

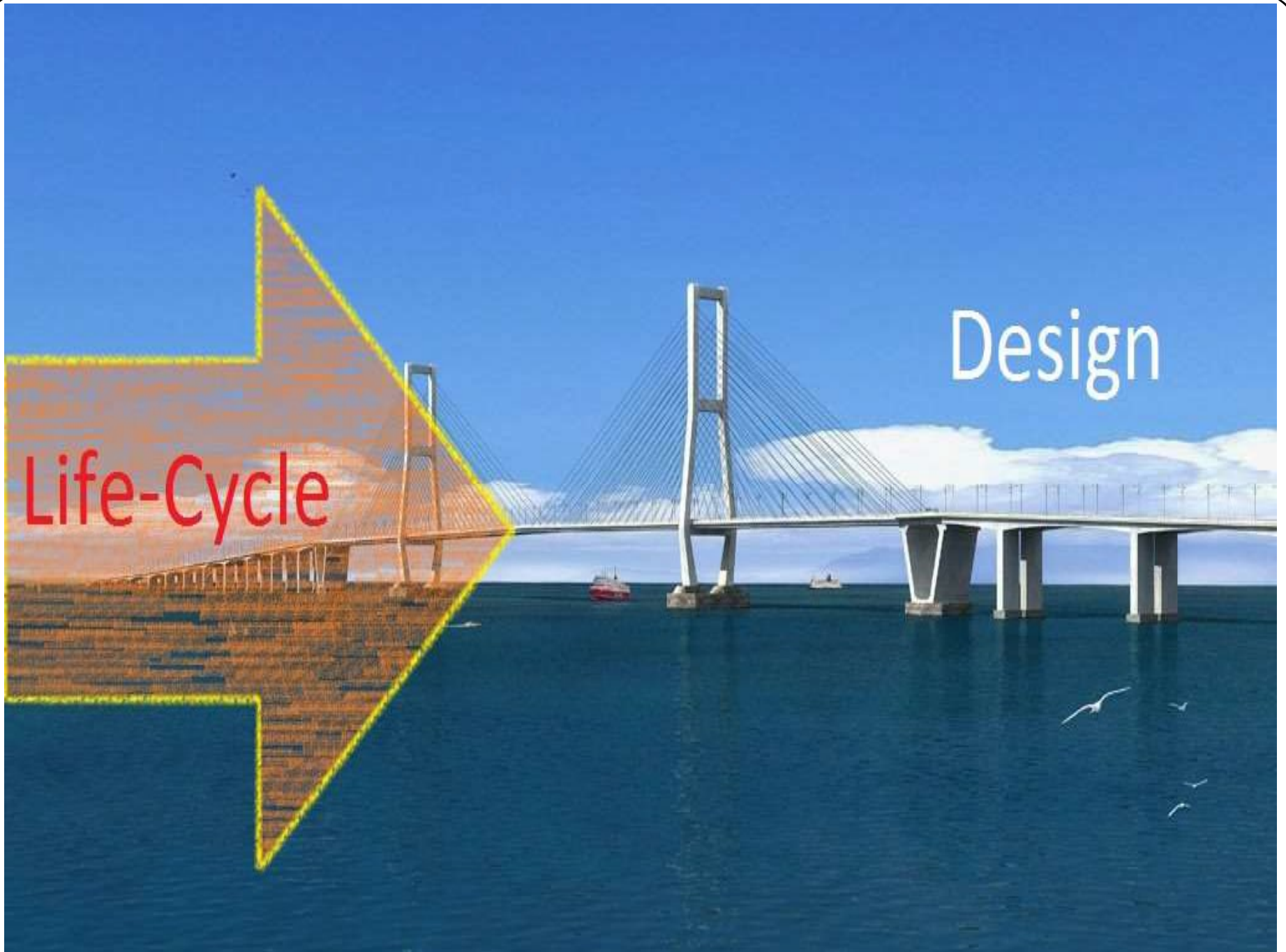
**Department of Mechanical Engineering**

**NIT Srinagar**

**Presented By- Dr. Abhijit Dey**



Design



# Content

- Introduction
- Design of recycling
- Life cycle management
- Life cycle chain
- Cost models

# Design for recycling

❖ Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. Recycling can benefit your community and the environment.

## **Benefits of Recycling**

- Reduces the amount of waste sent to landfills and incinerators
- Conserves natural resources such as timber, water and minerals
- Increases economic security by tapping a domestic source of materials
- Prevents pollution by reducing the need to collect new raw materials
- Saves energy
- Supports American manufacturing and conserves valuable resources
- Helps create jobs in the recycling and manufacturing industries in the United States

## **Steps to Recycling Materials**

Recycling includes the three steps below, which create a continuous loop, represented by the familiar recycling symbol

- Collection and Processing
- Manufacturing
- Purchasing New Products Made from Recycling Materials

Primary goal:  
**SUSTAINABILITY**  
(responsibility toward future generations)



Basic approach:  
**INDUSTRIAL ECOLOGY**  
(imitation of nature)



Imitation of ecosystem:  
**ECO-INDUSTRIAL PARKS**  
(closing material loops,  
energy efficiency)



In addition:  
**GREEN TECHNOLOGIES**  
(pollution avoidance rather  
than pollution treatment)



**DESIGN FOR ENVIRONMENT**  
(green design)

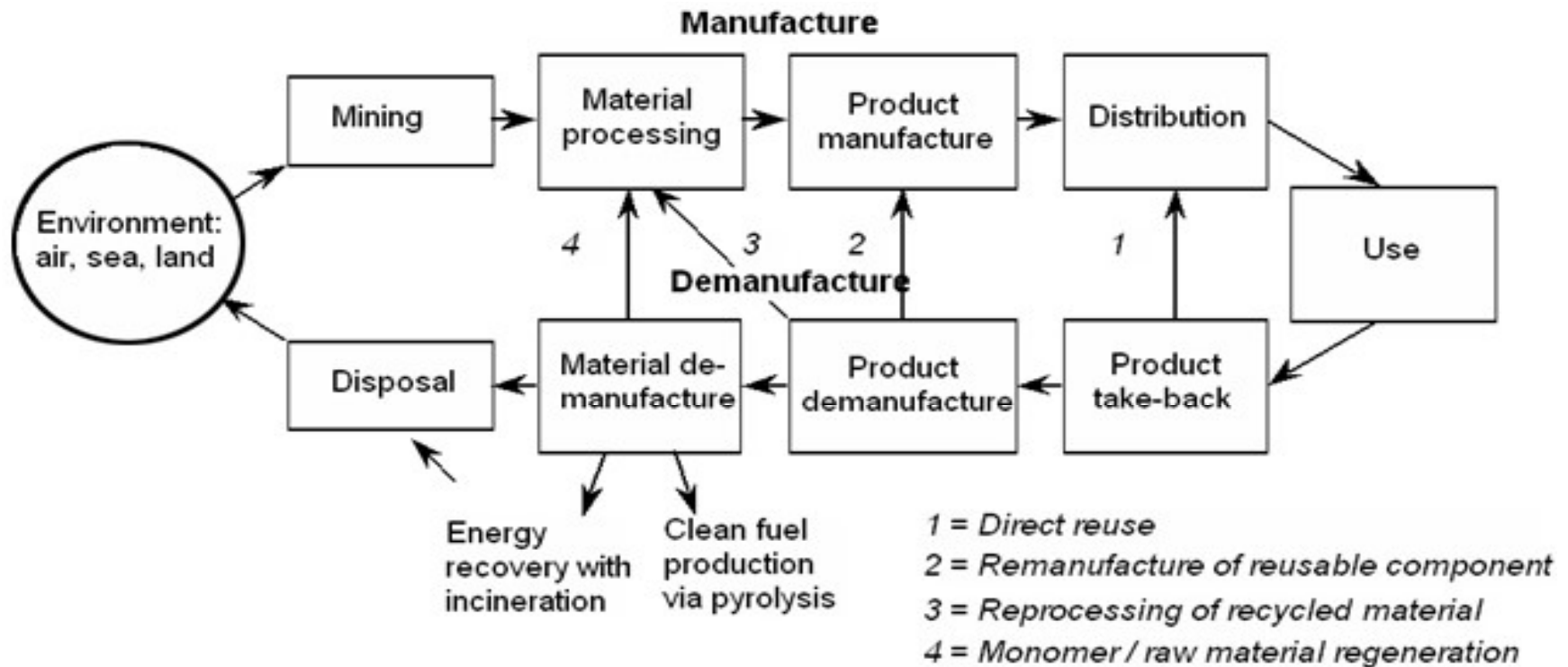


**DESIGN FOR RECYCLING**  
(to promote material loops)



**DEMATERIALIZATION**  
(doing with less)

# A product's Life cycle – From Cradle to Re-inclination



The term “demanufacture” is appearing more and more, especially in the electronics industry (DEC, Motorola, IBM), to characterize the process opposite to manufacturing involved in recycling materials and products. Companies (such as CinTech E-Waste) have sprung to corner the demanufacturing market.

