EA-SUSTAINABLE DEVELOPMENT Box 1

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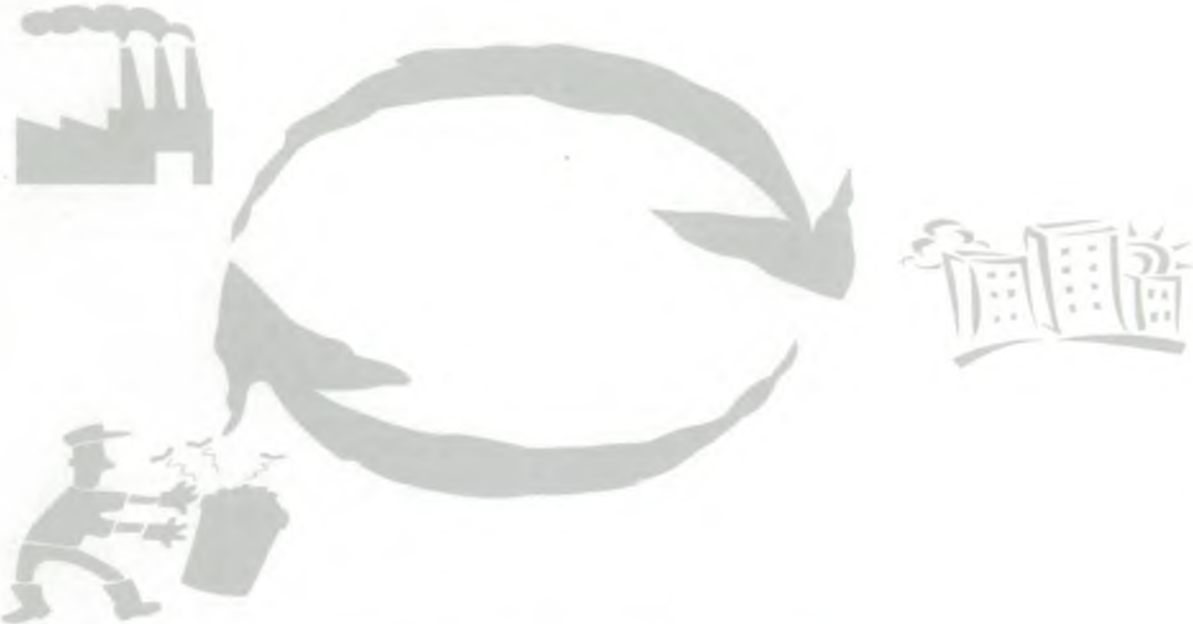
the NATURAL STEP



Towards the Sustainable Use of Material Resources:

An Evaluation Using The Natural Step Framework

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Summary

There is growing interest from policy makers, the business sector, investors and regulators in resource efficiency. Whilst many existing studies focus on the economic benefits of achieving the most efficient use of material resources, this *2020 Vision* evaluation by The Natural Step and its partners is motivated purely from a sustainability perspective.

Increasingly, we see indications that environmental and sustainability implications lie as much, or perhaps more so, in the *way materials are used* rather than necessarily in the properties of the materials themselves. The focus of this *2020 Vision* study is therefore upon *the way materials are used*, as opposed merely to considering the material type irrespective of patterns of use. The Natural Step (TNS) Framework is the strategic tool used in this *2020 Vision* study.

The study explores the history of resource use and the way that it contributes to today's resource use habits, provides examples of resource use, and explores their sustainability implications using the four System Conditions of TNS. This sustainability analysis is explored from economic, regulatory, social and political contexts. We are, it is unavoidable to conclude, a long way away from sustainability with respect to the way we use material resources today. Again on the basis of the four System Conditions of TNS, a vision was developed by delegates at a *2020 Vision* seminar of how resources would be used in a fully sustainable future. Nine key sustainability challenges are identified to make progress towards that vision from where we are today. These challenges, which relate to cultural change, the economic framework and remaining technical challenges, are:

1. Changing the 'throw-away' culture
2. Design for sustainability through cross-sectoral partnerships
3. Sustainable regulation and a 'beyond compliance' culture
4. Creating long-term business thinking
5. Internalising environmental and social implications throughout the life cycle
6. 'Joined up' economics
7. Seizing the new economic opportunity
8. 'Intelligent' use of material resources
9. Establishing performance-based standards

Perhaps the most surprising conclusion of this consensus-based work is that technical issues present relatively minor challenges. We are already capable of developing the necessary technology, but are held back from serious progress with sustainable development by political, regulatory and economic obstacles.

A model known as the *Cyclic Hierarchy* is provided to help designers, planners, regulators and other decision-makers apply sustainability considerations to deliver the greatest value to society per unit of physical resource in products and processes.

The Environment Agency has a specific interest in the broad topic of resource efficiency, and is a partner in this study. This *2020 Vision* project is also supported by the Ineos Group, a leading manufacturer of speciality and intermediate chemicals, through the Landfill Tax Credit Scheme. Additional input was provided by EVC (European Vinyls Corporation), part of the Ineos Group.

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EA: Sustainable Development - Box1

1. Introduction

1.1 Meeting the Challenge of Sustainable Resource Use

There is growing interest in resource efficiency. Policy makers, the business sector, investors and regulators are concerned to find new ways of 'getting more from less' or, in other words, increasing the efficiency of our use of the materials available to us. A report published recently (December 2001) by the Policy & Innovation Unit (PIU) demonstrates the UK Government's commitment to put the issue of resource efficiency high on the agenda.

Not all of this focus on material productivity is driven by sustainability concerns. The need to do more with less is often expressed purely as a component of improving our competitiveness in world markets and, for many, the focus appears to be purely economic. The inclusion of this topic in The Natural Step's *2020 Vision* Programme is motivated purely from a sustainability perspective.

Business sustainability is itself about far more than improving economic and environmental performance. Corporate reputation and its 'license to operate' around the world depends upon competing effectively but also meeting these wider responsibilities to employees and the communities in which an enterprise is located, to business partners, suppliers, selected NGOs (non-government organisations) as well as to the environment and future generations. Good business is, by its very nature, socially as well as environmentally responsible.

1.2 Patterns of Material Resource Use

Increasingly, detailed environmental and sustainability evaluations offer evidence that the impacts of materials used by society lie predominantly in the *way they are used*, rather than automatically in the properties of the materials themselves. For example, two Life Cycle Assessment (LCA) studies on PVC and its alternatives provide quantified evidence that the environmental impacts across the life of various applications selected for study vary little between material types[1]. Even materials traditionally viewed as 'green' or 'environmentally friendly', such as those produced from crops rather than fossil petrochemicals, immediately cease to be 'green' if they are used and disposed of in traditional unsustainable ways![2] This is not to say that material properties are irrelevant, but that we should not let this consideration alone blind us to the ways in which they are used.

1.3 Scope of Study

This *2020 Vision* study therefore considers the way materials are used, as opposed merely to considering material type irrespective of the way it is used. Specific material types are highlighted only as examples germane to use patterns. This project is intended to inform our thinking about the most sustainable patterns of resource use, and to inform change towards the reduction of human-induced resource flows to a level and content which stops them over-loading natural systems.

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[1] These studies are the Entec UK study for DETR in the UK on *PVC and its Alternatives*, as well as a similar study by the Fraunhofer Institute in Germany (both of these references are provided in the Bibliography at Annex 3).

[2] Extracted from *A Material Dilemma*, Mark Everard et al (2001) – see Bibliography.

The Natural Step (TNS) Framework is the strategic tool used in this *2020 Vision* study. The TNS Framework is based on fundamental scientific principles. It offers an understanding of the basic conditions which must be met to achieve a sustainable society in which everyone has the opportunity of a decent way-of-life. The TNS Framework is helpful in enabling us to focus on broad sustainability principles. It makes possible the application of these simple principles at a generic level, rather than getting lost in technical details that may or may not be germane to the eventual achievement of sustainability. It promotes an 'upstream' way of thinking. This approach differs significantly from historical approaches to resource regulation that are usually based on the containment and control of end-of-pipe pollutants in order to mitigate the effects on the environment, with little emphasis on resource flows through society in the use and post-use of materials.

The key questions explored in this project are:

- *Is current resource use sustainable?*
- *What are the factors determining current resource use patterns?*
- *What is our vision of sustainable resource use?*
- *What steps must be taken to enable sustainable resource use?*

It is recognised that a wide range of initiatives has been established to contribute to more sustainable resource use. A number of these initiatives are listed in Annex 2, including a short description of how they relate to the goals of this project.

1.4 The 2020 Vision Project and Partner Organisations

This evaluation forms part of the *2020 Vision* series of consensus-building projects, run collaboratively between The Natural Step in the UK and the Environment Agency. *2020 Vision* utilises the TNS Framework as the basis for <u>action research</u> and <u>consensus-building</u> about selected issues, setting them in the context of the achievement of sustainability. For a summary of the *2020 Vision* process, see the inside back cover of this report.

The topic of Resource Efficiency has been identified by the Environment Agency as one of six 'cross-cutting themes' that affect all of its policy areas. Indeed, for each of the six themes – Sustainable Agriculture, Energy, Resource Efficiency, Urban Regeneration, Climate Change and Greening Business – progress can only be made by developing dialogue across sectors of society. Indeed, some of these themes are not subject to regulatory control by the Agency, yet contribute to 'downstream' problems that the Agency has to manage. Resource Efficiency is a complex theme bringing in aspects of waste, process efficiency, customer specification, new business opportunities, as well as public expectations and behaviour. This study, examining how resources are used and putting the material type in that context, is intended to add value to resource efficiency policy development.

This *2020 Vision* project is supported by the Ineos Group through the Landfill Tax Credit Scheme.

2. Sustainability and The Natural Step Framework

The TNS Framework is a robust and science-based set of tools that defines sustainability in unambiguous and workable terms as it applies to resource use. It helps organisations engage with the practicalities of sustainable development.

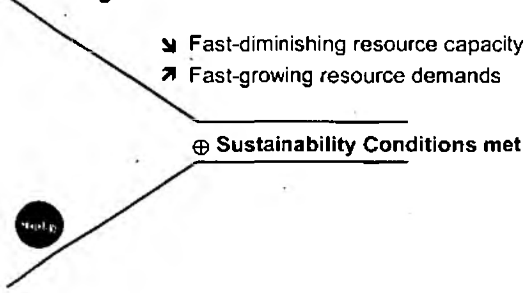
2.1 Sustainable Development and the Pace of Change

We all acknowledge that we live in a fast-changing world, in which the pace of change is accelerating. Thinking back just twenty years, and plotting the changes we've faced in our day-to-day lives, we become aware of the scale of this change. Although the pressures that have forced these changes may appear random or unforeseeable, many stem from the 'squeeze' of a world with a rising population and a diminishing resource base.

TNS uses the metaphor of the 'funnel' to describe how decreasing environmental and social headroom – the 'license-to-operate' granted by a society – will increasingly impinge upon the freedom of operation of a business or other organisation (Fig 1).

As one approaches the 'walls' of this metaphorical funnel, the impacts on the business manifest themselves in diverse ways which include resource scarcity and costs (critically including the resource provided by the natural environment in absorbing wastes), more stringent regulations, reputation with markets and the public, health and safety concerns, difficulty in securing capital and planning consent, and so forth. Sustainable development pressures have been with us for many years and will, inevitably and increasingly, define the business and government agenda.

Fig 1: The TNS 'Funnel'



2.2 How the TNS Framework is Applied

The four System Conditions of the TNS Framework provide a science-based conceptualisation of the conditions that must be met in a sustainable world, and therefore the sustainable future represented by the 'mouth' of the metaphorical funnel (Refer to Annex 1 for more information about TNS and the derivation of the four System Conditions, which are listed in Box 1). From this conceptual model, we can do three things. Firstly, we can make an objective assessment of our current state of sustainability, by running the present resource life cycle under the 'lens' of the four System Conditions. And then we can build a vision of a fully sustainable resource use cycle based upon this same conceptualisation of sustainability.

Box 1: The Four System Conditions

In the sustainable society, nature is not subject to systematically increasing...

1. *...concentrations of substances extracted from the Earth's crust*
2. *...concentrations of substances produced by society*
3. *...degradation by physical means*

and, in that society...

4. *...human needs are met worldwide.*

Once we know where we are today and where we need to get to tomorrow, we are then in a position to 'backcast' from this vision, identifying the incremental steps necessary to reach that sustainable future. By starting from the 'end-goal' perspective, backcasting can help make sustainable development tractable, and also help organisations make short-term investment decisions that make incremental steps towards the long-term achievement of sustainability.

2.3 Why a Commitment to Sustainable Development is Essential

The four TNS System Conditions provide the environmental and social boundaries for sustainability. They recognise that there are limits to the carrying capacity of the Earth in terms of the provision of material resources and environmental services and in terms of the capacity of nature to absorb and break down the by-products of society. Once we exceed these boundaries, we are compromising our own and future generations' ability to maintain or improve quality of life. These boundaries act as the limits within which we need to form a sustainable economy, with the economy ultimately being dependent on nature's carrying capacity.

If tackled proactively, sustainable development will not only enable us to avoid hitting the 'walls of the funnel' but also to identify the new business opportunities presented by an inevitably changing and more sustainable future world. If we continue to react to issues as we go on blundering into those walls, we will merely perpetuate the historic pattern of industrialised society of responding reactively, at substantial cost and disruption as issues hit us one after the other. A true commitment to sustainable development is therefore about a great deal more than altruism, as it helps deal strategically with the pressures that will inevitably define the future business agenda.

2.4 TNS Evaluations of Materials

Reports and papers documenting TNS projects are noted in the *Bibliography* at Annex 3 of this report. These material-specific documents provide a substantive part of the raw input for this more generic study of material life cycles. The TNS Framework has already been used to make this evaluation on a variety of materials, including:

- PVC
- Paper
- Nylon
- Metals
- Phosphorus
- Metal substitution
- Construction materials
- Generic material choice criteria
- Generic consideration of landfill

3. Sustainability Assessment of Today's Resource Use

In this Section, we will explore the ways that material resources are used today, apply the four System Conditions to undertake an assessment of the extent to which these patterns are sustainable, and undertake a brief examination of the roots of sustainability problems.

