Office of Health, Safety and Security Visiting Speakers Program

October 30, 2008
U.S. Department of Energy
Washington, DC

Office of Health, Safety and Security

The Office of Health, Safety and Security (HSS) is the Department of Energy's (DOE) corporate organization responsible for health, safety, environment, and security; providing corporate leadership and strategic vision to coordinate and integrate these vital programs. HSS is responsible for policy development and technical assistance; corporate analysis; corporate safety and security programs; education and training; complex-wide independent oversight; and enforcement. The Chief Health, Safety and Security Officer advises the Secretary and the Deputy Secretary on all matters related to health, safety and security across the complex.

Through its research on sustainability and industry's successful use of its concept, HSS has a clear idea of the types of organizations with which it would be beneficial to collaborate on sustainability. Such outreach efforts provide a cooperative advantage of sustaining an organization's efficiency and vitality by bringing together creative thought and diverse viewpoints toward common goals while demonstrating leadership's commitment to listening to and reflecting the concerns and issues of its shareholders and stakeholders.

As the first phase of its outreach efforts, HSS created a Focus Group forum. The HSS Focus Group forum integrates senior HSS managers from across the organization to discuss and address topics and issues of interest to DOE managers and stakeholders. The objective of the Focus Group is to establish a means for responding to questions and concerns regarding HSS initiatives and activities for improving, the health, safety, and environmental and security performance within the Department and to maintain an ongoing dialogue with involved parties supportive of these efforts. HSS believes an outcome of these continuing discussions and collaborations will be improved worker health and safety programs and the solidification of a safety culture at DOE sites.

Glenn S. Podonsky
Chief Health, Safety and Security Officer

HSS Visiting Speaker Program

The next phase of HSS outreach activities is the creation of the Visiting Speaker Program. The Visiting Speaker Program consists of presentations by leaders drawn from a variety of disciplines to include business, organizational theory, performance management, sustainability, and organizational resilience, made to HSS management and selected attendees from other interested organizations (i.e., Office of Science, Office of Environmental Management, and the National Nuclear Security Administration).

The program is intended to focus agency attention at the management level to the emerging challenges and issues threatening the national security and economic prosperity of the United States. DOE's mission, supported by HSS and other agency organizations, requires the most efficient and resilient leadership and organizational structure for successful mission completion and the continued safety, security, and prosperity of the nation. By inviting and having presenters from the wide range of public and private sector organizations, HSS is encouraging the transformation of government and demonstrating the various stages for change. This includes understanding the depth of the global issues, need for change, tools and means for transformation, and knowing the appropriate performance measurements to determine success and implement evolving management initiatives.

The Alliance for Science and Technology Research in America

ASTRA, The Alliance for Science & Technology Research in America, is a unique collaboration of individuals drawn from industry, professional and trade associations, universities, and research centers who are united in common cause to increase federal funding for the physical and mathematical sciences and engineering.

ASTRA was founded in 2001 by a group headed by Dr. Mary Good, former Undersecretary for Technology Policy at the U.S. Department of Commerce and currently Dean of the Donaghey School of Information Science and Engineering at the University of Arkansas. Members of ASTRA include leading industries, professional societies and associations, universities, and individual scientists and researchers. ASTRA is a nonprofit, tax-exempt organization whose members conduct policy research to educate the public about the linkages between scientific R&D funding and innovation, our standard of living, national security, and economic growth.

From a core group of about 16 key corporate, university and nonprofit leaders, ASTRA has expanded its membership to nearly 60 organizations and a nationwide network of about 3,400 individual scientists, researchers and policy makers.

Dow Chemical Company

With annual sales of $54 billion and 46,000 employees worldwide, Dow[1] is a diversified chemical company that combines the power of science and technology with the “ Human Element ” to constantly improve what is essential to human progress. Dow delivers a broad range of products and services to customers in around 160 countries, connecting chemistry and innovation with the principles of sustainability to help provide everything from fresh water, food and pharmaceuticals to paints, packaging and personal care products.

Dow people around the world develop solutions for society based on Dow's inherent strength in science and technology. For over a decade, Dow has embraced and advocated Responsible Care® - a voluntary industry-wide commitment to safely handle our chemicals from inception in the laboratory to ultimate disposal. This worldwide commitment helps consumers lead better lives, customers succeed, stockholders prosper, employees achieve and communities thrive. Dow's essential elements of mission, vision, values, and strategy describe why the company exists, who Dow is, what Dow intends to do, and how they intend to do it. These essential elements provide insight, offer motivation, and point the way forward as Dow seeks to grow and achieve its goals.

Mission
To constantly improve what is essential to human progress by mastering science and technology.

Dow's mission represents a greater purpose in society.

Constantly improve … This concept is and has been the bedrock of Dow's culture since H.H. Dow first said, "If you can't do it better, why do it?" It underscores Dow’s drive to continually seek the best in everything it does, and an unwillingness to settle for anything less.

[1] References to “Dow” or the “Company” mean The Dow Chemical Company and its consolidated subsidiaries unless otherwise expressly noted.

TRANSFORMING

The Dow Chemical Company 2007 Corporate Report

TRANSFORMATION…

the process of change

For 110 years, Dow has been in the business of change, rearranging atoms and reshaping molecules to create new materials and new technologies. It has been the cornerstone of our success.

Inspired by the Human Element, we strive to constantly improve those things essential to human progress. From the clothes we wear to the food we eat. From the homes we live in to the furnishings, fixtures and fittings that adorn them. Equipment that purifies water and materials that save energy. Products that make our daily lives easier, healthier, safer or more enjoyable. Dow's chemistry has long played an integral role in keeping pace with society's ever-changing ambitions and aspirations.

Today, transformation at Dow is taking place on a far broader scale than ever before … with new thinking and a new direction. We are changing the shape of the Company in a way that will deliver greater long-term value for our stockholders, while maintaining exemplary standards of social, ethical and environmental performance. It is not an overnight process, but in 2007 we made good progress, establishing the foundation upon which to build Dow as an earnings-growth company, clad with a reputation second to none among investors, customers, employees, partners, governments and the public at large.

This report provides an overview of Dow and highlights some of the Company's activities and achievements in 2007. For a more detailed review of the year's performance, please visit www.dow.com.

DOW®

Do it better.

Do it better. It is a simple philosophy, but one that has been at the very core of Dow's culture since it was founded by Herbert H. Dow in 1897, shaping the Company into today's world-class chemical industry leader—a company that is committed, through chemistry, to the betterment of global humanity.

The Company has come a very long way in 110 years. Today, we have customers in around 160 countries. We have 150 manufacturing sites in 35 countries. We have annual sales of almost $54 billion. And we have a powerful Human Element—46,000 men and women from virtually every part of the globe who set Dow apart as they drive the Company to new heights of performance, and help us meet the expectations of all our stakeholders.

THIS IS DOW

Dow's Performance Portfolio

Dow's $27 billion Performance portfolio serves customers in markets around the world with an extensive range of differentiated plastic, chemical and agricultural solutions. Our products improve lifestyles in many ways: making cars safer, buildings more energy efficient, food healthier, water cleaner, electronics more durable, computers faster, and more. The key to our success lies in aligning our technologies and capabilities with our customers' specific needs—and backing that with outstanding customer support. By accelerating innovation and growth, while sharpening market and customer focus, the Performance portfolio is creating businesses and brands that deliver higher margins and more consistent profitability for Dow.

PERFORMANCE PLASTICS
Dow Automotive
Dow Building Solutions
Dow Epoxy
Polyurethanes and Polyurethane Systems
Specialty Plastics and Elastomers
Technology Licensing and Catalyst

PERFORMANCE CHEMICALS
Designed Polymers
Dow Latex
Specialty Chemicals

AGRICULTURAL SCIENCES
Dow AgroSciences

Dow's Basics Portfolio

This powerhouse $26 billion portfolio of leading basic plastics and chemicals serves more than 6,000 customers worldwide, and is an integrated source of raw materials for Dow's Performance businesses. It meets the changing needs of a broad spectrum of industries—from packaging, personal care, toys, pipes and tools to adhesives, de-icers, pharmaceuticals, paper and construction. The Basics portfolio is growing primarily through joint ventures that enable Dow to reduce capital intensity, expand globally, and improve access to advantaged feedstocks and energy.