# Growing Importance of DfR

- Dwindling resources
  - Landfill space, especially in (over) crowded Europe
  - Raw material (lesser short term importance)
- For example:
  - Currently, around 80% of electronics are being sent to landfills
  - The US National Renewable Energy Laboratory estimates that 30 billion lbs. (14 billion kg) of plastics end up being land filled each year, and only 1% of plastic waste is recycled.
- Social and political climate is changing
  - Big social and political push in Europe
  - Some states, US Congress and President may want to follow Europe's lead.



# European Take-Back Legislation

- European “Take-Back Law” requires automobile (and other) manufacturers to take back all vehicles (and other products) which were ever sold in that country.
- German regulation on electronic waste obliges the retailer to take back used electronic equipment from the end-user. The manufacturer/importer is obliged to take back the products from the retailer.
- Voluntary agreements have been widely accepted by industry and the threat of legislation has subsided slightly.





# European Union - Automobiles

- *Objectives:*
  - Avoidance of waste
  - Reduction of landfill demand
  - Reduction of toxicity
- *Recycling Targets:*
  - Maximum of 15% of car weight may be land filled or incinerated without energy recovery.
  - For models beginning in 2002, maximum of 10% disposal.
  - Maximum of 5% of car weight disposal in 2015.
  - From 1995, cars must be depolluted before shredding.
  - From 1998, 100% of all wrecks to be collected.
- *A dream for politicians and a nightmare for car manufacturers?*

Maybe, but:

In Europe, people are VERY serious about cleaning up the environment. The US is generally expected to follow European experience and successes.

In the US, 95% of automobile hulks are captured and recycled.

(For reference: 17 million new vehicles are sold each year in the US.)

As a result, 750



## The various steps in auto recycling



# Airplane recycling in France



Photos of stages of dismantling at the airport in Châteaubriant, France. It takes as long as six weeks to break down the average commercial aircraft.

- In the US, largest companies formed the **Vehicle Recycling Partnership** and the Vehicle Recycling and Dismantling Center in Highland Park to look at recycling issues.

More than 10 million vehicles are already recycled in the US annually.

The screenshot shows the website for the United States Council for Automotive Research (USCAR) Vehicle Recycling Partnership. The header includes the USCAR logo with the tagline "Enabling Technology for a Stronger America" and the full name "UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH". Navigation links for "ABOUT US", "NEWS & INFO", and "CONTACT" are visible. Below the header, logos for "DAIMLERCHRYSLER" and "Ford" are displayed. The main content area is titled "VEHICLE RECYCLING PARTNERSHIP" and includes a welcome message, a mission statement, and a list of goals. A news highlight section features a press release about CRADA teams recognized for award-winning collaboration in environmental innovation at Argonne, IL, dated March 7, 2007. A "Related Teams" sidebar lists the Casting Emissions Reduction Program, Manufacturing Emissions Committee, and the Vehicle Recycling Partnership.

USCAR Enabling Technology for a Stronger America  
UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH

Media Room | Search USCAR

ABOUT US NEWS & INFO CONTACT

DAIMLERCHRYSLER Ford

USCAR Home > TLCS / Teams >

## VEHICLE RECYCLING PARTNERSHIP

Welcome to the official Web page of the Vehicle Recycling Partnership (VRP).

### Mission

The mission of the Vehicle Recycling Partnership is to conduct collaborative research and undertake collaborative pilot programs that:

- promote an integrated and sustainable approach to improving the technical and economic feasibility of vehicle recycling in North America;
- promote an integrated and sustainable approach to improving the technical and economic feasibility of vehicle recycling for current and future vehicles produced by U.S. automakers for the global marketplace.

### R & D News Highlights

**Press Release: CRADA Teams Recognized for Award-Winning Collaboration in Environmental Innovation**  
ARGONNE, IL, March 7, 2007 - The U.S. Department of Energy's Argonne National Laboratory, the United States Council for Automotive Research's Vehicle Recycling Partnership and the Plastics Division of the American Chemistry Council have been awarded the Plastics Recycling and Sustainability Award in Enabling Technologies by the Society of Plastics Engineers for their work in the optimum recycling of plastics and other materials from end-of-life vehicles. [...] [Read More >>](#)

### Related Teams

- ▷ Casting Emissions Reduction Program
- ▷ Manufacturing Emissions Committee
- ▷ Vehicle Recycling Partnership

# Recovery Priorities

## Re-use:

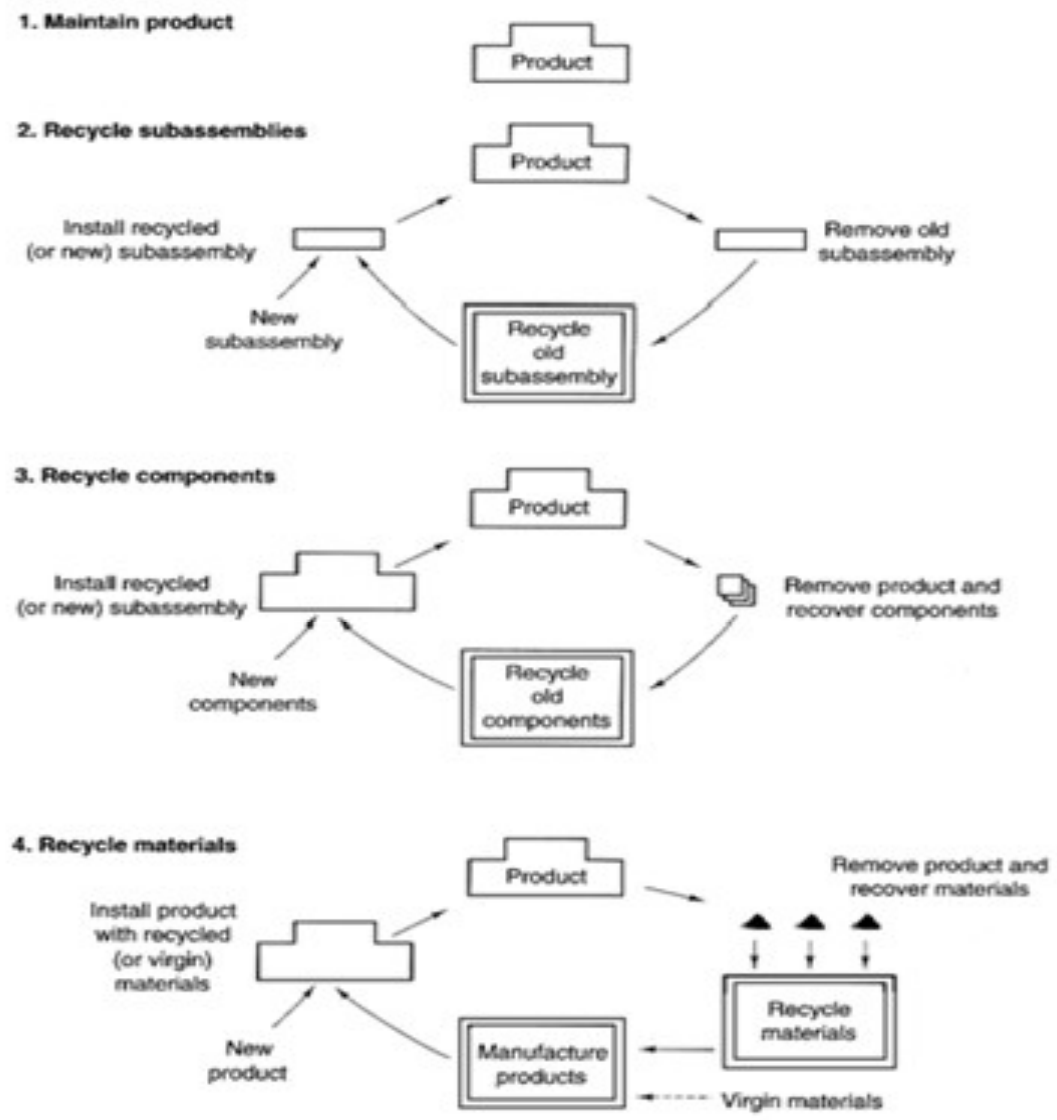
- Highest priority from environmental point of view
- All resources (material and energy) put into product during manufacturing are preserved.
- Requires non-destructive disassembly.

