GREEN PRODUCTIVITY: MOVING THE AGENDA

John Heap, President, World Confederation of Productivity Science
Tom Tuttle, President, World Academy of Productivity Science

As the scientific evidence regarding global warming has become widely accepted, so too has the realization by global businesses that resisting the move toward sustainability is no longer a viable business strategy. Even in the United States, which has not led this movement, the pressures from the major business community on Government to address this issue have become intense.

At the World Confederation of Productivity Science's (WCPS) 2001 World Productivity Congress in Hong Kong, one of the authors (Tuttle) chaired the track on "Green Productivity". In this forum, a representative of the Dow-Jones Sustainability Index stated that Corporate Sustainability:

"…… is a business approach to create long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments."

He went on to point out that leading "Sustainability Companies"

- Secure a long- term "license to operate" by responding to stakeholders changing needs, thus fostering superior customer and employee loyalty
- Meet shareholders' demands for sound financial returns, long-term economic growth and productivity increases, sharpened global competitiveness and contributions to intellectual capital
- Seek to increase long-term shareholder value by incorporating responsible economic, environmental and social behavior into their business strategy and;
- Invest in product and service innovations that use financial, natural and social resources in an efficient and economic manner over the long term.

Increasing emphasis on sustainability by the investment community is only one of the forces that is changing the landscape for businesses today. There is also increasing emphasis from insurance companies that have become attuned to the risks of not being sustainable. There is pressure from both business and the public who as customers want products and services that support their efforts to be sustainable. Civil society has also changed its standards for judging whether organizations are 'responsible' alongside its scrutiny of their performance. In the internet age the ways in which companies are assessed and perceived has also changed – with data on company performance and practice being much more readily available. These pressures do not apply only to industrial companies. For

example, universities who must compete for students are feeling the pressure as students ask for information on the university's sustainability practices. Legislators find themselves pressured on issues in their personal life in terms of their energy consumption at home, their carbon footprint and whether their "walk" matches their "talk."

The business case for sustainability was clearly stated by Holliday et.al (2002) in preparation for the 2002 World Summit for Sustainability when they described how the new paradigm of sustainable progress has changed how they think about doing business. They point out that the changes range from:

- "Moving from seeing only costs and difficulties in the concept of sustainable development to seeing savings and opportunities.;
- Evolving from using end-of-pipe approaches to pollution to using cleaner more efficient technologies throughout entire production systems and , further, seeking to make sustainable development integral to business development;
- Changing from linear "throughput" approaches to systems and closed-loop approaches;
- Moving from seeing environmental and social issues as the responsibility of technical departments or experts to seeing these issues as company-wide responsibilities;
- Changing premises of confidentiality to ones of openness and transparency;
- Changing from narrow lobbying to more open discussions with stakeholders."

Stuart Hart, a business strategy professor at Cornell University, summarizes this view by saying that:

"…. those who think that sustainability is only a matter of pollution control are missing the bigger picture. Rarely is greening linked to strategy or technological development and, as a result, most companies fail to recognize opportunities of potentially staggering proportions. " (Holliday et al.,2002, p.25)

A New Productivity Paradigm

The concept of Green Productivity was first introduced by the Asian Productivity Organization (APO) following the 1992 Rio Earth Summit. "**Green Productivity (GP) is a strategy for enhancing productivity and environmental performance simultaneously to achieve overall socio-economic development.** Its aim is well-rounded socio-economic development that leads to sustained improvement in the quality of human life. It is the combined application of appropriate productivity and environmental management tools, techniques and technologies that reduce the

environmental impact of an organization's activities, products and services while enhancing profitability and competitive advantage."

This definition reflects the fact that the Asian view of productivity has always had a dual focus. There is the narrow firm level view as well as the broad, macro societal view, both of which are reflected in this definition. The APO view is that Green Productivity involves a concern with using a customer focus (i.e. quality) to achieve the appropriate balance between profitability and environmental performance.