BASIC PLASTICS
Polyethylene
Polypropylene
Polystyrene

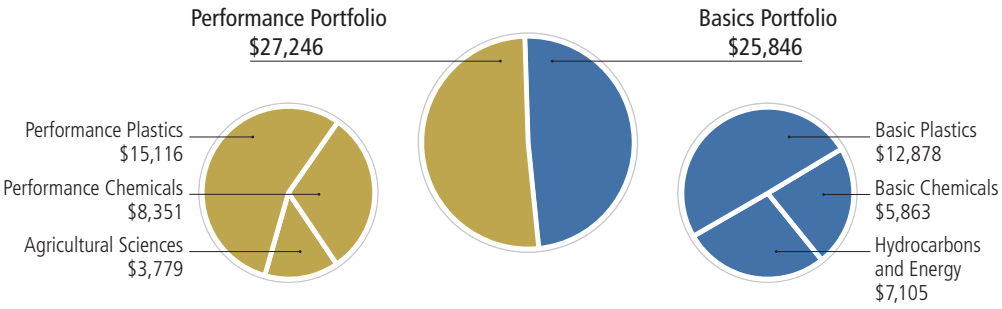
BASIC CHEMICALS
Core Chemicals
Ethylene Oxide/Ethylene Glycol

HYDROCARBONS AND ENERGY

2007 HIGHLIGHTS

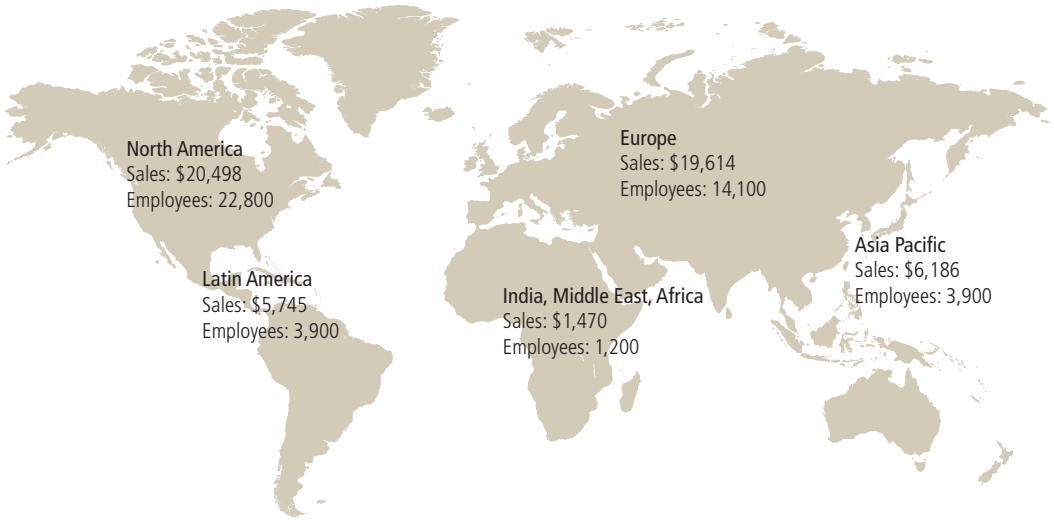
	2007	2006
Net Sales (dollars in billions)	$53.5	$49.1
Net Income (dollars in billions)	$2.9	$3.7
Earnings per Share–Diluted	$2.99	$3.82
Dividends Declared per Share	$1.635	$1.50
Energy Intensity (BTUs per pound of production)	3,811	3,863
Injury and Illness Rate (recordable incidents per 200,000 work hours)	0.29	0.40
Taxes Paid (dollars in billions)	$1.3	$1.6
Total Purchases (dollars in billions)	$42.8	$35.3
Charitable Contributions (dollars in millions)	$53.5	$27.9

2007 SALES BY OPERATING SEGMENT (dollars in millions)



Unallocated and Other: $421

2007 SALES AND EMPLOYEES BY GEOGRAPHIC AREA (dollars in millions)



The forward-looking statements contained in this document involve risks and uncertainties that may affect the Company's operations, markets, products, services, prices and other factors as discussed more fully elsewhere and in filings with the U.S. Securities and Exchange Commission. These risks and uncertainties include, but are not limited to, economic, competitive, legal, governmental and technological factors. Accordingly, there is no assurance that the Company's expectations will be realized. The Company assumes no obligation to provide revisions to any forward-looking statements should circumstances change, except as otherwise required by securities and other applicable laws. References to "Dow" or the "Company" mean The Dow Chemical Company and its consolidated subsidiaries, unless otherwise expressly noted.

NEW GAME

Dow's Executive Leadership Team

(at March 2, 2008)

Andrew N. Liveris
President, Chief Executive Officer and Chairman of the Board

William F. Banholzer
Executive Vice President and Chief Technology Officer

Carol A. Dudley
Corporate Vice President, Market Facing Businesses, Licensing and New Business Development

Julie Fasone Holder
Corporate Vice President, Chief Marketing, Sales and Reputation Officer

Gregory M. Freiwald
Corporate Vice President, Human Resources, Corporate Affairs and Aviation

Michael R. Gambrell
Executive Vice President, Basic Plastics and Chemicals, Manufacturing and Engineering

Heinz Haller
Executive Vice President, Performance Plastics and Chemicals

Charles J. Kalil
Executive Vice President, General Counsel and Corporate Secretary

David E. Kepler
Executive Vice President, Chief Sustainability Officer, Chief Information Officer, Corporate Director of Shared Services

Juan R. Luciano
Business Group President, Hydrocarbons and Energy

Geoffery E. Merszei
Executive Vice President and Chief Financial Officer

Back row, left to right
William F. Banholzer
Julie Fasone Holder
Gregory M. Freiwald
Juan R. Luciano
David E. Kepler
Charles J. Kalil

Seated, left to right
Michael R. Gambrell
Heinz Haller
Andrew N. Liveris
Geoffery E. Merszei
Carol A. Dudley

The past year was a notable one for Dow. We delivered solid financial results. We set the groundwork for our transformational growth agenda. And, by combining the power of science and technology with the Human Element, we took another significant stride toward our vision of being the largest, most profitable, most respected chemical company in the world.

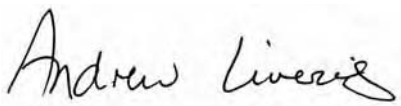
In creating that vision, we intentionally set the bar high … recognizing that our obligations—to our stockholders, to our employees, to the communities in which we operate and to our customers—are also high. At Dow, we not only accept those obligations, we use them as the fulcrum to lift ourselves and our Company to new heights of performance, sharply focused on the triple bottom line of people, planet and profits.

We well know the critical importance of addressing each of those elements. They are the pillars on which future success rests. Take any one away—weaken any single pillar—and we risk damaging the whole.

Our decision to sign the U.N. Global Compact in 2007 underscores our resolve to ensure those pillars remain strong. In this case, we will expand our pacesetting sustainability efforts and collaborate with like-minded stakeholders on some of the most pressing issues facing the planet and its people. Dow is already making significant contributions in areas such as clean water, health care, affordable housing, alternative energy and climate change. And through our groundbreaking 2015 goals, we've pledged to do even more by connecting chemistry and innovation with the principles of sustainability to create new opportunity, new promise and new hope—as well as to bring new business opportunities for our Company.

For Dow, sustainability is not only about strengthening the pillars of people and planet, it is also about profits. Which is why we're transforming … establishing ourselves as an earnings-growth company that is more predictable in its profitability. We took meaningful steps toward that goal in 2007 and we will make even greater progress through the year ahead—creating significant long-term value for our stockholders while delivering on our promise to constantly improve what is essential to human progress.

We thank you for your continued interest in Dow and we welcome your comments on how we can continue to improve our performance in everything we do.



Andrew N. Liveris
President, Chief Executive Officer and Chairman of the Board
February 14, 2008

"Our obligations—to our stockholders, to our employees, to the communities in which we operate and to our customers—are the fulcrum to lift ourselves and our Company to new heights of performance."

To realize our vision of being the largest, most profitable, most respected chemical company in the world, Dow must do more than keep pace…

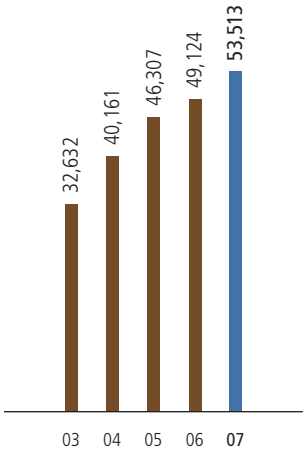
Dow must set the pace.

NEW HEIGHTS

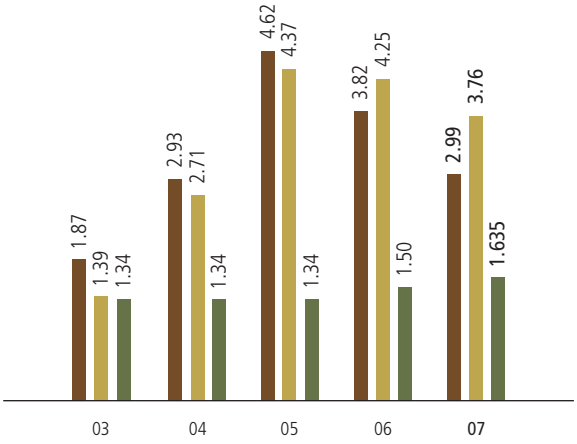
2007 was a significant year for Dow. It was a year of record sales and solid financial results. It was a year in which we scaled new heights in environmental stewardship and corporate citizenship, setting new benchmarks for the entire chemical industry. And it was a year in which we took further steps toward redefining what it means to be THE world-class chemical company—a company that surpasses its peers across every dimension of financial, social and environmental performance.

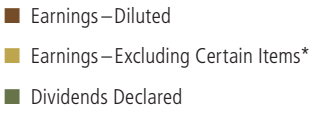
Financially, sales exceeded $50 billion for the first time in Dow's history, climbing to $53.5 billion, 9 percent higher than in 2006. Net income was $2.9 billion, which included the impact of certain items with a net unfavorable impact of $735 million, while earnings were $2.99 per share. Excluding certain items for both periods, earnings per share for the year were $3.76, compared with $4.25 in 2006.

Net Sales
(dollars in millions)



Per Share Data
(dollars)





*A reconciliation to the most directly comparable GAAP measure is provided on the Internet at www.dow.com in the Financial Reports page of the Investor Relations section.

We achieved record equity earnings of $1.1 billion, marking the fourth consecutive year in which this contribution has topped $900 million and the first year in which it has exceeded $1 billion.

