be delivered to the customer **at the right time, to the right place, with minimal cost to the maximum satisfaction** of customers

Supply Chain (flow of information & product)





Reverse Supply Chain (RSC)

- Product return has become a factor in supply chain flow management
- Companies are now assessed on their RSC/RL capability
- Up to 50% product returns and End-of-life regulations
- In specific large quantity of online sales



Return of product

- From the Supply Chain (defective or damaged)
- Reverse supply chain
- Waste stream (discarded)
- Major product recalls

5 steps of RSC

1. Product disposition
2. Reverse logistics
3. Inspection and disposition
4. Reconditioning
5. Sales



Modelling Approached to RSC (Rommert, 2003)

Topic	Methodology	Related traditional models
Product return forecasting	Time series analysis	Demand forecasting models
Reverse logistics network design	Mixed Integer Linear programming (MILP), stochastic programming, continuous approximation	Facility location models Logistics costs models
Production planning for product recovery	MILP, continuous optimisation	MRP, aggregate production planning
Inventory valuation	Net present value analysis	Economic Order Quantity (EOQ), stochastic inventory control models
Coordination in closed-loop supply chains	Game theory	Supply chain contracts
Stochastic inventory control in product recovery	Markov decision processes Stochastic optimisation	Stochastic inventory control models News vendor models



Importance and Challenges of Reverse Logistics Supply Chain

- Effective use of returns to maximise value of resources
- Large losses accrued due mishandling returned products (in US alone \$35-\$42 billion annually)
- Product return (RSC) is totally independent of the SC so every element should be well thought of and designed
- Without a proper RSC / RL model the costs would soar on the SC
- SC are designed for outbound flow – reverse may require a separate flow
- RL programme can reduce costs and increase customer satisfaction



Finally ...

- Environmental responsibility
- Reflect on systems that enables us to recycle manufactured products
- How a supply chain and reverse logistics system works
- Application of simulation a viable way of proving, monitoring and forecasting performance and yield
- Thus helping to assess the gains of better using and reusing resources.