The Problem and the Need for Converting Environmental Impacts to Monetary Value

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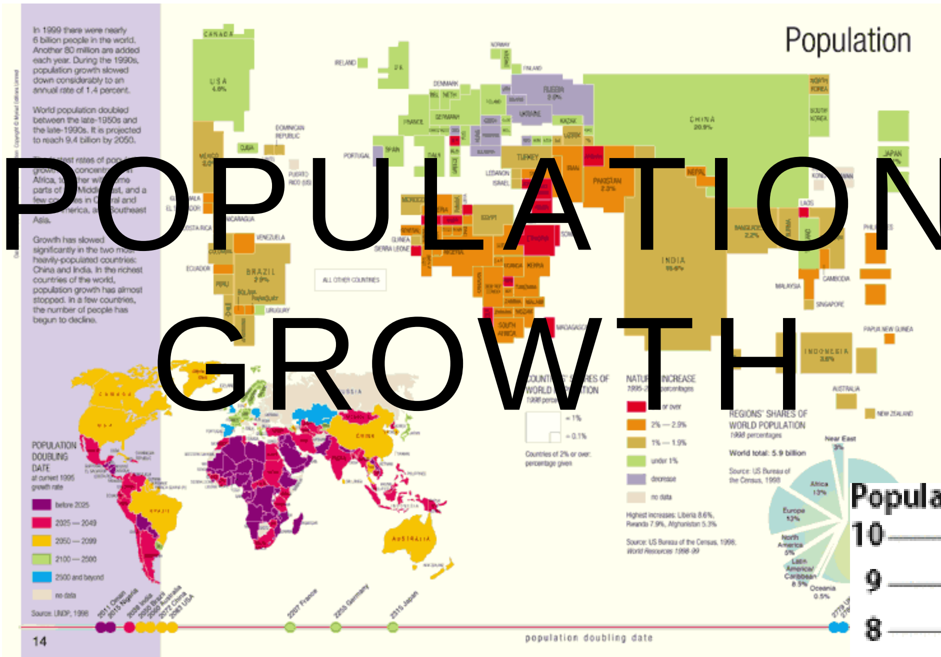
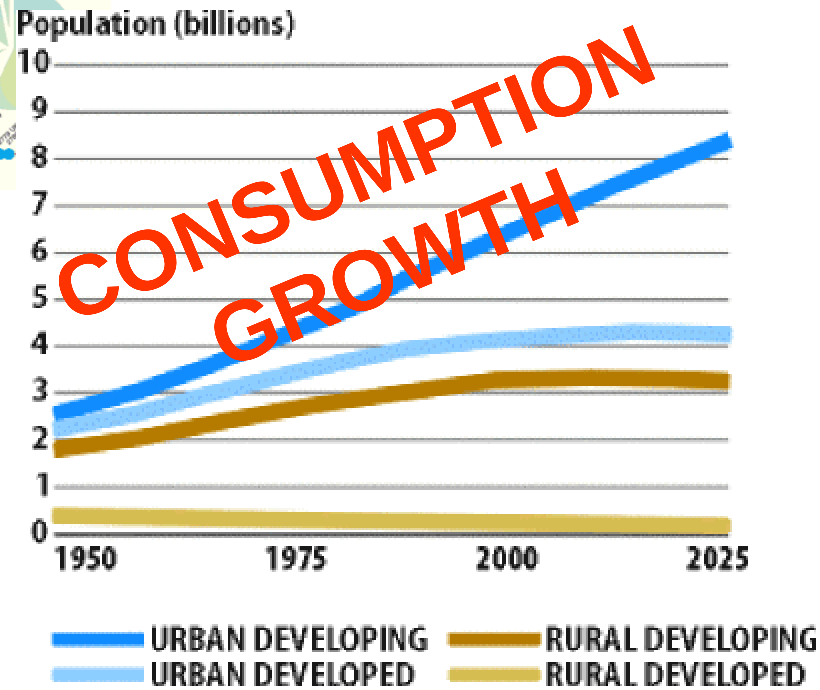
Life Cycle Engineering & Management Research Group at UNSW