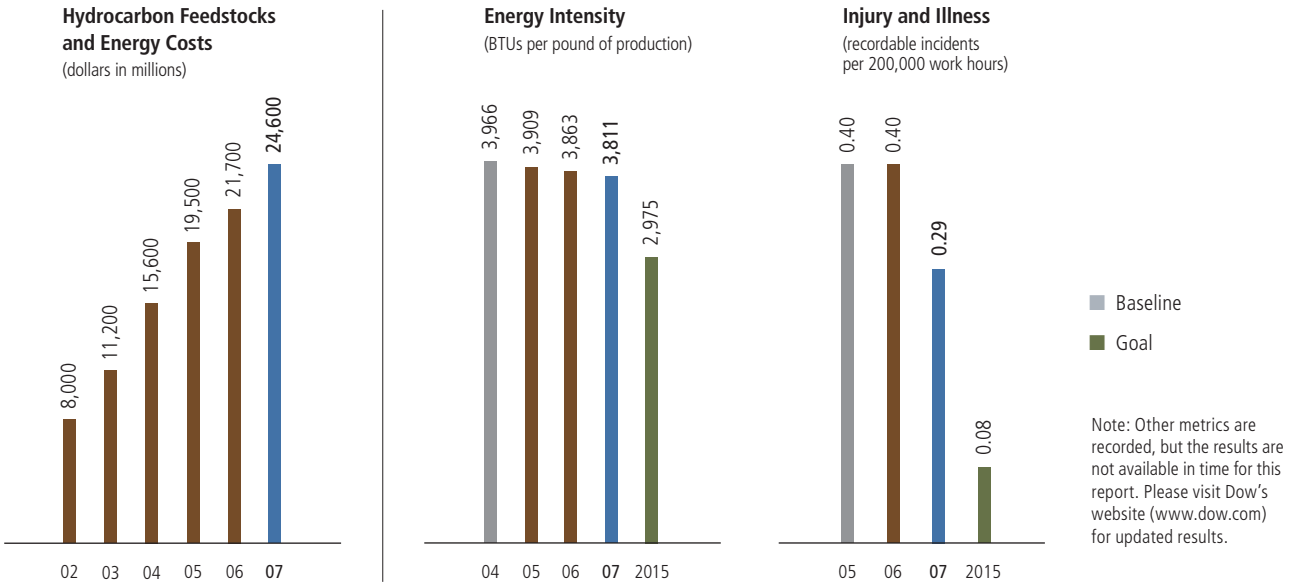
And we ended the year with our balance sheet as strong as it has ever been, with a debt to capital ratio of 32 percent, with our funded pension plans fully funded and with our priorities sharply focused on investing for growth and remunerating stockholders. Through 2007, that agenda gathered momentum. We invested more than $1 billion in strategic acquisitions, we increased capital spending by 17 percent to support organic growth, we bought back more than 32 million shares as part of our repurchase program, and we raised our quarterly dividend for the second time in 18 months. For 95 years, Dow's quarterly dividend has consistently either been maintained or raised.

In 2007, Dow experienced yet another sharp rise in feedstock and energy costs, which increased more than 10 percent compared with 2006 to top $24 billion for the year—three times what we paid in 2002.

Faced with this seemingly relentless climb, our commitment to energy efficiency remains as strong as ever. In 2007, we achieved a further reduction in energy intensity—the amount of energy used for every pound of product we produce—which is now down 4 percent from our 2004 baseline against our goal to achieve a 25 percent reduction by 2015.

Our commitment to employee health and safety also produced tremendous results in 2007, as we cut the Company's injury and illness rate by more than 25 percent year over year. But this solid progress was sadly overshadowed by the loss of one of our colleagues, who died in a tragic aircraft accident while traveling on Dow business. We continue to do everything possible to infuse an employee mindset, a leadership attitude and a corporate culture that will ensure all employees and contractors return safely to their homes at the end of each work day.

And finally, throughout the year, we focused significant resources on maintaining our leadership position in corporate citizenship, a role that we believe should drive positive change beyond our fence lines, into our communities and across the globe. One of our most notable actions was to support the Blue Planet Run, an around-the-world relay that raised awareness and funds to address the issue of 1.2 billion people who are living without access to safe drinking water. In total, the Company's charitable contributions during 2007 totaled more than $53 million, providing support to a broad range of events and organizations worldwide.



NEW DIRECTION

Better earnings growth. Better earnings consistency. To achieve these twin goals, we have embarked on a path to transform the Company in ways that will deliver greater long-term value for our stockholders. Rather than being a company predictable in its cyclicality, we will be a company that is more predictable in its profitability, even in an economic downturn. It's a new direction—and we are well on our way.

Building on a strong foundation

Dow already bears the hallmarks of an industry leader: a drive for financial discipline and operational excellence, a balanced portfolio with significant presence in all major chemical chains, unmatched global reach, the low-cost advantages of site and product integration, and a depth of technological innovation that extends to both new and improved products and manufacturing processes.

On this solid foundation, we are shaping the new Dow. We are focusing our investments on projects that will significantly bolster our Performance portfolio. We are expanding our geographic presence, strengthening our position in key emerging economies around the world. We are creating exciting growth opportunities for our Basics businesses through strategic joint ventures. And we are driving ahead with our innovation agenda, building a robust pipeline of differentiated solutions … new products and new processes.

A focus on Performance

Our Performance portfolio, with its array of higher margin products and market-facing activities, promises faster growth and more consistent profitability than can be achieved within our Basics businesses. For that reason, it is the focus of Dow's invest-for-growth agenda.

In 2007, we announced three new Market Facing businesses—Dow Coating Solutions, Dow Footwear Solutions and Dow Fabric and Surface Care—and we continued to aggressively grow our existing Performance business portfolio, both in size and geographic reach. Highlights from the year include:

- Dow Building Solutions successfully started up a manufacturing plant for the production of STYROFOAM™ brand insulation on the outskirts of Moscow, the Company's first-ever production facility in Russia. This plant enables Dow to better serve its growing customer base in both Russia and Eastern Europe—regions where demand for insulation materials is increasing rapidly.
- Dow AgroSciences took a number of significant steps to strengthen its position in the corn seeds business, including the acquisitions of Brazilian company Agromen Tecnologia, The Netherlands-based Duo Maize and assets of Maize Technologies International, an Austrian corn seeds company.
- The Company completed its acquisition of Wolff Walsrode from the Bayer Group and, in doing so, announced the formation of Dow Wolff Cellulosics, a $1 billion business serving a broad spectrum of industry sectors, including construction, personal care, pharmaceuticals and food.
- And we made a number of other strategic, bolt-on acquisitions, among them two European polyurethanes systems businesses—Hyperlast Limited and Edulan A/S—and three leading epoxy formulators—UPPC AG in Germany, and POLY-CARB Inc. and GNS Technologies in the United States.

Moving forward, our Performance growth agenda will center around strategic acquisitions that strengthen our position in areas such as health, energy, infrastructure and consumerism—major opportunities that we see developing across the globe. As we pursue that growth agenda, however, we will do so with discipline and diligence, making sure that every acquisition is strategically aligned, properly valued and takes place in a time frame that makes sense for Dow.

By transforming business models, refocusing innovation, strengthening our global presence and recognizing the Human Element…

Dow is opening the door to a new era.

With production facilities in 35 countries and customers in 160, with joint venture partners in key regions, and with a highly talented global workforce…

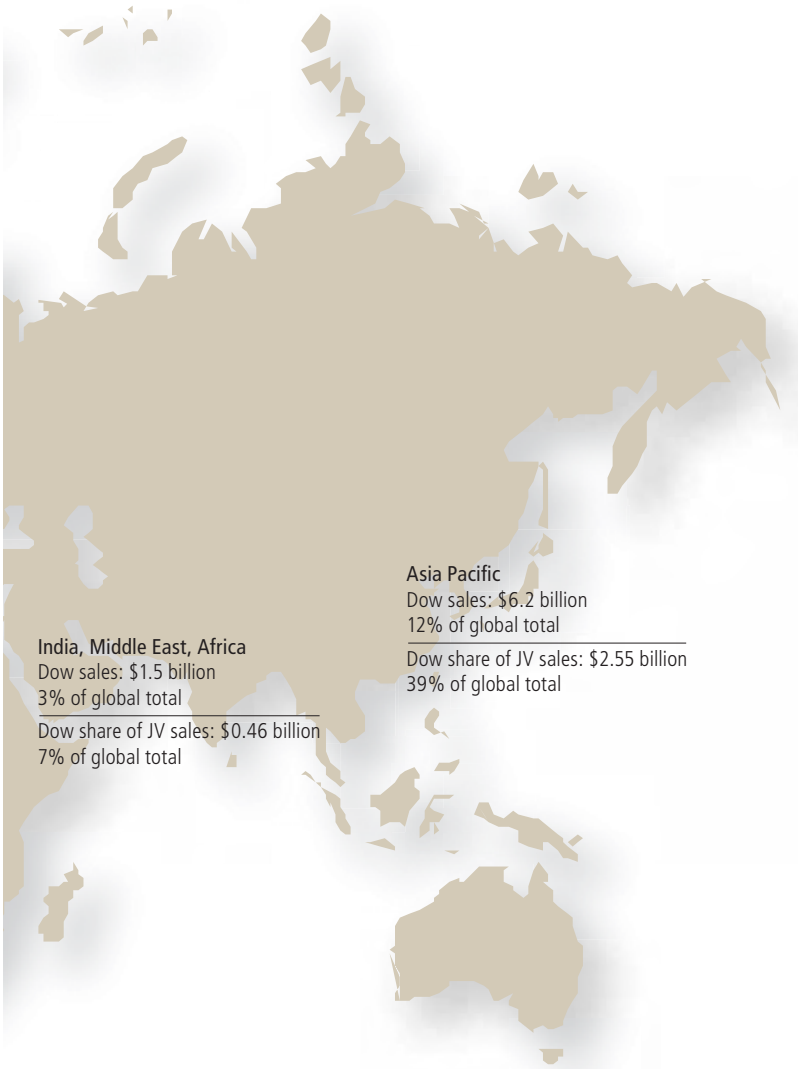
Dow is the most global of all chemical companies.