3.1 The Contemporary Resource Use 'Cycle'

The sustainability pressures contained in the TNS 'funnel' metaphor – arising primarily from increasing population and a decreasing resource base (including the assimilative capacity of the environment) – illuminate some trends in resource use that are of concern.

Of particular interest to this study is the largely linear use of resources – *make, use and dispose* – that has been the predominant habit since the Industrial Revolution. In the mid-17th century, when the reductive approach to science was unlocking unprecedented wealth creation, health improvement and material quality-of-life, this pattern of material use must have seemed sustainable. After all, the population was only about 600 million, resources were perceived as inexhaustible, and nature's capacity to 'dilute and disperse' waste seemed limitless.

Population has since escalated very rapidly. It has doubled since 1960 to six billion, and is spiralling upwards at a staggering rate of some million people a week towards nine billion by the middle of this century. The typical person in the western world consumes up to 50 times more resources than the average person in the developing world.[3] Both the continued economic growth in the western world and the reasonable desire of those in developing countries to attain improved levels of material welfare has resulted in an ever-increasing and unprecedented demand for resources. This has in turn placed unprecedented pressures on the environment and on societies. Unless alternatives to current resource flow patterns are devised, these environmental pressures will result in irreparable damage to environmental systems and their capacities to support people in living healthy and fulfilled lives.

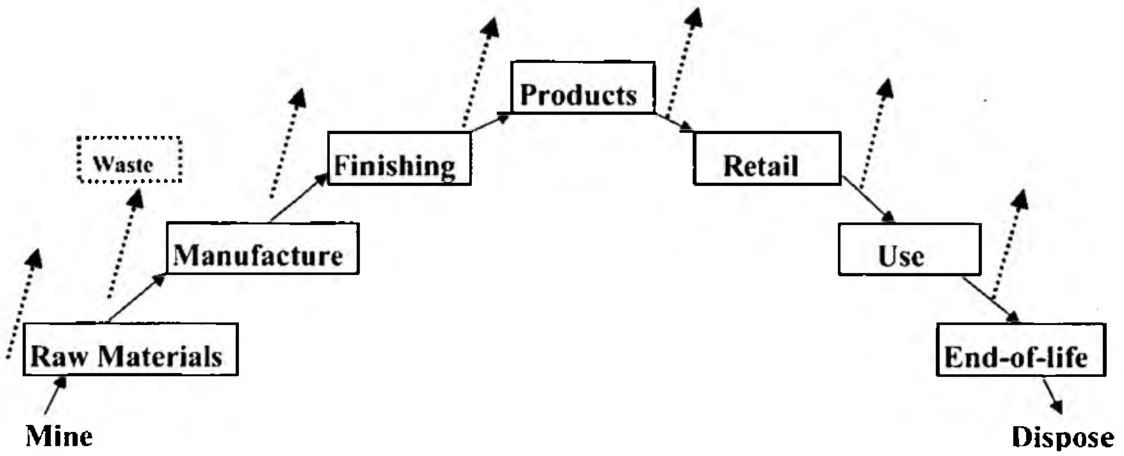
Trends in the global ecosystem – such as the loss of 70% of the world's forest over the past century, with 10% of the world's forests lost over the past three decades, and a global rate of species loss of up to 40 per day – point unambiguously to the degradation of nature, together with its ecosystem functions. It is these very ecosystem functions that make life possible, as well as potentially supplying economic opportunities, quality of life and the fulfilment of all people.

The economic system as it operates today makes substantial demands upon virgin natural resources. The linear resource use pattern we have inherited has environmental and social costs that are now beyond the capacity of the world to bear, stimulating as it does a high demand for raw resources, an accumulation of pollutants, the destruction of ecosystems, wastage, and an inequitable distribution of those resources and impacts.

Figure 2 illustrates a classic model of resource use. <u>This is a fundamentally *linear* resource flow, rather than a cycle</u>. Unlike the cyclic resource flows of natural systems, which result in *no* net accumulation of waste, human-induced linear resource flows *inevitably* lead to an accumulation of waste.

[3] The carrying capacity of global resources is thought to equate to about two billion people with current western lifestyles. Hence, with a 6 billion+ population and a developing world aspiration to attain this lifestyle, we are on an inevitable course of dramatic depletion of resources.

Fig 2: Linear resource flows



Not only are current patterns of resource flows linear, they are also very inefficient with losses from the system resulting through processing in particular. On average it takes 10 tonnes of raw materials to manufacture 1 tonne of finished goods, excluding water, though if water is included this ratio increases to 100 tonnes of inputs per tonne of output (Biffa, 1997). Lovins *et al* in *Natural Capitalism* estimate that, for the US, only 10% of manufactured products – representing only 1% of the original mass of raw materials – are still being used *6 months* later. This fact is illustrated by using a case study of British aluminium soft drink cans that was first published in *Lean Thinking* by Womack and Jones (1996) (see Box 2).

Box 2: Inefficiency of aluminium can production
Womack and Jones (1996) trace the journey of the aluminium from the bauxite mine in Australia to a smelter in Scandinavia. From there, the aluminium travels to a rolling mill in Germany and then to Britain to be manufactured into cans. For each tonne of aluminium cans, 4 tonnes of bauxite have been mined in Australia. The UK produces 110,000 tonnes of aluminium cans each year. In 1998, 64% were disposed of, representing a total wastage of 281,600 tonnes of bauxite mined in Australia with all the associated environmental degradation.

3.2 An Evaluation of Linear Flows Using the System Conditions

As explained in Section 2, the 'lens' of the four System Conditions provides an objective and science-based set of criteria for making a sustainability assessment of current patterns of resource use. The remainder of this Section addresses the sustainability implications – based on the four TNS System Conditions – of various materials that have been explored in previous TNS studies.

System Condition 1:
In the sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the Earth's crust

The current inefficiencies of our linear and predominantly once-through model of resource flows will typically contribute to a breach of System Condition 1 at each stage of the extraction – processing – manufacture – distribution – use – disposal chain (and of course the links between them such as transport and energy). Wastes and emissions are produced and released at every step, some or all of which comprise substances extracted from the Earth's crust. Most of these substances will tend to accumulate in natural systems. Their sustainability implications are related to the quantity of flows and the type of material. Today, the throughput of materials in the economy required by current patterns of resource flows means that many are emitted into the environment at a rate exceeding the capacity of nature to reincorporate or redeposit them, thus infringing System Condition 1.

The bullet points below exemplify some of the activities along traditional linear resource use chains that currently contribute to a breach of System Condition 1. Many are based on previous TNS-related studies referenced in the *Bibliography* at Annex 3 of this report. The bullet points follow the general structure of resource use chains from extraction through manufacture to disposal.

- **Leaching of mined minerals** contributes to widespread pollution, including eutrophication of soils and water. Example of these mined materials include mineral fillers in plastics, or the linear use of mined phosphorus in agriculture, domestic products and industrial processes. Unless they are present in forms that can be broken down completely in nature, and are emitted at rates that can be fully reintegrated by natural systems, they should be recovered for reuse at end-of-life or else they will have the potential to accumulate in nature with unpredictable consequences.

- **Agricultural applications of mined minerals** such as the use of phosphorus and nitrogen are common causes of diffuse as well as point-source pollution. Their systematic accumulation presents a sustainability problem (particularly in water).

- **Overburden and mining waste** are becoming increasingly problematic. In the Ukraine, 94% of the total material flow in the economy is associated with extraction and processing of minerals (Friends of the Earth 2000) and this is the predominant waste stream in most countries. This will become worse as high-grade sources of many ores are becoming harder to find and more stringent regulation of emissions increases the cost of pollution control. In addition, it should be pointed out that a lot of mineral extraction happens in developing countries with less stringent environmental and human health regulation. However, the important contribution mineral extraction makes to many developing world economies should not be forgotten. This links into the concept of environmental justice, as discussed subsequently.

- Use of **fossil carbon resources** represents a significant contribution to breaching System Condition 1 in the life cycles of all materials studied. These uses include combustion to produce energy (directly or indirectly), the formation of materials subject to linear usage, transport at every stage, and a range of other ways that may not be subject to traditional assessment (i.e. energy requirements for maintenance throughout the useful life of products). Fossil resources are commonly used in applications where linear use is inherent (e.g. combustion), and in quantities that far exceed the capacity of nature to integrate them. In a recent report, the UN stated that the global dependence on fossil fuel is now almost complete. Petroleum accounts for 95% of all energy consumption for transport, and is growing at the rate of 1.5% a year in developed countries and 3.6% in developing countries. In the 20th Century, carbon dioxide emissions grew 12-fold, from 534 millions metric tons in 1900 to 6.59 billion metric tons in 1997. Since the Earth Summit in Rio in 1992, carbon dioxide emissions have grown 9% (*Footprints and milestones: population and environmental change*, UNFPA). Globally we are returning fossil carbon to the atmosphere a million times faster than it takes to be produced (*All that is solid melts into air: the experience of Modernity*, Marshall Berman).

- **Carbon sequestration through afforestation/reforestation** offers the opportunity for industry to offset some of its carbon emissions, also providing wildlife habitat and other potential sustainability benefits. However, more research is required to explore the role of managed forestry, as the science is still quite uncertain. Carbon sequestration must be considered carefully to avoid justifying perpetuation of the linear use of fossil fuels.

- **Linear flows of minerals** can be deeply ingrained. Most countries rely on significant imports of minerals and metals for consumption since deposits of concentrations that can be economically extracted are limited geographically. The dispersal of those materials as they are consumed, and their mixing with other materials in waste streams, often makes it uneconomic to recover them. Indeed, the transport requirements entailed in recovery, if poorly planned, can itself contribute to breaches of System Condition 1, making it difficult to justify recovery environmentally. Numerous life cycle analyses discuss this point.

- The utilisation of **renewable energy** will be an increasingly pressing priority in the future. However, renewable energy itself is only part of the solution, as it has its own impacts that become increasingly serious with rising energy use. Energy minimisation and efficiency has a greater capacity for progress towards sustainability, and of economic self-benefit, in the short-term.

- **Metal flows**, for example where used as stabilisers in plastics or liberated as impurities in mined phosphorus deposits, also represent a linear flow contaminating the biosphere and thereby contributing to a breach of System Condition 1. However, metals can be more durable than alternatives and this, coupled with their economic value, has led to a complex system of grading and separation techniques that facilitate their recovery for reuse and recycling.

- The market price of **copper** creates an incentive for efficient recycling at end-of-life. This is a positive example of a current incentive for more cyclic use of a substance which, if merely thrown away, can give rise to a range of toxicity concerns. However, for other secondary materials, low and fluctuating market prices make it difficult to establish and maintain collection and processing infrastructure.

- In developing countries, 90-95% of **sewage** and 70% of **industrial wastes** are dumped untreated into surface waters, where they pollute the water supply. In many industrialised countries, chemical run-off from fertilisers and pesticides, and acid rain from air pollution require expensive and energy intensive filtration and treatment to restore acceptable water quality. This situation breaches SC1 and 2. Purely technological solutions to water quality are likely to have limited overall sustainability gains.

System Condition 2:
In the sustainable society, nature is not subject to systematically increasing concentrations of substances produced by society

The current linear system of resource use fundamentally contributes to breaches of this System Condition. As stated earlier, each stage of the traditional material use chain typically produces wastes and emissions that are dumped into nature in quantities that exceed assimilative capacity, either because of the scale of material flows or the material's form. Many chemicals that did not exist 50 to 100 years ago are now widely dispersed throughout the environment. Since 1900, industrialisation has introduced almost 100 000 previously unknown chemical substances into the environment. Many have accumulated in concentrations in air, water, soil, food, organisms (including human beings), disrupting the equilibrium and functioning of natural systems. Developed countries, the major producer of the new substances, vary dramatically in their concern and attention to the issue.

The bullet points below summarise some of the activities along traditional linear resource use chains that currently contribute to a breach of System Condition 2.

- For a number of reasons, it is too simplistic to consider materials as moving from manufacture to disposal at end-of-life. One of the key reasons is that there may be considerable **loss throughout the life cycle**, particularly at end-of-life, in the form of volatile compounds 'out-gassing', leaching to water, degradation leading to formation of dust, etc. All of these potential losses of materials to the biosphere are directly relevant to contributions to breaches of this System Condition (and others). The scale of these emissions to nature may be relatively small compared with other material flows, but the type of materials involved can make it an important flow, particularly as this pathway is often not included in resource life cycle assessments.

- The release of substances that are not harmlessly reintegrated into natural systems breach this system condition. For example, uncontrolled emissions from production and disposal of organic materials containing **chlorine** into ecosystems cause concern because of the potential formation of toxic and often very stable and bioaccumulative organochlorines, including dioxins and furans.

- **Synthetic materials**, such as many of those used in buildings and infrastructure, can also cause problems if they result in increasing concentrations in nature because of their mixed composition. The use of composite materials bonded with glues and cements can reduce the economic or technical feasibility of recovery of individual components.

- **Waste PVC, paper and other materials**, if not reused or recycled, can result in the generation of man-made substances (such as organochlorines) that either overload the capacity of natural systems or are otherwise not reintegrated by them.

- **Consumables** used throughout the life of products also have the capacity to generate man-made waste substances that may accumulate in nature. For instance, in the case of paper, mailbags, rubber bands, waste products, distribution infrastructure and vehicles have impacts that can infringe System Condition 2 (organochlorines, low-level ozone, dioxins, etc.)

- **Pesticides** can be contained in agricultural run-off from crops, especially when there is a crop specialisation or a lack of crop rotation and cover crops that require the use of larger quantities of pesticides in order to maintain productivity. Pesticides may enter our water sources by seeping through the soil to groundwater, or may enter streams as surface runoff. Researchers tracking run-off from poorly drained fields often find 1 or 2 percent of pesticide applications in surface water during the first or second storm after application. The pesticides have a direct toxic effect upon wildlife and, by accumulating in the biosphere, also an indirect effect. Evidence shows that this indirect effect, potentially also leading to a decrease in animal fertility, affects long-term freshwater biodiversity. In addition, some like DDT and 2-4D (agent orange) are known to be endocrine disruptors and have been banned in the United States and Europe but are still exported to and used in the developing world (UNFPA).