The authors both participated as speakers in the 2005 Productivity Forum in Beijing sponsored by the China Association of Productivity Science (CAPS). In his presentation Tuttle (2005) discussed how Green Productivity differs from the traditional Output/Input productivity model. He argued that it differs in three ways : (1) it recognizes the importance of the larger system that the enterprise or nation operates within; (2) it views output not in terms of number of units produced but in terms of customer and stakeholder perceived value, e.g. an output has no value until it is purchased or received by a customer or until its impact is felt by a stakeholder; (3) the Green Productivity model recognizes a broader range of inputs to the production process than does the traditional productivity model.

To support this view of Green Productivity Tuttle (2005) cited a new model of development that is gaining strength in China and is known as the "Beijing Consensus". (World Changing, 2005)

"This new view is apparent in the way Chinese thinkers are starting to measure growth. Tsinghua economist Hu Angang, among others, now disdainfully labels GDP growth, the sine qua non of Washington Consensus physics, "black GDP growth." He takes China's impressive black GDP numbers and subtracts off the terrific costs of environmental destruction to measure "green GDP growth." Then Hu nets out China's corruption costs to measure "clean GDP". This he says, is how China should measure progress. "It doesn't matter if the cat is black or white", Deng Xiaoping famously observed in one of his early speeches on economic reform. "All that matters is that it catches mice." But Hu's GDP tools, which I've heard leaders all over the country begin to talk about, reflect the government's new belief: the color of the cat does matter. The goal now is to find a cat that is green, a cat that is transparent."

So this view of Green Productivity at the enterprise level would argue that the enterprise must include in its productivity equation, the impact it is having on the external system it operates within. The calculation must recognize that, as Hu Angang's model suggests, that the firm delivers positive and negative value to customers and stakeholders. For example, there are dozens of MP3 players on

the market but the iPod reigns supreme. The “product” that Apple has produced, and refined, is of course an MP3 player. However, the “value” delivered to customers includes not only the functionality of the product but its “styling”, its image, its user interface, the integrated music management system that it connects with through the free “itunes” software and its “prime mover” market status. These factors represent the positive value.

Using a different lens to view “outputs”, Apple also (like all other companies producing manufactured goods) produces “negative outputs” – the emissions and waste that results from energy usage, production processes, transportation, packaging, etc.

Heap has long argued that addressing the top line of the productivity ratio – by increasing positive output factors such as value – is often the best way to start to improve productivity (Heap, 1992). Now, of course, the concept of green productivity suggests that when addressing this top line, we should also address – and eliminate or minimize – the negative output factors.

Of course, green productivity must also take into account the inputs utilized to produce the product or service. The traditional productivity model focuses on four classes of inputs: labor, capital, materials and energy. In this model no economic accounting is included to deal with the natural environmental inputs. The two most obvious are air and water. If Apple or its contract manufacturers in China utilize water in the production process and do not return that water to the environment in a condition at least as clean as when it entered the production process this creates a burden for society to clean the water. This must be considered an input cost to the manufacturer. The same principle applies to the air used as an input. The cost of restoring it to its original state is an input cost to the organization. It is obvious that the organization that minimizes the use of material to produce its product (while maintaining the value delivered to customers) and to package the product will have a “reduced input cost” and therefore increased productivity.

Recently, Tuttle & Tebo (2007) have introduced the concept of the three productivities economic, social and environmental as a means of further elaborating a comprehensive view of competitiveness and societal value creation from both the enterprise and national perspectives. While these terms mirror the elements of the Triple Bottom Line approach to measure organizational performance, there are key differences. First the focus on productivity involves consideration of both inputs and outputs and the three productivities also through the focus on perceived value have a customer perspective that is missing from the Triple Bottom Line paradigm.

Moving the Green Productivity Agenda: Macro View

The fact that there is now an international consensus among the scientific community and most nations (even the U.S. finally) that global warming is a reality increases the urgency to improve Green Productivity. There are roles to be played by International Organizations, National Governments and International Business and Labor Organizations. In this paper, we will not attempt to provide a thorough review of this macro perspective but we wish to cite a few examples of steps that can be helpful in moving this agenda forward.

