Lecture #8

Environmentally Responsible Design and Manufacturing

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The Product Design Process

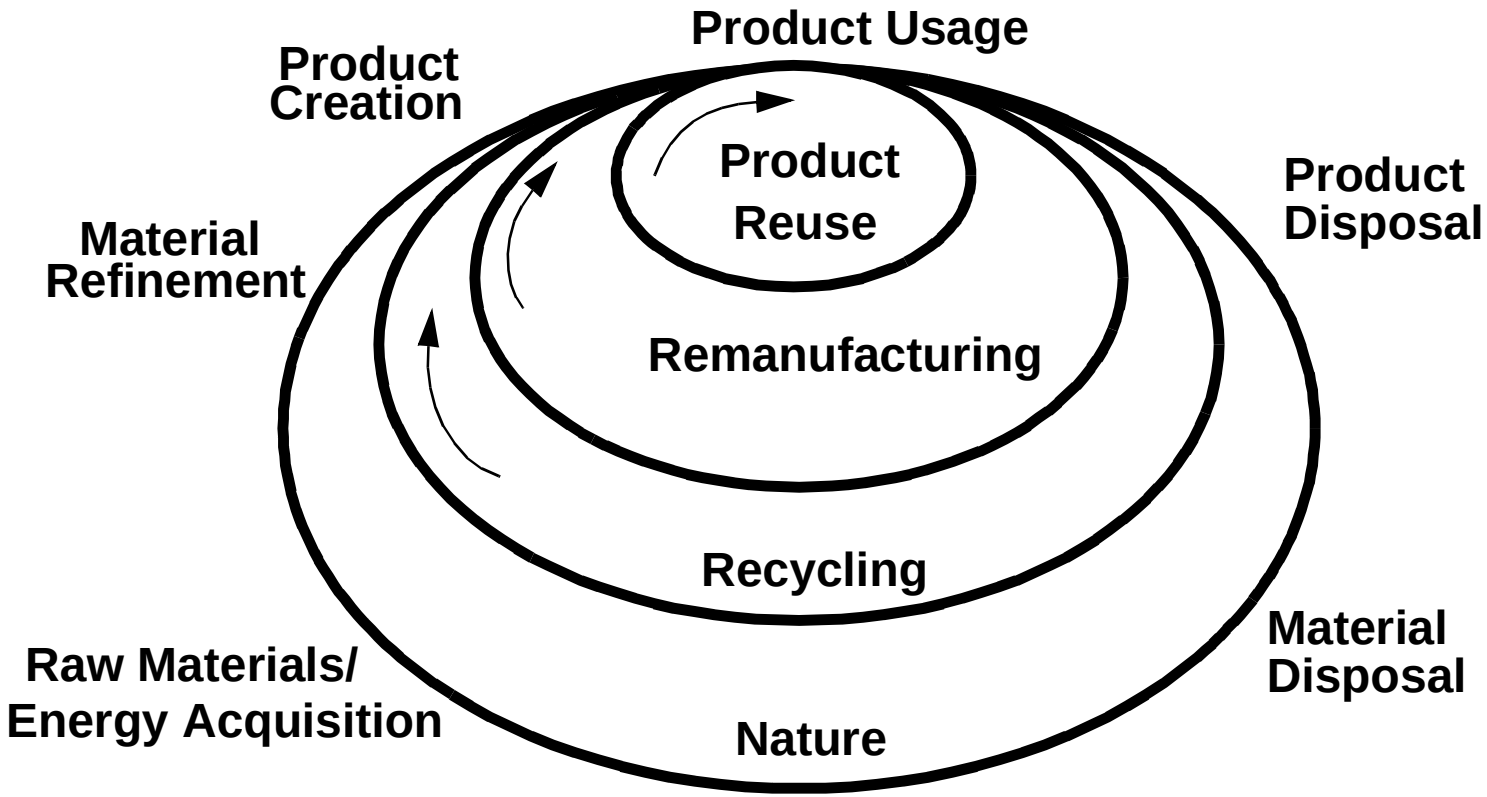
- **Concept Design - System Design**
- **Module definition - Assemblies**
- **Detailed Product Design - Material Type & Features**
- **Detailed Product Design - Dimensions & Tolerances**
- **Prototyping and Testing**

We will spend the next several lectures discussing these steps.

Achieving DFE

- **The starting point for DFE has to be an understanding of how a product/process effects the environment**
- **Life Cycle Analysis/Assessment/Inventory (LCA/LCI)**
- **Life cycle techniques study the product or process as it evolves over time**

What is a Life Cycle?