- For some emissions, this regime has reduced pollution. **Sulphur dioxide emissions** have fallen since the 1970s because regulation is tighter and the number of emitting SO_2 processes has declined. However, for the majority of materials, the overall mass of resource consumed is rising faster than is displaced by efficiencies. Innovations in pollution control technology can make it more economically viable to continue a linear resource flow and disposal via emissions, however relying on end-of-pipe control also carries a risk of technological failure that, some campaign groups would argue, is inadequately deterred through a system of fines and licensing. The risks and shortcomings of the current system, coupled with potentially increasing emphasis on impacts from maintenance, has the effect of putting an increasing strain on current regulatory mechanisms.

- The volume or content of **sludge** from paper recycling mills can exceed the absorptive capacity of soils to which it is applied. Toxic components can result in accumulation of a range of synthetic organic compounds in inks. The same principle also applies to contaminated **sewage sludge.**

- Emissions of **man-made pollutants** such as additives to air resulting from the burning of fossil fuels (as outlined also for System Condition 1 above), as well as to water from industrial processes of all kinds, contribute to increasing concentrations of man-made substances in nature.

System Condition 3:
In the sustainable society, nature is not subject to systematically increasing degradation by physical means

The degradation of nature by physical means is a direct consequence of the throughput of materials in the economy. Ultimately, every material has been obtained from nature by an extractive process that, to a greater or lesser extent, degrades the ecosystem. Clearly, therefore, the larger the throughput of materials in society the greater the physical degradation of nature. For the sustainable extraction of materials from nature, the rate and character of the extraction must not undermine nature's productivity, its self-restorative capacity, or its capacity to support people.

Amongst other forms of physical degradation of nature, loss of biodiversity may be the most serious problem facing the world in this millennium. A recent UNFAP report stated that *"...unless the rate of plant genetic loss is halted or slowed substantially, as many as 60,000 plant species – roughly one quarter of the world's total – could be lost by 2025"*. Equally, the UN recognises that more than 11,000 species are threatened with extinction. More than 800 are already extinct and another 5,000 could disappear unless steps are taken to reverse their population declines. Even taking into account currently-anticipated improvements in efficiency, recycling, changed transport modes, etc, when balanced against growth in population and economic activity, the activities of industry seem inevitably set to cause loss and damage to habitats in the short to medium term. The loss of natural productivity is a serious issue world-wide, as nature's supportive services ultimately sustain all life, provide primary resources for business, and contribute to 'quality of life'. Since loss of natural habitats, and the biodiversity and productivity that they support, is often a matter of 'death by a thousand cuts' – small incremental examples of damage resulting in substantial cumulative loss – there is a need to address habitat in all development decisions across material life cycles.

There are already some solutions emerging, such as funding compensatory habitat restoration schemes either as mitigation or by restoration of habitat previously degraded or lost, that may eliminate the net impact of incremental damage. However, we have to be careful of being over-simplistic, justifying continuing land- and resource-take, and imagining that we can restore habitats and their associated intricate and often unique ecosystems that have evolved over billions of years. Targeted habitat restoration schemes can however seek to mitigate some of the loss of natural productive habitats resulting from the construction of manufacturing plant or other societal infrastructure. By offsetting harm to ecosystems, and ideally restoring degraded habitat to increase productivity, biodiversity and supportive capacities overall, the 'permission to operate' of the company is increased both by improving the life-support services that make business possible as well as by building reputation.

The bullet points below summarise some of the activities along traditional linear resource use chains that currently contribute to a breach of System Condition 3.

- **Mining and quarrying** inevitably destroy habitats and cause physical degradation, through land loss, and should therefore be managed at the minimum level consistent with meeting human needs.

- The **physical impacts of fossil hydrocarbon use** are significant today. The production, refining and transport of the substantial quantities of fossil-based hydrocarbons used in the manufacture of a range of materials, as feedstocks or energy sources, inevitably damage or destroy habitats. Whilst the 'downstream' impacts of their emissions are dealt with under

System Conditions 1 and 2, the exploitation of fossil hydrocarbons also brings with it implications for the physical destruction or disturbance of natural systems (System Condition 3). The risk of smothering important and sensitive ecosystems as a result of spills, and the more insidious releases of oil across society, remain real threats.

- The **replacement of fossil hydrocarbons by crop-based alternatives** may not necessarily move us towards sustainability because of the quantity of current consumption and negative impacts of land take and biodiversity loss. Neither are today's patterns of industrial agriculture benign from the perspective of their impacts upon rural societies and economies. For energy and materials, non-food crops may be helpful in alleviating some concerns about rising greenhouse gas levels in the atmosphere, but the assumption that a biologically-based economy is more sustainable than a fossil-fuel based one has yet to be rigorously tested. Huge innovation in farming methods will be required to provide for the energy, chemical feedstock, pharmaceutical, fibre, dye and other needs of a growing population currently met by hydrocarbons. Potential transport implications would also need to be addressed within a further detailed sustainability analysis.

- For materials based on **forest products**, such as paper or timber, destruction of old-growth forests and habitat-rich secondary forests is still common and results in a potentially catastrophic loss of biodiversity and supportive ecosystems 'services'. The forestry industry has the potential to be fully sustainable since impacts on other System Conditions are indirect, and better stewardship is helping. However, much work is needed to identify strategic gaps in the industry's development and repair them.

- As the **quantity of resource use** increases, so clearance of highly productive, diverse habitats for alternative uses occurs widely. The plight of the world's rain forests is particularly well known but, even domestically, mature habitats such as heathland or bog still regularly succumb to tree plantations and other uses.

- The distribution of resource provision between rural and urban areas can help to alleviate negative impacts. **Healthy forest industries** help mitigate urban migration and sprawl by providing employment in rural areas, and may contribute to the health of the rural economy (itself germane to System Condition 4).

- Land itself can be viewed similarly to other resources, with implications for linear or cyclic use. Manufacturing and processing plants and office accommodation in all sectors of business **occupy land**, contributing to incremental loss of habitat, productivity and biodiversity. The trend in some businesses today is one of rationalisation of plant and release of land, though for others in the industrialising world in general the pattern is the reverse. Any future expansion of the industry on to new sites would need to include an assessment of this impact, and options for minimisation and mitigation. For example, use of 'brownfield' sites for future development will contribute to increased compliance with System Condition 3. Within large plants, there are often areas of land in which biodiversity can be encouraged to offset the ecosystem 'services' displaced by development.

- Loss of land to **infrastructure** is the shared responsibility of many sectors of society. Of major concern is the self-perpetuating pattern of reliance on road transport, and the use of *green field sites* due to relocation to road networks largely driven by the need to compete with other road-based distributors.

- Substantial quantities of **water** are used in the manufacturing and processing of many materials. Many forestry- and crop-based production systems, and ensuing manufacturing processes, may be water-intensive. While global population has tripled over the past 70 years, water use has grown six-fold. Worldwide, 54% of the annual available fresh water is being used, two-thirds of it for agriculture. In the year 2000, 508 million people lived in 31 water-stressed or water-scarce countries. By 2025, 3 billion people will be living in 48 such countries. Many countries use unsustainable means to meet their water needs, depleting local aquifers. The water tables under some cities in China, Latin America and South Asia are declining by over one metre per year. Water from seas and rivers is also being diverted to meet the growing demands of agriculture and industry, sometimes with disastrous effects. (For example, in 1997, the Yellow River in China ran dry for a record 226 days). Not all countries are equally affected. The more developed regions have, on average, substantially higher rainfall than less developed regions, and have devised techniques to use water more efficiently (UNFPA). In the short to medium term, desalinisation offers little to improve the situation, as desalinised sea water is expensive, energy-intensive and today accounts for less than 1% of the water people consume (UNFPA).

- Many **waste products** in the foreseeable future will be deposited in landfill sites or else incinerated. Although many landfill-sites are already degraded areas such as quarries, this waste nevertheless contributes to the loss of land area and quality arising from waste disposal in the long term. It would appear inevitable that a proportion of waste will continue to go to landfill in the short to medium term, because there is currently a lack of facilities for recovery and beneficial reuse. This dependence is exacerbated by waste streams containing mixtures of materials that are difficult or impossible to separate. Reducing the net amount of waste produced by increasing the level of reuse and recycling will be one of the most effective ways of tackling this problem.

System Condition 4:
In the sustainable society, human needs are met worldwide

Society, and business within it, relies not only on natural resources but also human resources. In a sustainable society, social and economic relations would be organised in such a way as to maximise the chances of meeting System Conditions 1 to 3. Basic human needs would be met with the most resource-efficient methods possible, including equitable resource utilisation and distribution.

Some of the activities along today's traditional linear resource use chains that currently contribute to a breach of System Condition 4 are listed below.

- In our increasingly global economy, it is evident that no sector of industry can operate without affecting **a wide range of stakeholders**. The inequity of the impacts felt by these stakeholders encompass resources (for example, food, shelter and energy), money, power and influence, and the quality of their environment. Addressing this is central to truly sustainable development. It is important to recognise, in examining associated impacts of resource use, that many of the forces that create wealth and poverty do so simultaneously as a result of patterns of trade, and predominantly trade in resources.

- After 10 years of intense globalisation and massively increased world trade, which was hailed by all political leaders as the answer to the developing world's problems, the total number of people living in **absolute poverty** declined only marginally from 1.3 billion to 1.2 billion (UN, 2001). In more than 100 countries, income per inhabitant is lower today than it was 15 years ago. As a result, nearly 1.6 billion individuals now have a lower quality of life than at the beginning of the 1980s (Speth, 1996). Today, 1.2 billion people live on less than $1 a day, and half of the world population still exists on less than $2 a day (UNFPA, 2001). The proportions are alarming even in wealthy developed countries where more than 100 million people live below the income poverty level, set at half the individual median income (UNDP report 1997). As a result, only fifteen percent of the world's population, mainly in the high-income countries, account for 56% of the total consumption, while the poorest 40% account for only 11% of total consumption (UN, 2001). The equitable share of wealth may be directly contributory to social instability.

- Through the supply chain, the financial **value** gained through the use of materials is largely from processes performed in developed countries. Each stage of the resource use chain is commonly interspersed with significant transport operations while, from extraction to use, the value of the material is increased. Supply chain issues can be addressed through purchasing policies encouraging use of locally-sourced and recycled materials. Countering the negative effects of globalisation will involve effective and inclusive communication with all stakeholders, local decision-making and sourcing, community involvement and education.

- It is currently so cheap to continue to rely upon virgin resources, and to merely throw them away at end-of-life, that perpetuating the 'bad habit' of linear resource flows may seem essential for **economic competitiveness**. This socio-economic condition therefore perpetuates breaches in all System Conditions. Business does respond to economic signals, as for example explored in the TNS study into phosphorus recycling from effluent and the example of copper recycling provided under System Condition 1 above. Today, it is far more expensive to recycle phosphorus from effluent than it is to mine, ship, purify and distribute phosphorus to farmed land from which a proportion runs off or is passed through sewage treatment works to pollute water resources. On the other hand, the market price of copper means that it is efficiently reclaimed and recycled at end-of-life of products. There is therefore considerable scope for more creative use of economic instruments to promote more sustainable resource use. The Landfill Tax Credit system in the UK is a good example of a hypothecated tax aimed at reducing linear inputs of waste to landfill, which establishes an important regulatory and economic principle.

- The emissions from linear resource use are commonly greatest and most toxic at the early stages of mining and refining. This means that the **bulk of the pollution occurs in less developed regions,** removed from the benefits and financial gain incurred through manufacture and the use of the product. This can be addressed through supply chain management and purchasing policies.

- Industry should continue to ensure that, in helping people meet their needs, it does so in ways that **eliminate risks**. A precautionary approach should therefore be taken to all risks posed to people *everywhere* in the manufacture, use and disposal of material resources.

- The development of products which focus on meeting **basic human needs** *per se*, is increasingly rare. In a sustainable society, resource use and manufacturing would aim first and foremost to meet the needs of the many rather than the few. In the case of paper, a TNS Study finds that the promotion of fairness through the low-cost and low-technology use of paper communication may represent a major contribution to a sustainable society. This includes low-tech access to information, promotion of literacy and provision of free public libraries, the social effects of a universal low-cost postal service, effective dissemination in newspaper and magazine distribution, etc.

- Various materials permit human needs to be met with differing degrees of **efficiency** and there is often a link between efficiency through the supply chain, technological evolution of a product and its ability to meet human needs widely. The PVC industry considers that this material makes a significant net positive contribution to helping people meet their needs since the plastic is relatively cheap, lightweight, strong, thermally insulating, has unique barrier properties, is appropriate for many medical applications and adaptable to many applications. The converse side of this argument is that some applications, such as packaging and other short-life applications, are often more widely dispersed with demographic factors and composite waste stream making recycling difficult. All of these factors have to be weighted together, on a specific application-by-application basis, and fully sustainable solutions sought long-term.

- The **point in the provision of a service at which a material is used** may have significance for overall sustainability impacts. Using exemplar the TNS study into paper once again, paper communication has traditionally been centrally printed and then distributed. Increasingly today, there is a trend towards electronic distribution for local printing. This may have a role in increasing customer choice of reading material, as well as more rapid and remote access to information. However, evidence that it reduces environmental impact is mixed (for example if one takes into account the distribution of paper and use of consumables for local printing). Traditional print and distribution strategies are still needed to offer the universality of access afforded by paper communication. There are a number of business opportunities open to those seriously addressing the many variations of distribution and printing.

- Some of the problems of resource use are deeply rooted in **developed-world culture**. One of the most common and problematic cultural legacies of our industrial evolution is the 'out of sight, out of mind' philosophy. We know, from basic science, that nothing disappears, and that through the process of entropy all material will disperse over time. The application of landfill and incineration technologies to 'dispose' of waste provides a conceptual obstacle to sustainable practice that needs to be challenged wherever it is enshrined in legislation, policy and practice.

