23 Business activity evaluation

Throughout the book we've attempted to examine the business case for each option for change—through some theory and some case studies. In this chapter we'll draw together the lessons we've learnt from this.

Our starting motivation in this book has been to find enough options to meet the emissions target we've set into law, and in the scenarios of chapter 19, unlike those in chapter 11, it appears that we do indeed now have enough options. However, in chapter 7 we found that the steel and aluminium industries are already extremely efficient because they pay heavily for energy, so have always had a strong commercial motivation towards using less. In Part IV when we looked at cement, plastic and paper, we found a similar story: all three industries have achieved remarkable energy efficiency already, simply driven by normal commercial concern. So, if we've identified in Part III that there are many options for using less material to deliver the same service, and if materials cost money, why hasn't similar commercial pressure motivated similar efficiency? If no one is investing in material efficiency does that mean that there's no demand for it? We will use this chapter to collect and examine all the issues we identified in case studies throughout the book that explain why companies are not taking up these opportunities. In each case we'll outline the concerns and discuss how they might be addressed.

Problem: the potential cost savings are relatively small

In chapter 6 we found that only a small part of the price of any final product was spent on steel and aluminium, typically 4 to 6%. This small fraction includes indirect demand for steel, for example the steel that goes into trucks used to transport the final product, but excludes any value added to steel inputs, for example through fabrication and assembly. We can estimate that this fraction is in effect equal to the maximum savings we might achieve from yield improvement and designing with less metal.

In demonstrating the relative insignificance of metals purchasing to the total cost of a finished product, we've been looking at the price paid by the final consumer. However, because production chains for products containing metal are typically rather long, the same metal is purchased and sold several times before reaching the final owner. For example, a steel company might sell its products to a stockholder. The stockholder might sell metal to a component manufacturer, who in turn might sell it to a sub-component assembler, and so on. For these earlier purchasers, metal purchasing costs are inevitably a higher fraction of their own sales income.

Figure 23.1 shows data for the sequence of companies adding value to metal in the automotive sector and shows the relative significance of steel purchasing to three companies along the chain: the fabricator, the manufacturer and the consumer. The graph shows that the relative importance of steel purchasing is different for each of the three companies. Metal costs are indeed a small fraction of the final price paid by the consumer, are a larger share for the manufacturer and are a significant share for the fabricator.

