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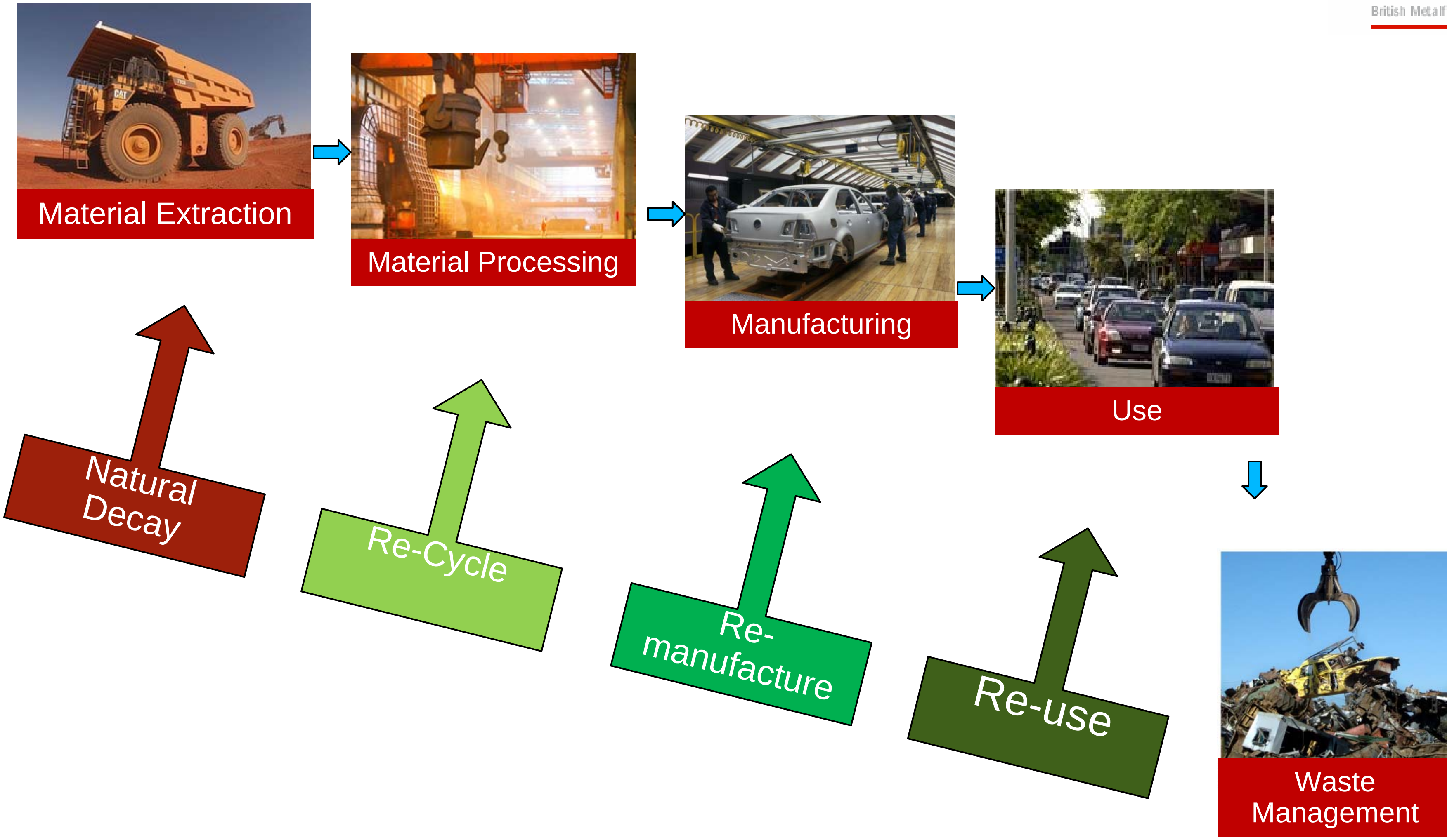
Metal Forming and the Environment