- **Regulatory drivers** today focus predominantly on maximising the eco-efficiency of steps in the linear flow from source to disposal (i.e. in each of the sequence of 'boxes' in Fig 2). This results in substantial investment and management attention in fragmented 'windows' along the life line, but a lack of integration of effort and investment across the complete life cycle of products and materials. The net output is 'eco-efficient unsustainability'[4]. As noted above, the UK Landfill Tax Credit Scheme and also the forthcoming EU Directives on the take-back of *Waste Electronic and Electrical Equipment* (WEEE) and of *End-of-life Vehicles* and their components introduce some important principles of hypothecated eco-taxation and producer responsibility.

- Linear disposal also represents a **squandering of resources**, since the materials are no longer available to society in helping it meet its needs. Since the most profligate material use habits are endemic to the already-developed world, and the richer and most influential sectors of it, this unequal share of material resources also raises major ethical questions. In the TNS study on paper, wastage of resources through inefficiencies in the paper chain (print over-runs for paper communication, poorly-targeted direct mail, unused promotional material, poor materials requirement-planning at every link in the chain, etc.) was found directly to contribute to the inequitable share of resources world-wide, as well as to breaches of all other System Conditions. The same principles are observed in TNS studies on phosphorus and material choice in construction projects. Such squandering is of particular concern in relation to water and other resources that are absolutely essential for human existence. (It is widely predicted that water shortages will be the major cause of conflicts during the 21st century).

- Low levels of recycling, and use of virgin resources purely on economic grounds, represent a **lost economic opportunity**. This includes both the lost opportunity for a more cyclical and efficient domestic economy and, importantly, loss of the value of highly purified and concentrated forms of material resources. These principles have been found to apply to all material studied by TNS, and their implications require further study right across the material use cycle.

- It would be wrong to assume that businesses and all people affected by material resource use (i.e. everyone) is acting in bad faith in their contribution to overall unsustainable material use patterns! It is more a matter of the **awareness** of the realities of the world and the necessity to reorient habits and practices towards sustainability. The Industrial Revolution paradigms already discussed are manifestly unsustainable, yet remain prevalent today in the economy and common assumptions. Sustainable development depends upon an understanding of the mechanics of the natural world, and how its support systems ultimately make life and business possible. When natural systems are damaged, all of society - including businesses - is harmed and its activities are constrained. This fundamental understanding is not currently to the fore in any of the industries providing the materials that society uses, nor in the way that society then uses these materials. It is therefore essential to address sustainable development not merely as a technical issue but as a learning exercise in which all participants understand the purpose for this commitment. The raising of awareness amongst all players involved in material resource

[4] This argument has been advanced previously in Section 3, and also appears in The Natural Step's response to the DETR study *Life Cycle Assessment of Polyvinyl Chloride and its Alternatives* (see Bibliography).

life cycles would indicate a commitment to addressing sustainable development as a matter of organisational and cultural change, not merely of reacting to a threat.

3.3 Interpreting this Sustainability Assessment

The natural world within which we live is fully sustainable, and this is not by chance. It is due to the fact that there are definite and non-negotiable laws of nature that govern events, and that nature has evolved intricate and adaptive ecosystems over the course of nearly four billion years to efficiently cycle substances through the use of captured solar energy. Natural cycles result in no net accumulation of waste, since the outputs from each unit of the biosphere are used as resources by other units. Yet, as a society, the developed world has established a framework that favours the adoption of linear resource use habits, inevitably creating waste, and constantly breaches the four TNS System Conditions of sustainability.

It is now widely recognised that the resultant unsustainability has potentially adverse implications for all. Our economic framework, regulatory context, cultural concepts, and forms of government all contribute to define this complex and unsustainable framework. These are discussed in Boxes 3-6.

Box 3: ***Economic Context***

Raw materials are cheap in the sense that their prices are maintained at an uneconomically low level. This condition is due to 'external costs' or 'externalities' not being taken into account. External costs are the social and environmental costs arising throughout product life cycle, including the management of waste streams, and that are not reflected in their market prices. There is obviously a need to find ways of internalising these costs. Indeed, valuing these external costs in monetary terms and internalising them to the product price at its various life cycle stages would, in principle, favour via the market mechanism an environmentally and economically sound use of resources. However, for the time being, a range of practical difficulties limits the implementation of an overall internalisation strategy, notably the pricing of priceless resources such as biodiversity. Public subsidies of polluting resource flows constitute another economic parameter, intrinsically related to particular historic economic development, which is creating misleading real prices for material resources. For example, the EC recognises that '*...coal subsidies slowed down the shift to cleaner sources of energy production such as gas or wind farms because using coal remains artificially cheaper*' (European Commission 2001). However, important progress has recently been made under Agenda 2000 process to review and revise subsidies applied under the Cohesion and Structural Funds and the Common Agricultural Policy.

In addition, labour is priced higher than the economic optimum. Conventionally, governments have tended to raise many of their revenues on labour (and capital) rather than on materials (Jackson 1996). This constitutes a significant distortion of the market economy and leads western economies, as the European Commission recognises in a white paper on *Growth, competitiveness, and employment*, to "*...over-consume resources and under-consume people*". Indeed, industrial employers have vigorously pursued one particular means of reducing costs: improved labour productivity. Employers spend a lot of time trying to cut down on labour costs, instead of treating human capital as a precious and expanding resource.

The actual economic signals are saying to producers that it is cheaper to produce plenty of poor quality products rather than good quality products that could be repaired, and to consumers that it is cheaper to throw away your fridge than to try to have it repaired.

A way forward is Ecological Tax Reform that aims at re-balancing taxes on resources and labour, and would favour economy of resources through eco-efficiency, clean technology, design for environment... as well as a high level of qualified jobs to maintain resources in the economic system for as long as possible. Some EU Member States are starting to implement some forms of Ecological Tax Reform. For example, in the UK since 1999, part of the revenues from the Landfill Tax Credit System are recycled to lower the costs of labour. Similarly, the revenue of the Climate-Change Levy, applied to non-domestic use of energy, is used to reduce by 0.3% employers' National Insurance contributions.

Box 4: ***Regulatory Context***

Traditionally, environmental politics have focused on regulating the output side of the economy (end-of-pipe approach). More recently, policy measures have been focusing on the inputs, which can provide higher regulatory efficiency with much less effort in control. More recently still, regulatory efforts have been spent on reducing throughput (landfill) and promoting cyclic reuse of resources (for example, the EU WEEE and End-of-Life Vehicles Directives cited previously). Further changes in regulation are required to favour durable products, design for modular repair or upgrades, etc.

Some of this regulatory effort needs to be redirected towards creating incentives, and breaking down barriers, for more sustainable resource use in material specification. These need to be based on the properties of the material, such that the product is fit for purpose and durable, rather than the current bias towards a requirement for virgin resources (i.e. aggregates for many construction applications). Specifications can facilitate integration of materials from recycled sources where they meet the necessary technical performance. However, in some ways, those specifications have proved problematic, for example where consistency of material requires it being from a single source. Fitness for purpose also drives regulation of design that serves to prolong the life of buildings and infrastructure. Prolonged durability is an important factor in resource use and many minerals and metals are used because of their durability.

Box 5: ***Social Context***

The industrial economy arose from within an economic system designed primarily to provide for the material needs of subsistence and protection. Those needs have been fulfilled for a large part of the population, at least in developed countries (although this might be questionable based on the facts outlined under *System Condition 4*). However, mass production of material goods has to be matched by a mass market for industrial products. The 'genius' of the industrial economy has been to extend the trade of needs to other material products - some will argue by transforming wants into needs - thus creating the phenomena of mass consumption and maintaining it through fashion, driven by advertisement. This is why 90% of products are thrown away within six months of purchase (Lovins et al.).

However, many people today have started to make efforts to change their personal and family behaviour, for example, by recycling, buying environmentally-friendly products and installing energy-efficient systems into their houses. One of the key factors to enhance sustainable consumption patterns will be the provision of quality information to consumers. Consumerism also has to be put in the context of the results of two surveys. When the British Social Science Research Council asked 1500 people what were the most important elements in determining their quality of life, 71 per cent of the replies they got had little or nothing to do with economic goods (Jackson 1996). Moreover, the work by Zolotas in the USA has demonstrated that, with increasing material wealth, people become less content with their quality of life.

Another social aspect relates to the work-related decisions of individuals. Few have a vision of what could happen in a society where resources are used in a sustainable way, or have considered that there are alternatives to the current resource-intensive life styles (for example, dematerialisation or developing service economies). Therefore, sustainable development is often perceived as a threat to trade, and hence employment. There is a great need not only to raise awareness of sustainability issues, but also to provide a clear and realistic picture of what it could be like.

Box 6: ***Political Context***

As resource flows become more cyclic, monitoring of policy and regulatory efficacy must also change. Measuring end-of-pipe pollution will no longer be appropriate as wastes and emissions will be increasingly reincorporated into the ecological and economic system, making it difficult to define an appropriate monitoring point. This has been explored by recent mass balance research that found information about virgin raw materials relatively straightforward to collect, but information about secondary materials comparatively scarce (Biffa, 1997, also Strategic Waste Management Assessments). As markets for recycled materials further diversify, understanding inefficiencies and the effect of policies could become more difficult.

It is widely recognised that, while the issue of sustainable development is now well identified, the will to decouple economic growth from resource use is still lacking. There is still a lack of understanding of sustainable resource use, and of its self-benefits, and a lack of political will to take the steps necessary to move towards sustainability. This lack of political will, driven by short-term political time horizons, can be identified both in the development and drafting, and in the implementation stages of legislation. It takes years to set Directives, and even to produce preliminary Green and White Papers. In a progress report (EC 1996) on the Fifth Environmental Action Programme: *Towards Sustainability* (EAP), it was recognised that the programme identified most of the elements to make the process work but that the political will to make them work was still lacking. More recently, in the Sixth EAP (2001-2010), one of the strategic approaches identified is to improve the implementation of existing legislation. There are various reasons for the poor and slow implementation of legislation, including for example national self-interest or industrial lobbying, raising fear of unemployment or lack of integration of environmental concerns into other policies.

It is the responsibility of all, including companies, citizens and ultimately governments, to make more progress with sustainable resource use. However, it is down to governments to redress their responses to the market-driven forces of globalisation in order to give the impetus to start to work seriously on setting up the right economic signals.

We are, it is unavoidable to conclude, a long way away from sustainability with respect to the way we use material resources today. There may appear to be no feasible solutions to some contributions to breaches of System Conditions, both economically and practically, in the short-term. However, it is important to remember that those assuming that sustainability is easily or quickly achievable have merely missed the point! Achievement of the end-goal of sustainability may be remote, and will certainly depend upon partnerships across different sectors of society.

If industry does not recognise the strategic challenges and focuses only on immediate pressures, it will neither develop sustainably, nor spot the massive new (and unavoidable) opportunities presented by a more sustainable economy. What is apparent is that many of the sustainability goals for a wide range of materials are generic – we need to challenge the ways that we *use* materials across their whole life cycles, rather than merely focus upon eco-efficiency within the narrow constraints of 'windows' in their life.

4. Vision of Future Sustainable Resource Use

In this Section, we will explore elements of a vision of the fully sustainable use of material resources. This is not based on a more eco-efficient version of today's unsustainable linear resource use patterns. Instead, it reflects the pressing need to adapt the production and use of materials to match the sustainable and cyclic patterns of resource flows in the natural world[5]. A major part of achieving sustainable resource use patterns includes the convergence of the concepts of wastes and resources. In a sustainable society, wastes will have to be seen as potential resources. (Further explanation of these cyclic systems is provided at *Annex 1: Sustainable Development and The Natural Step.*)

Some of the opportunities entailed in the delivery of more sustainable and cyclic resource use are noted in Fig 3, which also indicates the challenges in moving from the current linear system.

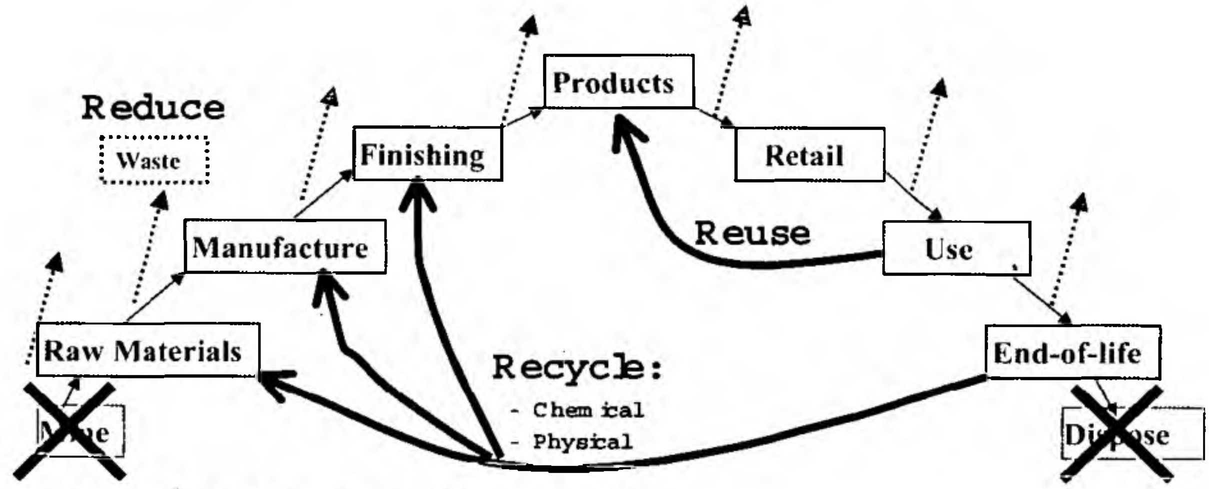


Fig 3: Towards the Cyclic Use of Material Resources

4.1 Visioning with the TNS Framework

The TNS process enables the development of a vision of fully cyclic resource use, based on meeting the requirements of the four System Conditions. Given the endemic unsustainability of the world's use of resources today, the vision will be necessarily long-term, setting goals that will rarely be immediately achievable. By establishing a long-term goal, founded on unambiguous and science-based principles of sustainability, we can guide our thinking by offering a clear target for incremental steps that may be taken today, as well as helping us identify necessary partners and spot the economic opportunities of a more sustainable world.