NEW FRONTIERS

Positioning ourselves in growth markets

We established our first business outside the United States in 1942—the same year in which sales surpassed $50 million for the first time in Dow's history. Sixty-five years later, as we broke through the $50 billion mark, roughly two-thirds of our revenue was generated overseas.

Our commitment to geographic growth remains strong, with a specific focus on emerging economies … supplying the chemical and plastic building blocks that address a vast array of human needs. As a result, the international reach of our businesses is having an evermore significant impact on the Company's bottom line. And we expect this contribution to grow further as we reap the benefit of being the most global of all chemical companies, with assets in key regions around the world, strong partnerships with major players in many different countries, and highly talented, locally hired employees who have the relationships, the experience and the knowledge to make things happen.



DOW'S 2007 GLOBAL SALES

$53.5 BILLION

DOW'S PROPORTIONATE SHARE OF 2007 JOINT VENTURE REVENUE*

$6.6 BILLION

Collaborating for smarter growth

As Dow focuses on improving earnings growth and consistency, joint ventures are a crucial enabler, creating opportunities to accelerate the Company's strategic agenda across several different dimensions. Joint ventures can provide access to key markets, growth geographies, new technologies and advantaged feedstocks, while at the same time lowering capital investment and reducing risk. During 2007, we advanced our joint venture agenda on several fronts.

Most notable was our agreement with Petrochemical Industries Company (PIC), a wholly owned subsidiary of Kuwait Petroleum Corporation, to form a global petrochemicals giant. When the deal closes toward the end of 2008, the new 50:50 joint venture will have sales of more than $11 billion and employ around 5,000 people, manufacturing and marketing polyethylene, ethylene-amines, ethanolamines, polypropylene and polycarbonate to customers worldwide.

Our agreement with PIC was not the only highlight of the year. For example:

- We signed a Memorandum of Understanding with Chevron Phillips Chemical to form a joint venture involving polystyrene and styrene monomer assets in North and South America.
- We announced plans to form a joint venture with the National Oil Corporation of Libya that will operate and expand the country's Ras Lanuf petrochemical complex.
- We signed a Memorandum of Understanding for our proposed joint venture with Saudi Aramco, to build a large-scale petrochemicals complex in eastern Saudi Arabia.
- We signed a cooperation agreement with Shenhua Group to build a world-scale coal-to-chemicals complex in the Shaanxi Province of China.
- We signed a Memorandum of Understanding with Crystalsev, one of Brazil's largest ethanol producers, to form a joint venture to design and build a world-scale facility to manufacture polyethylene from sugar cane.
- And we signed a Memorandum of Intent with Russia's Gazprom and SIBUR to explore a number of joint venture opportunities in the area of hydrocarbons processing.

*Sales of nonconsolidated affiliates, excluding sales to other Dow entities.

By aligning our innovation agenda to the areas of greatest future global need — health, energy, transportation, infrastructure and consumerism…

Dow is ideally placed to harvest future value-growth opportunities.

NEW SOLUTIONS

The roads to solutions often start as needs. The need for safer, more fuel-efficient cars. The need to protect crops. The basic needs that sustain us: clean drinking water, an adequate food supply and decent housing. Our aim is to find better solutions through science and technology, combining the power of chemistry with the Human Element in a way that delivers long-term value to our stockholders.

For example, during 2007, we signed a corn technology cross-licensing agreement with Monsanto aimed at launching SmartStax™. SmartStax will provide the broadest spectrum insect protection and weed control technology available to farmers, through the first-ever eight-gene stack offering from Dow AgroSciences and Monsanto.

Dow AgroSciences also announced Dow Herbicide Tolerance technology, an innovative new family of traits that provides tolerance to multiple classes of herbicides in different crops and offers farmers a wider choice of weed-fighting products.

Also in 2007, we launched Dow's RENUVA™ Renewable Resource Technology, which uses soybeans to make natural oil-based polyols that can be used to manufacture foams for furniture, carpet and bedding applications that are virtually odor-free. The technology consumes around 60 percent less fossil fuel resources than conventional polyol technology and is greenhouse gas neutral.

And Dow Building Solutions unveiled a next-generation foaming technology, enabling it to manufacture STYROFOAM™ insulation products with a zero ozone-depletion factor and to significantly reduce Dow's greenhouse gas emissions for North America.

During the past decade, our research and development (R&D) spending has increased by around 30 percent in real dollar terms. It is an investment that is paying dividends: in those same 10 years our project pipeline has doubled from a net present value of $5 billion to about $10 billion; in 2007, 34 percent of Dow's sales were from products introduced in the past five years; since 2004, patent disclosures have more than doubled (from 411 in 2004 to almost 1,100 in 2007); and last year Dow was ranked one of the 10 best global R&D companies by *R&D* magazine.

With more than 350 large projects currently in the development pipeline, and with major new R&D facilities now being built in Shanghai, China, and Pune, India, that in-house success is set to continue. But innovation doesn't just occur in our own labs.

Taking the philosophy of the Human Element beyond the boundaries of our Company, we also partner with universities, government institutions and members of the scientific community around the world to develop new ideas and technologies. In 2007, for example, Dow issued a challenge to researchers to develop an effective way to convert methane into chemical feedstocks without using costly synthesis gas processes. To encourage this research, Dow will award grants of approximately $1 million to $2 million annually, for three years.

NEW AMBITIONS

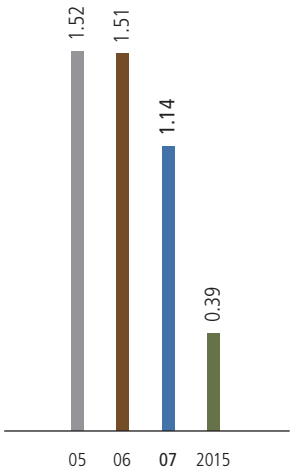
Environmental stewardship and corporate citizenship have long been key priorities for Dow. Today, they have a place at the very heart of the Company's strategy, ranked among the most important drivers of Dow's long-term success.

Through 2007, we continued to make progress toward our ambitious 2015 Sustainability Goals. Launched in 2006, these goals raise the bar significantly higher for our environmental, health and safety performance, while also addressing a broader set of challenges focused on local communities, product stewardship and the reduction of our global environmental footprint.

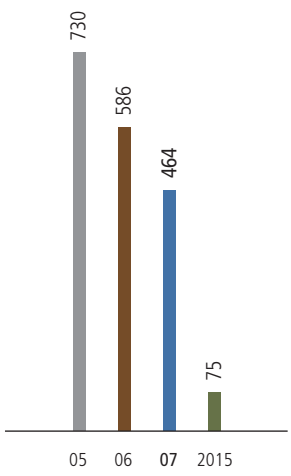
In this respect, the year saw a number of significant achievements by Dow, including:

- The Company continued efforts to enhance energy efficiency through a broad range of initiatives, including a process at Dow's Terneuzen site in The Netherlands to re-use treated household wastewater. The project saves energy, conserves water and reduces greenhouse gas emissions.

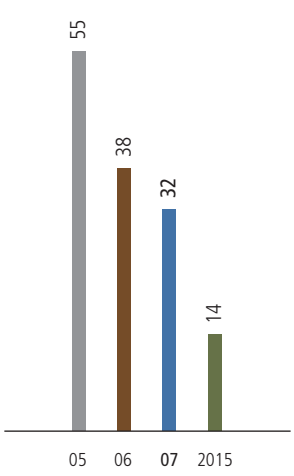
Severity Rate
(recordable incidents, weighted for type, per 200,000 work hours)



Leaks, Breaks and Spills
(number of incidents)



Process Safety
(number of incidents)



Baseline
Goal

Note: Other metrics are recorded, but the results are not available in time for this report. Please visit Dow's website (www.dow.com) for updated results.

Through its 2015 Sustainability Goals, which set ambitious targets for local citizenship, product stewardship and standards of environmental performance…

Dow is scaling new heights.

- Dow joined with the Lawrence Berkeley National Laboratory and China's Energy Research Institute to develop a program aimed at supporting China's efforts to improve energy efficiency and reduce energy intensity.
- Dow Building Solutions made further headway with its building-integrated photovoltaic program, which will enable solar energy generation cells to be incorporated directly into the design of commercial and residential building materials, such as roofing systems, exterior sidings and fascias. The project received a $20 million grant from the U.S. Department of Energy as part of the Solar America Initiative Pathways Program — bolstering Dow's efforts to design, develop and scale up production of building-integrated photovoltaic components that will significantly reduce the cost of solar energy.
- Dow Brazil and Jean-Michel Cousteau's Ocean Futures Society launched the Ambassador of the Environment Program in Guaruja, Brazil. This extension of Dow's U.S. partnership with Cousteau is designed to connect young people with the environment and teach them how to live more sustainably.
- We continued to successfully introduce products and technologies to the marketplace while demonstrating our commitment to sustainability. We launched Propylene Glycol Renewable, a product used in a variety of industry applications that is made from glycerin generated during the manufacture of biodiesel, a diesel-fuel alternative produced from vegetable oil. And customers responded very positively to our announced joint venture with Crystalsev to build the first world-scale sugar cane-to-polyethylene facility, based in Brazil. As well as using a renewable feedstock, the process will produce significantly less carbon dioxide than traditional polyethylene manufacturing processes.
- And we stepped up efforts to prepare next-generation leaders in the area of sustainability. The Dow Chemical Company Foundation committed $2 million to establish a new Sustainable Products and Solutions program with the University of California at Berkeley's Haas School of Business, in partnership with its College of Chemistry. In addition to its financial contribution, Dow also loaned an executive to facilitate the growth of the program. This multi-disciplinary research and learning environment will lead to new thinking in the development of products that will be sustainable, improve quality of life, and protect health and the environment.

