Outline – CLSC

• Class 1
  – Description
  – Motivation
  – Examples
  – Problems
  – Solution approaches
Outline – CLSC

• Class 2
  – Solutions to Problems
    • Supply Control
      – Product Acquisition Management
      – Design, Accessibility and Life Cycles
    • Operational Control
      – Testing, Sorting and Disposition
    • Market Control
      – Commercial Returns & Time Value
      – Competition Strategy

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Outline – CLSC

• Class 3
  – Evolution of CLSC Research
  – Lessons Learned
  – Current Trends
  – Suggestions
Class 1

Introduction to Closed-Loop Supply Chains

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Closed-Loop Supply Chains

• Supply chains that are designed and managed to explicitly consider the reverse and forward supply chain activities over the entire lifecycle of the product.
Traditional, Open-Loop Supply Chain

Raw Materials → Manufacturing → Distribution → Reseller or Customer → Sales

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A Closed-Loop Supply Chain

Raw Materials → Manufacturing → Distribution → Reseller or Customer

- Commercial Returns
- Return Stream
- Returns Evaluation
- Secondary Market

Spare Components

Spares Recovery

Remanufactured product

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Examples of Closed-Loop Supply Chains

• Containers (cameras, toner cartridges)
• Industrial remanufacturing (copiers)
• Consumer electronics (mobile telephones)
• Product life extension (jet engines, aircraft)
• Tire re-treading (passenger and commercial)
• Telecommunications (circuit packs and routers)
Why CLSC?

• Product Returns!
• How to handle product returns?
Woman about to smash a cathode ray tube from a computer monitor in order to remove the copper laden yoke at the end of the funnel. The glass is laden with lead but the biggest hazard from this is the inhalation of the highly toxic phosphor dust coating inside. Monitor glass is later dumped in irrigation canals and along the river where it leaches lead into the groundwater. The groundwater in Guiyu is completely contaminated to the point where fresh water is trucked in constantly for drinking purposes. Guiyu, China. December 2001. Copyright Basel Action Network.
Two different Return Streams

- Waste-driven
- Market-driven
Product Returns

• Producer Responsibility Laws
  – Popular in the EU
    • Electronics
      – computers, mobile phones, consumer appliances
    • Automobiles
    • Other durable goods

• These may be referred to as waste-stream driven returns
Product Returns

• Many remanufacturing firms actively influence product returns by providing incentives for the return of products
  – Incentives include:
    • Deposits
    • Cash paid for a specified level of quality
    • Trade-in

• These may be referred to as *market-driven* returns
Product Returns

• These two views result in extremely different behavior towards of reuse activities.

• A *waste stream* approach:
  – Fundamental issue: minimize the amount of money the firm loses

• A *market-driven* approach:
  – Reuse is a profitable economic proposition
Product Returns

• A *waste stream* approach will have, on average, returns of *lower quality.*

• These returns will have *larger variances* in quality, quantity, and timing.
Operational Characteristics

Waste Stream

Sort & Test (based on Q)
Conditions:
• High inventory
• Large facility
• High leakage (disposal)

Disposal

Remanufacture
Conditions:
• High WIP
• Low utilization
• Highly variable lead times
• Complex condition based routings
• Highly variable processing times

Products

Case 1: Waste Stream

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Operational Characteristics

Market-driven

Staging Conditions:
- Low WIP
- No testing

Sort, test & grade
Done by seller

Disposal

Remanufacture
Conditions:
- Low WIP
- High utilization
- Stable short lead times

Case 2: Market Driven

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Again: Why CLSC?

- Product Returns!
- How to handle product returns?
- Can we make profit?
- Or should we minimize the costs?
- How to decide then?
Types of Product Returns

- Commercial returns
  - 30- to 90- day free returns policy in the US
  - Policies not as free in Europe (mostly 7 days) – Internet and catalogue sales are more liberal
  - HP – total costs ~ 2% of gross sales dollars annually
  - Bosch Power Tools: ~ 2.6% of sales
  - Total cost estimated at >$100 billion in the United States alone
- Repair/Warranty returns
- Leasing
Types of Product Returns

• End-of-use returns
  – Cell phones
    • Over 1 billion cell phone handsets in use world-wide in 2002
    • Replacement rate: 80% after first year of use

• End-of-life returns
  – Mandatory take-back requirement in the European Union
    • WEEE (Waste Electronics and Electrical Equipment) Legislation

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Assessing the Economic Attractiveness of Reuse Activities

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Basic CLSC Activities

• Remanufacturing
  – In the U.S. > 100,000 firms
  – Annual sales estimate > $200 billion
  – Direct employment > Steel Industry

• Direct Reuse:
  – 2nd hand markets?