There are literally hundreds of environmental advocacy organizations that are promoting various environmental agendas. They all have a role to play. In addition, the United Nations has a number of environmental programs and acts as a very influential force. The Coalition for Environmentally Responsible Economies (CERES) in partnership with the United Nations Environmental Program (UNEP) created in 1997 the Global Reporting Initiative (GRI). The mission of the GRI is to develop and disseminate guidelines for organizations to report their environmental, economic and social initiatives in order to increase private sector transparency. The Sustainability Reporting Guidelines enable governments, businesses and civil society to monitor progress of organizations in improving environmental stewardship.

Some nations have created their own reporting requirements. The United Kingdom Government through its Companies Act 2006 is requiring by 2008 all companies to report in their Annual Report on non-financial issues including information on environmental, HR and social/community issues. In addition they are required to report on their associated policies and their effectiveness.

How would the new productivity paradigm impact policy and actions at the national level? Some views of this are contained in the book ***Walking the Talk: The Business Case for Sustainable Development by*** Charles O. Holliday, Jr. , Stephan Schmidheiny, and Philip Watts. The book was prepared to articulate the business case for sustainable development at the 2002 World Summit on Sustainable Development in Johannesburg, South Africa.

These authors outline 10 macro policy building blocks for sustainable development that emphasize the use of market mechanisms to drive appropriate behaviors by business. Basically, their argument is that properly structured markets can be the most effective mechanism to drive the desired behaviors. They go on to outline the steps required to create effective markets. They argue that legislative and regulatory policy should promote: competition among enterprises, effective intellectual and property rights, reliability of contractual terms, fair and transparent accounting standards, accountability of government intervention, predictability of government intervention, freedom and democracy and full-cost pricing of goods and services.

A second area of government action is in the area of tax reform. Tax policy can be an effective instrument to encourage green productivity. The authors cite a number of examples:

- Sweden's 1991 sulfur tax led to a drop in the sulfur content of fuels to 50% below legal requirements and stimulated power plants to invest in abatement technology.
- Norway's carbon tax levied in 1991 lowered emissions from power plants by 21%.
- Germany and Japan instituted high respective rates of taxation on regular unleaded gasoline. This did not negatively impact competitiveness as it has led to higher energy productivity and to lowering CO2 intensity. For example the German economy grew by 1.1% per year between 1990 and 1994 while energy consumption declined by 1.5%.

The World Confederation for Productivity Science (WCPS) in its last two World Productivity Congresses has devoted a major "track" to Green Productivity. The presentations have addressed both macro and micro issues. At the macro level there have been issues dealing with public sector policy making. In addition there has been a focus on the actions by the investment community to stimulate investment decisions based on sustainability performance by firms.

The WCPS is encouraging national organizations – whether government agencies, business support organizations or commercial enterprises - to work on their own green productivity programmes but also to work across national boundaries on benchmarking studies and on joint research activities – again to "move the agenda onwards".

One of the most fruitful areas of activity for 'productivity catalyst' organizations is to lobby for change in macro-economic policy since, as we have seen, this often creates an agenda for business change and alters the 'productivity infrastructure' in ways that motivate companies to first engage with such issues. Knowledge of the concept of 'carbon footprint' is good but the existence of financial penalties for not acting to reduce it (or financial incentives to reduce it) may have more impact. In fact, this is often when environmental issues move from being a corporate social responsibility issue to being a productivity issue – when the motivation is to improve the productivity ratio and improve business performance.

Moving the Green Productivity Agenda : The Enterprise Perspective

Our discussion of green productivity at the enterprise level perhaps created the impression that firms that embrace the concept will become less productive as full cost accounting principles are applied. Of course there is a difference between full cost accounting and full cost pricing. To maintain a level playing field, it is necessary for full cost pricing to be driven from a national policy perspective or even better from an international perspective. However, regardless of the environment the firm is operating in, there are substantial business benefits associated with green productivity strategies that more than offset additional costs associated with assuming responsibility for the societal costs associated with a given business.