By connecting chemistry and innovation to the Human Element … creating new hope, achieving new standards and securing new business opportunities…

Dow is balancing the needs of its stakeholders.

NEW EXPECTATIONS

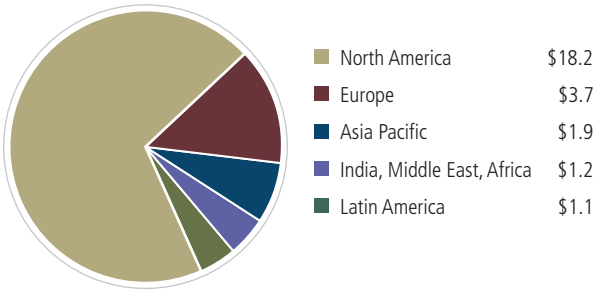
As we press forward with our long-term growth agenda, we remain committed to understanding the needs and expectations of the people affected by our activities … and delivering on those expectations. That commitment extends beyond the immediate sphere of our employees, our retirees and the communities in which we operate, to embrace the Human Element across a far wider societal plain: the end-users of our products, the governments and municipalities that benefit from our presence, and people across the globe facing fundamental needs that Dow can help to address.

2007 was a year in which we advanced that agenda on many fronts, including:

- Conducting research to assess the quality of life in several Dow locations around the world, to understand and prioritize local environmental, social and economic needs in the communities in which we operate. The research will not only help to ensure that we are a good neighbor and partner in our 150 global communities, but will also help to strategically position Dow in areas where we seek to have a presence in the future.
- Making further strides to tackle the growing global issue of clean water, including our sponsorship of the 15,200-mile 2007 Blue Planet Run.
- Provisionally agreeing to provide up to $30 million of loan guarantees to WaterHealth International that would support the installation of 2,000 community water systems in rural India and provide a sustainable source of safe drinking water for 11 million people in remote locations across the country.
- Launching a Sustainable Living campaign with our 46,000 employees around the globe, promoting ways that employees and their families can reduce energy use, and encouraging people to sign a personal commitment to the campaign.
- Building on our long-standing efforts to improve the safety and security of chemicals transportation. In 2007, Dow joined with the U.S. Federal Railroad Administration, Union Pacific Corporation and Union Tank Car in various initiatives to enhance the safety performance of rail tank cars, improve shipment visibility, support community emergency response education and design supply chains that reduce risk.
- Contributing more than $36 million to support a wide range of programs that contribute to community success, support sustainability, foster science in society and stimulate innovation around the world. The Company also made substantive one-time contributions to several global projects and a major revitalization initiative in its hometown of Midland, Michigan, U.S.A., bringing total philanthropy in 2007 to $53.5 million. This compares with $27.9 million in 2006.
- In 2007, several of Dow's commitments supported the marketing activities and product development efforts of individual businesses. For example, our continued partnership with Habitat for Humanity not only supported the group's quest to eliminate substandard housing, but also served to showcase the performance and versatility of a range of products from Dow Building Solutions … including a complete photovoltaic installation at Habitat's 2007 Jimmy Carter Work Project in Los Angeles, California, U.S.A.

Together, Dow's environmental and societal commitments put our Company on record as affirming that our workplace, community and environmental accomplishments will be among the most important success factors for Dow's future.

Charitable Contributions by Geographic Area (dollars in millions)



Global Business and Functionally Aligned Projects: $3.7
Global Corporate Projects: $22.6
Disaster Relief: $1.1

NEW ACHIEVEMENTS

First Quarter

- Dow starts up its first-ever production facility in Russia, located in Kryukovo, outside Moscow. The plant will produce STYROFOAM™ Extruded Polystyrene insulation boards for Dow Building Solutions.
- Dow announces plans to increase production of CELLOSIZE™ Hydroxyethyl Cellulose at its site in Institute, West Virginia, U.S.A. The additional capacity will be used primarily in paint and oil field applications.
- The Company confirms it will begin global-scale production of its new INFUSE™ Olefin Block Copolymers at Freeport, Texas, U.S.A., following a successful trial manufacturing run at the facility.
- Dow introduces Propylene Glycol Renewable, a propylene glycol made from the glycerin that is generated during the manufacture of biodiesel, a diesel-fuel alternative produced from vegetable oil.
- Dow's Polyurethanes business unveils capital investment plans for two European facilities to expand capacity at its polyols plant in Terneuzen, The Netherlands, and its propylene glycol facility in Stade, Germany.
- The U.S. Department of Energy awards Dow a $20 million grant to advance integrated photovoltaics, a technology that incorporates solar power components directly into a variety of building materials.
- Dow declares a dividend of 37.5 cents per share … the Company's 382nd consecutive cash dividend.
- A major new research program, sponsored by Dow, is announced by the Company, offering three-year grants to help develop technology that will convert methane to chemicals.
- Dow commits to being a founding sponsor of the Colorado Center for Biorefining and Biofuels, a research center devoted to developing new biofuels and biorefining technologies.
- The Company accepts a leadership role with EPCglobal, a non-profit agency developing industry-driven standards for electronic product code technology that tracks items within a supply chain.
- Dow launches eight new grades of VERSIFY™ Plastomers and Elastomers, a highly versatile product range that delivers performance and processing benefits across an array of end-use applications.

Second Quarter

- Dow hosts its 110th Annual Meeting of Stockholders.
- Saudi Aramco and Dow sign a Memorandum of Understanding to move forward with their multibillion-dollar joint venture chemicals and plastics production complex near Ras Tanura, Saudi Arabia.
- Dow and Chevron Phillips Chemical announce plans for a 50:50 polystyrene and styrene monomer joint venture in North and South America.
- Beijing-based Shenhua Group and Dow agree to a detailed feasibility study for a coal-to-chemicals joint venture in the Shaanxi Province of China.
- Dow raises its quarterly cash dividend by 12 percent to 42 cents per share. Since 1912, Dow has consistently either raised or maintained its quarterly dividend.
- Twenty-two elite runners gather in New York, U.S.A., at the start of the 2007 Blue Planet Run, an around-the-world relay sponsored by Dow to focus attention on the one billion-plus people without ready access to safe drinking water.
- The Company signs a Heads of Agreement with the National Oil Corporation of Libya to operate and expand the Ras Lanuf petrochemical complex on the country's Mediterranean Sea coastline.
- Dow announces the completion of its acquisition of British Vita's polyurethane systems business, Hyperlast Limited, which includes elastomer systems facilities in the United Kingdom.
- CKE Restaurants Inc. announces that its Carl's Jr.® and Hardee's® restaurant chains are converting to Dow AgroSciences' zero trans fat Omega-9 Canola Oil.
- Dow joins the United States Climate Action Partnership, an alliance of major businesses and environmental groups calling on federal legislation to reduce greenhouse gas emissions.
- The Company opens a new polyurethane systems market development and prototyping laboratory in Egypt to help meet the growing needs of customers across the Middle East, India and Africa.
- Dow announces a partnership program with Lawrence Berkeley National Laboratory and the Chinese Energy Research Institute to support China in its efforts to improve energy efficiency.
- Dow joins the United Nations Global Compact, the world's largest global corporate citizenship initiative.
- At the Guaruja site in Brazil, Dow partners with its Community Advisory Panel and Jean-Michel Cousteau's Ocean Futures Society to create Latin America's first Ambassador of the Environment program.

Third Quarter

- Dow completes the acquisition of Wolff Walsrode and forms Dow Wolff Cellulosics, a $1 billion specialty business focused on cellulosics and related chemistries and serving a broad spectrum of industry sectors.
- A corn cross-licensing agreement between Dow AgroSciences and Monsanto, aimed at launching SmartStax™, breaks new ground in the commercialization of gene stacking technology.
- The Company signs a Memorandum of Understanding with Brazilian ethanol producer, Crystalsev, to form a joint venture to manufacture polyethylene from sugar cane.
- Dow AgroSciences acquires Agromen Tecnologia, substantially expanding its Brazilian corn seeds business and strengthening the Company's global corn seeds platform.
- Dow's Polyurethanes Systems business announces plans to acquire Danish company Edulan A/S, an independent polyurethanes systems house specializing in rigid foam and elastomer technologies.
- Definitive agreements are signed by Dow to acquire three leading epoxy systems formulators: UPPC AG in Germany, and POLY-CARB Inc. and GNS Technologies in the United States.
- Dow AgroSciences unveils a new family of herbicide tolerance traits that will provide tolerance to multiple classes of herbicides in different crops. The technology should be ready to launch in corn in 2012.
- The Company introduces RENUVA™ Renewable Resource Technology, a proprietary process to produce bio-based polyols with high renewable content.
- Singapore's national water agency, PUB, signs an agreement to test Dow's next-generation 16-inch FILMTEC™ membranes for use in water reclamation.
- Dow AgroSciences wins the "Best Formulation Innovation" award in the 2007 *AGROW* Awards for EcoZome™, an aqueous formulation technology for crop protection products that addresses issues with solvent systems.
- The Company launches SAFETOUCH™ Fiberglass-Free Insulation, a polyester fiber batting with insulating properties of fiberglass-based materials that does not irritate skin, throat or eyes.
- Dow AgroSciences wins the United Nations' Montreal Protocol Innovators Award at the annual Meeting of the Montreal Protocol.
- Dow Footwear Solutions announces its official launch as a new Market Facing business for Dow.
- The Company declares a dividend of 42 cents per share … its 384th consecutive cash dividend.
- The Company launches Dow Fabric and Surface Care, a new Market Facing business.
- Dow FORTEFIBER™ Soluble Dietary Fiber products receive an inaugural Institute of Food Technologies *Food Expo* innovation award.
- Once again, Dow is included in the Dow Jones Sustainability World Index for the global chemical industry. The Company's overall score ranks third highest across all 18 industry groups included in the Index.

