Where's the Profit in Industrial Ecology?

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At the heart of the metaphor of industrial ecology is the idea that it is possible to make industrial systems—companies, product cycles, service systems—more like natural ecosystems. The legitimacy of the metaphor depends on a number of different factors. For example, we need to know that technological opportunities exist within the industrial system for increased recycling, improved material efficiency, or the "cascading" of materials from one use to another. Fortunately, there is now plenty of evidence that this sort of opportunity is in fact abundant.

Equally, however, industrial ecology requires what sociologists would call a "theory of agency." That is, it needs to have some idea who the actors in the industrial ecology are, and what motivates their actions. Without such a theory, we will be at a loss to determine which actors should take which steps, and whether the incentives are in place to encourage them to act appropriately. Indeed, the whole success of the industrial ecology metaphor depends crucially on its assumptions about agency.

So what are those assumptions? Is there a theory of agency in industrial ecology? Is it consistent with actions in the real world? And what does it tell us about the legitimacy of the industrial ecology metaphor? These questions are not easy to answer, partly because they tend not to have been addressed explicitly. Nevertheless, it is possible to make a tentative stab at answering them.

Modern industrial society is a system based heavily on the notion of profit. The bottom line for industrial companies is a financial one. To be successful in corporate terms is to increase revenues, reduce costs, and thereby achieve a healthy profit margin. This profit margin has two major purposes: first, to fund the investment needed to ensure the future survival—the sustainability, if you like—of the company; and second, to provide the dividends that shareholders expect, the promise of which has persuaded them to invest their capital in the company to start with.

In terms of making decisions, the important actors are the industrial managers, the CEOs, and (in theory) the company shareholders. Customers are important as well of course: their custom provides the revenues from which profits are made. And if the neoclassical economic model of human behavior is to be believed, then every individual actor from shop-floor manager to chief executive officer, from shareholder to consumer is also essentially a self-interested maximizer of individual profit. Profit, according to this theory, is what makes the system tick. Even if one disagrees vehemently with the narrowness of the neoclassical description of human nature, the reality of the profit motive as a fundamental driver in industrial ecology is hard to deny.

Most people do not try to deny it. On the contrary, the importance of the profit motive has been widely cited as the very best of reasons for engaging in preventive environmental management. Ever since 3M's innovative "pollution prevention pays" program in the 1970s, there has been a plethora of industrial initiatives based on the premise that it is possible to save money by saving the environment—the win-win scenario: Waste Reduction Always Pays (WRAP)

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claimed Dow Chemical; Save Money and Reduce Toxics (SMART) urged the Chevron Corporation. The Landskrona project in Sweden, the PRISMA project in the Netherlands, and the Aire and Calder Valley project in the United Kingdom all set out to demonstrate the economic advantages of regional pollution prevention. The Kalundborg industrial park in Denmark, the very flagship of industrial ecology, is predicated on the idea that waste is just "an economic resource in the wrong place."

Here then is the implicit theory of agency that underlies the industrial ecology metaphor. The relevant agents are economic ones; their principal motivation is to maximize profits. By acting in this way, the theory implies, it is possible to achieve a sustainable industrial society. This is as far as the implicit theory takes us. But what is its basis in reality? Where is the analogy in natural ecosystems? Is it really true that there is profit in pollution prevention? And if it is true, then how is it that we still have pollution in an industrial society driven largely by the profit motive?

First of all, let us make quite clear that the evidence for profitable pollution prevention is extensive and convincing. Furthermore, there are some extremely sound reasons for this. Cost savings often arise from lower disposal costs, fewer environmental penalties, and reduced liability insurance. Improved public image can increase market share and equity value. But even when environmental legislation is lax and public awareness is low, companies can still make a profit simply because they reduce the material input costs per unit of output. In fact, there is absolutely nothing new in this. You can see the same principle in action from the time of the industrial revolution onward. For example, the volume of coal needed to produce a ton of iron fell by more than half between 1790 and 1830; and the energy intensity of iron and steel production (and many other commodities) has fallen pretty much continually ever since. There is clear evidence of declining material intensity in a number of sectors. The average weight of mobile phones, for example, has fallen from around 1.5 kilograms to 130 grams in less than five years, driven partly by resource cost minimization, and partly by technological innovations in response to consumer demand.

Declining trends in the material content of economic output are also visible on a macroeconomic scale, prompting some to conjecture that economies naturally "dematerialize" as they grow, and that the most effective way of safeguarding the environment is therefore to pursue economic growth as fast as possible. At this point, however, an astute observer must surely smell a rat. One of the observable trends in developed countries over the last few decades has certainly been a shift away from primary processing industries toward secondary and tertiary industries. This shift has been driven by a number of factors. Principally, however, it is clear that the materials extraction and primary processing industries are the "dirtiest" parts of the industrial economy. The movement up the supply chain from extraction, through processing, component manufacture, and assembly, to retail and financial services brings lower and lower direct emissions per unit of economic output (figure 1).