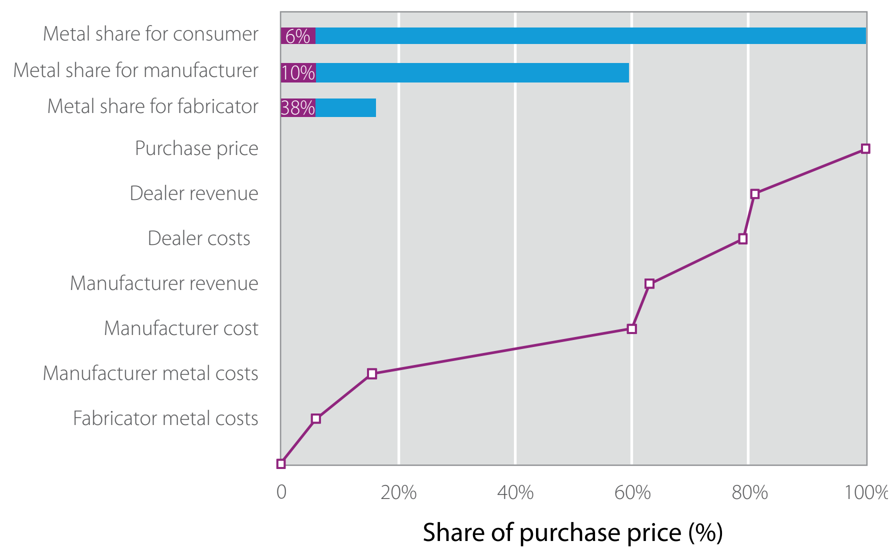

Figure 23.1—**Value added in automotive production**

So why are upstream component suppliers not taking every opportunity to save metal when it forms a substantial share of their costs? The answer inevitably is that using less material incurs other costs, such as higher labour costs, higher tooling costs, or higher costs for higher performance materials. In the UK, if we assume that half of us are currently earning, so divide our GDP by half our population, we have an average income of £50,000 per person per year, or around £30 per hour. Steel sections currently cost around £400 per tonne and aluminium ingots around £1,400 per tonne so one hour of UK labour has the same value as 75 kg of steel or 20 kg of aluminium[1]. If companies are to be motivated to pursue the material efficiency options that we found in Part III of the book, they will want to save more than 75 kg of steel or 20 kg of aluminium every time they pay for an extra hour of labour.

Solution: Governments could act to stimulate demand for material efficiency, not because of its cost savings but because of its emission savings, in the hope that their stimulus will lead to future reductions in the cost of material efficiency and so release value to both consumers and producers. Developments in equipment and other technologies may allow companies to benefit from material savings with lower additional labour costs, and of course, final consumers can stimulate demand for materially efficient goods through purchasing choices.

Problem: standardisation and optimisation are at loggerheads

Both the steel and the aluminium industry operate at scale: a modern integrated steel plant will easily manufacture more than 1 million tonnes per year and aluminium smelters are approaching 300,000 tonnes per year. By delivering standardised, high volume products, the industries can reap economies of scale in production, handling, storage and transport[2]. However, a consequence of this standardised high volume production is that the efficiency is dedicated to making standard stock products that, as we have seen, are the wrong shape.

Downstream companies can also benefit from economies of scale: producing cars at scale can save a quarter of fabrication costs[3]; in chapter 12 we described the practice of "rationalisation" in the construction sector by which contractors reduce their purchase costs and reduce the difficulty of organising the production site, by substituting standard beams for those originally specified.

However, eventually standardisation reaches a limit, as Henry Ford famously learnt, when his Model T Ford was outclassed by competitors. Consumers have different needs so will pay more for products that serve their particular needs than for standard goods. Steel and aluminium producers, competing in a tough market with standard geometries and composition, have developed an ever wider range of niche alloys to try to gain a competitive advantage[4] but aren't yet applying this competitive instinct to geometries. Producing specialised metal goods, such as optimised beams, has always been more expensive than standardised goods, because more labour is required. However new flexible production technologies may reduce these additional costs, and so stimulate competition to produce semi-finished products made with less metal.

Any innovation that allows material savings through producing semi-finished or stock products nearer to the final required shape are unequivocally worth having, if the cost can be managed. However, our exploration of opportunities to design products with less metal raises a question we cannot yet resolve: does using less metal now to make an optimised component compromise our ability to adapt or reuse the component in future for a changed or different use? As yet we have no clear basis for answering this question—it depends on how certain we are about future requirements. Optimised components are typically more expensive to produce, although they save metal and may have co-benefits, while cheaper standardised components may have a longer service if they can be adapted or re-used.

Solutions: Suppliers of metal components can aim to design more flexible production systems to tailor product geometries efficiently without increasing costs. Customers for components can aim to design families of products around standardised architectures, for instance to use standardised grid spacing in the layout of buildings, or to agree a standardised base architecture for vehicles, so that optimised parts can be produced at sufficient volume to capture the benefits of scale economies and facilitate reuse. Together customers and suppliers can engage in discussions to decide whether the right shapes are being made and explore alternatives.

Problem: the evolution of the industry is path dependent

Some of the strategies that we found in Part III with both eyes open have not already been pursued because they go against industry conventions, or because they require new technology that, if deployed, would devalue existing industry assets. Both the steel and aluminium industry are capital intensive and have long asset cycles, so they can be slow to adapt to change. For example, in the UK we have equipment designed for primary steel making from ore, located in the vicinity of mines that have long since been exhausted. We import 15 Mt of iron ore to feed these primary production plants and at the same time export 7 Mt of scrap because we have inherited our primary assets, and so do not want to switch to secondary steel making. This sort of reticence to change is widespread: by the year 2000 it was claimed that not one traditional primary steel producer anywhere in the world had successfully invested in secondary production, despite the fact that nearly half of North America's steel was produced by Electric Arc Furnaces (EAFs) at the time[5].