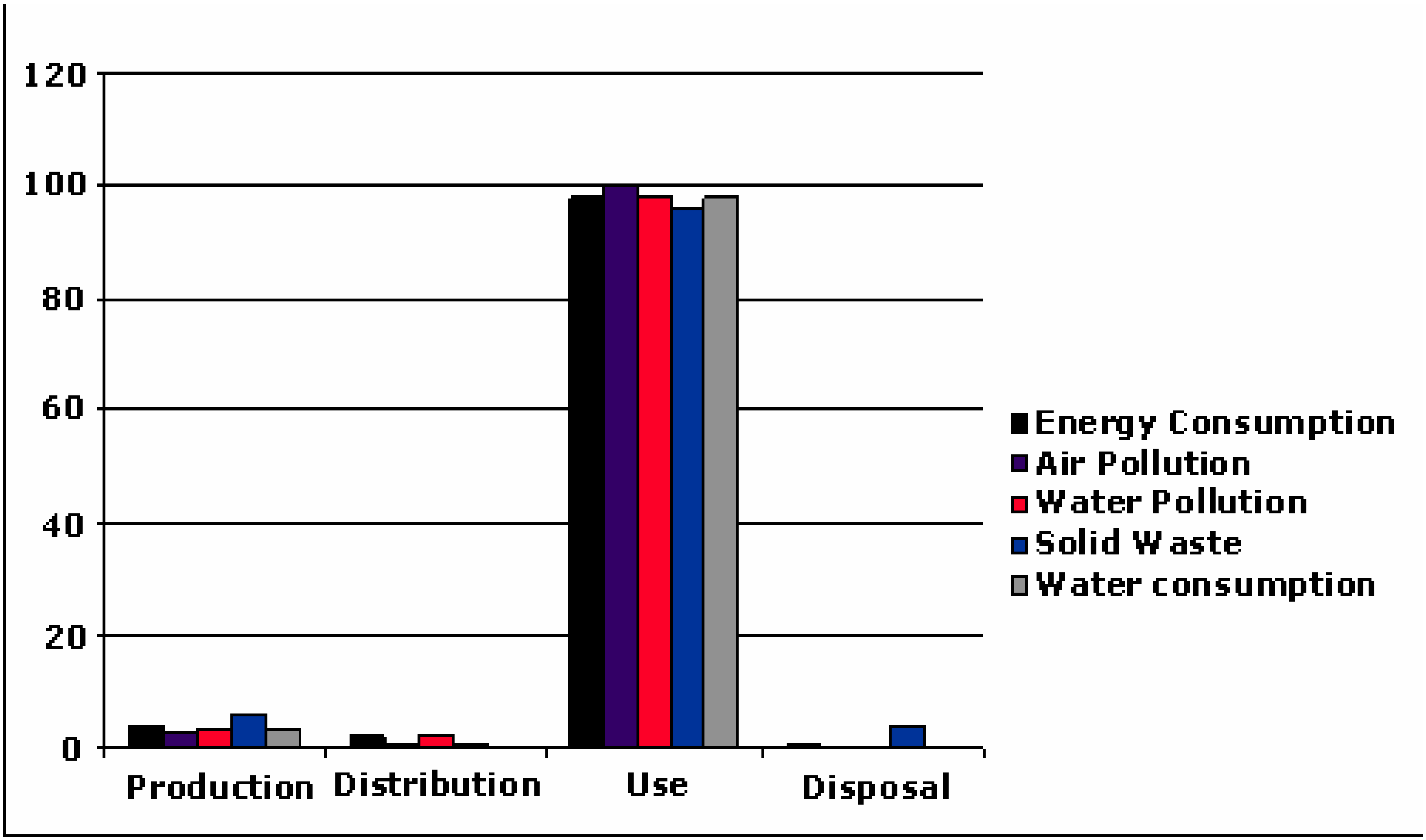
Threat?

or Opportunity?