LCA

Definitions:

Life Cycle Analysis: A quantitative evaluation of all effects of a product or process

Life Cycle Assessment: A qualitative evaluation of all effects of a product or process

Life Cycle Inventory: A listing of all inputs and outputs

LCA

Major Problem

- **There is no agreed manner by which to conduct a life cycle analysis or assessment**
- **There is no "cookbook"**
- **Metric problems.... What is the value of a "clean" lake? How to combine ozone depleting emissions and energy consumption measures?**
- **Lots of unknowns!! (whose data are you using???)**

Definition: Life Cycle Analysis

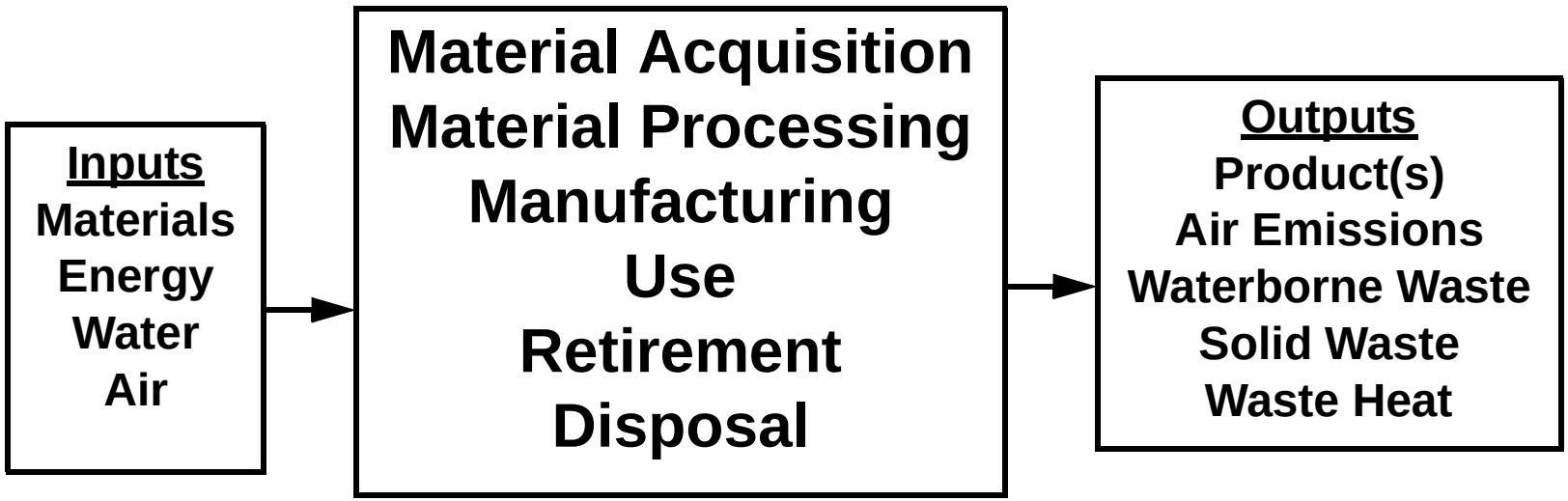
Life-cycle analysis (LCA) is a sophisticated way of examining the total environmental impact of a product through every step of its life -- from obtaining its raw materials through making it in a factory, selling it in a store, using it at home, and disposing of it.

SETAC Definition of LCA

Life-cycle assessment is an objective process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and material usage and environmental releases, to assess the impacts of those energy and materials uses and releases to the environment, and to evaluate and implement opportunities to effect environmental improvements. The assessment includes the entire life-cycle of the product, process or activity, encompassing extracting and processing raw materials; manufacturing, transportation, and distribution; use/reuse/ maintenance; recycling; and final disposal.