- Established in 1998 by Prof. Hartmurt Kaebernick
- 3 main researchers, 8 PhD students, 8 Master & BE students, 2 visiting researchers, hosted more than 5 exchange students
- Research areas including:
  - Life time monitoring of appliances
  - Critical design parameters for condition monitoring
  - Reverse logistics
  - Sustainable product & process development
  - Disassembly planning
  - Environmental assessment of industrial products
  - Reuse of industrial products

POPULATION GROWTH



CONSUMPTION GROWTH

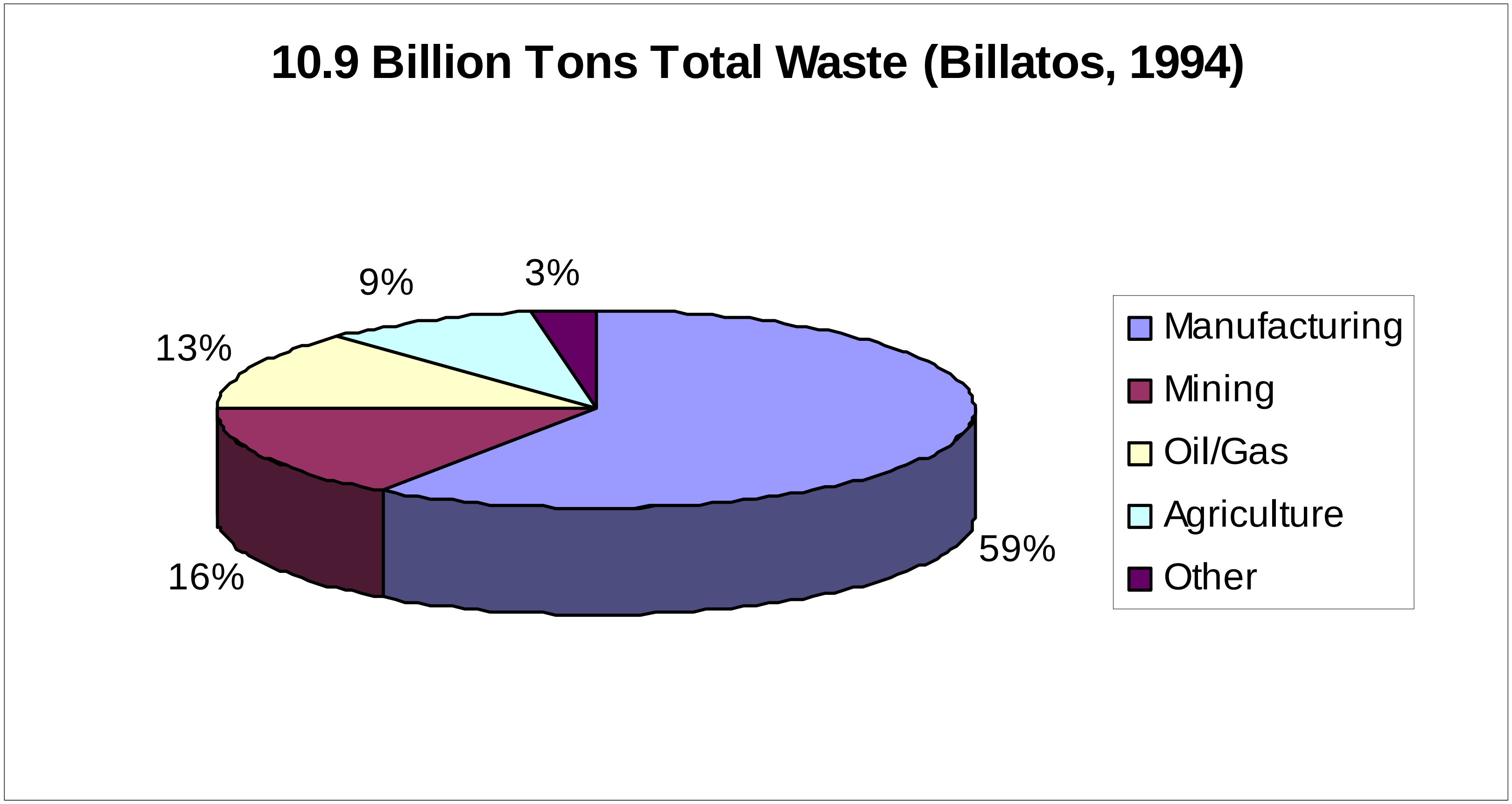


DEPLETION OF NATURAL RESOURCES

SCARCITY OF LANDFILL

POLLUTION & WASTE PROBLEMS

Manufacturing Contribution

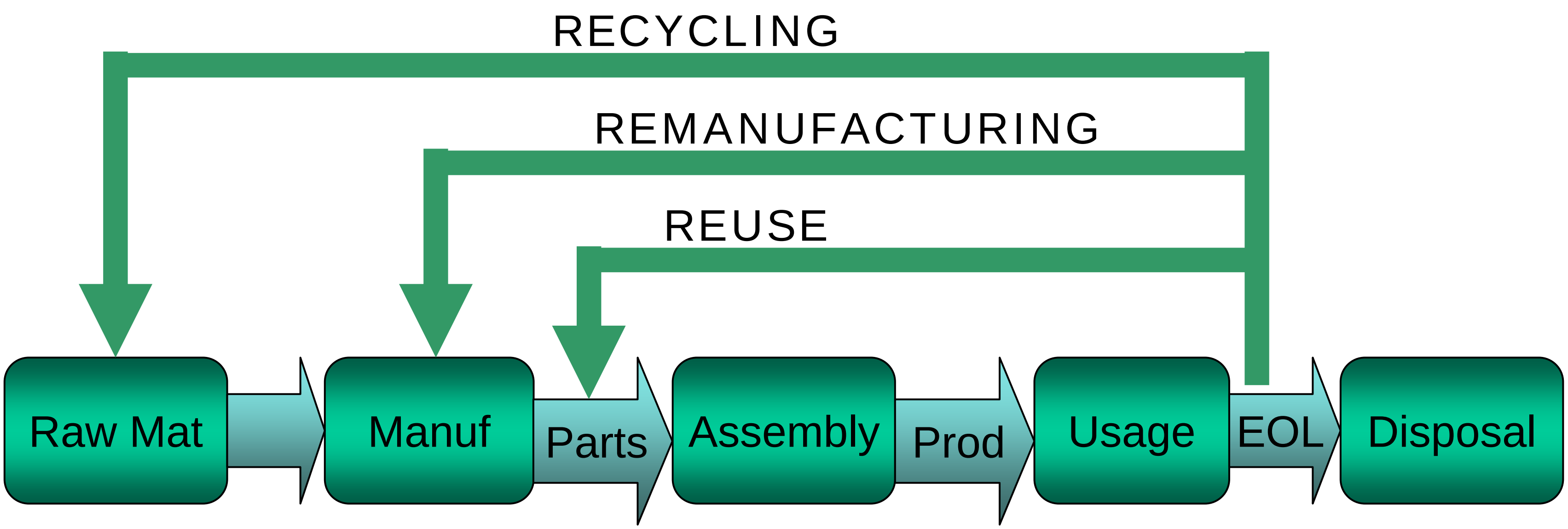


Waste from
Production Processes

&

PRODUCTS AT THEIR
END OF LIFE !!!!

~~OPEN LOOP~~ SYSTEM



CLOSED LOOP SYSTEM

Reuse is the best strategy….?

??

Challenges for Reuse

- Quality and Reliability of Reused Products
- Procurement (Take Back & Logistics)
- Economic Feasibility
- **Environmental Impacts**

The lifecycle of reuse parts including collection, sorting, cleaning, and remanufacturing activities also produce environmental impacts that may lead to **WORSE** environmental performance overall

The Evaluation Model - PG4REUSE

$$PG = PVL - PLCC$$

$$PVL = MP \times PE$$

$$PLCC = C_P + C_E$$

$$C_{Preu} = C_{pro} + C_{rem}$$

$$C_{Pnew} = C_{mat} + C_{man} + C_{op}$$

$$C_{Ereu} = C_{Epro} + C_{Erem}$$

$$C_{Enew} = C_{Emat} + C_{Eman}$$

Definition of parameters

- Product Gain (PG) - the monetary outcome from the sales of the product after deducting product life cycle cost
- Product Value (PVL) – the technical performance or quality status of the product
- Product Effectiveness (PE) – how effectively the product performs its intended function and meets customer requirements
- Product Life Cycle Cost (PLCC) – all costs that occur during the product's life cycle phases

