REVERSE LOGISTICS

impact, trends and issues

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CONTENTS

- introduction reverse logistics

- macro-economic impacts
recycling / remanufacturing / re-use

- reverse logistics operations management:
issues and results

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Partners

- Erasmus University Rotterdam (NL)
- Eindhoven University of Technology (NL)
- INSEAD, Fontainebleau (FR)
- University of Magdeburg (GE)
- University of Thessaloniki (GR)
- University of Piraeus (GR)

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REVLOG

http://www.fbk.eur.nl/OZ/REVLOG

Objectives

Study reverse logistics and its effects on industry

Reverse logistics aspects studied

- Production planning / inventory control
- Distribution
- Business economics (marketing, accounting, etc)
- Information technology
- Environmental aspects

Reverse Logistics

Options for returned or discarded products

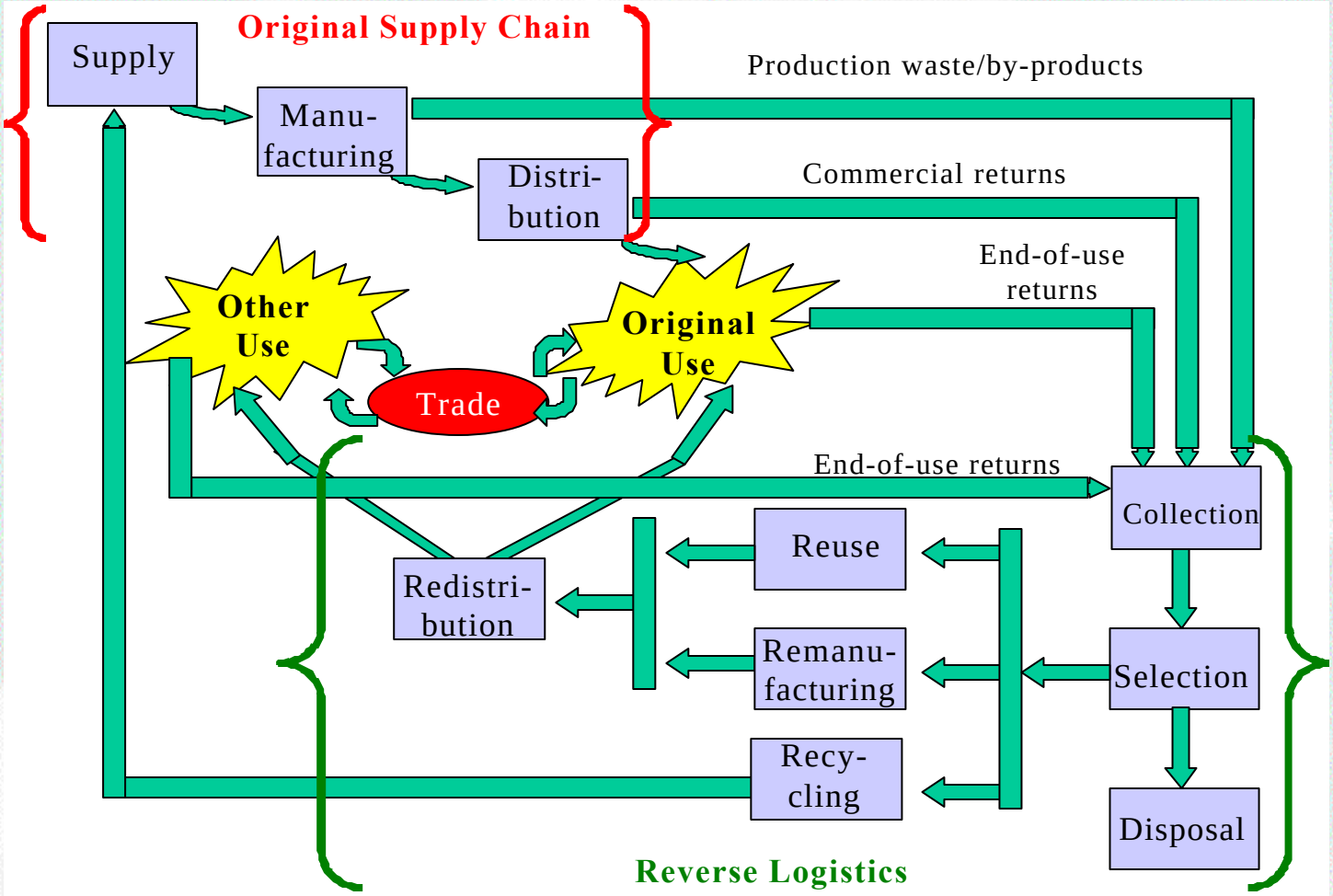
- Re-use as is after testing and minor restoration activities and re-use in same or different functionality on same or secundary market
- Remanufacture - disassembly into components, inspect, clean and re-use components in production of new products (same or different functionality)
- Recycle - dismantle, grind (destroy product structure), sort and re-use materials