SETAC: Society of Environmental Toxicology and Chemistry

System Overview

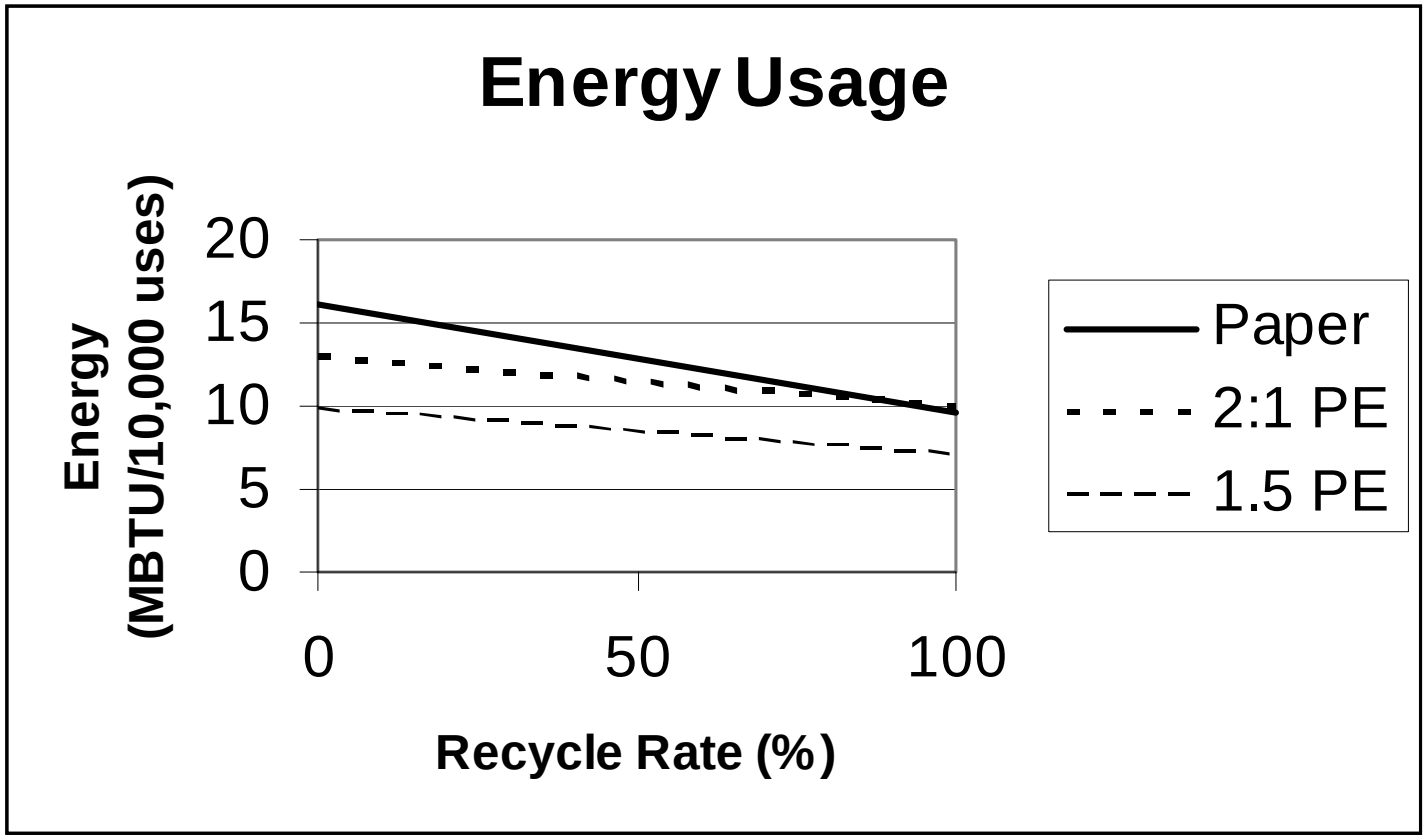


Material Issues

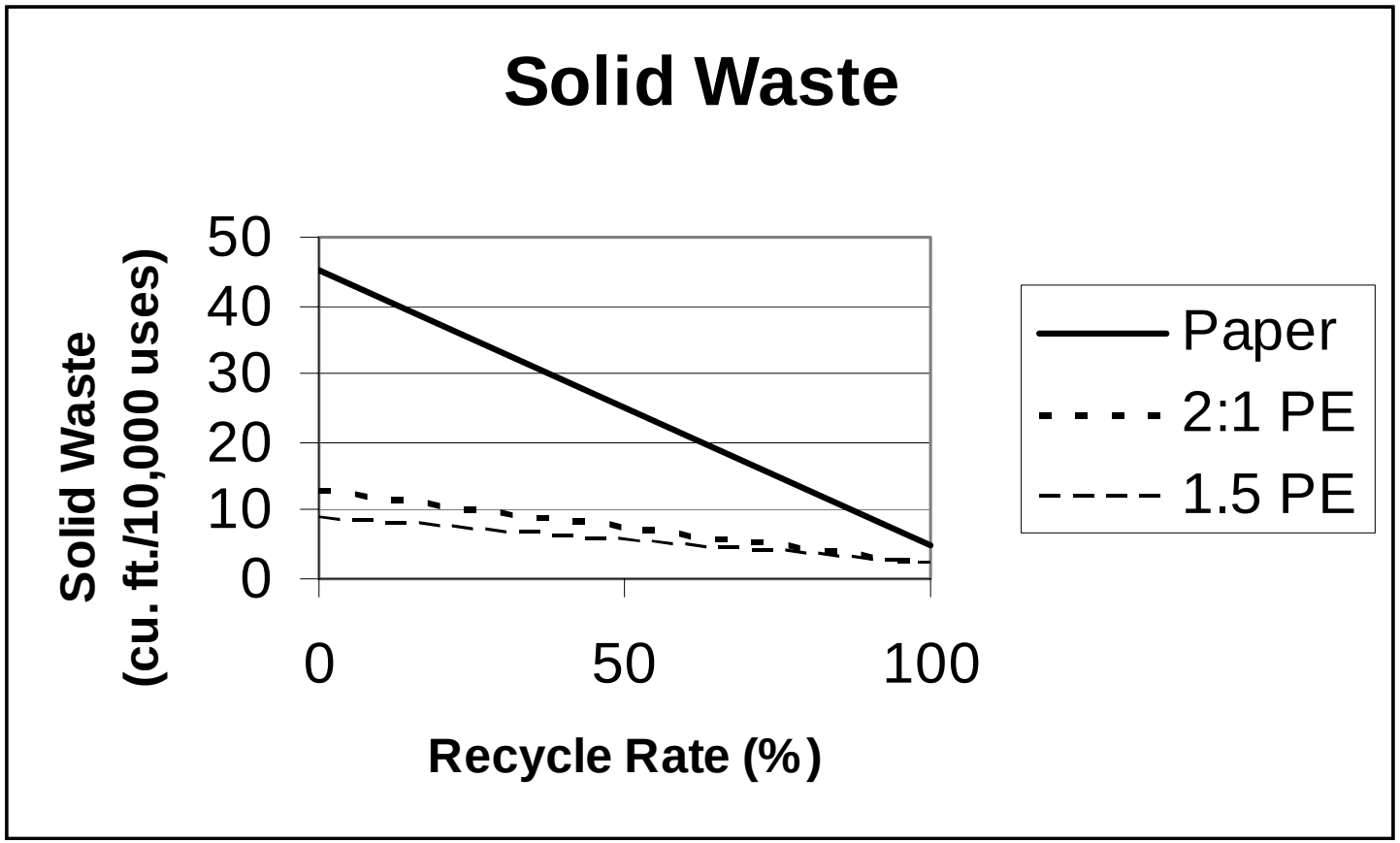
Paper vs. Plastic??

- **Study done by Council for Solid Waste Solutions now American Plastics Council**
- **Focus on manufacturing and disposal including recycle**
- **Energy use, solid waste production, air emissions, water emissions**
- **Biodegradation not a factor**