Material Life Cycle



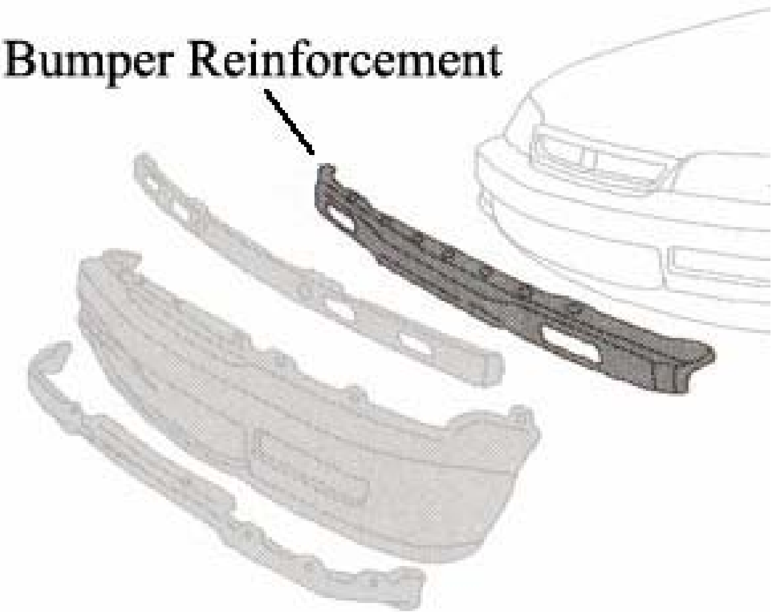
Environmental Impact of a Domestic Washing Machine