Reverse Logistics

Types of return streams

- Rework during manufacturing
- Commercial returns → re-sell or remanufacture (overstocking, outdated or surplus stocks, returns from customers)
- Warranty returns → repair or remanufacture
- End-of-use returns → re-use, remanufacture (leased, rented products)
- End-of-life returns → remanufacture or recycle (because of producer responsibilities)

Forward and Reverse Logistics



Macro-economic effects
Reverse Logistics / Product Recovery

Reverse Logistics

- direct re-use
- remanufacturing
- recycling

Aspects covered

- what products are involved
- what industry has been created

Effects direct Re-use

Type of products

Containers, pallets, re-usable bottles, packaging material, returned unsold clothes

Type of industry involved

- logistic service providers (return handling and transport)
- specialised quality testing and repair firms

Remanufacturing and employment

Three purposes of remanufacturing:

(i) to make as-good-as new products

(ii) to obtain parts for the production of other products,

(iii) to obtain spare parts (cannibalization)

Examples

(i) car / aircraft engines, car parts, cellular phones, photocopiers, tires, multi-use cameras, medical equipment

(ii) chips from computers**,** parts for industrial equipment,

(iii) computers, aircraft rotables

US - *turnover of remanufacturing industry 53 billion USD!*

Recycling - macro economic effects

Recycling - a way to avoid waste, but has created a new source of raw materials

general collection and recycling schemes in Netherlands

cars, white-and-brown goods, electric and electronic equipment, glass, paper, clothes, shoes, building waste, spilled gasoline, used lubricants, food, furntiture, organic waste, diapers, carpets, polluted soil, plastics, scrap metal, wood

The Netherlands is now a main exporter of raw materials of glass, paper, wood pallets, etc to the Far East!

Abundance of recycled materials has shifted traditional industrial patterns: e.g. all new European paper plants in the last 10 years have been build in North West Europe!

Recycling and employment

Types of industry involved:

- collectors (municipalities), sorters
- waste processors, recycling plants (often new technology is needed, e.g. carpets, soil cleaning, diapers, plastics)
- recycling equipment fabrication

Case: Car Recycling Netherlands

Introduced in 1995

initial removal fee of 250 Dfl (=110 Euro) on the sales price of new cars, later lowered to 70, now to 40 Euros; funds kept by a foundation which pays companies for recycling certain parts (seats, windows, bumpers, oil, etc)

recycling targets (in terms of weight and volumes) increases to 90% of weight in 2001

no more landfilling of car wrecks

disassembly and recovery of valuable carparts, traded through website

Reverse Logistics - Trends

- Shorter product life cycles make products age faster,
- Longer responsibility of firms for their products (warranties, after sales service).
- Increased environmental concern and threatening EU / governmental actions make large companies become proactive on product recovery
- Garbage collection becomes waste management - recycling business: an interesting business - international consolidation of firms (Genco, BiLo, etc)

Reverse Logistics - Trends Europe

Remanufacturing

Larger firms more and more see value of remanufacturing (Xerox, IBM, car manufacturers, tire producers). Initially (and still sometimes), they tried to prevent it, later they embrace remanufacturing themselves

Small remanufacturing firms have long history and can grasp chances e.g. Vege motor recycling in Netherlands, now multi-million business

Return handling

logistics firms realise potential market (UPS, TNT, etc)

do handle returns generated by e-commerce

Reverse Logistics - Trends Europe

Recycling

- More legislation at national or EU level propagating higher levels of recycling of waste
- Technology - slow but steady increase in recycling technology (which products, how, yields, effectiveness)
- Use of recycled materials becomes more and more accepted in production processes (paper, glass, etc)

Problem - international trade of waste / recycled material is sometimes blocked

Product Recovery and effect on Logistics

Business functions changed:

- *production planning and inventory control*
  became much more complex
- *collection / distribution*
  new networks had to be set-up under uncertainty
- *quality control*
  how to test returned products cheaply, predict yields
- *business economics (accounting, marketing)*
  how to value returned products and recovered components
- *information technology*
  how to use IT to reduce most uncertainties involved

For more information see Revlog website

Reverse logistics and B2C

B2C generates many returns (up to 50% of sales)
return management is one of the top three e-logistic challenges

issues

- avoidance of returns and return authorisation
- collection of returns - who pays, which transportation option
- what to do with the returns:
  inspect, re-sell or remanufacture

Mail order companies have already large experience in this respect

E-business also supports Reverse logistics

Several business models have been set-up to support reverse logistics

- *return aggregators* - create market place for exchange of used products - horizontally integrated
  ex www.qxl.com
- *specialty solution providers* - create solutions with vertical market integration
  ex www.bigmachines.com
- *integrated solution providers* - e-commerce companies who specialize in providing full support of reverse logistic activities
  ex www.returnlogistics.com

Conclusions

- Recycling schemes seem to cost the consumer money, yet they are good for environment and create new industries and employment both directly and indirectly (esp. when products are imported otherwise)
- Remanufacturing is a good way to make products, it is good for the environment; in general it is labour intensive, hence stimulating it is good for the employment
- *Reverse logistics has been around for ages, but it is now time to make it a professional business, both practically and scientifically*!

Appendix

A discussion of the effects of reverse logistics on

- Inventory control
- Design of Collection networks

Inventory control

Four cases

- commercial returns of fashion and action products
  direct re-use
- direct re-use of other standard products
- end-of use returns of complex products, e.g. photocopiers
  remanufacturing and re-use of components
- end-of-life returns, e.g. computers, machines
  recovery of spare parts

Inventory control - fashion products

Aspects (mail order companies):

seasonal demand and a high return rate (up to 50%!)

one initial ordering and one re-ordering possibility

Advice (Vlachos and Dekker (2000))

- reduce return lag where possible
- initial order estimate depends on expected nr. of returns
- profits strongly depend on number and handling of returns
- better (adaptive) forecasting of sales and returns saves much

Inventory control - standard re-usable products

Case: stationary demand

- Standard (s,S) policies are optimal (Fleischmann 2000)
- Average costs and optimal policy can be calculated
- Netting demands with returns is viable policy up to 20% return rate
- For higher return rates: adapt reorder level for expected number of returns

Inventory control: end-of-use returns

Aspects (assembly products):

products need to be inspected and disassembled (costly), returns difficult to predict (coordination within company)

Production planning issues (vd Laan, MS, vWh, RD 1999):

- pull (disassembly upon demand) advocated above pull (directly disassembly) unless yields are highly uncertainty
- always use disposal option to avoid high inventories
- use as much information on returns as possible
- dual sourcing (remanufacturing and manufacturing can give problems: optimal policies are difficult if leadtimes differ by more than one period (Inderfurth (1998)
- more research needed on multi-item structures

Inventory control: end-of-life returns

Issue: how large should final order be to have enough spare parts for the remaining service period (often several years)

Recovery of spare parts from returned products is a profitable option to counter demand uncertainty (see Fleischmann 2000)

Problems:

- know what is in (or has come into) your products
  → CRM, product configuration
- in early life phase returns are needed, but few come,
  in last life phase no returns are needed, but many come

Cost allocation in inventory models

Standard approach

- use average cost criterion; set holding cost equal to 20% - 30% of value of items in order to balance inventories with ordering costs (e.g. through EOQ model)
- *problem*: how to value returned cores,
  how to value remanufactured items (which are as good as new obtained items)

Results: same cost allocation can lead to bad results because of dual sourcing option (Teunter et al. 1999)

Better approach: use Net Present Value Techniques

Product Recovery Networks

- Uncertainty in amount, timing and quality of returns is a major problem is setting up recovery networks
- Three types of networks can be distinguished (recycling, remanufacturing and re-use networks), most commonly applied technique is location theory see Fleischmann et al 2000)
- Avoid transports of useless products
  → recycle local, remanufacture centrally
- Stochastic programming models may be used, but more added value is obtained by reducing uncertainty and awaiting for more information (Listes and Dekker (2000)