Bob Willard (Willard, 2002) suggests that there are 7 types of business benefits that can be achieved from adopting a sustainable business strategy. These areas of benefit include:

1. Easier hiring of the best talent
2. Higher retention of top talent
3. Increasing employee productivity
4. Reduced expenses in manufacturing
5. Reduced expenses at commercial sites
6. Increased revenue/market share
7. Reduced risk, easier financing

For each of these benefits, Willard presents a detailed worksheet that allows a firm to consider and calculate the degree of benefit that can be derived from each of these 7 factors. He also points out that in order to achieve these benefits, the firm must invest a substantial amount in education of all of its employees. Utilizing a fictitious case example, based on data from a group of information technology companies, Willard shows how in this case example (company with $44 billion in sales, 3 billion of profit and 120,000 employees) over a 5 year period the company receives a total net benefit of $11,078,566,830 with an internal rate of return on the education investment ranging from 714% in year 1 to 5327 % in year 5.

Willard makes a strong case at the firm level for how green productivity initiatives lead to improved business results. Furthermore, his worksheets can serve as a blueprint for a company to conduct its own analysis to determine the actual or potential benefit.

Green Productivity – The Individual Level

Before the paradigm will shift, it is necessary for change to occur at the individual level. As the French novelist Marcel Proust stated: ***The real voyage of discovery consists not in seeking new landscapes but in having "new eyes"***.

The need for "new eyes" was illustrated by stories of Western business executives who participated in trips to Japan in the mid – late 1980s to observe the miracle of Japanese management. Eager to learn the secrets underlying the Japanese quality and productivity successes, they would travel to Japanese offices and factories to see what was different. The Japanese hosts were quite accommodating even though some of the visitors were competitors. Japanese "tour guide" was heard to remark that even though we show you our processes, you will not see them!" He was saying that the American executives had not yet developed the "new" eyes that would allow them to understand the new paradigm.

In order to accelerate the move to the new productivity paradigm, a key role for productivity promotion organizations is to help people gain "new eyes".

We can further illustrate the issue with a reminder of how the quality paradigm evolved. It was widely believed in the 70's and early 80's that quality, cost and delivery were competing performance dimensions and that it was not possible to achieve all three simultaneously. One executive said to me after drawing the cost, quality and delivery triangle, "I can give you any two!" Inherent in this view was the notion that there are trade-offs between the three ideas. Of course, what we learned from "guides" like W. Edwards Deming was that under the old business paradigm that was true. However, if we focus on making quality as viewed by the customer the most important dimension, and if we shift from a functional to a process focus, we can and indeed must achieve improvements in all three of the dimensions simultaneously. This shift took over 50 years to be widely accepted in the United States after it had first been articulated by Walter Shewhart in 1931 and later elaborated by his colleague W. Edwards Deming in Japan in 1950 and in the United States beginning with the 1980 NBC television show "If Japan Can, Why Can't We?" which introduced Deming to American audiences.

We are now 25 years later at the beginning of a new paradigm. Stan Meyer, an American consultant and author describes the shift from a technology evolution perspective as a shift to the biological era. The past century was dominated by the industrial era and the information era. The information era served as an enabler of the quality paradigm shift with its emphasis on process management, re-engineering, enterprise systems, web-enabled software tools to support global process integration and management of the entire value chain. The green productivity paradigm will be enabled by the convergence of the biological era

and the information era. Meyer and his colleague Stan Davis write about this shift in their book "It's Alive" which describes how the biological perspective will transform management and organizations. "…..***management is shifting from a stance of predicting and controlling change to one of building an organization to sense change and to respond appropriately. We refer to this as the shift to adaptive management." (Christopher Meyer and Stan Davis, 2003, p. ix)***

The new paradigm involves the elements that are described by John Elkington (Elkington, 1998). The triple bottom line view is that organizations must measure their performance in terms of Economic outcomes, Social outcomes and Environmental outcomes. As was the case in the shift to the quality paradigm, the issue is how to accomplish all three simultaneously. The old paradigm views social, environmental and economic performance as conflicting priorities which often tradeoff against each other. For example a power plant must add scrubbers to its smokestack to mitigate some of the air pollution resulting from burning coal. Therefore, this investment takes funds that could otherwise contribute to profitability. However, just as the quality paradigm demonstrated that by reframing the problem – gaining new eyes – we can find methods to achieve all three.