The Need for Converting Environmental Impacts into Monetary Value

- To incorporate environmental performance with other parameters in decision making model
- To ease the communication among parties
- To increase the acknowledgement of environmental aspects in the current society including government bodies, industries, and the community

Environmental Cost will be…

- Part of Product Life Cycle Cost (PLCC)
- Addressing all impacts during product life cycle
- Including Internal and External Costs

Internal Cost

- ISO14000 series
  - Life Cycle Costing

External Cost or Social cost

- Economic Environmental Valuation Methods
  - Evaluate the environmental impacts which are the public goods into monetary value

The impact assessment methods which are currently incorporating the external cost…..

- **Environmental Priority Strategies in product design version 2000 - the default method (EPS2000)**

Developed by CPM (Centre for the environmental assessment of Products and Material systems) – a joint research environment at Chalmers University of Technology (Sweden) with participation from industries

- **LIME: Life-Cycle Impact Assessment Method based on Endpoint Modelling**

By AIST, JEMAI, Japanese Government organizations

The method is announced in 2003

- **TCAceTM, Total Cost Assessment software**

by **Greg Norris, A commercial software from Sylvatica company**

Tools for Integrating Life Cycle Cost Analysis with Life Cycle Assessment

Overview of the environmental valuation methods

EPS2000 (Units: ELU)	TCA (Units: US$)	LIME (Units: Yen)
- Using life cycle inventory analysis - Using factor which are from WTP for human health, world market price for ecosystem and production cost for resources depletion - Environmental Load Units (ELU) equals to EUR	- Identify the potential risks of a particular environmental impact category - Evaluate the external costs through an external cost literature (site specific)	The Japanese version modified Eco-Indicator 99 and converted to Yen currency. (Not many English publication available for the external costs background)

Overview of the environmental valuation methods

Impact categories

EPS2000	TCA	LIME
- Life expectancy (ELU/YOLL) - Severe morbidity (EUR/PrYr) - Morbidity (ELU/PrYr) - Severe Nuisance (ELU/PrYr) - Nuisance (ELU/PrYr) - Crop & wood growth capacity - Fish & Meat production - Soil acidification: Liming cost (EUR/moleH+) & EUR/ton - Prod. Cap. Irrigation/Drinking water: WTP & Production costs (ELU/kg) - Depletion of resources - Species extinction	- Pollutant Discharges to air - Pollutant Discharges to surface water - Pollutant Discharges to ground water/deep well - Pollutant Discharges to Land - Natural habitat impacts: local community, wetlands, wildlife reserves - Value chain impacts - Product health impacts	- Urban air pollution - Human toxicity - Ecotoxicity - Ozone layer depletion - Climate change - Acidification - Eutrophication - Photochemical ozone creation - Resource consumption - Land use

The Problems

- Available methods and converters are applicable for particular areas
- Different methods have different damage categories
- Many uncertainties involve in such evaluation
- A simplified method that can be applied at the early stage of design phase is needed

Future Works

- To collect and compile (or combine if possible) more methods and converters
- To investigate the use of simulation for addressing uncertainties
- To implement the evaluation model to evaluate the reusability of wide range of industrial products

Thank you for your attention…

Example of the other converter currently available

- Amelia L. Craighill, Jane C. Powell , 1996, Lifecycle assessment and economic evaluation of recycling: case study Resources, Conservation and Recycling, Vol. 17, pp. 75-96.

Table 2
Economic parameter values for external costs

Emission	(Pence/kg)	Road casualties	(£/casualty)	
CO_2	0.40	Mortality	744 060	
CO	0.60	Serious injury	84 260	
CH_4	7.20	Minor injury	6540	
SO_2	258.40	Road congestion	(pence/PCUkm	/HGVUkm)
NO_x	127.00	Motorway	0.26	0.52
N_2O	61.40	Non central	12.30	24.60
PM10[a]	898.00	Rural	0.07	0.14

Sources: CO_2, CO, CH_4 and N_2O: Fankhauser [37]; SO_2, PM10 and NO_x: Commission for the European Communities [38]; Road casualties: Department of Transport [39]; Road congestion: Newbery [33].
[a]Particulates of less than 10 μm diameter.