Source : "Life Cycle Thinking" ami.ac.uk/courses

Life Cycle Energy Analysis as a Method for Material Selection

Vehicle Bumper Beam

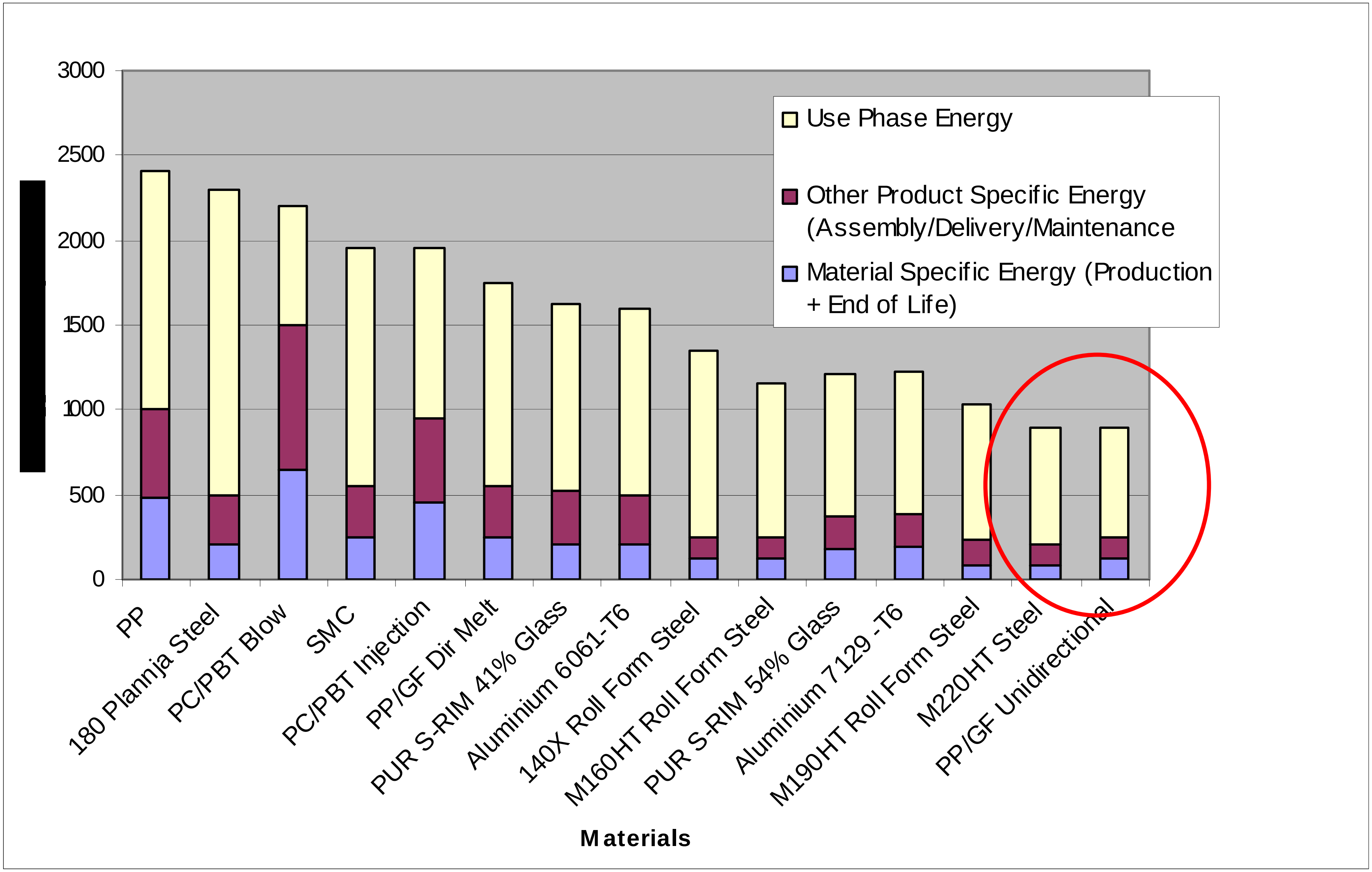


Peder E. Fitch and Joyce Smith Cooper

Department of Mechanical Engineering

University of Washington / Ford Motor Company 2004

Bumper Beam – Life Cycle Energy Analysis



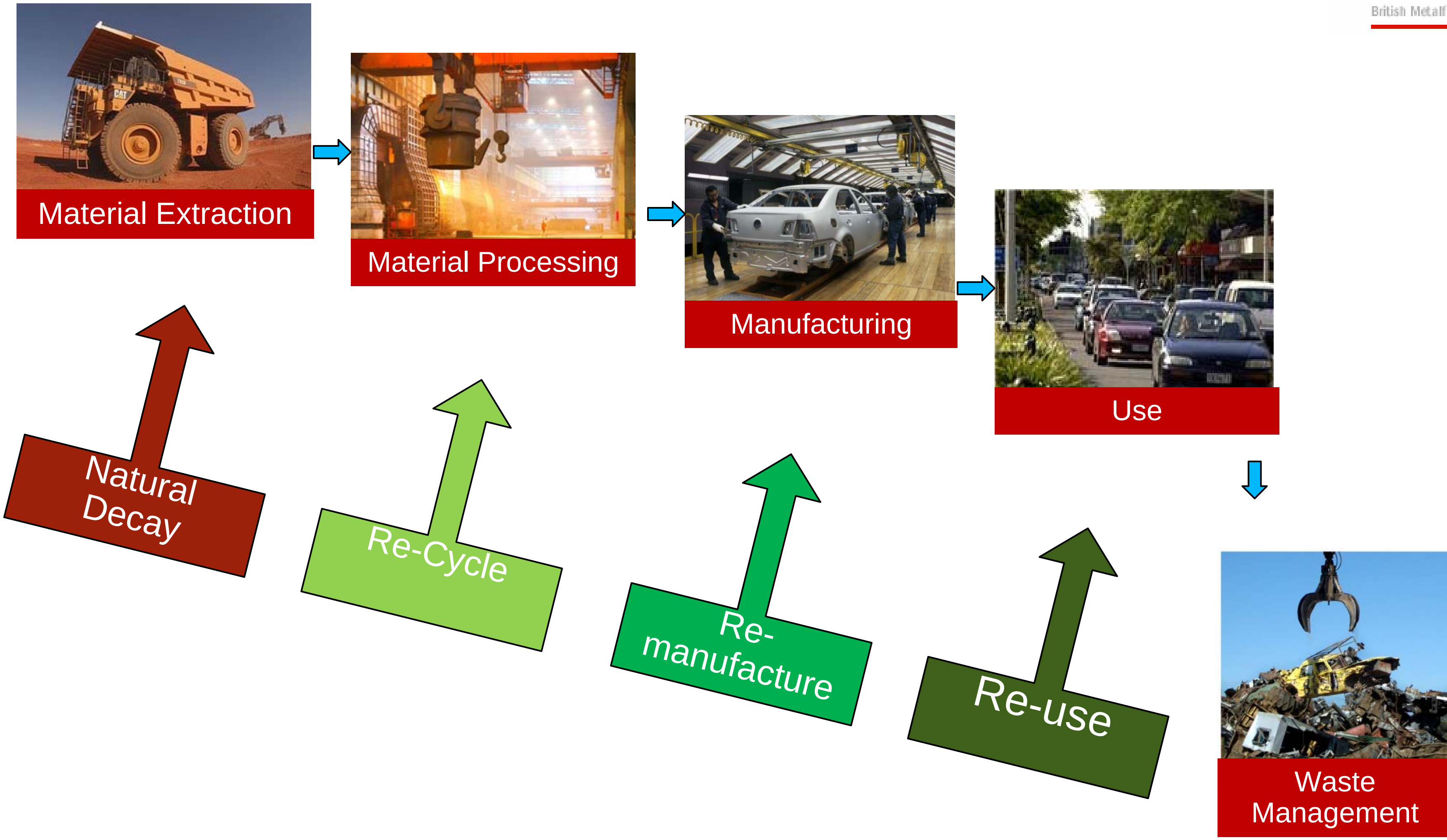
ECO Friendly Racing Car Concept

Source : Warwick Manufacturing Group

Formed Metal

- Low Cost and Plentiful
- Technology well known and Understood
- Durable and Versatile
- Excellent Mechanical Properties
- Temperature and Electrical conductivity
- Recyclability
- Re-usability?

Material Life Cycle



Design Disciplines

- DFF – Design for Functionality
- DFA – Design for Aesthetics
- DFM – Design for Manufacture

- DFD - Design for Disassembly?
  - DFRU – Design for Re-use?
  - DFRM – Design for Re-Manufacture?

What do Metal Formers need to know / do?

- What is the critical “Life Cycle Phase” of our product?
- What does our product’s “Environmental Impact” look like?
- Keep the pressure on material suppliers.
- Use our innovative skills to become part of the solution.

Good Morning, I'm Alan Shaw - the Confederation Of British Metalforming (CBM), of which I am currently President, is the leading trade organisation for all UK manufacturers of Fasteners, Forgings, Stampings and Fabricated parts.

My own background is in the Stampings, or Pressings industry, as we call it in the UK. I am the Executive Director of The Regent Engineering Co, a family business started by my father in 1946.

Metal Forming and the Environment – Threat or Opportunity?

The main purpose for this study of the relationship between Metalforming and the Environment is the proposition that "The Environment" or perhaps more correctly "Environmental Impact" is fast becoming a major competitive factor for all forms of manufacturing, and those of us who stamp, forge, fabricate and machine metals will face increasing pressure from alternative materials and processes, such as moulded plastics, fabricated and formed composites, alloy castings etc.