W. Edwards Deming exhorted management to continue to gain knowledge. ***'Everyone doing his best is not the answer. It is necessary that people know what to do. Drastic changes are required. The responsibility for change rests on management. The first step is to learn how to change. Long-term commitment to new learning and new philosophy is required of any management that seeks to improve quality and productivity. The timid and the faint-hearted, and people that expect quick results, are doomed to disappointment. "*** (Deming, 1982)

The message that he delivered in 1982 is no less relevant today. If we are to create organizations that can simultaneously improve social, economic and environmental performance we must begin by creating new knowledge. Those of us who are in the productivity movement or who are in academia must build our capability to help leaders acquire that knowledge. That means we must become the vanguard of the new paradigm.

The shift to the new paradigm will be driven by competitive pressures, and by pressure from stakeholders. It will be enabled by technological advances in biological sciences and by convergence of biological and information technology, by biology and chemistry and by biology and material science.

We are seeing this happening. The major U.S. Chemical company Du Pont built its brand around petrochemical-based products such as nylon, rayon, and Dacron. This company is divesting its petroleum-based businesses and substituting business that are biology based e.g. seeds, soya products, etc.

In 2004, we completed the transformation of our company begun more than five years ago and unveiled a new vision for DuPont – to be the world's most dynamic science company, creating sustainable solutions essential to a better safer, healthier life for people everywhere.

In articulating our vision, we also set key milestones to be met by 2010. These milestones connect our fundamental business and the products we make with real societal needs. The milestones include: saving the life or reducing serious injury to 1,000,000 people; being recognized among the top 3 enablers of human connectivity worldwide; being recognized among the top 2 enablers of healthy, safe, affordable food; and deriving 25% of our revenue from non-depletable resources. We view these goals as major opportunities for DuPont to create more value for our shareholders. They also challenge the people of DuPont to create a more sustainable company that will provide tremendous and measurable societal value. (Excerpts from DuPont Sustainable Growth report)

One of the leading practitioners and advocates for the new paradigm is architect William Mc Donough. McDonough and his partner, German chemist Michael Braungart, share their philosophy and methodology in a book *Cradle to Cradle: Remaking the Way We Make Things.*

Hopefully, further along the road toward a rich definition of corporate performance. The triple bottom line has been, and remains, a useful tool for identifying problems and integrating sustainability into the corporate agenda. In practice, however, measuring performance at the bottom line tends to be a balancing act between economic value and environmental liabilities. For example, if the environmental impact of a profitable product has been minimized by a more efficient use of materials, its performance likely meets the triple bottom line. But if the material itself is unsafe, as is often the case, then efficient manufacturing is merely slowing down ecological destruction - a rather dispiriting measure of quality.

Consider this measure of quality writ large in the U.S. economy. Due to the strength of the dollar against foreign currencies, U.S. manufacturers rely more and more on cheap materials from overseas. Many materials from Asia, where occupational health regulations are minimal, have been found to be carcinogenic. Globally sourced materials are rarely, if ever, assessed, so many "lean-thinking" U.S. companies are applying efficiency measures to toxic materials. The result: cheap products, expensive waste management systems, and rising health care costs - all of which add up to a very dull competitive edge in the global marketplace. The U.S. trade deficit, a whopping $346 billion in 2001, suggests the scale of the problem. A national commitment to product quality could solve it…..