Fourth Quarter

- Gazprom, the world's largest gas producer, signs a Memorandum of Intent with Dow and Russian petrochemical company, SIBUR, to evaluate potential chemical manufacturing opportunities using Russia's natural gas capacity.
- Dow provides seed money to establish a new Sustainable Products and Solutions program, based at the Center for Responsible Business at the University of California at Berkeley's Haas School of Business and in partnership with its College of Chemistry.
- Dow Wolff Cellulosics begins construction of the world's largest methylcellulosics plant in Bitterfeld, Germany.
- Dow Wolff Cellulosics introduces an enhanced emulsion technology using METHOCEL™ Food Gums that helps eliminate trans fats in baked goods.
- The Company signs a Memorandum of Understanding with Hunton Energy relating to a potential petroleum coke gasification plant in Texas, U.S.A. Hunton would build, own and operate the facility, and Dow would purchase synthetic natural gas and steam for its Texas Operations manufacturing site in Freeport.
- Dow and Petrochemical Industries Company of Kuwait announce plans to form a 50:50 joint venture petrochemicals company with revenues of more than $11 billion and 5,000 employees worldwide.
- Dow Building Solutions announces next-generation foaming agent technology that will enable the manufacture of STYROFOAM™ insulation with a zero ozone-depletion factor.
- Dow declares a dividend of 42 cents per share … the Company's 385th consecutive cash dividend.
- The Company pledges $2 million to the Young Arab Leaders' Global Action Program, an initiative designed to encourage dialogue among leaders across the globe.
- Dow Canada finalizes the sale of Dow's caustic soda business in Western Canada to Univar Canada. This sale includes the West Coast Distribution Centre terminal assets as well as miscellaneous equipment.
- Dow completes the sale of its ETHAFOAM™ performance foam business to Sealed Air Corporation.
- Dow provisionally agrees to provide up to $30 million of loan guarantees to WaterHealth International that would support the financing of 2,000 community water systems, serving 11 million people in rural India.
- Dow unveils its renewable grade polyurethane footwear soling system, VORALAST™ R.
- Dow announces plans to shut down a number of assets and make organizational changes within targeted support functions, eliminating approximately 1,000 jobs. As a consequence, the Company reports restructuring charges totaling $590 million in the fourth quarter, and expects to realize estimated savings of $180 million a year.
- Dow endorses the CEO Water Mandate and Caring for Climate, two voluntary initiatives of the U.N. Global Compact.
- Dow launches Dow Coating Solutions, a Market Facing business focused on providing materials, technology and solutions to the global coatings industry.

The Dow Chemical Company
Midland, MI 48674 U.S.A.

Form No. 161-00693

2015 Sustainability Goals Update 2Q 2008

This report provides an overview of second quarter progress on Dow's 2015 Sustainability Goals and other significant sustainability events.

Events

- Dow Latin America holds first ever Dow Sustainability Week

Citizenship

- Local Protection of Human Health and the Environment
- Contributing to Community Success

Solutions

- Product Safety Leadership
- Sustainable Chemistry
- Breakthroughs to World Challenges

Footprint

- Addressing Climate Change
- Energy Efficiency and Conservation

Dow Latin America holds first ever Dow Sustainability Week

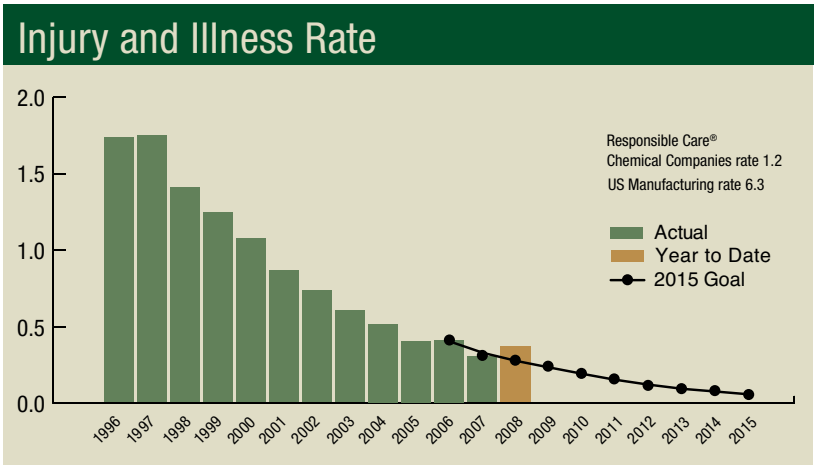
This customer-centered event in Brazil was designed to promote the debate about sustainable development, taking three crucial aspects into consideration: People, Planet, and Sustainable Business. Dow prepared a four-day agenda with activities designed to accelerate collaboration with customers, employees, partners, NGOs, the press, authorities, associations and communities. Read more about this on dow.com.

Local Protection of Human Health and the Environment

Although our performance during the first half of the year was excellent in the context of industry performance, our results did not keep pace with our 2015 Goal aspirations, and we are engaged in a variety of activities aimed at improving performance in these areas, including:

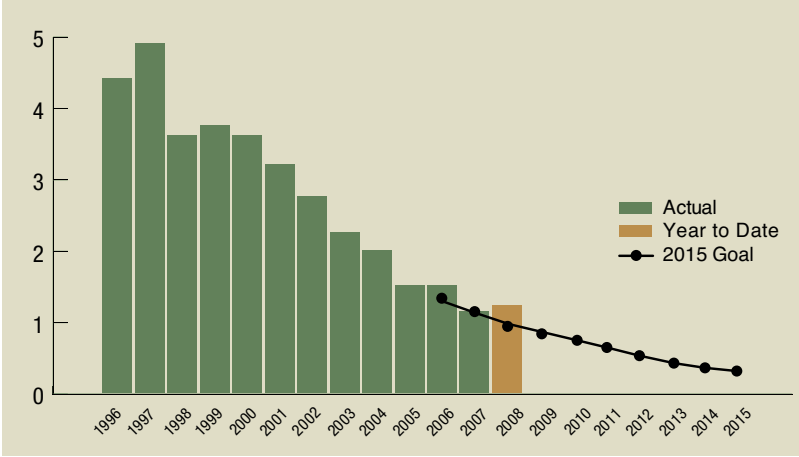
- Developing and implementing intervention plans. Underperforming sites and businesses have been charged with developing specific plans to reverse the trend in the areas of personal and environmental safety, and leaders in our manufacturing and engineering function have developed and implemented a plan specific to Process Safety.
- Identifying and leveraging common solutions. Our EH&S experts have combed through site and business plans to identify areas where they can lead in developing common solutions across all sites and businesses.

At the end of the second quarter of 2008, the Injury and Illness rate was 0.34 per 200,000 hours of work. Performance through the second quarter was 26 percent worse than the goal for the year. The 2015 Goal of 0.08 per 200,000 hours is a 75 percent improvement from 2005.



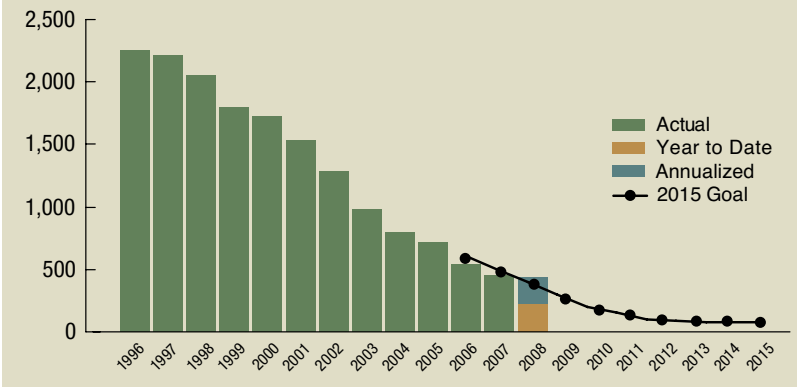
At the end of the second quarter of 2008, the Injury and Illness Severity rate was 1.15 per 200,000 hours of work. Performance through the second quarter was 16 percent worse than the goal for the year. The goal in 2008 is a rate of 0.99. The 2015 Goal to accomplish a rate of 0.39 per 200,000 hours is a 75 percent improvement from 2005.

Injury and Illness Severity Rate



At the end of the second quarter of 2008, Loss of Primary Containment (LOPC) incidents have occurred at an annualized rate of 440 per year. The 2008 performance to date is 10 percent worse than the rate defined as our 2008 goal of 400 or fewer incidents. The 2015 Goal of 75 or fewer incidents is a 90 percent reduction from 2005.