## Material recycling:

- Most common.
- Only materials are preserved, all geometric details are lost.
- Allows for destructive disassembly.
- Also done for recovery of valuable material (*ex.* gold in electronics)

## Energy recovery:

- Only energy embodied in materials is preserved through incineration or pyrolysis.



**Figure 8.1** The hierarchy of preference in recycling of industrial products. Recycling should generally be accomplished as high up the chain as possible. Dashed lines indicate alternatives discouraged in the practice of industrial ecology.

# Recyclables vs. non-recyclables

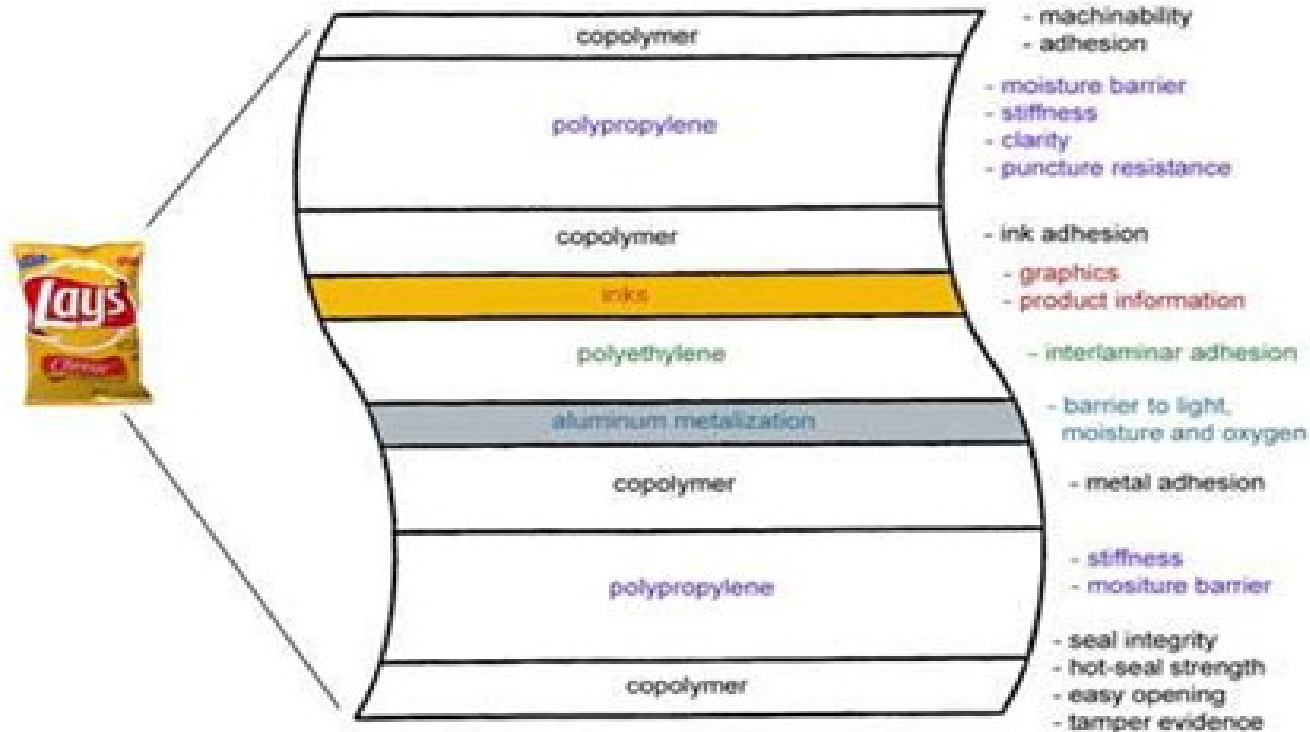
Class of Non-renewable material	Recycling Technically feasible?	Recycling Economically feasible?	Examples
I	Yes	Yes	Most industrial metals Catalysts, some solvents
II	Yes	No	Packaging materials Refrigerants, some solvents
III	No	No	Coatings, pigments Fuels, lubricants Pesticides, herbicides, fertilizers Reagents, explosives, detergents

Problem! None of these materials are renewable!



# Some products just can't be recycled!

Cross-section of a bag of potato chips



*Solution:* These products need to be redesigned to become recyclable.

- If separation can be performed, it is at a cost of energy.
- because the natural tendency of things is to mix rather than un-mix (second law of thermodynamics).
- There is a theoretical minimum amount of energy,  $E_{\min}$ , required to separate an element in concentration  $c$  in a containing material:

$$E_{\min} = -\frac{RT}{c} [c \ln c + (1-c) \ln(1-c)]$$

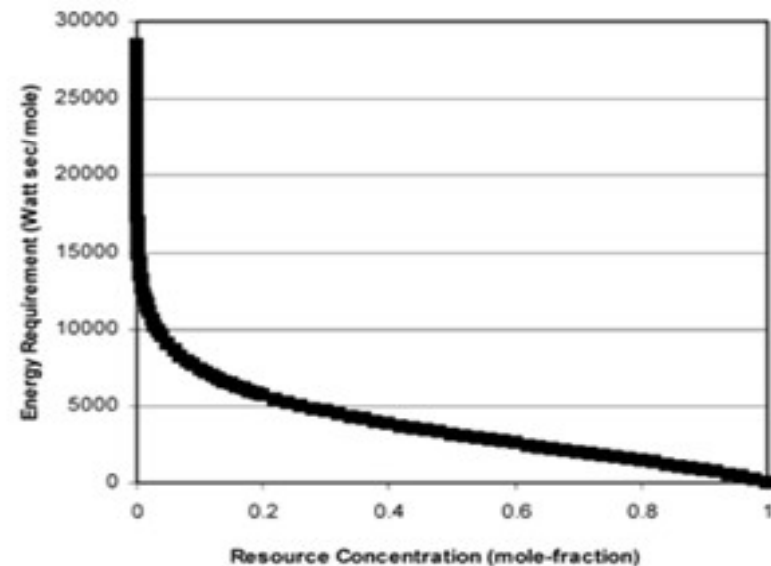
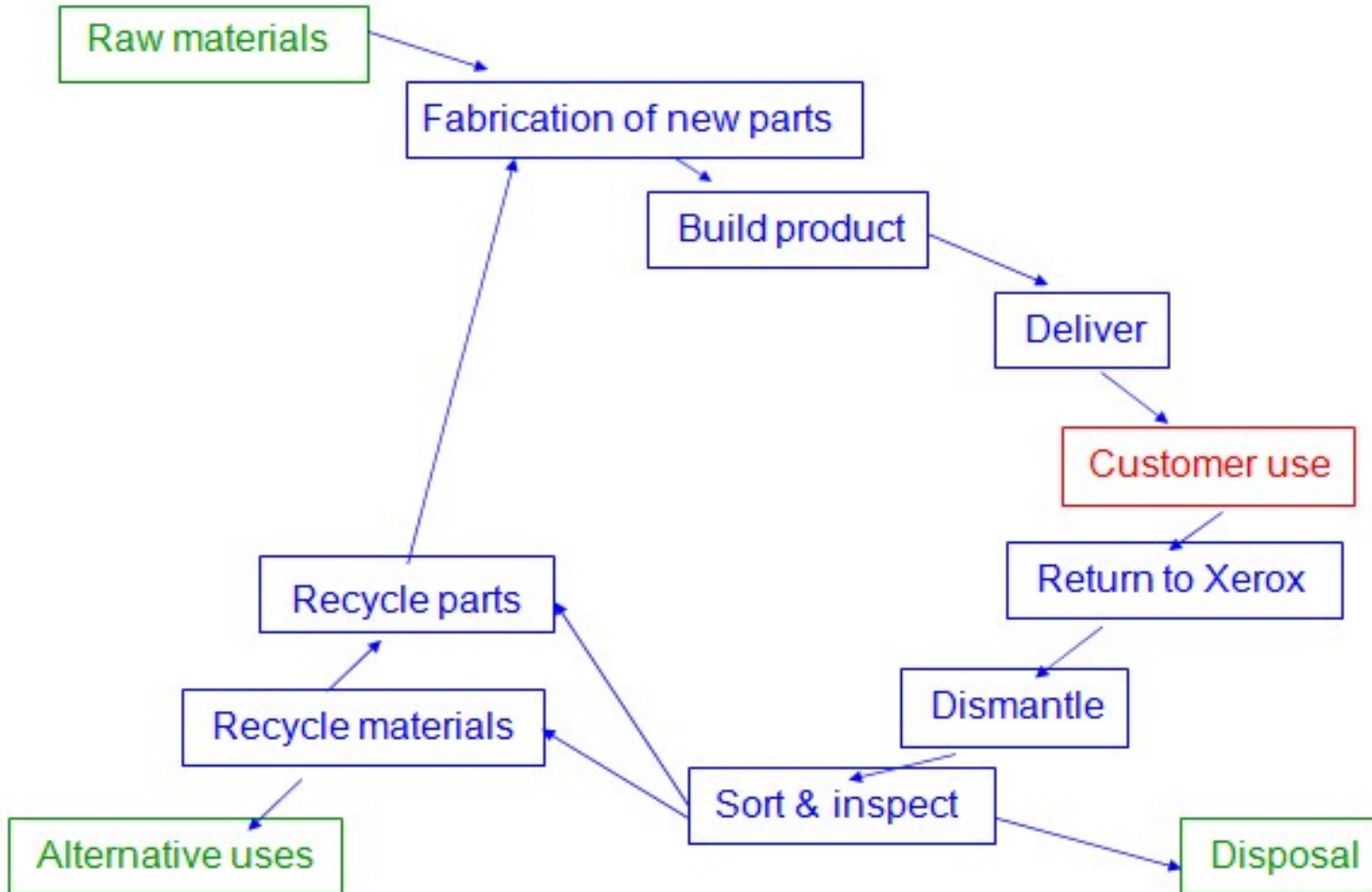
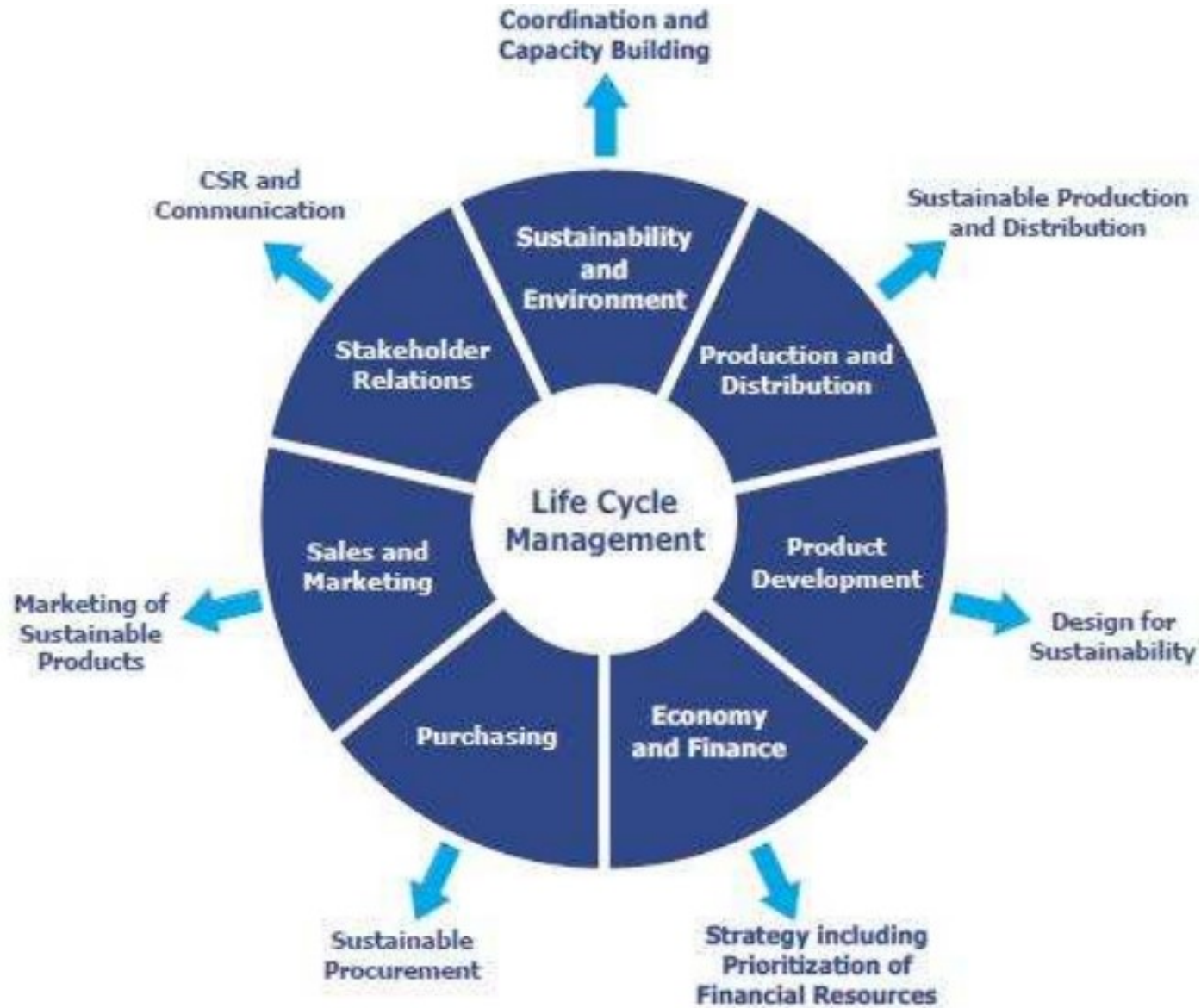


Fig. 2. Relationship between energy requirement and resource concentration at 273 K according to Eq. (1). (based on Fig. 4.5 in Faber et al. 1995)

# XEROX Equipment Recovery & Parts Reuse/Recycle Process



# Life-Cycle Management

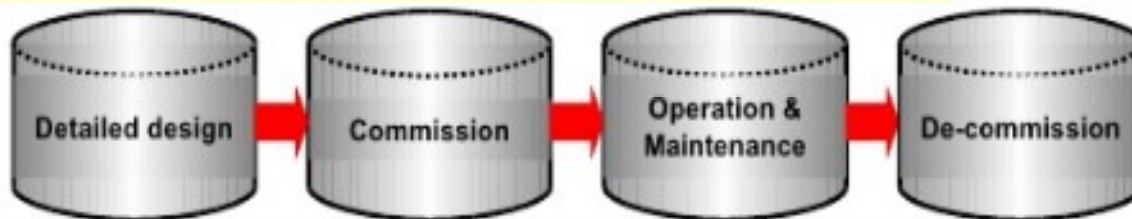


# Life cycle in manufacturing industry

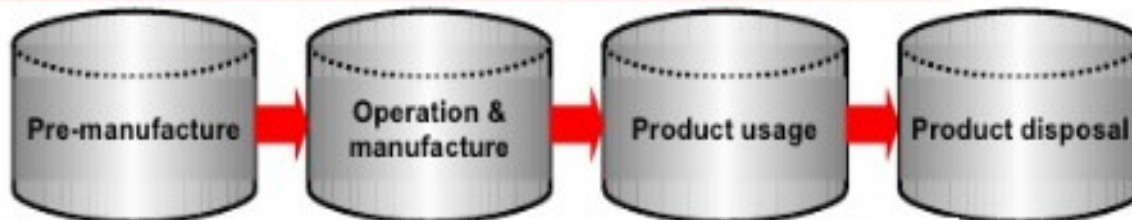
## Project Life Cycles – Drivers of Internal Change