Ford Motor Company is showing how a blue chip company with a sharp eye on the bottom line can adopt triple top line vision. When Ford's executives and engineers began to plan the renovation of their famed Rouge River manufacturing plant they wanted to maximize economic value. So along with other innovative designs, we conceived a storm water management system based on a 450,000 square-foot roof of topsoil and growing plants. In concert with porous paving and a series of wetlands and swales, the "living roof" will filter storm water run-off, replacing a water treatment facility at a savings of $35 million. Thrown in for free: habitat for native species, plants that create oxygen and absorb particulate matter, and a pleasing natural landscape. Now Ford executives are dreaming of the day when children will safely and happily play along the Rouge. (William McDonough and Michael Braungart, Beyond the Triple Bottom Line: A new standard for 21st century commerce, Greenmoney Journal, Fall 2005).

One of the metaphors used by business to describe its environmental improvements is to focus on a shift from “end of pipe” technologies to “beginning of pipe” prevention. For example rather than focus on scrubbers at the top of the smokestack to prevent air pollution, change the characteristics of the incoming fuel that will eliminate the need for the scrubbers.

McDonough and Braungart take this thinking a step further and say eliminate the “pipe altogether.” The key is to “take the filters out of the pipes and put them where they belong – in the designer’s heads.” Everything that shouldn’t be in the process should be eliminated by design. Design mentality can reshape industrial production processes and the entire structure and logic of a business. These are the ideas that are being applied to the Ford Rouge plant.

This line of reasoning is directly comparable to the lessons learned in the quality revolution. In the initial phase of quality, end of the line inspectors sorted good product from bad product. As we moved into the era of quality control, the focus was on prevention so we moved inspection from the end of the process to the beginning of the process (e.g. incoming inspection) and added the use of statistical sampling methodology. Further improvement led to the elimination of inspection of incoming parts altogether by choosing and certifying suppliers who demonstrate the ability to deliver error-free parts and components on time.

McDonough and Braungart describe an example of how this thinking can be applied. A Swiss textile manufacturer made upholstery fabric for office furniture as a supplier to Steelcase. The European Government regulators declared the waste trimmings from the factory to be hazardous waste. McDonough and Braungart set out to redefine the process so that the trimmings could become mulch for gardens – application of the cradle to cradle principle. The key was to find chemicals for the production process that would lead to the desired performance characteristics for the fabric and have none of the hazards. They

screened 8,000 chemicals and eliminated 7,962 as being too dangerous. However with only 38 chemicals, they were able to design a production process that produced an entire line of fabrics that met the customer requirements and had none of the toxic chemicals. When regulators came to test the effluent out of the plant, they thought their instruments were broken. After testing the influent as well, they realized that the equipment was fine --- the water coming out of the factory was as clean as the Swiss drinking water going in. The manufacturing process itself was filtering the water. (adapted from Hawken, Lovins and Lovins, p.72.)

From a total economy perspective, the Japanese may be as advanced as any nation in the definition and adoption of this new green productivity paradigm. In some ways the island nation has an advantage in that they must import virtually all of the natural resources required by their production processes. Therefore, they are acutely aware of the importance of conserving raw materials. However, like much of the rest of the world, Japanese industry had its share of issues with regard to social and environmental performance.

Following the 2001 World Productivity Congress, Tuttle had the opportunity to visit Tokyo and meet with a leading Japanese industrialist Mr. Keizo Yamaji. Yamagi shared with me a book entitled ***Japan's Green Comeback: Future Visions of the Men Who Made Japan*** (Mitsuhasi, 2000)***.*** Ignoring the politically incorrect title which implies that women had little to do with the making of Japan, this book is interesting. Its 18 chapters are each written by a Senior Executive of a major Japanese company in each of 18 different industries. Each chapter addresses how that company and that industry is redefining itself to focus on the goal of Zero Emissions – the Japanese label for Green Productivity. This book was written in 2000. The second chapter was written by Kosuke Yamamoto, the Executive Vice-President of Toyota Motor Corporation. He refers to a survey conducted by the Nihon Keizai Shimbun newspaper in November 1997. 1,295 publicly listed companies were asked to respond to 14 questions about the environment. Based on these responses, the newspaper established a scale based on how much consideration these companies gave to the environment and then ranked the top 100 companies. The top 30 companies had an average revenue increase of more than 4%. Companies ranked 31 to 100 had an average revenue increase of 2%. Further, the top 10 companies had an ordinary profit increase rate of 54%, while the companies ranked 11 to 100 showed profit increases of only 18%. This survey illustrates that "Green can be Gold."