• Recycling

• Disposal

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Key Activities

• Product returns management
  – Product acquisition
  – Reverse logistics
  – Test, sort, grade, and disposition

• Remanufacturing/reconditioning operational issues
  – Repair
  – Remanufacture
  – Recycle

• Remarketing
  – Distribution
  – Sales
  – Reuse
Closed-Loop Supply Chains

- **Product Acquisition** – the acquisition of used (discarded) products that serve as the input to a reuse system.
  - Classic assumption: Product return rates are an exogenous process, and cannot be controlled by the firm.
Closed-Loop Supply Chains

• Reverse Logistics
  – The process of planning, implementing, and controlling the inbound flow and storage of goods and related information for the purpose of recovering value or proper disposal.
Closed-Loop Supply Chains

• Test, Sort, Grade and Disposition
  – The disposition choice is determined by the most profitable alternative:
    • Repair
    • Refurbish
    • Remanufacture
    • Recycle
    • Dispose
Closed-Loop Supply Chains

• Reselling-Remarketing
  – New market creation
  – Consumer attitudes
  – Market cannibalization
### How hard are these key activities?

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<tr>
<th>Product Life Extension ⇒ Jet engines</th>
<th>Product Acquisition</th>
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Economics of Product Reuse

• We develop a simple method for determining the economic attractiveness of reuse activities.  
  – Is reuse a value creating activity for a firm?

• We reject the idea that firms must passively accept product returns and show that a system for control exists
Solution: A Business Process Approach

• Need to remove bottlenecks (acquisition, remanufacturing, remarketing)
• Need to optimise as a global process with a view on maximising value recovery (as opposed to cost minimisation)
• Need to consider time value of the product over its lifecycle
Solution: A Business Process Approach

• Product acquisition is a major driver of success
• Creating effective remarketing channels is another major driver
• Research emphasis has largely been on reverse logistics, disassembly and remanufacturing operations

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Solution: A Business Process Approach

- Remanufacturable Product Supply Control
- Remanufacturing Operational Issues
- Remanufactured Products Market Development
Value Creation: End-of-Use Returns

• Some examples of current supply chains
A Closed-Loop Supply Chain for Cartridge Reuse

Supplier

Manufacturer

Retailers

Customers

Forward Flows

Reverse Flows

Pre-paid mailers

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A Closed-Loop Supply Chain for Single-Use Cameras

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Characteristics of Closed-Loop Supply Chains for Refillable Container

- Commodity goods
- Containers for consumables
- High volume
- Low variability
  - Volume
  - Quality
- Non-distinguishable products
- Simple products
- OEM controlled
- Short lead times

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Closed-Loop Supply Chains for Refillable Container

• Basic Issues:
  – Return Acquisition
  – Reverse Logistics
  – Competition

• Solutions:
  – Supply Control
  – Logistics Setting
  – Entry deterrence
A Closed-Loop Supply Chain for Photocopiers

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Characteristics of Closed-Loop Supply Chains for Industrial Remanufacturing

- High variability
  - Timing
  - Quality
- Stable production technology
- Limited volumes
- Modular design
- Imbalances in supply and demand
- Cannibalization
Closed-Loop Supply Chains for Industrial Remanufacturing

• Basic Issues:
  – Cannibalization
  – Variability

• Solutions:
  – Leasing
  – Secondary Markets
A Closed-Loop Supply Chain for Cellular Telephones

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Characteristics of Closed-Loop Supply Chains for Cellular Telephones

- Dynamic spot markets for supply and demand
- High volumes
- Perishable good
- High information requirements
- High variability
  - Quality
  - Timing
- Cascade reuse opportunities (worldwide market)
Closed-Loop Supply Chains for Cellular Telephones

- **Basic Issues:**
  - Cannibalization
  - Competition
  - Variability

- **Solutions**
  - Acquisition Management
  - Secondary markets
  - Speed (Sell as is)
A Closed-Loop Supply Chain for Passenger Tire Retreading

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A Closed-Loop Supply Chain for Commercial Tire Retreading

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Characteristics of Closed-Loop Supply Chains for Tire Remanufacturing

Passenger tires
- High volumes
- High variability
  - Quality
  - Timing
- Poor image
- Limited markets

Commercial tires
- High volumes
- Information requirements

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Closed-Loop Supply Chains for Tire Remanufacturing

• Basic Issues:
  – Passenger: Image
  – Passenger: Variability
  – Commercial: Disposition

• Solutions:
  – Passenger: Market creation
  – Passenger: Acquisition management
  – Commercial: Installed Base Management
Next Class:

– Solutions to Problems
  • Supply Control
    – Product Acquisition Management
    – Design, Accessibility and Life Cycles
  • Operational Control
    – Testing, Sorting and Disposition
  • Market Control
    – Commercial Returns & Time Value
    – Competition Strategy