This is of particular importance today to help us avert unwise investment decisions that merely lock capital into 'blind alleys' that may make no long-term contribution to sustainability, for example increasing the eco-efficiency of manufacturing of a material that is itself inherently unsustainable and should be phased out as a priority.

[5] Some of these principles have also been explored by other authors and groups under titles such as 'industrial ecology' or 'biomimicry'.

4.2 The Vision of Sustainable Resource Use

The Vision of future sustainable resource use developed during the *2020 Vision* seminar strongly emphasised behavioural, regulatory, economic, social and value-oriented aspects. One of the most surprising conclusions was that the technical issues were not so much of a challenge. The technical steps were by and large already possible, but it was the lack of will for change within society that created socio-economic obstacles to their application.

Delegates at the *2020 Vision* seminar concurred that a future world using resources sustainably would be defined by aspects listed as bullet-points below. These points are not in an order of priority. All are interrelated and define the large picture of the vision, though they are subdivided here into *Broad Principles*, *Management Principles*, *Economic Innovations* and *Social Factors*.

Broad Principles

- **Dematerialisation**[6]. The economy would be designed to deliver services in a sustainable manner rather than material products in a throw-away culture. We would be enjoying the use of integrated transport systems, for example, or buying thermal comfort and not energy units!

- **Local versus Global**. People would generally agree that, while not everything can be produced locally, not everything should come from far away. Local and global production would be integrated, and the true costs of transport would be fully internalised. Goods that can be produced locally would not be transported half way around the world any more, with similar goods travelling in other directions. A great deal of energy and materials would be saved as currently demonstrated by Bioregional Development Group[7], whose energy study shows that, on average, the supply of the BioRegional's locally-produced coal compared with imports from South America or South Africa use only 15% of the energy required for transport. Production is likely to be more local in order to remove an existing barrier to recycling and enable more sustainable relationships between producers and consumers, since impacts would be more obvious. Farmers in Asia or Africa wouldn't spend their lives cultivating crops for export yet still not share adequately in profits to earn a decent living. The argument of the importance of sweatshops and child labour in helping developing countries to develop would have been tempered by wider sustainability concerns.

- **A 'zero waste' economy with closed-loop material use**. The laws of thermodynamics tell us that, just as it would be impossible to achieve a truly 'zero waste' society, it would equally be impossible to 'close the loop' fully of material use within the economy. However, the dispersion of materials to the environment would be limited so as to avoid exceeding the Earth's carrying capacity as described by System Conditions 1 to 3. Where those limits were not known, the precautionary principle would be invoked above economic motive. In addition, in regard of System Condition 4 and environmental justice, discharges to the environment would be evenly distributed geographically.

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6 Dematerialisation is a term that arises out of the recent work in industrial ecology. Definitions vary but, in general, dematerialisation refers to the reduction in the quantity of materials used and/or the quantity of waste generated in the production of a unit of economic output [Cleveland, 1999 #67].

7 http://www.bioregional.com

- An important shift in our cultural concepts must occur that changes from the linear resource use system where all emissions are undesirable, to **cyclical system** where losses must be seen as by products and their generation optimised, essentially leading us to question what we mean by efficiency. This shift will have the biggest impact on the waste industry. Associated problems have already been encountered in the energy from waste industry where, rather than increasing efficiency of resource flows by recovering value from waste, throughputs to maintain economic viability of the operation.

Management Principles

- New **reporting and accounting systems** will have driven changes in governance and business performance, building upon early ideas such as FTSE4 Good and the Dow Jones Sustainability Index, and the SIGMA Management System.

- The concept of **industrial ecology** first appeared amongst the work of the 'Brundtland Commission' prior to its report in 1987. Industrial ecology would have been recognised as a valuable framework for designing and operating industrial systems as living systems interdependent with the natural system. Industrial ecology reconciles economics and ecology by fundamentally redesigning our production systems, bringing them closer to the cyclical processes of nature. In such a system, the 'waste' generated in one industry are utilised as inputs by other industries whose co-product/waste can in turn be used by other industries. This maximises value from each unit of material. Some companies have already integrated this approach, and are beginning the journey of seeking alternatives to virgin raw materials, and markets for their waste so that, potentially, markets for 'by-products' may develop out of current 'waste' markets. This may inform waste minimisation decisions where, for example, a beneficial further use can be made of material formerly classified as 'waste'. It might be expected that recovery of value from waste or other emissions (such as heat or gases) will extend towards a system of industrial ecology, which is being driven by increased awareness of the desirability of 'closed-loop' processes, and economic drivers such as the Landfill Tax Credit Scheme and Climate Change Levy. As a result companies are beginning to seek alternatives to virgin raw materials, and markets for their waste so that potentially, markets for 'by-products' may develop out of current 'waste' markets. Optimising those flows will certainly have an impact on the markets for some, more flexible materials (for example waste glass is now used for construction fill and for sand blasting) but it is too early to evaluate the impact on overall mass balance. There will probably be a balance between minimising losses from a process, and optimising recovery of those losses for sale as raw materials.

- **Design for sustainability** would be a fully integrated process from the earliest stage of the production process, avoiding wastage of resources, environmental impacts and premature disposal. Designers would know the origin and characteristics of the materials they are using, and be active in specifying responsibly-sourced materials. Simplification in the design of products would save energy and materials, and favour reuse (by being easier to maintain, to dismantle and to repair) and recycling (by not mixing too many different materials, substituting polluting products with less polluting products, being easier to dismantle and envisaging the use of recycled materials). The design of everyday products would integrate sustainable design with aesthetics through appropriate design, not over-design. There are already some good examples, such as the competition to 'design for sustainability' which has been organised by the Design Museum in London since 1998. This links into the notion of durability and substitution detailed below. These design concepts will apply equally to products, processes and services. Sustainable thinking would also happen at an earlier stage (market research) as detailed below. The concept of design for sustainability will be as or more fundamental to design than environmental protection is today.

- Firms would view themselves as participants in a **chain of production** and create a dialogue among suppliers, customers. Supply chains would be founded on mutually beneficial long-term relationships sharing common sustainability goals. This would displace today's 'lowest price at any cost' model.

- **Product durability** would be envisaged at the design stage through the choice of materials, assembly methods, the potential for repair and upgrade, etc. Expected product life spans and initial as well as lifetime energy/ material input would be balanced. For example, short-life products, such as packaging, would effectively be designed in that perspective. This would avoid problems such as those raised in the early age of photovoltaic panel for example when the initial input of energy couldn't be paid-back within their life span (this is not the case anymore). Equally, The DETR's Life Cycle Assessment work on PVC (see bibliography) and a number of other studies suggest that energy and material inputs *during use* may be as great or greater than those entailed in manufacture and disposal for many products. So, regulating maintenance impacts is increasingly important.

- Originally, the concept of **substitution** was developed to address the toxicity of certain products to the environment and human health, but it is now proving useful to address substitution in relation to resource use efficiency (limiting the use of non-recyclable resources) and sustainable waste management (use of substances that do not accumulate in nature). Substitution will be resorted to in a strategic and proactive manner. The potential environmental impacts of the different materials will be identified from cradle to cradle, (the notion that there is a 'grave' will have been abandoned), and even beyond as the substitute has to offer the same physical, chemical properties with less environmental impacts through the life cycle of the product.

- **Life Cycle Analysis (LCA)**. It is not necessarily a product or material that is inherently 'green'. Rather, its sustainability very much depends upon the way it is extracted/harvested, processed, used, re-used, recycled and ultimately discarded across the whole life cycle[8]. Use-related considerations would be built into LCA, and this would become a common tool used to evaluate the 'greenness' of products not only from cradle to grave, but also including post-disposal. Indeed, the potential use of materials as recyclates would be integral to the 'up front' LCA.

- **Extended producer responsibility** (and liability) beyond direct stakeholders will be commonplace. The principle of producer responsibility that has been recently used in European environmental policy (for example in the End-of-life Vehicle, Packaging and Waste Electronic and Electrical Equipment Directives) would extend responsibility for waste throughout product life.

- Wider stakeholders would share responsibilities. For example, the principle of **investor responsibility** would have been developed. Shareholders would be entitled to ask for profit but would be responsible for any environmental and social drawbacks associated to profit generation.

- **Corporate accountability increased**. Large multinational companies' power would have been restrained and the non-elected international organisations such as the WTO, the

[8] *A Material Dilemma*, Mark Everard et al (2001) see bibliography

IMF, through which they have been exercising their power, would have been democratically reformed and a new sustainable trading system defined. Companies would be accountable for any social, environmental and economic drawbacks associated to their activity. Formal accounts for all of these attributes would be required.

Economic Innovations

- **Greater value in activities that don't consume resources.** As a result of the transformation of the economy as referred to above, individuals would spend a larger proportion of time on personal and community activities. Perhaps a system developed from current time-banks might facilitate non-resource consuming trade.

- **Economy at the service of society.** The current economic system will have been re-framed, in order to satisfy material human needs while respecting human, social and environmental systems. The place of economic activity in society would be limited so as to leave space and time for spirituality, human relationships and networking opportunity. Material throughput would have finally been de-coupled from growth.

- **Labour value – materials value.** The true cost of the use of resources would be internalised in product prices. The internalisation of costs of social and environmental impacts would have shifted the emphasis for profit from economies on labour to economies on materials. Labour would be more valued.

Social Factors

- **Awareness, ownership and empowerment.** Individuals would be conscious of the limits to Earth's carrying capacity and the availability of resources, and therefore of the impact of their material demands. Sustainable development would be fully integrated in everyday life and a real cultural shift would have happened. As a result, people and economic signals would 'naturally' implement sustainable decision making, perhaps through a hierarchy of resource use.

- **End of materialism and consumerism.** The ownership of material possessions would not any more drive individuals' priorities and values as currently the case (albeit mainly in Western societies). People would be more conscious of the difference between Needs and Wants. Accumulation of goods would not be a goal in itself but a step towards meeting human needs informed for example, by Maslow's[9] hierarchy of human needs. The emphasis would be upon every person reaching their full potential. As human beings, our survival would still very much depend on resource use. However, this will have developed with respect for the 'carrying capacity' of the biosphere, as articulated by the four System Conditions.

- **Vibrant social fabric.** Moving beyond our materialistic behaviour, we would make the most of our human qualities and live in a caring society with a strong social dimension encouraging relationships and discouraging undesirable social impacts.

[9] Maslow's hierarchy can be found for example at: http://chiron.valdosta.edu/whuitt/col/regsys/maslow.html

- **Environmental justice.** We would have moved away from the hypocrisy of consumption versus 'NIMBYism'.[10] The idea that waste disappears once it is 'binned' would be completely obsolete. Therefore, all emissions would not only be limited to the assimilative capacities of the environment, but even distribution would be accepted.

- **Marketing sustainable resource use**. Marketing would have played a major role in embedding sustainable development concepts into everyday life. Sustainable development would have been made 'cool', even 'sexy', finally overcoming the difficulties communicating the concept (Wright and Hooper 2001).

[10] NIMBY is an acronym standing for Not In My Back Yard.

5. The 'Cyclic Hierarchy'

The concept of a *Cyclic Hierarchy* emerged as helpful in guiding day-to-day decisions about material choice. It also provides keys into the right types and sequence of questions that those specifying materials might explore. The essence of this *Cyclic Hierarchy* is slowing the flow of material resources through society, maximising their value to society in the journey from source to reintegration into natural processes (where material quality is rebuilt). The model is outlined in Fig 4, with the supporting questions in Table 1.

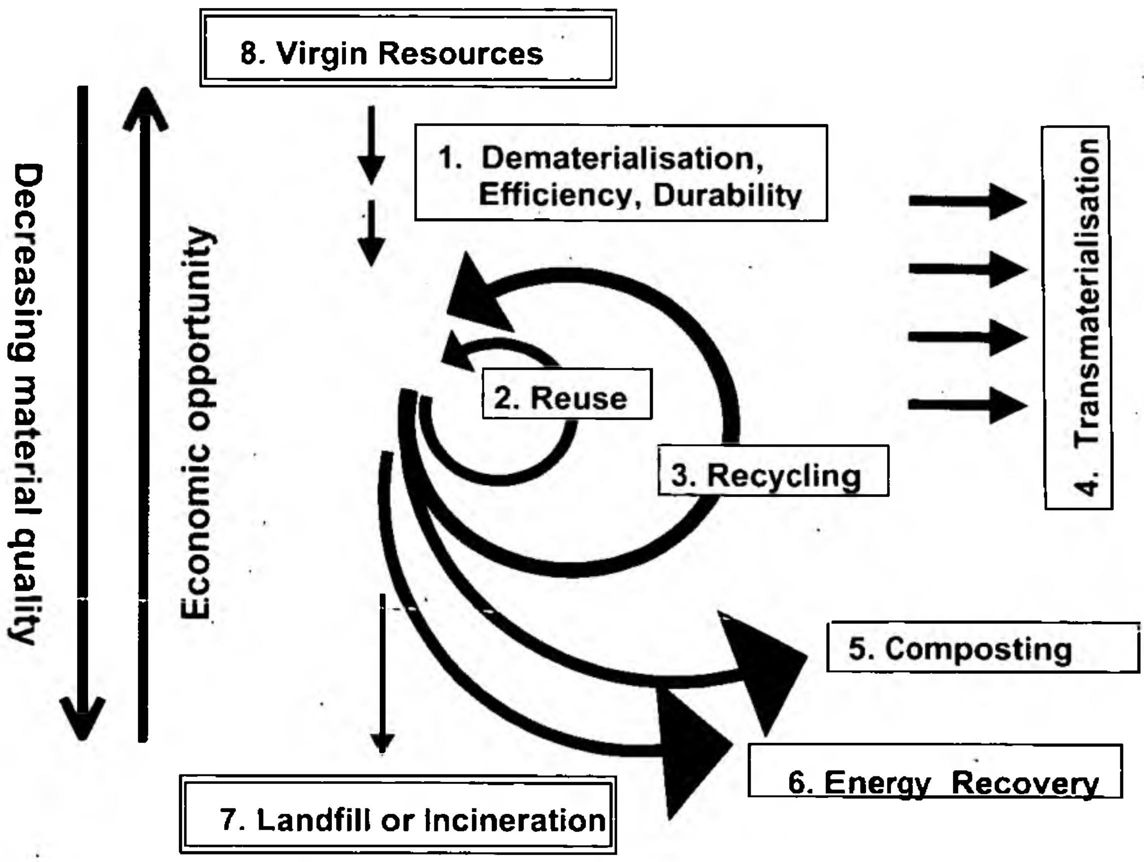


Figure 4: The Cyclic Hierarchy

Linear use represents a sharp drop in quality of materials, both in terms of material and economic value, from virgin to 'waste'. The approach of the *cyclic hierarchy* is to seek to slow the plummet from high to low value, maximising social value and economic opportunity throughout the life of the materials. Table 1 below focuses on these implications from the perspective on the numbered items in Fig 4.