Toyota has demonstrated this in their performance in the U.S. market. While U.S. auto makers debated whether the U.S. market would purchase hybrid vehicles, Toyota and Honda were busy bringing them to the market. These vehicles have been very successful and buyers have been willing to pay premium prices to purchase them. Only after seeing this success have U.S. companies rushed to enter this market. Thus, the Japanese are introducing the 4th generation vehicle and have established a strong competitive advantage.

A Model for Moving Forward with Green Productivity

The urgency of the environmental challenges requires business organizations to strive for breakthrough improvement rather than incremental improvement. Tuttle and Tebo (2007) presented a Breakthrough Life Cycle Model for Strategic Environmental Performance that is particularly relevant for manufacturing organizations. This model is presented in Figure 1.

The model highlights 6 points of intervention in the value stream that can create improvements. However, the breakthroughs come from a focus on all the areas simultaneously. The six points of intervention are described below.

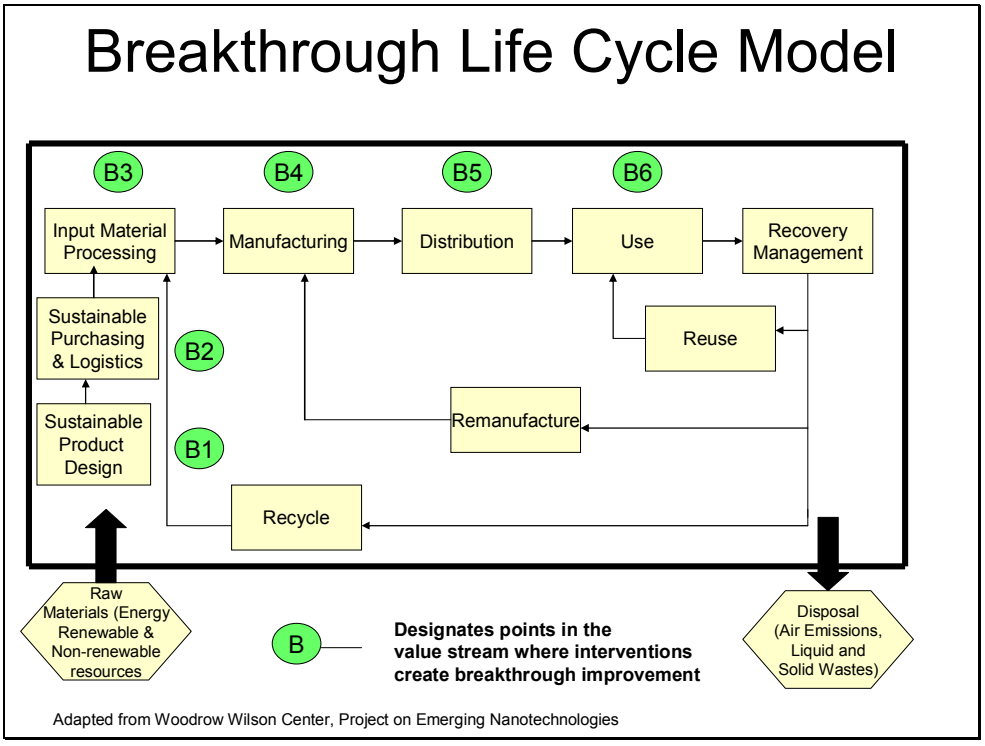

Figure 1 – Breakthrough Life Cycle Model for Strategic Environmental Performance in a product-oriented value stream