The rise of EAF steelmaking in the 1960's occurred with no support from the existing industry and is a classic example of a successful 'disruptive technology'[5]. Possibly this new EAF approach (led by Nucor in the United States) was tolerated by the existing primary industry because its initial production was limited to rebar, a relatively less profitable product (with gross margins of approximately 7%). As EAF steel quality improved, the production method was used for products with tighter quality requirements, first bar (with margins of approximately 12%) and later sheet, so intruding on key markets for conventional producers and indeed causing some bankruptcies. Undoubtedly one of the reasons that EAF became successful was because it could be introduced via independent, profitable production at small scale.

The radical process innovations proposed in chapter 9 do not have this luxury. Implementing novel processes now would only be possible if existing equipment were relocated or replaced. Apart from these physical constraints related to the location of existing assets, development of the new processes also raises concerns about protection of local jobs and the protection of existing intellectual property (patents).

The history of how this industry has developed depends not just on its long-lived assets, but also on industry conventions: earlier in this chapter we mentioned the convention of using standardised rather than customised parts; in chapter 12 we saw that metal savings could be achieved in the production of food cans by addressing cooking conventions; in chapter 13 we saw that metal savings could be achieved in automotive blanking if conventions about tessellation were changed.

Solutions: This inertia which inhibits change could be addressed with government support for new approaches. A simple example at present is the development of the re-used steel market. As far as we can tell this already looks economically attractive, but doesn't occur because without scale, it is too difficult for a willing client commissioning a new building to find suitable supplies of old steel. It would be relatively easy for a national government to stipulate that all new government buildings should contain a fraction of re-used steel—and such a stipulation would force the development of the required supply of steel from deconstruction.

Problem: risk aversion and imperfect information hinder material efficiency

Construction and manufacturing risk is a major driver of design choices, and the risk of product failure carries very high penalties, especially for safety critical parts. Therefore throughout the production chains associated with steel and aluminium, over-specification and over-design is a natural tendency. The strategies of chapters 15 to 16, aiming to make better use of metal after its first use, also carry risk. For example, although we saw that I-beams can be reused with little risk of physical failure, uncertainties over certification introduce legal risks to reuse, and uncertainty over availability of supply can cause delay, which increases costs, and for fabricators creates the risk of damage to their reputation. For other products, such as cars, sellers have an incentive to exaggerate claims of product quality. This decreases the confidence buyers have in product quality and increases the risk of physical failure[6].

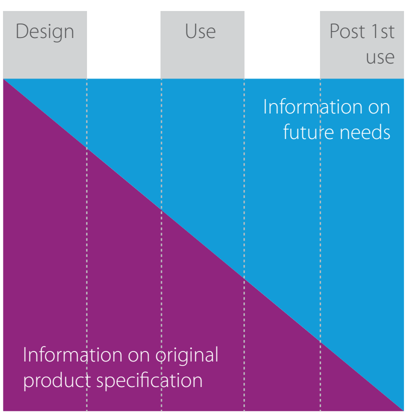

Figure 23.2—**Information availability over the product life cycle**

Figure 23.2 shows how available knowledge changes between the stages of product life. At the design stage we have perfect information about the original product specification, but little is known about future needs (especially for long lived products). After first use, these future needs are now clear but information on the original design, specification and production may be missing.