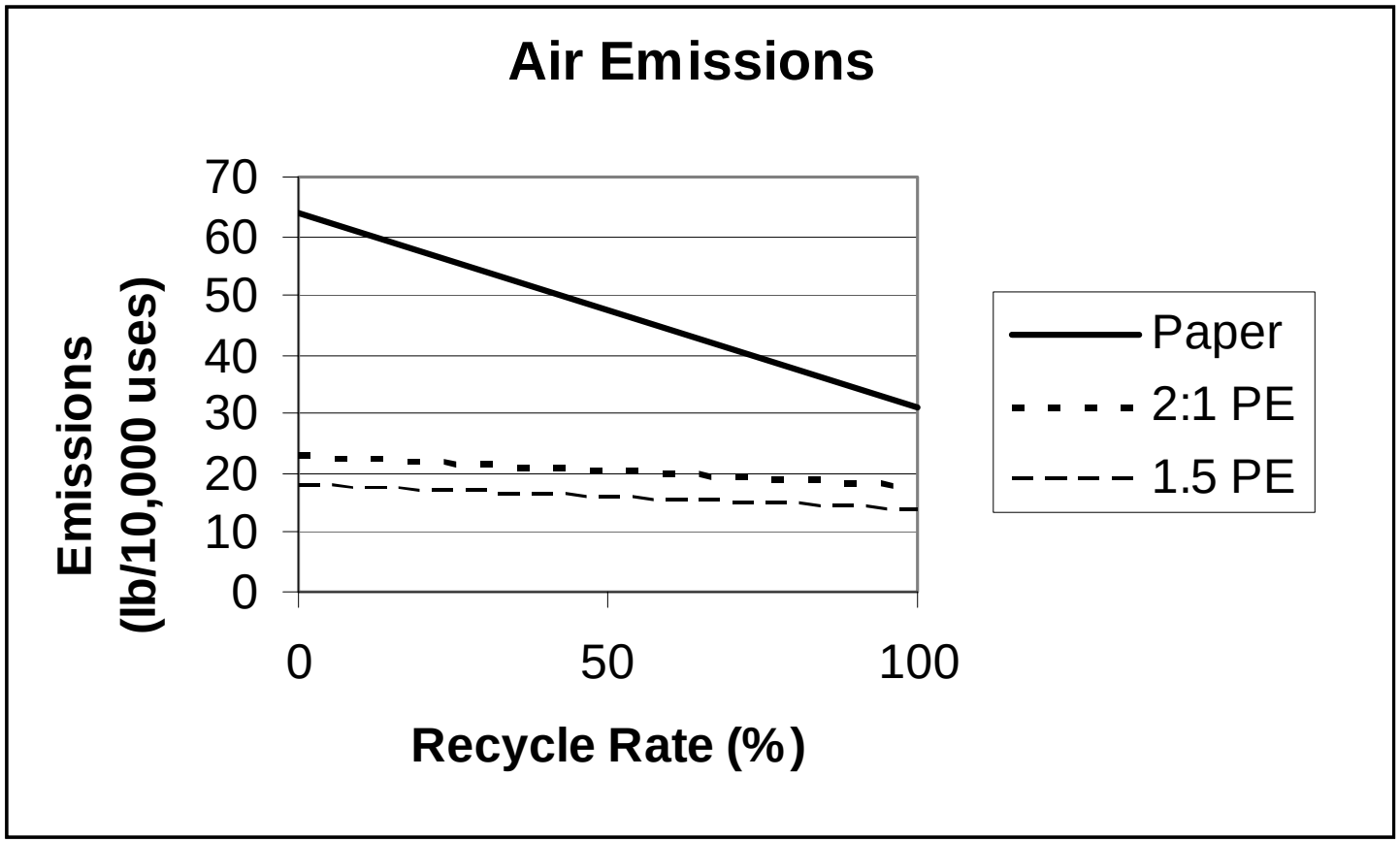
Energy



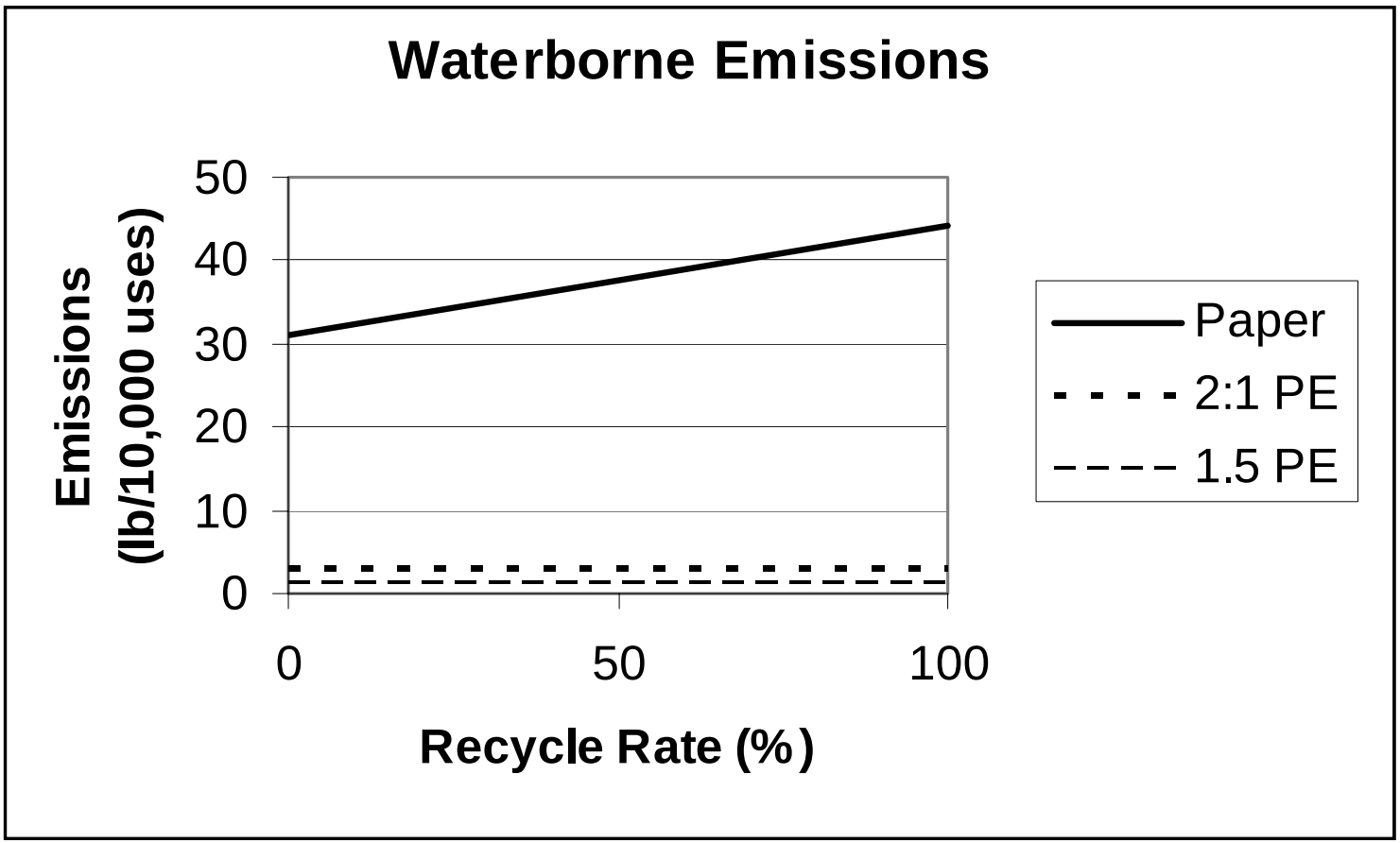
Solid Waste