In many instances, it will undoubtedly be the case that alternative materials and processes will be preferred over formed metal, because of their inherently superior suitability for a given application. However, it is important that we in the metal-forming industry are familiar with the terminology and arguments used in the "environmental aspects" of the decision making process, so that we can make a credible, well-informed contribution when the opportunity arises.

The question posed in the title is a simple one. Regrettably of course, the subject itself is so massively complex that there can be no simple general answer to it, and within the time constraints of this presentation it is only possible to give a snapshot view of some of the considerations

We can view the overall picture for a product life cycle as looking something like this, a simplified diagram representing the various phases in the products "material" life.

At each of the these phases, material can be responsible for the consumption of energy and water resources, and the generation and release of waste products, many of which may be environmentally damaging.

Life cycle considerations for products can vary drastically between different types of product.

For example, the life and environmental impact of a domestic washing machine looks something like this,

The concentration of environmental damage is heavily biased in the “use” phase. In contrast a piece of structural steel used in a building, for example, would have a fairly benign impact on the environment in its “use” phase, but a relatively higher impact in the Production, Distribution and Disposal phases.

Quite a lot of specific terminology has emerged around this subject area, and a large number of different methods of trying to quantify the data have also been proposed.

The technique of Life Cycle Analysis (LCA) has now been expanded and extended to incorporate Life Cycle Inventory, Life Cycle Assessment and Life Cycle Management. Life Cycle Analysis attempts to measure the energy and raw materials consumed in a product life cycle, taking into account the solid, liquid, and gaseous waste generated at each stage.