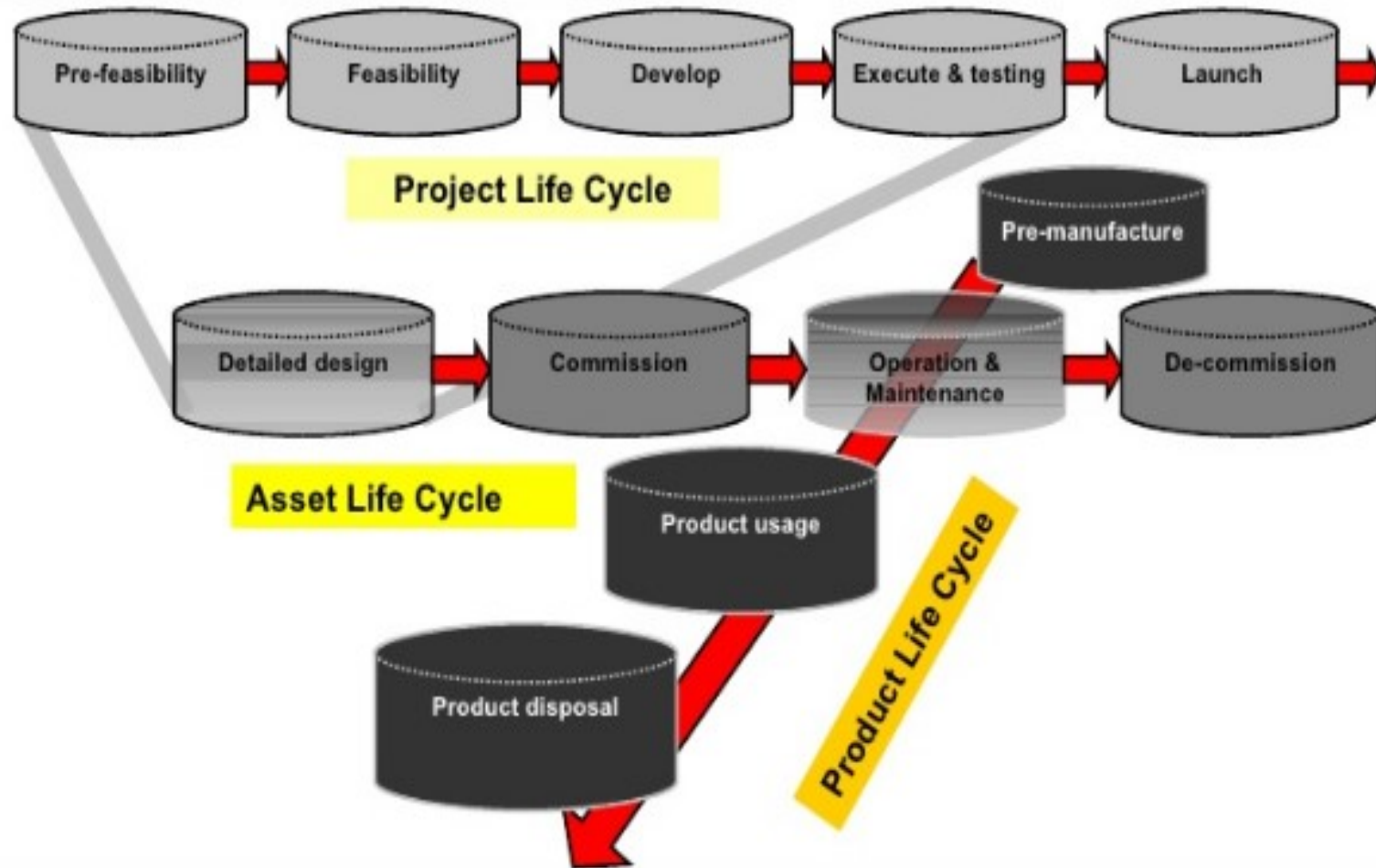
## Asset Life Cycles – Optimise Internal Operations



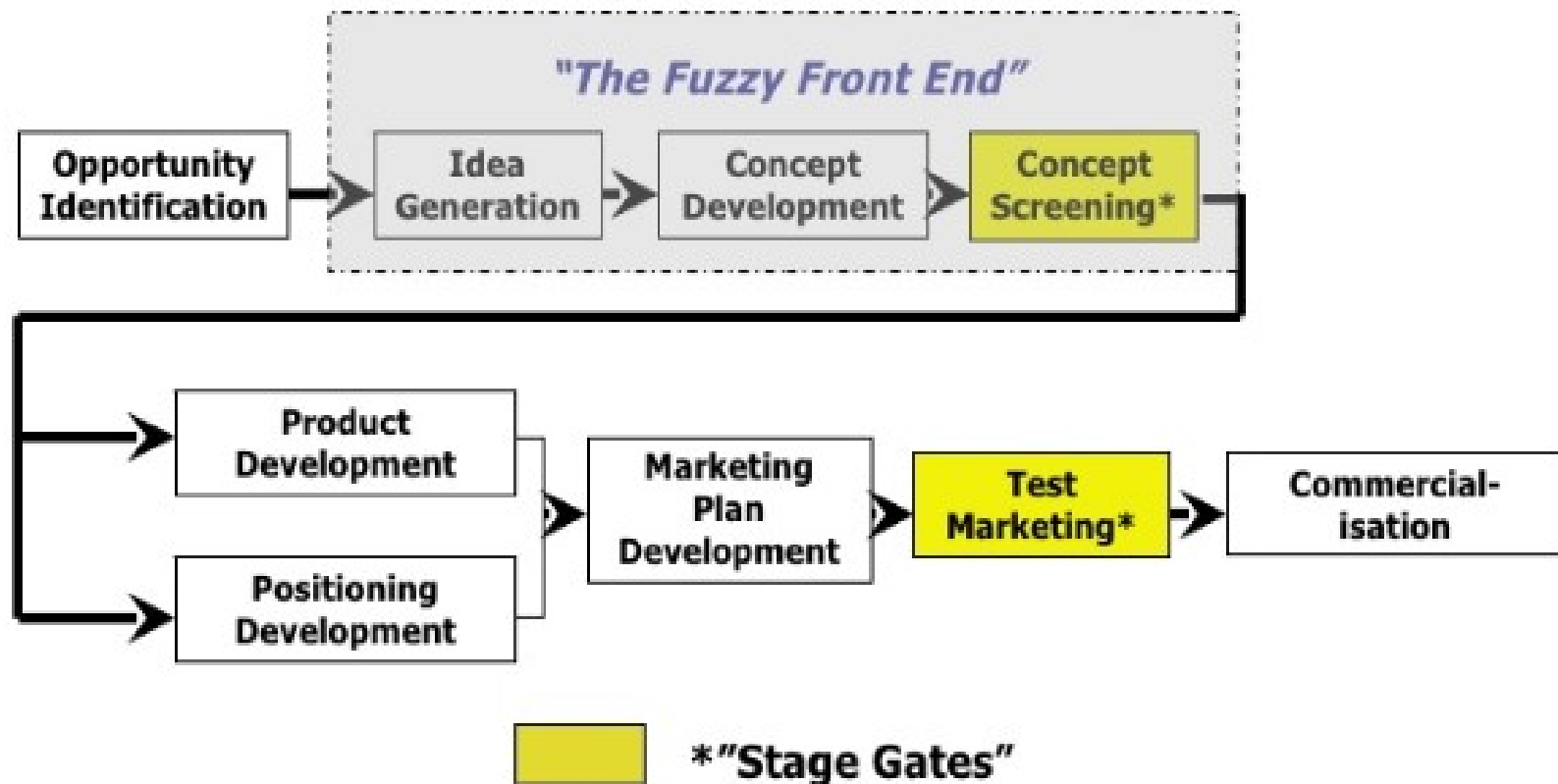
## Product Life Cycles – Profit generated from operations