Air Emissions



Waterborne Emissions

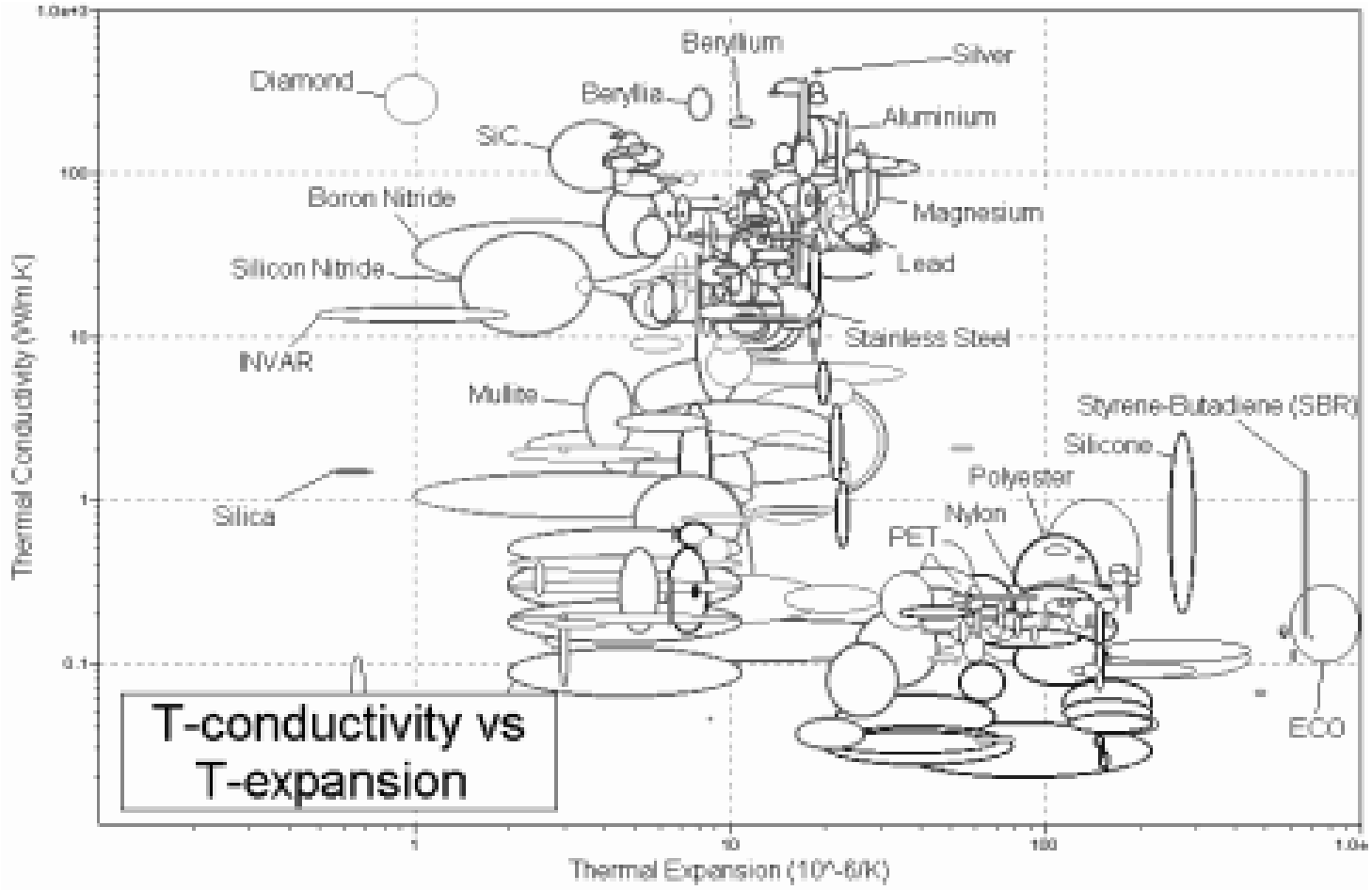


What Kind of Materials Are Out There??