We saw in chapters 15 and 16 that knowledge about future needs is critical when choosing between strategies for long life design, and that information on product composition is critical for reuse, adaptation and upgrade. As products progress from manufacture to use, through successive reuse to discard, we forget what they were made of, but we begin to understand how they should have been designed. Although, without a crystal ball, we cannot foresee future needs, we can at least improve in remembering what is in our products. We've come across a couple of examples where this better remembering has been imposed: the refurbishment of 55 Baker Street was aided by original calculations and drawings; when installing 'flexible' foundations, developers at Canary Wharf commissioned a close out report from the engineers to document the exact specification of the foundations. Improved information reduces subsequent testing and certification costs and so increases the chances that at the end of its first life a product will be adapted for life extension or reused.

Solutions: Design with excess material is currently promoted by conservative design standards or governmental regulations, particularly when they are written to specify minimum rather than target levels of safety. Collaboration between the full set of companies involved in making a product may allow a more rational selection of a single safety factor, and insurance industries could work with standards bodies to control the tendency to over-specify and to provide certification and buying standards for reuse. Designers can ensure that detailed knowledge about their original intentions survives with their products, to facilitate intelligent adaptation or re-use after first use.

Problem: most companies continue to focus on product sales not service revenue

The steel and aluminium industries make money by selling metal, so are primarily motivated to sell more of it. Similarly component manufacturers, and even final manufacturers of products such as washing machines, are mainly motivated by volume of sales. A switch to a business model based on service more than sales would allow quite different behaviour to become profitable and would internalise the downstream benefits of greater material efficiency. Figure 23.3 shows the relative size of up-front purchase costs and lifetime maintenance costs for two products, a rolling mill and a car.

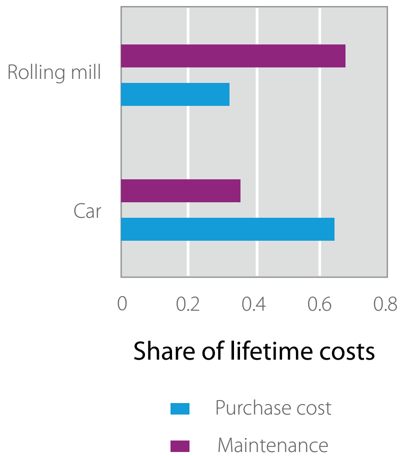

Figure 23.3—**The relative size of purchasing and maintenance costs**

The relative share of these two costs for these products are opposite: for the long lived rolling mill a lifetime maintenance contract is worth twice as much as the original sale; for the car the value of the initial sale exceeds the lifetime service and maintenance costs. Can we say that rolling mills are long lived because they have a higher service share? Probably not because, as we saw in chapter 16, there are many other reasons for the long life of rolling mills (such as the high value of the core components and fortuitous developments in metallurgical science by which higher strength materials can be rolled in old mill frames), and because the high service share is an outcome of this longer life. We can however, say that, as explored in chapter 16, for long life vehicles to be attractive for car manufacturers, greater profits must be achieved through services than from initial sales.

We've seen in our case studies that there may well be other benefits to offering enhanced services in a longer lasting contract: businesses offering upgrades may be able to develop closer relationships with customers through more regular upgrade of existing products; they may also benefit from more regular cash flows; they may be able to offer their customers a lower total cost of ownership through upgrades.

Solutions: Suppliers can investigate options to provide material services rather than materials. We have begun to assess this approach for cars but, due to commercial sensitivity, this sort of analysis is better conducted internally.

Problem: bigger and sooner is better

We have come encountered several examples where excess material is used in order to satisfy customer perceptions of quality. For example, customers demand that cans and car body shells remain rigid in use, and, in the UK, letting agents require office buildings to withstand loads beyond the requirements of building regulations.

We also saw, in chapter 16, that there may be many reasons why consumers do not choose long-lived products: decisions often take into account only a subset of costs; discount rates have a punishing effect on the future benefits of greater durability; short sighted decisions governed by the need for quick payback periods do not allow comparison of options across the longer time spans that would favour more durable products; comparing marginal rather than average costs of two options negates some of the benefits of long life.

Solutions: We need to raise awareness of the emissions and cost implications of these choices and encourage consumers to re-evaluate these preferences.