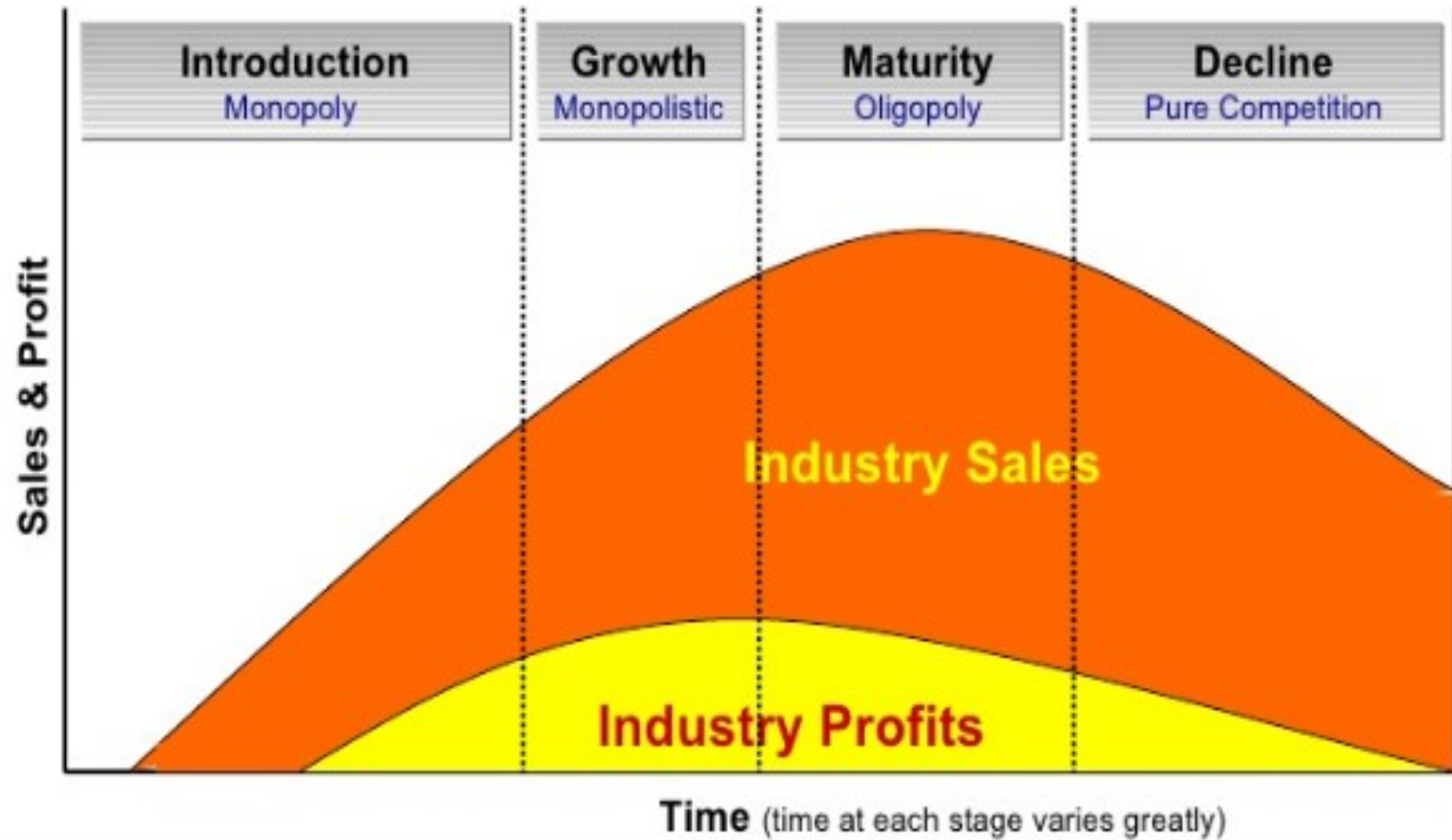
# Life Cycle Integration



# New Product Development Process

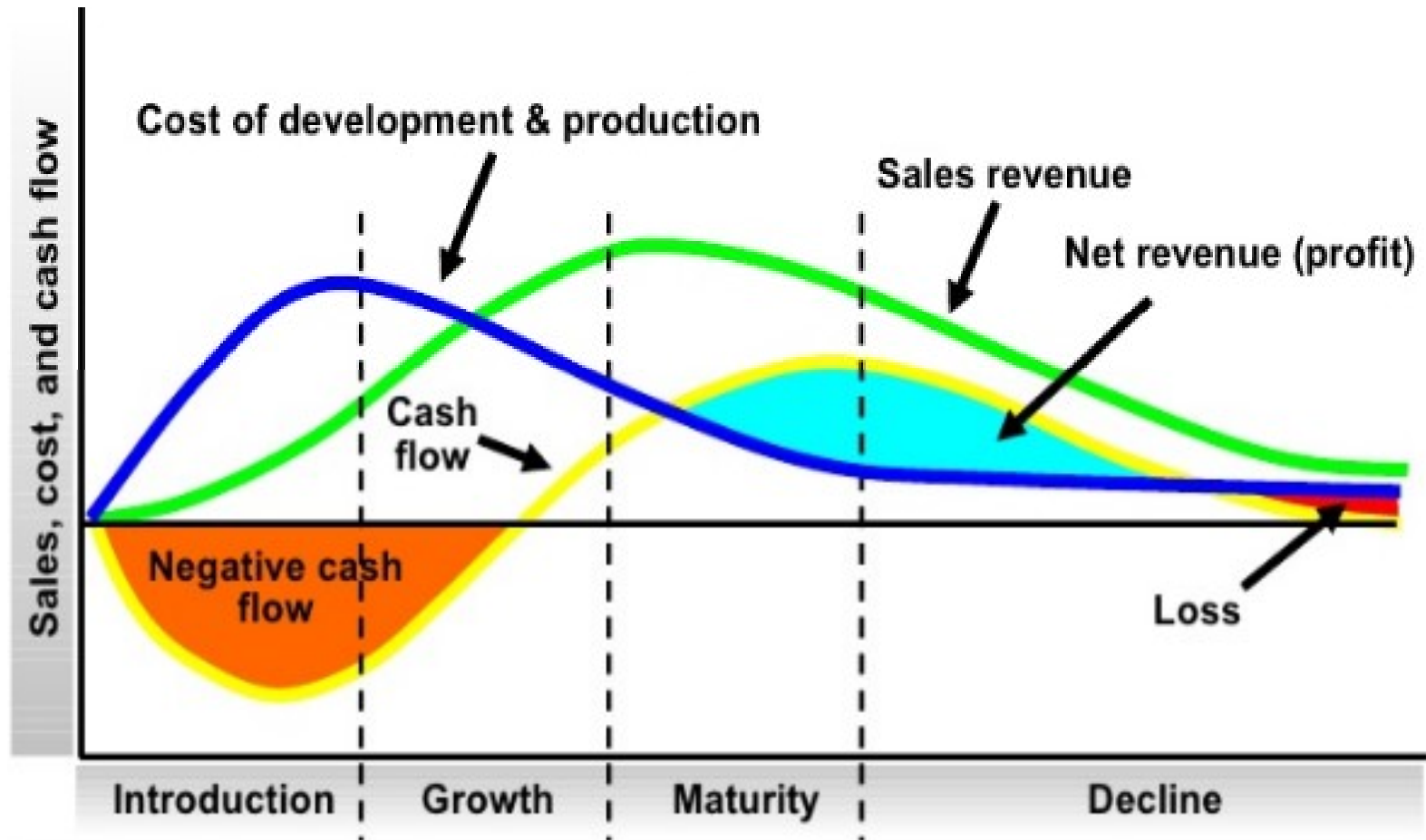


# Product Life cycle - Stages

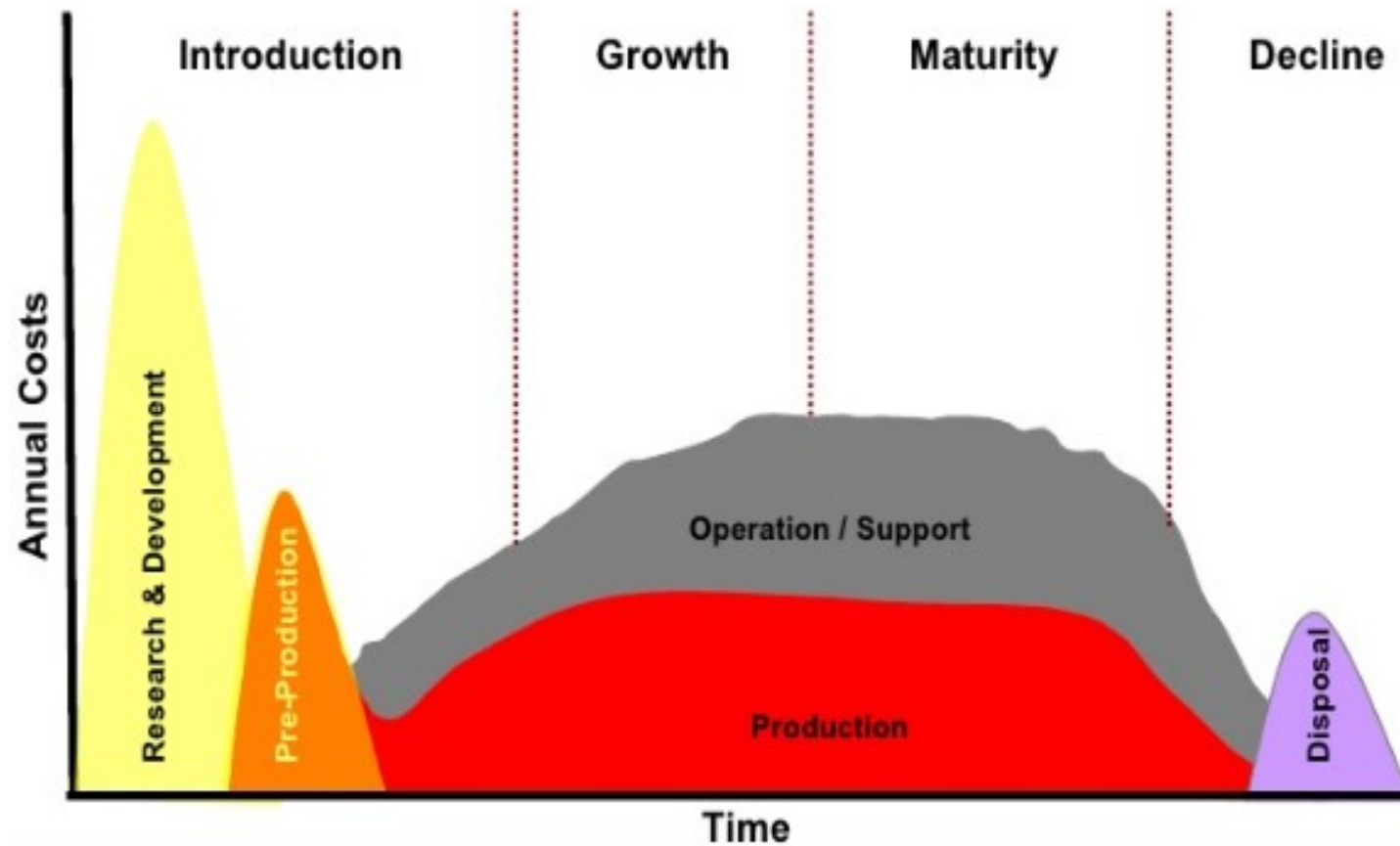




# Managing Product Life Cycle



# Product Life Cycle - Costs



# Product Life Cycle