B1 – Sustainable Product Design. Perhaps the key step in achieving breakthrough improvement is creating sustainable product and process designs that fully meet customer requirements. The design challenge is to design products that fully meet the customer requirements with the minimum use of input materials and the specification of materials that are environmentally friendly. In addition, B1 refers to the choice of raw materials that are environmentally friendly as well as creating designs that minimize the quantity of materials utilized. When it is not possible to identify materials that have required functional attributes and environmental friendliness, then this step also involves making plans for process designs that create closed cycle systems that control the material throughout the production process and minimize end of life product disposal requirements. From a process design perspective, the approach also involves the specification of energy efficient manufacturing processes that create zero waste streams. These process and product design processes require knowledge and utilization of new technologies (e.g. nanotechnology, biotechnology, information technology, etc.) effectively integrated with effective market research, and advanced manufacturing technologies and processes.

B2 – Sustainable Purchasing and Logistics. This step assures that the suppliers of input materials and components utilize the sustainable design principles addressed in B1 above. It also assures that the movement of these materials from supplier locations to the manufacturing site is done in ways that create minimal environmental impact (e.g. energy consumption, emissions, etc) and waste (e.g. product damage, disposable packaging material, etc.)

B3 – Input Material Processing - In the case of vertically integrated manufacturers, this step refers to the utilization of sustainable processes for converting raw materials to parts or components that are produced "in-house." The concerns are the same ones described in B1 and B2 above. Primary issues relate to the use of efficient processes in the production of error free components or materials with zero waste and zero emissions. The additional concerns are with minimizing energy utilization and assuring that closed cycle production processes are utilized when necessary for materials that are hazardous to people or the environment. Throughout the B3 stage, there must be an emphasis on reducing the cycle time of production processes and the detection and elimination of waste in all forms.

B4 – Manufacturing – This step addresses the processes and systems utilized to create final products from raw materials, processed materials and components. The concerns are the utilization of manufacturing processes that produce defect- free products with zero waste and zero emissions. As with B3 above, this requires that we transform existing processes through eliminating non-value added activity and reducing the time required to carry out value-added production steps. The additional concerns are with minimizing energy utilization

and assuring that closed cycle production processes are utilized when necessary for materials that are hazardous to people or the environment.

B5 – Distribution – This step refers to the use of distribution processes that meet customer delivery requirements with minimum energy consumption, zero damage to products and zero waste of materials.

B6 – Use - This step addresses the extent to which sustainable products are put into use as designed. This requires that customers purchase the products and that they are used as intended. While in part this relates to the extent to which the products are appropriately designed and manufactured to appeal to customers it also relates to marketing, advertising, and pricing issues. In addition, customer product choice may also be influenced by government policies that create incentives for use of environmentally friendly products. In some cases it can also relate to the need for regulation and enforcement to assure that beneficial products are used appropriately.

Of course there are those who still need convincing that such approaches work in both environmental and business terms. Models and theories do not necessarily convince hard-headed businessmen. We need further research and we need to establish performance measures of companies that have adopted green productivity approaches; we preferably need them benchmarked against others in the same industry that have not. In the UK, the National Productivity Centre (which is supported by the Grimsby Institute of Further & Higher Education and by North East Lincolnshire Council) has recently signed a Memorandum of Understanding with the Chinese Association of Productivity Science to undertake such joint benchmarking and research projects. Within the overall green productivity agenda, these particular projects will initially focus on:

- Green energy in heavy plant production processes
- Green logistics.

The authors hope that they have demonstrated that the agenda is moving forward …. but it is still moving slowly and perhaps now is the time to accelerate this change - as realization dawns that value and environmental impact can be addressed at the same time when we tackle the environmental impacts of business as a productivity issue.

Summary

It is possible to 'go green' and still run a successful business. In fact, your business can be more successful by ‘going green’.

If you don't do it voluntarily now, you might in the future have to play 'catch up' as compliance rules toughen.

If you want to do it effectively, you have to take a holistic view of the entire organization and all of its processes.

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