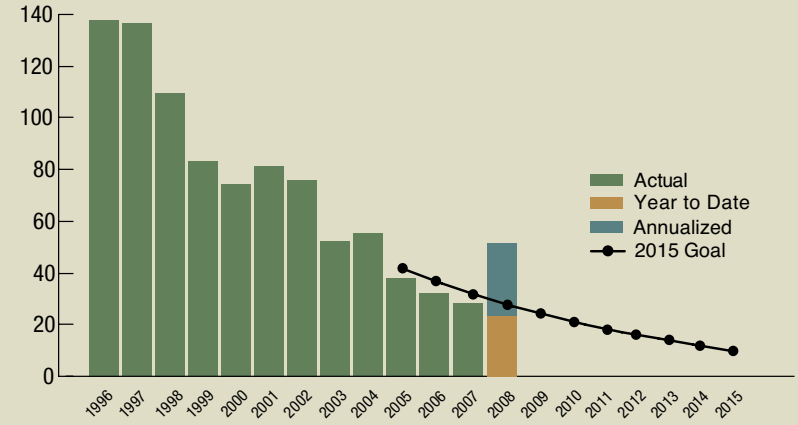
Loss of Primary Containment Incidents



At the end of the second quarter of 2008, there were 27 Process Safety Incidents. When annualized this indicates a rate of 54 events per year. The 2008 performance to date is 64 percent above our 2008 goal level. The 2008 goal is not to exceed 33 incidents. The 2015 Goal of 14 is a 75 percent improvement from 2005.

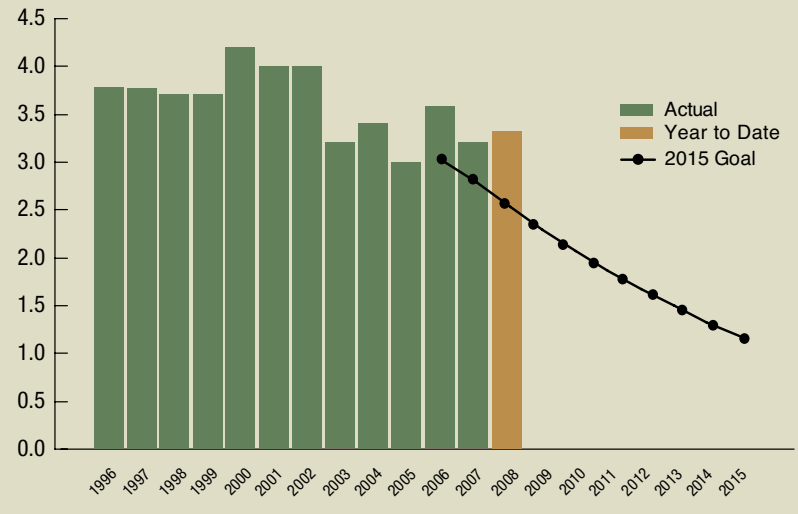
Several actions have been taken or are in progress to begin to address the increase in incidents.

Process Safety Incidents



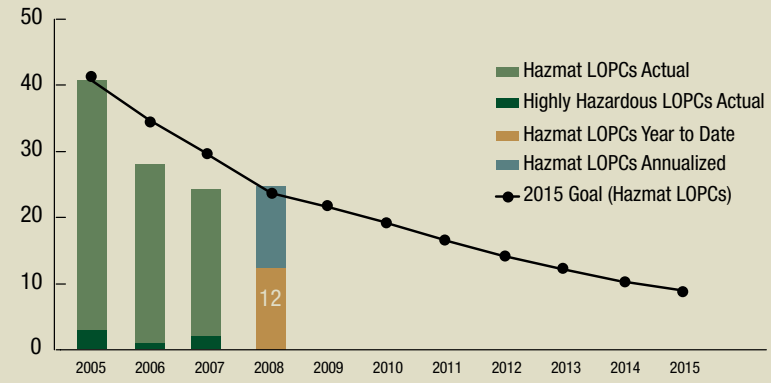
At the end of the second quarter of 2008, the Motor Vehicle Accident (MVA) rate was 3.3 accidents per million miles driven. The 2008 performance is running 26 percent above our 2008 goal of a rate of 2.6 accidents per million miles driven. The 2015 Goal intends to cut the MVA rate to half of what it was in 2005 – which was 3.0 MVAs per million miles driven.

Motor Vehicle Accident Rate



At the end of the second quarter of 2008, Dow had experienced 12 Hazmat Transportation Loss of Primary Containment events. Annualized, this is slightly above target for our internal 2008 goal of 22 such incidents. Our 2015 Goal is to reduce all Hazmat Transportation incidents to 10 or less per year. There have been no LOPC events involving Highly Hazardous Materials (Toxic Inhalation Hazard and Flammable Gas) in 2008.

Hazmat Transportation LOPC Count

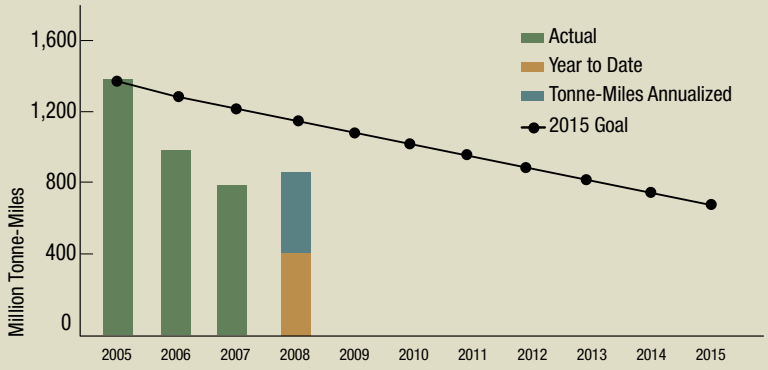


The following metric is included for the first time in this second quarter 2008 report. Dow believes it is part of our corporate responsibility to reduce the volumes of Highly Hazardous (Toxic Inhalation Hazard and Flammable Gas) materials that need to be transported. As such, we've set a 2015 Goal to reduce the number of tonne-miles (a measure of how much we're shipping and how far) by 50 percent from our 2005 total, which was 1,410 million tonne-miles. We'll accomplish this by looking at ways to redesign our supply chain to reduce or eliminate many shipments or the distances they must travel. [A tonne-mile is one metric ton of freight moved 1 mile (1.6 km).]

By reducing the number of tonne-miles of these materials, we will reduce the chance of in-transit incidents that could impact communities and areas through which our products travel. It's important to recognize that supply chain redesign is a longer term strategic business effort that may not show annual change. However, strong progress toward this goal has been made over the last two years, and as of second quarter 2008, key businesses are progressing well with actions and future plans that will help us achieve this goal.

Through the second quarter 2008, there were 429 million tonne-miles of Highly Hazardous Materials shipped via road and rail.

Highly Hazardous Material Tonne-Miles



Contributing to Community Success

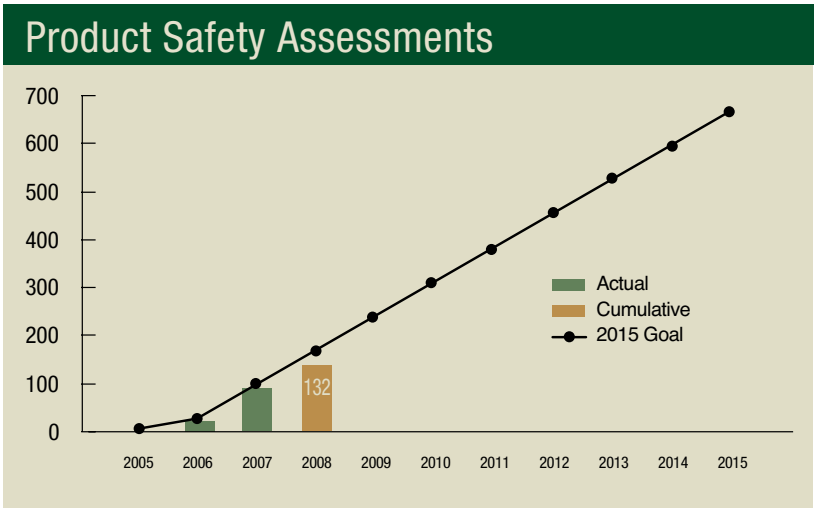
The business growth in China and Dow's commitment to sustainability in that region were drivers for introducing the Community Success planning process to the manufacturing site in Zhangjiagang, China, in the province of Jiangsu. Gathering community input, understanding quality of life issues, and engaging site leaders in Community Success objectives are core components of this process and resulted in a plan of action that will focus on improving local education, working with government on industry park designs that incorporate sustainability principles, and leveraging Dow programs and resources to local community and schools. The Zhangjiagang site is a model of corporate citizenship that enables it to be a leader in driving sustainability in its community.

Communicating Dow's performance remains a top priority – not only to demonstrate progress in attaining the goal, but to enable others to learn about and leverage our experiences. A series of features in *Around Dow*, an external and internal electronic publication reaching all employees and site communities, has highlighted our partnership with Habitat for Humanity and science education in local schools. Upcoming features will focus on Community Advisory Panels and employee volunteerism.

As we progress with implementing Community Success plans at our strategic sites, work has begun to reach all corners of the Dow world. Adaptations of our tools and process have enabled smaller sites in West Virginia and Texas to begin Community Success planning.

Product Safety Leadership

At the end of the second quarter of 2008, there were 132 Product Safety Assessments (PSAs) posted on www.dow.com/productsafety/finder/. Compared with the year-end 2007, we have added 45 PSAs to the website. We are currently on track to meet our target of 170 PSAs posted by year-end 2008. The 2015 Goal is to have all applicable Dow products covered by publicly available PSAs.