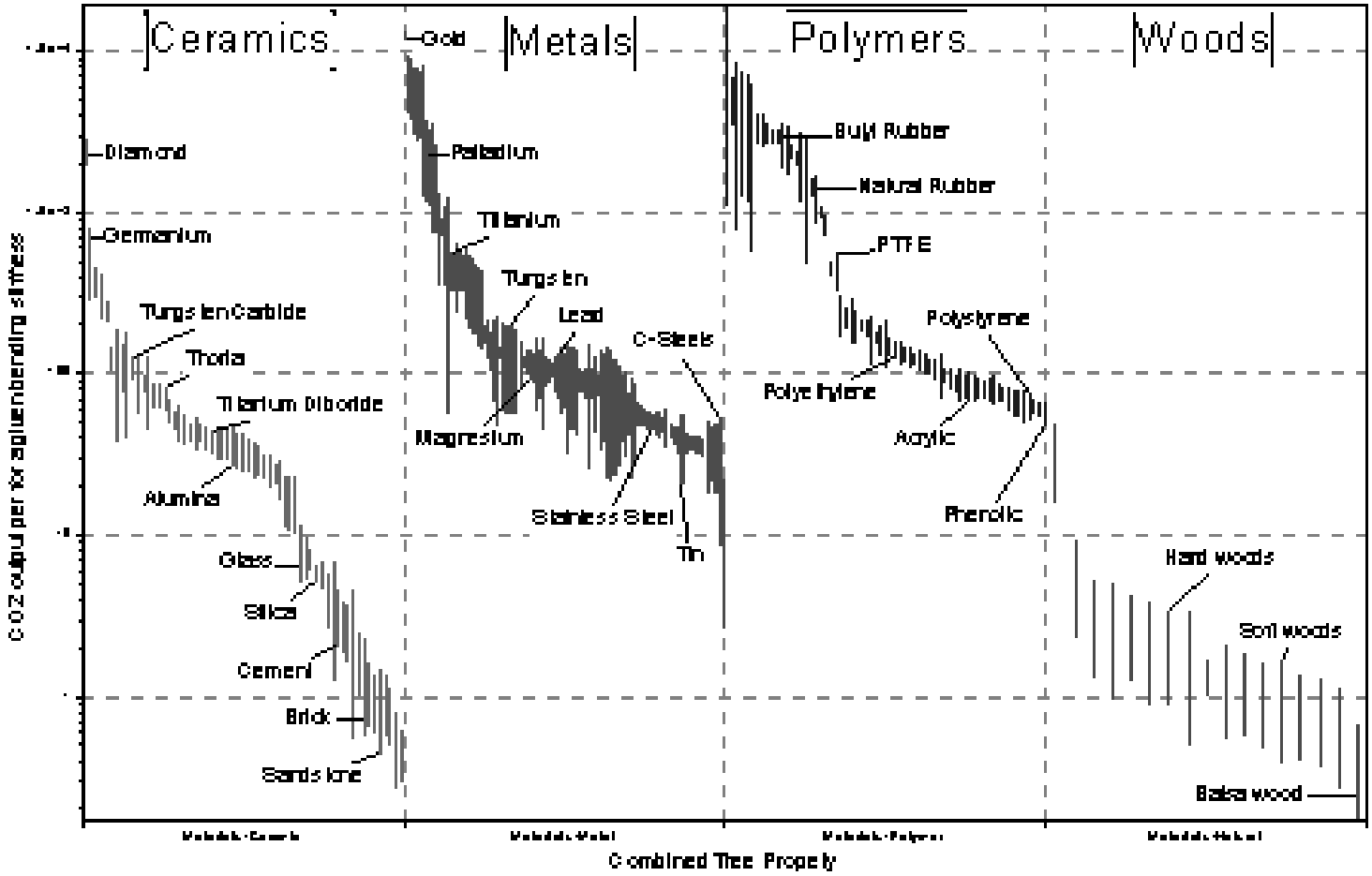
Automobile Materials

Material	1950s Car (kg)	1990s Car (kg)	% of Total U.S. Consumption Used in 1990 Automobiles
Plastics	0	101	3.2
Aluminum	0	68	18.9
Copper	25	22	10.0
Lead	23	15	69.5
Zinc	25	10	23.0
Iron	220	207	34.5
Steel	1290	793	13.5
Platinum	—	0.002	41.4