Management

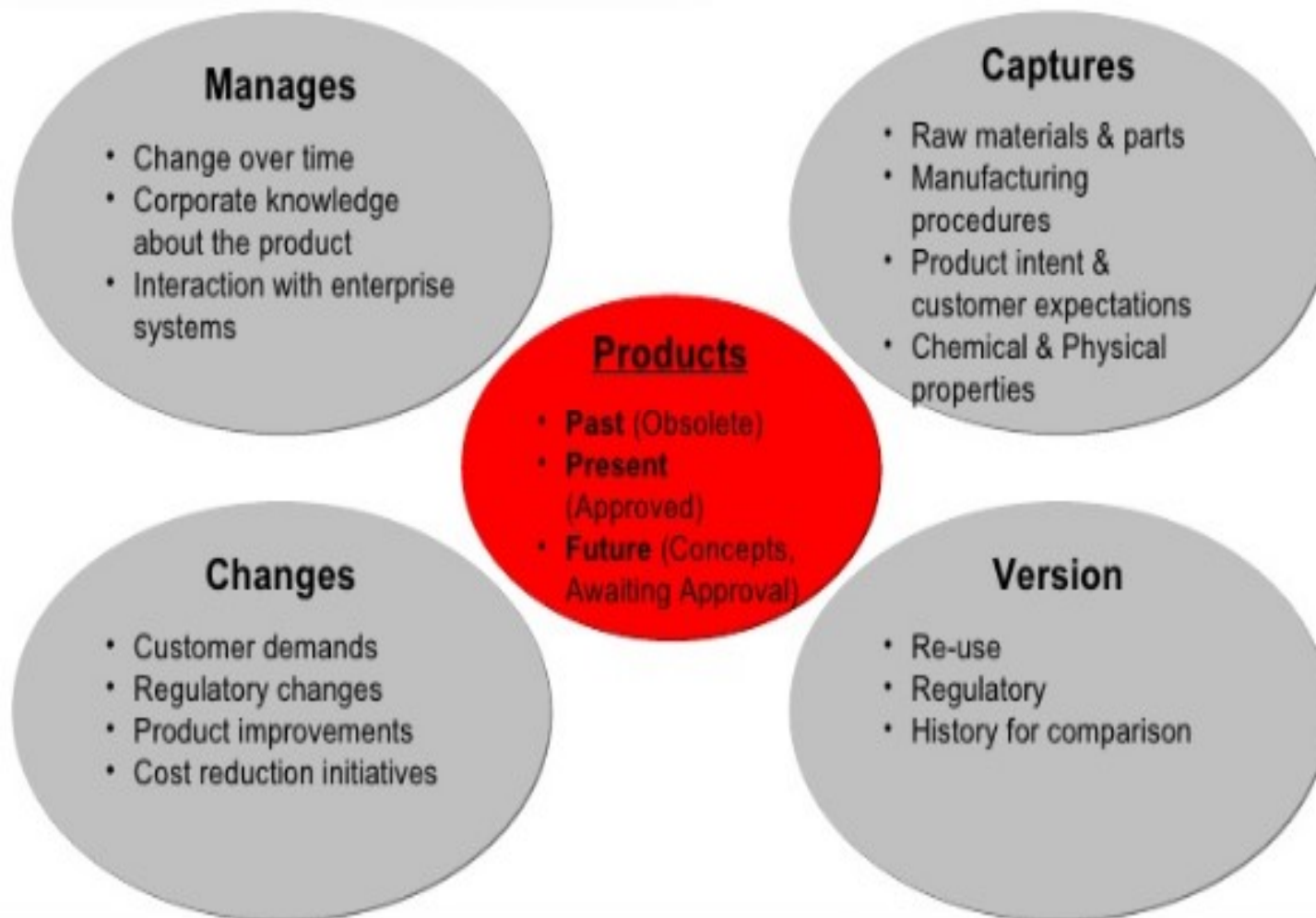
## Business Environment

- Globalisation
- Consolidation
- Market shakeout
- Economic challenges
- Increased competition
- Limited capital funding
- Product customisation
- Changing global security
- Outsourcing scope widening
- Protect Intellectual Property