But in doing away with dirty production, have the developed economies done away with dirty consumption? There is very little evidence that they have. Economic consumption continues to rise, and an increasing proportion of this consumption rests on the throughput of material commodities: cars, audio-visual equipment, mobile phones, personal computers, and so on. The neat little conjuring trick that makes the developed economies look a bit cleaner is, in part, achieved by exporting the polluting bits of the manufacturing base to other countries—usually in the developing world—and importing more finished products.

Notice that the economic incentive is still in play. The imported products are cheaper than they would be if they had been entirely manufactured at home, mainly because indigenous resources would have been scarcer, domestic labor more expensive, and environmental regulations more stringent. Retailers want cheaper products to attract more consumers. Consumers want cheaper products to maximize the utility they can glean from a limited income. Here is the profit motive again, but this time it is working as a magician's wand to conceal the environmental and social impacts of high-consumption lifestyles. International trade hides the real extent of our "ecological footprint" by distributing it around the globe. Natural ecosystems rarely have it so easy.

Worse is to follow. Profit is not simply a driver for efficiency improvement. Nor does it restrict

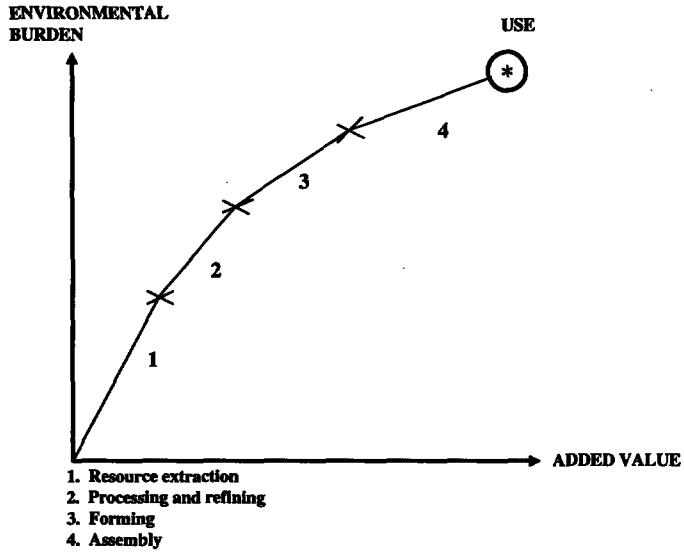

Figure 1 Accumulated environmental burdens along the supply chain.

itself to playing the sorcerer's apprentice. The profit motive is actively engaged in hindering the dematerialization of industrial ecology. It is easy to see how this occurs. Profit margins are determined by the balance between revenues and costs. Reducing costs (including material input costs) improves the profit margin. But the same effect can be achieved by increasing output, and thereby increasing revenues. All the way along the supply chain, companies have an incentive to reduce their material input costs. But all the way along the same supply chain companies also have an incentive to increase their material outputs.

Furthermore, each reduction in material input to one company is (ceteris paribus) a reduction in the material output of another company. Material consumers may profit from reduced consumption of input materials, but material producers (all the way along the supply chain) must by the same token be losing out. The reality of this impasse is aptly highlighted by the history of toxics use reduction legislation in the United States. The first state to introduce such legislation was Massachusetts. A number of other states quickly followed suit; but, subsequently, the process slowed up considerably. The reason was abundantly clear. The states that actively pursued legislation to reduce toxics use were, in the main, net toxics consumers. These states stood to gain financially by reducing their industrial chemicals bill. The states that resisted the introduction of such legislation were, in the main, net producers of toxic chemicals. Part of the income of these states depended on producing and selling toxic chemicals.

We can see now why modern industrial society has not solved the problem of environmental pollution. The profit motive encourages us, with one hand toward improved production *efficiency*, and with the other hand toward increased production *output*. The same economic imperative is driving us in two conflicting directions, creating an almost irresolvable tension at the heart of industrial ecology.

This is a systemic problem, and it demands systemic solutions. It is still possible to negotiate considerable leeway for improvement, for instance, by shifting the burden of taxation from social "goods," such as employment, onto social "bads," such as material consumption. In other words, the signals that regulate the economic system must be turned around to point in the right direction. European Union countries, in particular, are giving increasing attention to the possibility of "ecological tax reform." Ultimately, however, we are surely driven to reexamine the notion that human beings are purely self-interested profit maximizers. The analysis here indicates that such actors will find it very difficult indeed to develop a sustainable industrial society. The metaphor of industrial ecology is either flawed or else it needs a better theory of agency.