Such studies can be highly contentious as it can be difficult to decide whether, One very detailed study, completed in 2004, considered fifteen alternative material types for the production of a vehicle “Bumper Reinforcing Beam” on a 1030Kg vehicle. The study, reported in a paper by Peter E Fitch and Joyce Smith Cooper of Washington University, used a variety of existing, adapted, and novel metrics to try to quantify and compare the relative advantages of each material, from a Life Cycle Energy Analysis perspective only.

The materials selected included basic Plastics, Glass Reinforced Plastics, Glass Fibre composites, Aluminium, and various grades of steel.

The study concluded that the two preferred materials, based on their Life Cycle Energy Analysis profile, were M220HT formed Steel and Glass Fibre Reinforced Polypropylene. The two came out almost exactly equal, with a total life cycle energy consumption of around 900 Mega Joules each. Interestingly, M160 HT Roll Formed Steel and 7129-T6 Aluminium came close in 3^{rd} and 4^{th} places respectively.

Similar studies are currently being carried out on a wide variety of industrial and domestic products.

The study techniques continue to be refined and developed, and large databases of information on the energy and pollutant characteristics of materials now exist.

On a lighter note, a recent project led by the Warwick Manufacturing Group in the UK produced a design for a concept “eco-friendly” racing car. Based on a steel tubular space frame, the team made structural panels from a composite of hemp matting impregnated with a resin based on rapeseed oil. The main body panels are made from a resin based on cashew nut shell oil, the tyres contain a cornstarch derivative, and the brakepads contain jute. The oils and lubricants are all based on plant oils.

The vehicle can do 0 to 62 MPH in 4 seconds and has a top speed of over 140 MPH.

The aim of the project was to “Create a high-performance racing car that had a conscience. The team researched the most technologically advanced sustainable materials available, and then used them wherever possible during construction.”

There are many attributes of Formed Metal which could be listed, but I am particularly interested in the last one on this short list.

In the 20 years or so up until about 2004/05 we saw a steady and significant decrease in the real cost of almost all manufactured products, from cars to computers, domestic appliances - you name it. This has been partly due to the transfer of manufacturing to countries with low labour costs, but also the relative stability in the costs of energy and raw materials.

In the last two to three years we have begun to see a weakening in the impact of low labour costs, and very significant increases in the cost of energy and materials.

One of the consequences of the long run of ever cheaper consumer products has been that the “throw away” society has more and more become the norm, but

If we go back to the diagram we started with – our aim should be to get more redundant (or “end of life”) products flowing back into circulation in the re-use and re-manufacture channels

– re-usable Bumper Beams? Why not?

This scenario could be viewed as potentially both a Threat and an Opportunity for metal formers. The volume of new Bumper Beams manufactured would fall if intensive re-use is made possible, and makes economic good sense – on the other hand, the company with the best designed beam, which can easily be detached from an “end-of-life” vehicle and re-used in a new vehicle, will prosper, and a new business opportunity could be created for specialist recyclers of re-usable parts such as this.

We already have an array of Design Disciplines, associated with certain characteristics required of the product.

How about some new ones, such as Design for Disassembly, which would be a pre-condition for efficient Design for Re-use, and Design for Re-Manufacture?

So what do we need to know or do, in order to keep our industry thriving and successful in the face of these challenges?

First of all we need to understand what is the critical Life Cycle Phase of our product (or our customer's product which contains our component)? Is it in the use phase?, manufacture, extraction, or end of life?

Secondly, do we know how our materials and processes compare with competitive alternatives in the area of "Environmental Impact"? Databases are under development which will make it easier to identify the whole-life impact of all commonly used materials and manufacturing processes. The danger here is that, even the most sophisticated database and applications algorithms will almost certainly not be sensitive enough to give an accurate assessment at the product/component level. We may need to develop our own expertise in this area so that formed metal gets a fair chance.

We must keep the pressure on our material suppliers to continue developing new variants of formable metals and alloys with Higher Strength to Weight, Improved Corrosion Resistance etc.

We must continue to use our own innovative skills to develop new components and assemblies which capitalise on the strength and durability of Formed Metal. Innovation has always been a strong characteristic of the metal-forming trade – long may it continue!