Opportunity: awareness about embodied emissions is increasing

We're optimists so cannot end a chapter with another problem, so this one's an opportunity. We are all becoming more aware of embodied energy. At present, supermarket chains are competing for 'green credentials', one aspect of which is exploring options to label the 'carbon footprint' of all goods sold. If this occurs, products such as deodorant aerosols or canned drinks, which are sold in aluminium cans, will show significantly higher impacts than those sold in other packaging and this may influence customer purchasing. As part of its waste prevention strategy, the UK government has funded trials of refillable packaging at UK super markets. For example Asda trialled in-store refillable packaging for its own brand fabric softener. This could be a precedent for radical change in the use of metal packaging, reversing the trend away from refillable packaging (for example, as observed for refillable milk bottles (94% of market volume 1974 to 10% 2006), soft drinks (46% 1980 to 10% 1989) and beer containers (33% 1961 to 0.3% 2006))[7].

More broadly, with legislation driving significant reductions in energy used in buildings and vehicles, the embodied energy in their construction and manufacture is a growing fraction of their total impact and developments in certification will increasingly demonstrate this to final purchasers.

We don't yet know when or if the public will radically change its purchasing behaviour due to environmental concern. A much discussed positive example of behaviour change occurred in response to concerns over the Ozone layer, when the public switched to aerosols without CFC propellants as a result of a ban on using CFCs first enforced in the US in 1974. In contrast, despite the fact that every packet clearly tells customers that purchasing carries a significant risk of death, the sale of cigarettes continues. And as we saw, the Easter Island community continued building stone statues cutting down trees until they had no means to continue living.

Taking the opportunity: if customers become more aware of embodied emissions in products, and therefore change their behaviour, this will create a much stronger driver for material efficiency than provided by material cost savings, because it will become part of core marketing messages.

Outlook

In this chapter we have discussed a wide range of opportunities and barriers relating to the material efficiency strategies put forward in Part III. Two things are clear: (1) material efficiency requires a greater level of cooperation between the many companies involved in producing a product made with metal components; (2) some of the changes we have suggested require a radical change in company strategy. A key requirement for many of the strategies we've identified with both eyes open is to create full scale commercial demonstrations to find out how they apply in different sectors and to allow detailed examination of costs and customer responses. That will be the focus of our future work.

Meanwhile, our analysis of costs has shown that material cost savings are only a weak driver of change towards significant material efficiency. Although we've seen that there may be co-benefits and other reasons for companies to change, it is clear from this chapter that change will be instigated much more rapidly if stimulated by other incentives. And in turn that sounds like an invitation to a chapter on policy to promote material efficiency.

Notes

1. This price data was supplied by Steel Business Briefing (SBB,2009) and accessed via UNCTAD (2011)
2. Pratten (1971) examines the source of economies of scale in manufacturing. His analysis includes a case study of the UK primary steel industry in the 1960s
3. Kelkar et al. (2001) provide data on the fabrication costs of five vehicles. On average mass production (say of 200,000 cars per year) saves 26% of production costs compared to medium scale production (around 60,000 cars per year).
4. In his précis of technology shifts in the steel industry, Tomiura (1998) writes "The mass production system is collapsing due to the diversified market requirements"
5. Christiansen (2003) uses the rise of secondary production of steel (referred to as production by mini-mill) as an example of the successful implementation of a disruptive technology.
6. A seminal paper by Akerlof (1970) explains how asymmetric information between buyers and sellers of used cars ultimately causes market collapse because consumers, who lack information on product quality, are only willing to pay the price of an average quality car. Sellers of above average quality cars are unwilling to sell at this price, depressing the average quality (and so price) of used cars brought to market and ultimately causing market collapse.
7. Brook Lyndhurst (2009) conducted an evidence review of refillable packaging pilots. They found that refillable packaging has seen greater success in the US where there is a tendency to shop less frequently and buy in bulk and in Asia Pacific where consumers are well informed about the benefits of reuse/refill