Table 1: Questions to be Asked in Addressing the *Cyclic Hierarchy*	
1. Dematerialisation, efficiency, durability	• Can the demand be satisfied with a *service* approach, rather than through material *products?* • Can the *service* under consideration be met without the use of materials, or in less material-intensive ways? • Can the product or process be designed more efficiently to maximise value/durability per unit material resource?
2. Reuse	• Can the product or process be designed to aid the reuse of: - The whole product? - Components of the product? • What economic opportunities are there available to promote reused products and components?
3. Recycling	• Is the product designed in such a way that recycling of component materials is maximised? • Is physical recycling possible (for example, grinding and melting of plastics)? • Are there chemical (feedstock) recycling routes? (These are generally more energy and chemically-intensive than physical recycling routes, which are therefore favoured.) • What economic opportunities are there available to promote recycling of used products and components? **Note: recycling should always be directed at maximising beneficial use through the preservation of material quality and economic value. <u>Down-cycling</u> is an option only where higher-value options are not possible.**
4. Transmaterialisation	• Where material will inevitably be released into the biosphere by breakdown throughout life or linear disposal, can the material be substituted with another that is more readily reintegrated by natural systems or which will be less harmful?
5. Composting	• Can non-reusable or non-recyclable component materials be degraded biologically to produce compost, which can be used to deliver further social benefits (and divert waste from 'disposal' routes)?
6. Energy Recovery	• This is a low-value (linear) option and may only apply to contaminated waste such as medical applications. • Have all other options been considered to avoid this loss of value? Or is the material used already degraded in quality through many cycles of use by society? • Pyrolysic and other 'cutting edge' technologies should be used to minimise pollutants and maximise energy recovery if disposal is the 'last resort' option.
7. Landfill and Incineration	• This is the lowest-value option and should be avoided. • Have all other options been considered to avoid this loss of value? Or is the material used already degraded in quality through many cycles of use by society? • Have all contents that can not be reintegrated by nature be eliminated from waste upstream?
8. Virgin Resource	• Is the use of virgin resources essential, or can its use (or the requirement for its use) be challenged or averted by other recycled inputs? • Are the virgin resources sourced in ethical and ecologically sustainable methods?

New business opportunities are presented through each question, with the aim of maximising cyclic use. Different solutions may be applicable at different geographical scales and for different materials. <u>All</u> solutions should be applied as far 'upstream' – at source and not in the 'downstream' consequences – as is possible.

This is a logical extension to producer responsibility that also represents good stewardship and economic opportunity.

6. Sustainability Challenges

From a vision of full sustainability, it is possible to 'backcast' to the present. This helps make sustainable development tractable, and also helps decision-makers identify the short-term decisions that form incremental steps towards sustainability. In this Section, we will explore the key sustainability challenges entailed in moving from where we are today towards our vision of more efficient and integrated resource management.

6.1 The Unavoidable Challenge

We have a long way to go before we attain a more sustainable society. The vision presented here is very challenging to today's common material use habits, together with their underpinning assumptions and also current regulators and economic drivers. Nevertheless, the unavoidable nature of the challenge of sustainable development – illustrated by the 'funnel' – leaves us a clear choice. We can address change proactively, as both a necessity and an opportunity that will deliver a better future for all, full of new business opportunity. Alternatively, we can wait for the 'walls of the funnel' to squeeze in around us – in the shape of new Regulations, increasing costs and resource scarcities, loss of reputation with our markets, etc – and react to change at net cost and disruption.

6.2 Key Challenges

Perhaps one of the most surprising outcomes from this *2020 Vision* seminar, and the overall consensus-building process, was that, technical issues are not the major barrier to delivering more cyclic use of resources. These are perceived as 'do-able', once the constraints of economic pressures and behaviour have been addressed.

Three broad groupings of challenges that cover the principal barriers to achieving sustainable resource use were identified by the stakeholder group: cultural, economic and technical. These by no means cover the entire range of challenges faced, but were identified as key categories. Each of the categories are dealt with in turn in this section, following the general consensus of the order of importance identified by the stakeholder group.

infrastructure for paper, or for other materials managed by Local Authorities or other organisations) can be exploited and jointly invested in - often entailing collaboration between those responsible for municipal and commercial waste streams - by those concerned with the more cyclic use of other types of material. From these collaborations, efficiencies and opportunities will arise.

Challenge 3. Sustainable regulation and a 'beyond compliance' culture

A regulatory regime that rewards proactive progress towards sustainable development needs to be developed. The current set of regulations have been inherited from a predominantly 'end-of-pipe' regulatory paradigm. Efforts are being made to develop more appropriate outcome-oriented and flexible Regulations, but these need to continue to deliver 'intelligent Regulations' truly geared to the end-goal of sustainability rather than merely 'holding the bottom line' in a deeply unsustainable world.

It is critically important that regulators recognise that the true challenges to more sustainable resource use may be as much (or more) social and economic than purely technical, a distinction that should apply for example to identifying and implementing Best Practicable Environmental Options (BPEOs). In particular, they will have to escape today's compliance-based mentality, and create incentives for business to benefit from proactive and more sustainable behaviour (for example, by investing in cyclic processes).

There is a clear role for leadership not merely by national governments, but also transnational organisations (WTO, UN, European and other regional trade associations, WBCSD, etc).

6.2.2 The Challenges of the Economic Framework

Challenge 4. Creating long-term business thinking

The narrow definition of the requirement of companies to maximise profit alone means that the long-term view necessary for sustainability is not generally taken. Short-term gains are frequently made at the expense of long-term sustainability, as shareholders reap the dividends of economic growth whilst shedding longer-term sustainability risks. The economic framework needs to be modified such that returns on capital are considered in the long-term, and responsibility for the longer-term sustainability implications of investment decisions remains with those desiring the benefits of those decisions.

This long-term business thinking will take account of changing energy and material use economies, such as a transition to hydrogen from oil-based energy carriers.

Challenge 5. Internalising environmental and social implications throughout the life cycle

It is critically important that environmental and social costs are internalised on the basis of sustainability *across the whole life cycle,* including fate at end-of-life. From consideration of 'green materials' and the sustainability implications of material use today, it is clearly apparent that unsustainability lies in the *ways that materials are used* in addition to the properties of the materials themselves. Evaluations will therefore need to be undertaken

6.2.1 The Challenges of Cultural Change

Challenge 1. Changing the 'throw-away' culture

A key driver of excessive resource use is the dominance of the 'throw-away' culture in our society. Changing consumer behaviour needs a concerted effort of communication, education and awareness raising to make the concept of sustainable development accessible, and even fashionable. Culture change is necessary to encourage people to embrace the underlying ideas of sustainable development.

Educators, at primary, secondary and higher education levels, are an important part of achieving this change. A change in the language surrounding sustainable development concepts may make the concept more accessible. Companies could also do a lot by putting the issue of sustainable development at the top of their agenda, both internally (employee-oriented) and externally (customer-oriented). If the investment in advertising to make us buy more was refocused to also address sustainable consumption, significant changes could be expected. Celebrities may also have a role in making sustainable development a 'cool' concept. In the meantime, in addition to education and awareness raising, an element of compulsion, through price signals for instance (also discussed in Challenge 5), is required to begin the process of changing culture and perception.

Challenge 2. Design for sustainability through cross-sectoral partnerships

It is not just consumer behaviour that needs to be changed. It is also important to reach those with influence in the resource use chain, such as marketeers, engineers, designers and professional bodies, as these professions need to integrate sustainable development into their everyday working practices. By considering the entire life cycle of the products they are designing, fabricating or selling, they can take steps to ensure that material flows are minimised. This can take the form of improved recyclability of products through material choice, material labelling, or enabling easier maintenance through careful design. (These concepts are systematised in the *Cyclic Hierarchy*). This should be seen as a positive step, maximising preparation for the inevitable changes ahead.

Sustainability considerations will have to be included right up-front at the design phase, or in the choice of materials in construction and other projects. Design for reuse of products or components, recycling of material, and maximisation of social value per unit of material resource will become more important considerations as sustainability pressures bite. There are already regulatory signals in the new EU Directives containing take-back provisions (*WEEE*, *End-of-life Vehicles*, Packaging etc), and the Landfill Tax Credit Scheme is an example of a new approach to economic instruments in the UK. Design that does not take account of sustainable development will be creating future liabilities.

Achieving design for sustainability will depend upon partnerships of interested organisations involved in different aspects of the full life cycle of materials, including use and post-disposal of products. These partnerships will need to extend across sectors of society, such as central and local government, energy and waste industries, manufacturers and retailers, etc. Planning incremental steps in partnerships will be a complex task.

Collective learning will be entailed by all partners across material use life cycle, and from the 'best practice' of life cycles of other materials here and overseas. In some cases, existing infrastructure that aids cyclic use (for example, existing take-back, collection, and sorting across this whole life cycle, and appropriate measures identified to deliver more sustainable use. It will be essential to evaluate all materials on a 'level playing field' of objective sustainability principles, in order that over-simplistic assumptions and judgements can be eliminated from decision-making.

Many or most environmental and social factors are currently externalised from production and disposal of materials. Even with the current Landfill Tax Credit Scheme, the cost of disposal remains far from fully reflective of the longer-term environmental and social costs. A revaluation of resources to reflect the environmental and social costs of obtaining, using and disposing of them is therefore needed. This objective can be achieved through the intelligent use of regulatory and economic instruments. However, there needs to be a balanced and intelligent use of regulatory drivers, awareness-raising, incentives and disincentives. For example, revenues generated through the Climate Change Levy could be hypothecated to energy efficiency, for example through removal of VAT on insulation materials.

These regulatory enforcement and incentive instruments need to be 'joined up' to drive progress towards the cyclic economy as a matter of good business sense and self-interest. There is a clear equity issue in the use of fiscal drivers to change the patterns of resource use. People must have the means to respond to price signals. Even in the UK, the poorest people cannot always respond to price signals. If the cost of insulation, even with no VAT, is beyond the means of those in fuel poverty, no amount of increase in the cost of fuel will encourage its installation. It will simply exacerbate the problem. However, the UK Government has started to address the issue in a sustainable way through the *Home Energy Efficiency Scheme.* It also clearly demonstrates that a shift from a 'product society' to a 'service society' is needed. For example, electricity companies would have the means to invest to improve insulation of individual houses and could therefore sell thermal comfort rather than energy units (an example more thoroughly described in *Material Concerns, Jackson 1996*).

Challenge 6. 'Joined up' economics

An economic regime that creates incentives for progress towards sustainable development will have to be developed. Some aspects of the vision also challenge the current economic basis of industry. For example, today the economic climate tends to favour the sale of more *product*, rather than the provision of *services* reliant on less physical materials or the provision of more service per product, although there is evidence of some change in this respect.

The relative pricing of labour and materials is another aspect of the current economic framework that leads to the linear pattern of resource use we have today. Raw materials are priced at a much lower level than labour, making it not cost effective to reuse and repair goods (high labour input – low material input) when compared with manufacturing new goods (low labour input – high material input). Economic instruments are needed to change the balance between the cost of labour and the cost of materials.

Other parts of the vision offer major new economic opportunities, and there are examples of these in operation already in the case of investment in recycling of paper and PVC. New opportunities for cyclic business will have to be grasped, but there is also a pressing need to revise a fundamentally unsustainable economic system that makes virgin resources and disposal so cheap, and encourages exploitation of other nations for cheap raw materials.

Challenge 7. Seizing the new economic opportunity

The cyclic economy will create major new opportunities that promise to redefine business. As outlined above, a new paradigm of thinking about resources will change the economic map, creating new opportunities for business as other current activities (such as uncontrolled mass mining or disposal) are 'sunsetted'. In a world that is as fast-changing, a sound grasp of sustainable development and acknowledgement of the unavoidable pressures it will impose upon society will help us identify and seize those opportunities.

6.2.3. The Technical Challenges

There are many technical challenges that need to be overcome to change the current linear flow of resources to a more cyclical flow. However, the consensus amongst the *2020 Vision* stakeholder group was that these are more easily overcome than the cultural and economic challenges. Technical challenges in relation to specific resources may remain, though these were beyond the scope of this study.

Challenge 8. 'Intelligent' use of material resources

It is firstly vital that we are able to identify materials. The enormous range of different material types used today makes the task of identifying them for separation into different recycling streams very difficult. Clear identification of material components of products will be clearly marked to aid decision-making in design, use and reuse, or recycling beyond end-of-life.

It is also crucial that the necessary technical expertise about those materials be developed, communicated and made available for decision-making to enable organisations make objective, sustainability-based, assessments relating to design, waste and recycling infrastructure. This will be important for all users and handlers of resources in order to enable the necessary partnerships and responsibility. Technical expertise in the recovery and processing of recycled resources must also be developed.