## Business Objectives

- Optimise supply chains
- Increase market share
- Innovation & Sustainability
- Drive short-term profitability
- Manage product complexity
- Improve customer satisfaction
- Integrate Product Data Systems
- Improve liquidity / cash reserves Increase quality / reduce costs
- Improve speed / time to market
- Design, build, and maintain anywhere & anytime
- Build end-to-end processes & systems

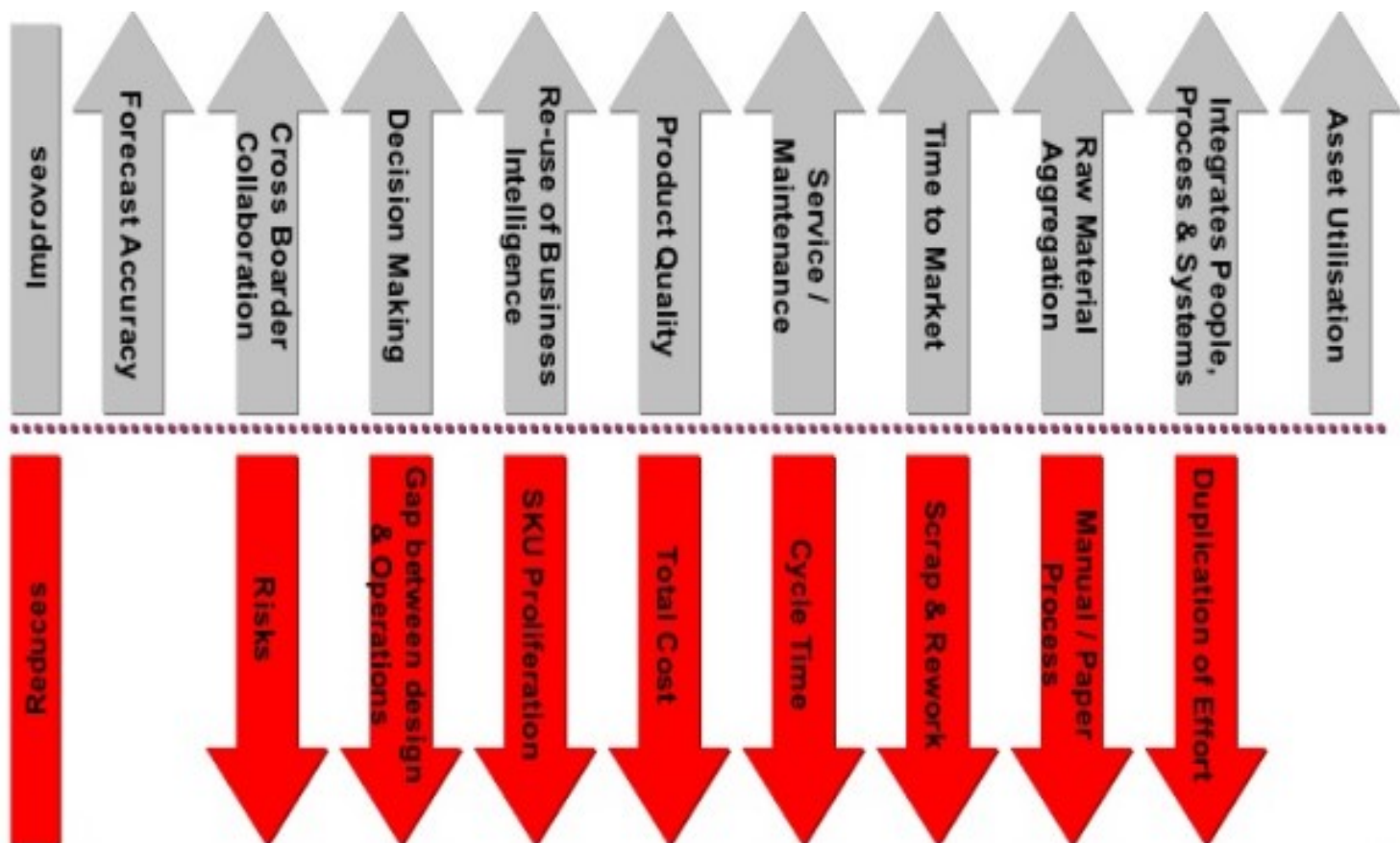
# PLM - Speed to Market



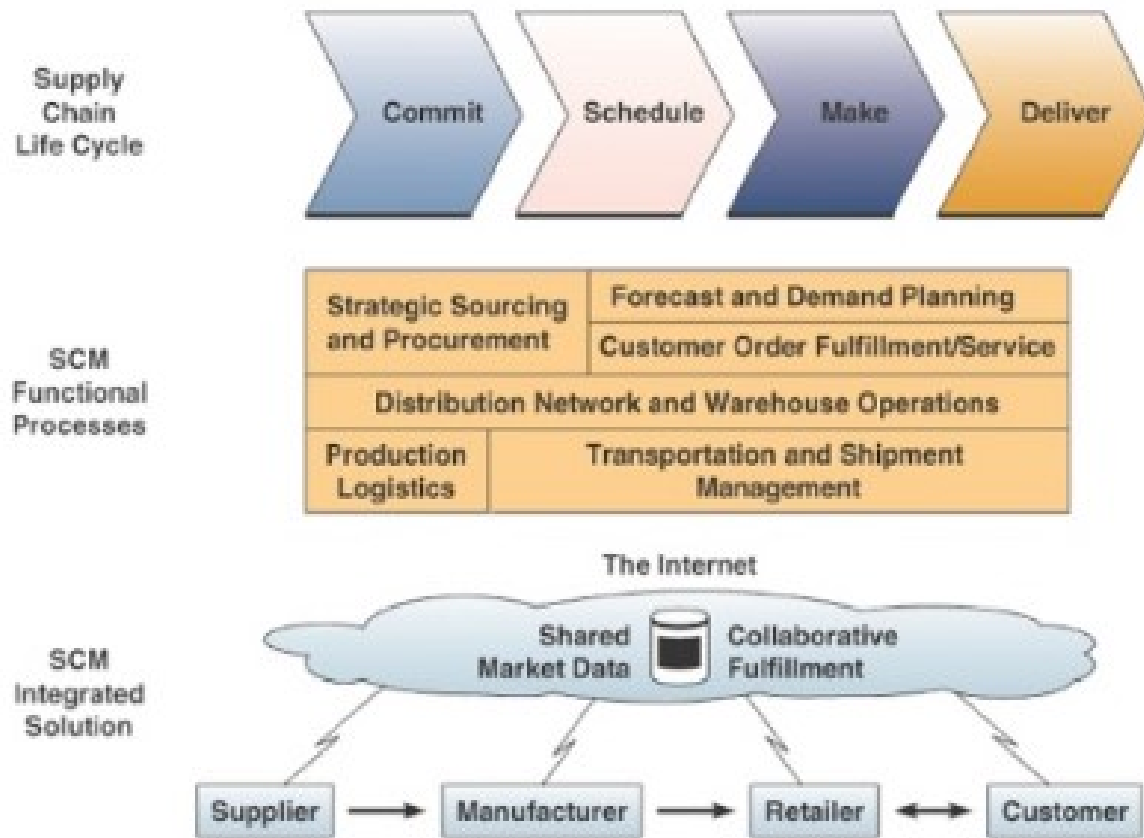
# Business Drives for PLM



# Benefits of PLM



# Life cycle chain



# Life Cycle Costing Model

LCC model is an accounting structure containing terms and factors which enable estimation of an assets component costs.

- **The LCC model should:-**
  - Represent characteristics of the assets being analyzed
  - It should be comprehensive
  - It should be easily understood



# Life Cycle Costing Process

- Determine time for each cost element.
- Estimate value of each cost element.
- Calculate Net Present value of each element, for every year.
- Calculate LCC by adding all cost element, at every year
- Analyze the results

# Find Costing Models?

- ❖ Manufacturing cost
- ❖ Maintenance coast
- ❖ Initial cost
- ❖ Cost of environment
- ❖ Cost of recycling

**THANK  
YOU**