Rubber	85	61	62.9
Glass	54	38	—
Fluids	96	81	—
Other	83	38	
Total	1901	1434	

Material Selection (Ashby)



Ashby on the Environment



“National Material Metrics for Industrial Ecology,” Wernick & Ausubel

all values in Mmt

Figure 1

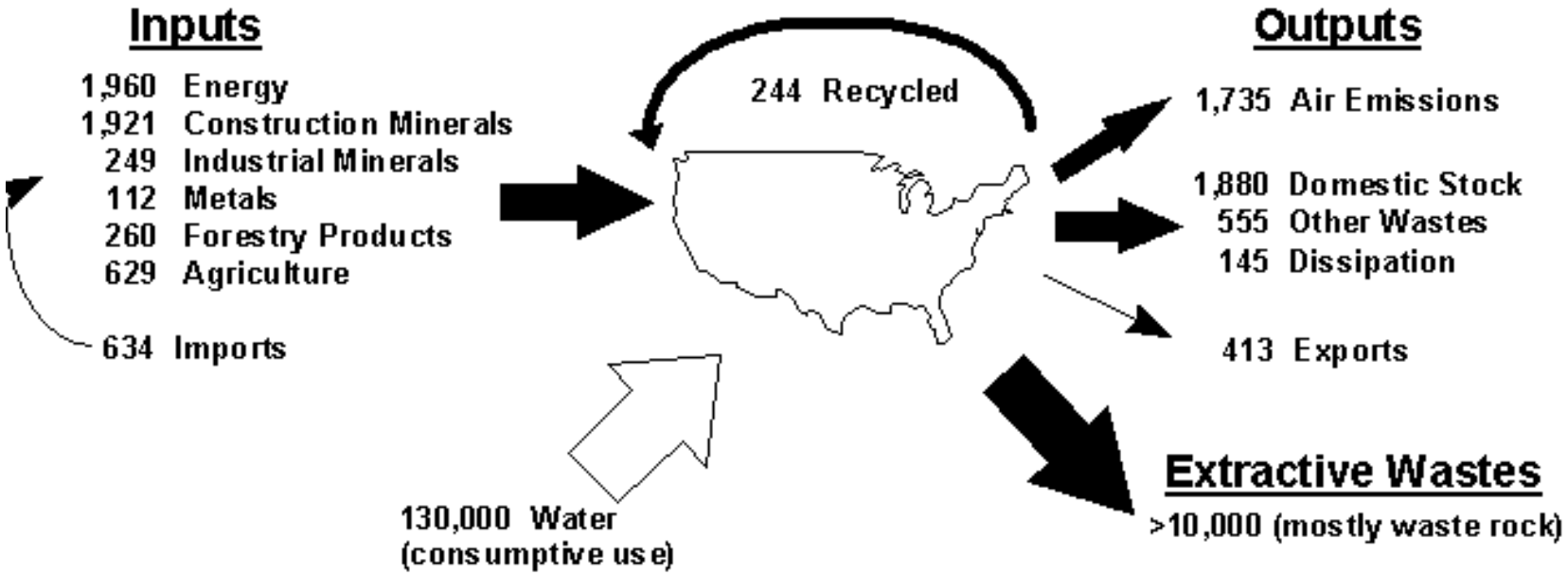


Figure 2