Challenge 9. Establishing performance-based standards

Standards based on technical performance, not on specific material type, are needed to 'level the playing field' in material choice. It will also break down prejudices between recycled materials and those from virgin materials (as for example in aggregate use in roads).

This will help break down assumptions that recycled materials are inferior or that they should be cheaper. To support breaking down of these barriers, the quality and availability of recycled materials will have to be high and predictable.

The quantity and quality of materials collected for recycling must also be measurable for stable and reliable markets for recyclates to develop, which will require efficient sorting. There is a role for more sophisticated specifications and accounting systems to level this playing field.

6.3 Summing up the Challenges.

These nine key challenges equate to eliminating pollution, demands on virgin resources and wastage. Society needs to migrate incrementally towards sustainable cyclic resource use patterns, ensuring that the unavoidable virgin resource inputs and disposal are minimised and implemented in sustainable ways. This is implicit in the achievement of sustainability, addressing the implications of the four System Conditions that include:

- The achievement of carbon neutrality;
- The elimination of releases of metals and other mined materials into nature;
- The elimination of releases of persistent substances into nature;
- Reduction of demands on all virgin resources to a bare minimum; and
- Reduced consumption towards a level dictated by needs rather than wants.

These challenges do, to a certain extent, represent some of the UK/EU context in which they were developed, but the underpinning principles are generic.

Annex 1: Sustainable Development and The Natural Step

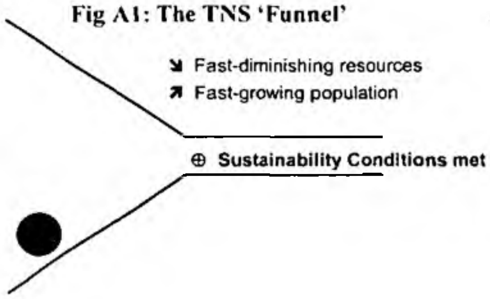
The challenge of sustainable development affects us all. Most of us can agree that it is an important concept, but what does it actually mean and how do you go about getting to grips with it in the messy world in which we live? This short annex defines what sustainability and sustainable development mean – they are quite distinct – and the scientific principles that help us understand them. It then introduces The Natural Step (TNS) – both the organisation and the principles and tools of TNS that are known as the *TNS Framework*. TNS and its tools are founded upon the application of this science in educating about sustainability, and the practical application of sustainable development.

A1.1 About Sustainability and Sustainable Development

Growing world population, increasing demands upon and depletion of natural resources, accelerating levels of global pollution and resource depletion, and concerns about the impacts of businesses on society both at home and overseas, are not new problems.

Neither are they avoidable. They will increasingly constrain the 'freedom to operate' of organisations and society at large. The Natural Step (TNS) uses the metaphor of 'the funnel' to describe the inevitable tightening of these constraints, and the pressures to become more sustainable (Fig A1). Sustainable development addresses these challenges proactively, based upon a sound understanding of what sustainability means and implies for us.

Fig A1: The TNS 'Funnel'



A sustainable system is one that can continue indefinitely. A sustainable society is one that does not impair or overload the life-support systems that provide for its needs. A sustainable product, process or organisation is one that respects nature's non-negotiable limits and the rights of those with whom it interacts, however remotely. It is that basic and, at the same time, that remote from what we do today!

All too often, problems are addressed reactively, using technical means to cure symptoms after problems have arisen. True sustainable development goes a long way beyond merely complying with basic environmental and social obligations, and differs from traditional 'end-of-pipe' solutions to pollution and social problems. It addresses issues 'upstream', in the early decision-making process, such that the pursuit of business does not systematically create the kinds of social and environmental problems that will, sooner or later, harm business performance and reputation.

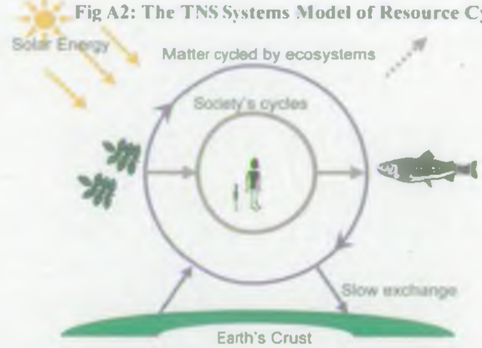
How does one move from concept to practice, and begin applying it in the messy world in which we live? If we chase them back far enough, it is easy to see that businesses ultimately depend upon natural and human resources including for example, energy, timber, clean air and water, as well as the ingenuity and labour of people that converts these natural resources into economic goods. We all share the same world, and therefore our activities inevitably affect that same world and all those with whom we share it.

Since sustainability challenges are unavoidable, sustainable development is also possibly the greatest business opportunity of the age. It is firstly essential to acknowledge that the inherently sustainable Earth ecosystem, upon which we are fully dependent, operates in definite ways – ways that it is possible to define using science – which ultimately determine what is and what is not sustainable. The Natural Step's approach to sustainable development is based upon a systematisation of these scientific principles.

A1.2 The Natural Step Framework

The Natural Step (TNS) Framework presents a set of principles and strategic tools based on the scientific principles governing the Earth's ecosystem, the inherently sustainable system that supplies all our needs. At the heart of the TNS Framework is a science-based systems model of this sustainable Earth system (Fig A2). The Framework defines what sustainability means and helps organisations get to grips with sustainable development in their decision-making processes.

Fig A2: The TNS Systems Model of Resource Cycles



It can also be used to explore the sustainability implications of today's products and processes, and the measures that must be undertaken to make them more sustainable. The TNS Framework comprises four elements:

A. **Sustainability awareness** comprises an understanding of sustainability, or in other words the conditions that must be met in the mouth of the funnel. The TNS Framework includes four necessary System Conditions for sustainability stemming from the science-based systems model. These four TNS System Conditions are illustrated in Fig A3 and listed below:

Fig A3: The Four TNS System Conditions

In the sustainable society, nature is not subject to systematically increasing...

1....*concentrations of substances extracted from the Earth's crust*
2....*concentrations of substances produced by society*
3...*degradation by physical means*

and, in that society. . .

4. ...human needs are met worldwide.

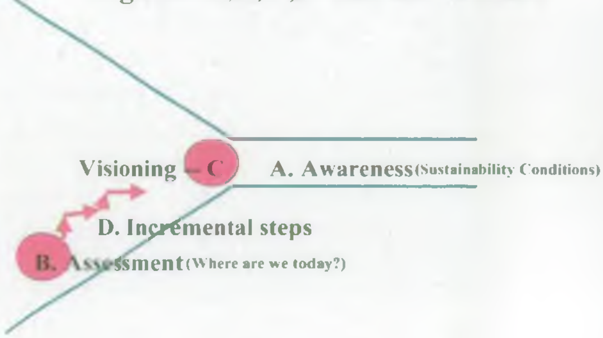
B. On the basis of these four necessary System Conditions of sustainability, one is then in the position to make an objective Sustainability Assessment of one's present degree of sustainability.

C. Visioning. Having used the System Conditions to determine one's present state of unsustainability, one can then use them as a helpful tool to create a vision of how one might operate in a fully sustainable future. If based on the System Conditions, our scenario-planning is based not merely on possibilities we might conceive today, but on the scientific realities of the future into which society will unavoidably be squeezed.

D. Backcasting is a process by which one determines the incremental steps that we have to take to reach our vision from where we are today. This differs radically from today's more common technique of *forecasting*, which is an extrapolation from today's knowledge, situation and trends to predict the future. Whilst yielding short-term gains, forecasting overlooks the inevitable changes and discontinuities with current trends that will arise through sustainability pressures. Incremental steps derived from backcasting acknowledge current constraints to full sustainability (for example limits to capital investment or the readiness of the market). However, they also reflect the progressive steps that can be made today, from which further future steps can be taken to lead along a clear path towards the vision of full sustainability.

The A,B,C,D steps for applying the TNS Framework are illustrated in the context of 'the funnel' in Fig A 4. Together, they help define in unambiguous terms what sustainability means, and provide a readily-understandable framework to get to grips with the practicalities of sustainable development. They help the integration of sustainable development into strategic planning, communication of complex ideas, the sharing of these concepts with partners and across social sectors, and making strategic judgements about the steps we need to take now towards a more sustainable future.

Fig A4: A,B,C,D and the 'Funnel'



It helps us address the fact that we can not realistically hope to achieve sustainability immediately in a world that is far from sustainable, but enables us to 'navigate' increasingly towards sustainability through incremental decisions. Importantly, the strategic approach to sustainable development enabled by backcasting – at odds from today's more common eco-efficiency emphasis which merely makes unsustainable practice more 'lean' – helps organisations avoid decisions that may represent 'blind alleys' that do not lead on a strategic path towards a clearly-articulated end-goal of sustainability.

A1.3 About The Natural Step

The Natural Step (TNS) organisation was established in Sweden in the late 1980s as a means for tackling the difficulties facing society. TNS is now an international charity based in nine countries including Sweden and the UK, the USA and Canada, Australia and New Zealand, South Africa, Japan and Israel. The purpose of The Natural Step is:

> "*To deepen a genuine commitment to sustainable development throughout UK society using The Natural Step Framework.*"

TNS has worked with a wide range of major companies to help them address their sustainability challenges, including DuPont, Electrolux, Tarmac, Carillion, IKEA, Interface, Mitsubishi, Air BP, Nike, The Co-operative Bank, Wessex Water, Sun Microsystems, etc. In addition, we have applied the TNS Framework as a form of 'intellectual round table' around which to build consensus about the place of contentious issues in a sustainable future. This consensus-building programme, known as *2020 Vision* in the UK where it has been run in collaboration with the Environment Agency, has covered topics including GMOs, PVC, SuDS (sustainable drainage), biosolids (sewage sludge), bulk printing, material resource use, etc. TNS principles have also been used to illuminate a wide range of scientific matters, including the more sustainable use of materials such as phosphorus, PVC, metals, construction materials, etc., and the reorientation of environmental tools such as LCA (life cycle assessment) and ISO 14001 from eco-efficiency towards sustainable development.

The Natural Step office in the UK was established in early 1997, where it operates under licence of the charity *Forum for the Future*, which is itself dedicated to the promotion of a practical commitment to sustainable development across UK society. The Chairman of TNS in the UK is Jonathon Porritt, the leading environmentalist, Chair of the government's Sustainable Development Commission, and Programme Director and founder of Forum for the Future. The scientific work of TNS in the UK has been kindly supported by the Environment Agency via the secondment of its Director of Science.

A1.4 More Information About The Natural Step

There is clearly a great deal more to The Natural Step than it is possible to convey in this brief Annex. We believe that TNS offers a unique tool for getting to grips with sustainable development, putting it into practice within enterprises, building consensus about contentious issues, and for doing so as a matter of 'enlightened self-interest'. For further information about TNS, or the TNS Framework, please contact us directly using the information on the back cover of this report.

End of Annex 1

Annex 2: Existing Initiatives Relating to Sustainable Development

In this Annex, we will provide a very brief consideration of the way that a broad range of existing initiatives fit as 'jigsaw pieces' within the broader context of sustainable development. This list does not pretend to be complete, nor do these considerations purport to be definitive, but it does at least set the listed initiatives within that broader context. The Natural Step Framework is helpful in setting that broader context of sustainability that identifies why each listed initiative is important, and the role it can play within the broader aim of working towards sustainability.

- **Environmental management systems**, as for example standardised in the ISO14001 series or the EMAS scheme, make a significant contribution to measurement and management of potential progress with sustainable development. The problem arises when there has been inadequate consideration of the appropriateness of management targets with respect to making incremental progress towards a clearly articulated vision of full sustainability. Eco-efficiency relative to today's performance is all too often the goal established by management systems today. At TNS, we say that "*Management systems will help you do things right, whereas The Natural Step Framework will help you do the right things.*" SIGMA is being developed as a **Sustainability Management System**, and its impacts are yet to be felt.

- **Stewardship Council accreditation** makes a step towards the more sustainable sourcing of raw resources. Today, these include the Marine Stewardship Council (MSC) and Forestry Stewardship Council (FSC) schemes, offering independent certification to open and agreed standards respectively for marine products and forestry products. There is scope for further certification schemes to drive forward greater supply chain responsibility and reward. However, there remains a risk that procurement of accredited materials, whilst a major step-change from current practices, is seen as sufficient to address sustainable development in its entirety. To do this, the whole life cycle of products and processes will have to have been addressed – including supply chains, value chains, fate at end-of-life, etc. – as discussed in this report. 'Greener' sources of materials that are then used in today's habitual linear ways may leave us woefully short of our final goal of full sustainability. That said, certification of production does at least set us off on the road in a manner that is consistent with today's procurement practices.

- **Life Cycle Assessment** (LCA) comprises a set of tools, standardised in the ISO 14040 series, seeking to systematise and quantify the environmental impacts of a product or process across its life cycle. This form of science-based approach to material resource management is essential if we are to escape subjectively. However, virtually all applications of LCA today define the 'life cycle' as the *linear* journey from raw resource through to disposal. This flies against the premise of sustainable development by assuming that 'waste' simply disappears and can have no consequences for the environmental and society post disposal. A separate document titled *Life Cycle Assessment and Sustainable Development: Adding Value with The Natural Step Framework* has been produced to help map established LCA techniques to the wider terrain of sustainable development[11].

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[11] At the time of writing, this document is in late draft. Further information, and ordering of copies once published, is available from the TNS office in the UK using the details on the back cover of this report.

- **Responsible Care** is a voluntary initiative of the global chemical industry, established in 1987. It includes a set of *guiding principles* and seven specific measures to put them into effect. Responsible Care has undoubtedly 'upped the game' of the chemical industry world-wide in the fields of health, safety and environmental performance (HS&E). It has also added some international harmonisation of best practice. It was however conceived at a time when sustainable development concepts were less well-developed and widely-understood. Many perceive that Responsible Care is in need of a major overhaul to add strategic direction, as well as renewed vigour and relevance, to its established practices and track record. A separate document titled *Responsible Care and Sustainable Development: Adding Value with The Natural Step Framework* has been produced to help map established Responsible Care techniques to the wider terrain of sustainable development[12].

- **Green accounting** is a term covering a range of initiatives that seek to account for environmental and/or social impacts of business activities in a framework broadly comparable with financial accounting. By bringing more aspects of the 'Triple Bottom Line' – environmental, social and economic – into the decision-making process, the journey towards full internalisation of costs is aided. As with many of the other initiatives listed here, success will depend upon ensuring that appropriate elements are measured, that metrics are relevant, and the rationale for the accounting process is understood by and has 'buy in' from management.

- **Environmental Impact Assessment** is an initiative commonly used in the development planning process, with parallels in various forms of Environmental Audit in other fields of business. These seek to identify all environmental elements of a development, process or product that can then be factored into the decision-making process. As with many other initiatives listed here, it is essential to first ensure that all parameters relevant of sustainable development have been addressed.

- **Environmental Footprinting** is a well-respected approach that seeks to identify the broader environmental burden of products or activities. It takes account of the energy and material inputs to those processes or products, equating these to physical productive land area. As a communication tool, footprinting is excellent, although quantification retains a good degree of subjectivity. No attempt is made to map impacts across full material life cycles, which are critical to objective evaluation and planning.

- **Factor 4, Factor 10, Factor X** and other explicitly eco-efficiency initiatives acknowledge the need to deliver more value to society per unit resource. (Factor 4, for example, has been described as 'Halving Resources, Doubling Wealth'). As communication tools, and a clear demonstration to business of the self-interest of addressing eco-efficiency, those initiatives are highly effective, and can drive transmaterialistion and dematerialisation decisions. However, the dangers of targeting thinking exclusively on eco-efficiency without a broader context of sustainable development have been well exercised in the body of this report.

- **Corporate Social Responsibility** (CSR) is just one of many initiatives seeking to define and aid management of the social impacts of business. Social and economic elements of

[12] At the time of writing, this document is also in late draft. Further information, and ordering of copies once published, is available from the TNS office in the UK using the details on the back cover of this report.

sustainable development are of course crucial, and initiatives such as CSR help the process of bringing them closer to decision-making. Dangers arise when we seek to define social, environmental or wider economic implications i.e. (not as an indissolubly integrated set of factors), or indeed removed from core business decisions.

- The **Environmental Rucksack** concept is akin to Environmental Footprinting in that it seeks to identify the wider-scale environmental demands of parochial decisions and applications. The same comments therefore apply.

- **Environmental Space** is another concept akin to Environmental Footprinting, and the same comments apply.

- **Environmental Technology Best Practice** (ETBP), the Best Available Technology (BAT) perspective of IPPC and a range of other initiatives to share and disseminate best practice, offer efficiencies in manufacture. The danger remains where the benchmarking is against today's performance as eco-efficiency alone. Whilst continuous improvement is very important, it may not deliver the spur for major innovation required to address the step-changes that must inevitably be made if we are to make progress to the goal of full sustainability.

- **MIPS** (Materials Intensity per Unit of Service) attempts to measure the efficiency of service provision in terms of energy and materials use. Within many economies in the world, services that we take for granted and improve our quality of life, such as indoor light, clean water, good nutrition and travel, are produced using vastly different amounts of material or energy per lumen or per passenger mile. MIPS is able to measure eco-efficiency product-by-product or within industrial sectors, communities or nations. Its flexibility of approach enables MIPS to complement other appraisal tools such as LCA and TMR, whilst supporting more systematic and overarching analysis tools of resource use such as the TNS Framework.

- The UK Government's paper on **Resource Productivity** developed by the Performance and Innovation Unit (PiU), addresses eco-efficiency. The most interesting initial conclusion is that the limiting resources today are not raw materials, but the land and air into which waste may be disposed. This conclusion alone is consistent with principles of sustainability as articulated by The Natural Step Framework. However, the remains of the report plough traditional furrows through well-established eco-efficiency arguments, the dangers of which have been reiterated in the body of this report.

In concluding this Annex, let's repeat the acknowledgements that this list is very far from complete, and that the discussion is preliminary. It does however serve to:

1. Demonstrate the breadth of positive initiatives already in place to tackle aspects of sustainable development;

2. Outline the role they can fulfil but also some concomitant risks of misapplication; and

3. Articulate the need to 'ground' planning for sustainable development on an objective and holistic conceptual framework (such as that provided by TNS), from which initiatives and issues can be put into context.

End of Annex 2

Annex 3: Bibliography

The following documents were used in this study.

A3.1 Publication by The Natural Step, and about Application of the TNS Framework

- The completed *2020 Vision* project on **PVC** reported in *PVC an Evaluation Using The Natural Step Framework*;

- The follow-up *2020 Vision* project on **PVC** titled *PVC: Delivery of Sustainable Social Value*;

- TNS response to the DETR consultation document *Life Cycle Assessment of Polyvinyl chloride and Alternatives*;

- The completed *Pathfinder Project* on **paper** with PaperCom Europe, reported in the document *Sustainability and the Paper Communication Chain: An Evaluation Using The Natural Step Framework*;

- Study of measures to increase the sustainable cycling of **phosphorus**, published in the scientific paper:

    - Everard, M. (2001). Taking a systems-oriented view of phosphorus enrichment in fresh waters. *Freshwater Forum*, **15**, pp.35-54.

- Work on the **Nylon** life cycle undertaken with DuPont and reported (excluding various commercial-in-confidence elements) in *DuPont Nylon Europe Pathfinder Report*;

- Exploration of today's myths about 'sustainable materials' with consideration of the types of material life cycles that should feature in a sustainable future. This is summarised in the paper:

    - Everard, M., Bowdler, D. and Shayler, M. (2001). A Material Dilemma. *Industrial Environmental Management*, **11(12) [May 2001]**, pp.12-13

- Research on **metal substitution** by John Holmberg and other Swedish associates of TNS, published in the scientific paper:

    - Azar, C., Holmberg, J. and Lindgren, K. (1996). Methodological and ideological options: socio-ecological indicators for sustainability. *Ecological Economics*, **18**, pp.89-112.

- Detailed work on **construction materials** reported in:

    - Everard, M. and Dhami, J. (2001). Sustainability: brick by brick. *Industrial Environmental Management*, **12(4) [September 2001]**, pp.12-13.

    - Everard, M. and Dhami, J. (2001). Sustainability: spotlight on construction. *Industrial Environmental Management*, **12(5) [October 2001]**, pp.14-15.

    - Various reports and press articles produced stemming from TNS involvement with Wessex Water;

- Various reports and press articles produced stemming from TNS involvement with Sun Microsystems.

- Various **other considerations of material** use in the *Pathfinder* Programme, *2020 Vision* programme, and in subsequent projects with TNS Partners.

- Everard, M. Russell, A. Archard, D. (2000). *Renewable Energy: A Sustainability Analysis Using The Natural Step Framework.* The Natural Step, Cheltenham.

- *Landfill and the TNS Framework* paper published in *Stepping Stones, No. 60, October 2001.* The Natural Step, Cheltenham.

A3.2 Other Non-TNS Publications

- Berman, Marshall. (1982). *All that is solid melts into air: the experience of Modernity.* Penguin Books, New York.

- Commission E. (2001). *Environment 2010: Our future, our choice.* The Sixth Environment Action Programme, European Commission: 66.

- EC. (1996). *Progress Report on implementation of the European Community Programme of Policy and Action in relation to the environment and sustainable development "Towards sustainability".* Brussels, European Commission.

- Friends of the Earth. (2000). *Materials Evidence: Practical recommendations for national and European resource use.* Friends of the Earth Scotland.

- Hird A.B. et al. (2001). *Tyre Waste and Resource management: A Mass Balance Approach.* Biffaward.

- Jackson, T. (1996). *Material Concerns. Pollution, Profit and Quality of Life.* Routledge. London.

- Lovins, A.B., Lovins, L.H., Hawken. P. (1998). *A Road Map for Natural Capitalism.* Ed: Harvard Business School Press.

- National Centre for Business and Sustainability. (2001). *Product Stewardship: Identifying the Fate of End-of-Life Products.*, Draft report from the NCBS for the PVC Coordination Group.

- Performance and Innovation Unit (PIU), Cabinet Office. (2001). *Resource productivity: making more with less*. Cabinet Office, London.

- James Gustave Speth (UNDP Administrator), reported in *Le Monde*, 1 October 1996.

- The Real World Coalition. (1996). *The Politics of the Real World.* Earthscan, London.

- UN. Economic and Social Council, Commission on Sustainable Development acting as a preparatory committee for the World Summit on Sustainable Development. (2001). *Implementing Agenda 21*. 20 Dec. 2001. E/CN.17/2002/PC.2.7.

- UNFPA. United Nations Population Fund. *The States of the World Population 2001. Footprints and Milestones: Population and Environmental Change.*

- Weizsäcker, E. Von, Lovins, A. B. and Lovins, L.H. (1997). *Factor Four: Doubling Wealth, Halving Resource Use – A New Report to the Club of Rome.* Earthscan Publications Ltd, London.

- Womak, J.P., and Jones, D.T. (1996). *Lean Thinking.* Simon & Schuster.

- Worldwide Fund for Nature. (1999). *Living Planet Index.*

- Wright, M. and Hooper, S. (2001). Break it down, open it up... *Green Futures*, **September/October 2001**, pp.20-24.

- Zolatas, X. (1981). *Economic Growth and Declining Social Welfare.* New York University Press.

End of Annex 3

Annex 4: About the *2020 Vision* Seminar

There are many contentious issues around developing and adopting more sustainable ways of using material resources. Such issues relate to technical, social, ecological and economic factors, and present a number of challenges to those responsible for material choice and use decisions. The aim of the *2020 Vision* process, and the focus of this *2020 Vision* seminar, was to involve a range of participants to share information and build consensus about the delivery of more sustainable means for using physical materials, and the steps necessary to achieve that goal. The process helps create a vision of the kind of environment, social benefits and sustainable future to which society aspires. Key points arising during the seminar are included in the main body of this report.

The following people were involved in the development of this project

Attending the *2020 Vision* Seminar

From The Natural Step
Lorna Berry
David Cook
Dr Mark Everard
Anna Kennedy

From the Environment Agency
Stefan Carlyle

From Forum for the Future
Phil Allies
Fiona Brookes
Anna Browne
Heloise Buckland
Jo Forster
Dr Caroline Gervais
Dr Conor Linstead

Other Invited Guests
Carole Bond, Carbon Data
Jas Dhami, Carillion plc
Suzy Edwards, Building Research Establishment
Jayn Harding, J Sainsburys plc
Andrew Horsley, Carillion plc
Peter Jones, Biffa
James McKenzie, J Sainsburys plc
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This project was substantially funded by the Ineos Group via its subsidiary European Vinyls Corporation (EVC) using Landfill Tax Credit Scheme funding made available from the landfill site managed by the Ineos Group at Runcorn. Management of the landfill site is currently transferring from Ineos Chlor to Ineos Fluor.

End of Annex 4

About the *2020 Vision* Series

The ***2020 Vision* Series** of publications aims to provide information about a range of contentious issues, many of which have featured in the media. The Natural Step office in the UK, together with SATIS (the Scientific and Technical Information Service of the Environment Agency), runs a series of ***2020 Vision* Seminars**. These seminars involve invited participants in the sharing of information and debate about the place of specific contentious issues in a future more sustainable world. This *2020 Vision* Series publication reports on the sustainability evaluation using the System Conditions of TNS, as well as the outcomes of the *2020 Vision* Seminar, *Towards the Sustainable Use of Material Resources*. A summary document is also available at The Natural Step's UK web site: *http:\\www.naturalstep.org.uk*. (You can also find the *2020 Vision Series No.1*, *No.2* and *No.3* documents, respectively on GMOs, PVC and Sustainable Drainage [SuDS], on the same web site.) The detailed report *Towards the Sustainable Use of Material Resources: An Evaluation Using The Natural Step Framework* is also available from The Natural Step office in the UK, priced £20 to cover production and handling costs, using the contact details at the end of this document.

About The Natural Step

The Natural Step (TNS) Framework is a science-based learning and decision-making programme aimed at helping organisations to understand and apply the concept of sustainable development. It was developed in Sweden in the late 1980s. The Natural Step office in the UK has been operating as a charity, chaired by the well-known environmentalist Jonathon Porritt, since the beginning of 1997. It has already been successful in helping a range of large companies[13] address sustainable development as a strategic issue. The science-based model of a sustainable world, which lies at the heart of TNS, together with a range of other specialist TNS tools, provides an 'intellectual round table' for the building of consensus about various social, environmental and economic aspects of contentious issues and their place in a future more sustainable world.

About EVC and Ineos Chlor

EVC (European Vinyls Corporation) is the largest European polyvinyl chloride (PVC) manufacturer. In March 2001, the Ineos Group, a leading manufacturer of speciality and intermediate chemicals, acquired a majority shareholding in EVC. The Ineos Chlor business at Runcorn in Cheshire operates a landfill site and EVC were able to secure Landfill Tax Credit Scheme funding for this *2020 Vision* seminar and report from its new parent company. Ineos Chlor is one of the major chlor-alkali producers in Europe, and is a global leader in chlorine derivatives. It is also a leading manufacturer of sulphur chemicals and a key player in the field of electrochemical technology.

About the Environment Agency

The Environment Agency has wide-ranging powers and duties relating to water management, environmental protection and pollution control across England and Wales. Its principal aim is to exercise them so as to contribute to sustainable development. The Agency therefore has strong interests in the application of science to decision-making – both its own and that of other sectors of society – as an important part of its contribution towards the achievement of sustainable development. The Environment Agency is a partner of TNS in the UK in the *2020 Vision* series of seminars and publications, supporting the Agency's aspiration to envisage the kind of environment that it wishes to work towards.

[13] Pathfinder partners of TNS in the UK comprise: Air BP and BP Scotland, Carillion, the Co-operative Bank, Crest Nicholson, Interface, Sainsbury's, Sun Microsystems, Nike Europe and HP Bulmer.

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