Dow is in the final phases of discussion with an external third-party consultant to evaluate our product safety assessment processes. We expect to be in a position to announce the arrangements in the third quarter of 2008.

Sustainable Chemistry

Highlights for second quarter 2008 include:

Dow received a Presidential Green Chemistry Challenge Award when its subsidiary, Dow AgroSciences LLC, was presented with the 2008 Award for spinetoram – an innovative insect control technology derived from the fermentation of a naturally occurring soil organism followed by chemical modifications. This is the sixth award that Dow has received since 1996. The award, presented by the U.S. Environmental Protection Agency (EPA) on behalf of the White House, recognizes technologies that incorporate the principles of sustainable chemistry into chemical design, manufacture and use.

Bill Banholzer, chief technology officer, presented a keynote speech to the American Chemical Society (ACS) Green Chemistry and Engineering Conference, about Dow's efforts in the related areas of sustainability and energy, and some of the rationale behind those efforts.

Dow Automotive, a business unit of Dow, has won a PACE (Premier Automotive Supplier's Contribution to Excellence) Award from Automotive News for IMPAXX™ energy management foam. The foam is designed to absorb energy on impact and cushion the blow that a vehicle occupant receives. In addition to its safety features, the foam is 100 percent recyclable, provides design flexibility and assembly advantages, conserves weight and improves vehicle fuel economy. It also improves occupant comfort by offering increased passenger space. One of the automotive industry's highest global honors, the PACE Awards recognize innovation among suppliers who contribute products, processes, materials or services directly to the companies that manufacture cars and/or trucks. More than 250 entries competed this year for the eight PACE Awards.

Dow products and materials were the subject of three case studies this year, as part of a graduate-level Industrial Ecology class at the University of Michigan. Student teams used Life Cycle Assessment (LCA) and life cycle costing to characterize the environmental and economic impacts of functionally equivalent materials or services. The three examples were comparisons of decking made from SYMMATRIX™ composites and wood, of SAFETOUCH™ insulation with soy-based foam, and of salsa packaging in glass or plastic. All three studies yielded useful quantitative analyses and excellent questions and perspectives from the students. In the salsa packaging study, for example, the students found that plastic pouches had lower energy input, greenhouse gas emissions, acid gas and ozone depleter emissions, and solid waste than did glass, even if 80 percent of the glass was recycled.

Dow's Performance Fluids business is enabling three large solar power plants in Spain to collect heat and convert it to electrical energy, through the use of DOWTHERM™ A – a specialized heat transfer fluid. Each plant will supply 50 megawatts of electrical power for a total of 150 megawatts. This is enough electricity for about 90,000 homes. Two of the plants will save approximately 450,000 tons of carbon dioxide that would have been released to the atmosphere had traditional fuels been burned. Read more about this on dow.com.

Dow Coating Solutions, a market facing business of Dow, has introduced ECOSURF™ SA Surfactants, a new generation of patented, biodegradable, nonionic surfactants that offer excellent performance and economics. Made using naturally occurring palm seed oil alcohols, these new surfactants are ideal candidates for a broad range of applications including coatings, without sacrificing key product attributes. Since they are based on seed oil alcohols and create no VOC emissions, ECOSURF SA Surfactants also give paint systems an improved overall environmental profile. Read more about this on dow.com.

In an effort to better inform employees about Dow's intentions around Sustainable Chemistry, the company has produced a 15-minute program that provides employees with an overview of Dow's approach to sustainable chemistry, an explanation of Life Cycle Analysis, the changing marketplace dynamics and the public policy implications.

Case studies of how Dow is contributing to sustainability through chemistry are available on our website.

Breakthroughs to World Challenges

Exploration to define opportunities to contribute to more affordable housing in India were initiated. This project is taking advantage of the perspective of interns from the Haas School of Business at the University of California, Berkeley. The project includes defining the market trends, research in country, and identification of the needs and gaps that frame the challenges involved. Next steps will be defined in the third quarter of 2008.

A Corporate Water Strategy Team has been created to help elevate the effectiveness of the overall Dow effort related to water use by the company and in external market opportunities. They will have an impact in helping to reduce costs, increase market share, and foster awareness of how water-related issues influence company reputation. The team will facilitate a coordinated approach to multiple businesses, geographies and functional teams already involved in aspects of the water issue, which will identify optimization opportunities and provide a place to incubate opportunities for breakthrough contributions in the area of water management. The team will propose a corporate goal about water during the third quarter of 2008.

Solutions from Dow – AIRSTONE™ Systems for Wind Energy and STYROFOAM™ Vital Structural Blade Element – are helping wind-energy manufacturers deliver on technical challenges and meet the explosive global demand for wind energy. This participation in the wind energy industry is one example of how Dow and its customers are building solutions together that are sustainable – both environmentally and economically. Read more about this on dow.com.

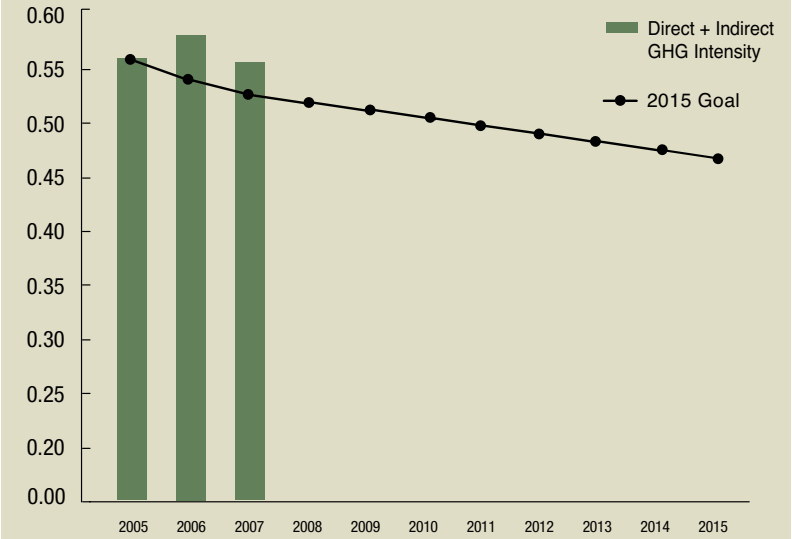
Addressing Climate Change

Energy Efficiency and Conservation

During 2007, Dow's greenhouse gas (GHG) emissions were 0.549 metric tons per metric ton of production. Compared to the base year 2005 intensity, this is about a 2 percent improvement in intensity. By improving energy efficiency and implementing climate friendly technologies, Dow's goal is to reduce GHG intensity 2.5 percent per year from 2005 to 2015.

Kyoto GHG intensity is the sum of CO_2 equivalent direct and indirect emissions of the "Kyoto" family of greenhouse gases divided by unit of production. Indirect emissions are the consequence of Dow's consumption of energy but are emitted from sources controlled by another company.

Intensity of Kyoto GHG as CO_2 Equivalent



Dow's Energy & Climate Change (E&CC) Business is involved in a number of activities designed to manage GHG reduction for the company. These activities include more than 30 alternative and renewable energy projects in various stages of development around the world. These projects range from biomass power and waste water treatment projects in Indonesia to developing an integrated, world-scale facility to manufacture polyethylene from ethanol derived from sugar cane in Brazil.

In addition, the E&CC Business is identifying and pursuing projects that reduce Dow's GHG footprint through the best technology options available. One identified technology is using byproduct CO_2 streams in enhanced oil recovery (EOR) efforts. Dow is in discussion with leading EOR operators, including companies on the U.S. Gulf Coast.

The E&CC Business continues its focus on energy efficiency efforts. Since 1995, Dow has saved more than 1,400 trillion BTUs of energy, which is equal to the electrical power needs of all California residential homes for more than a year. During this time, Dow's energy efficiency program has prevented more than 70 million metric tons of CO_2 from entering the atmosphere.

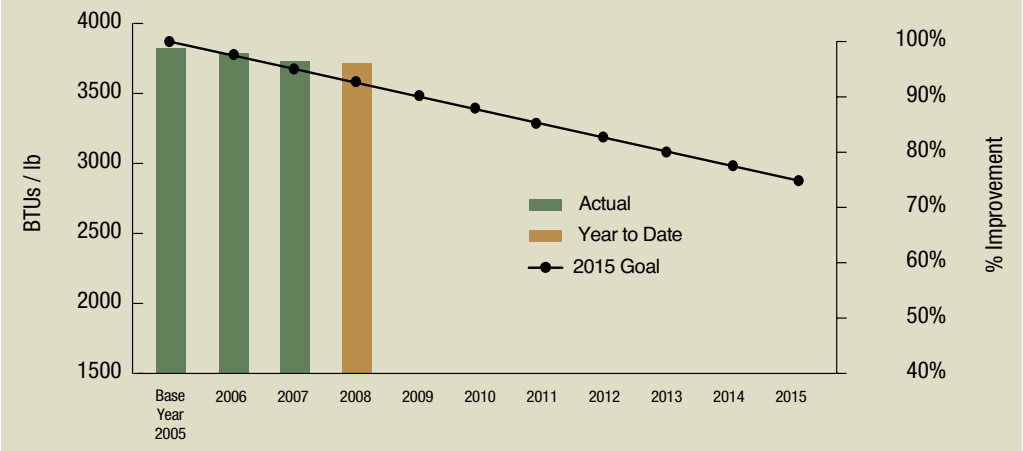
In April, Rich Wells, vice president of Energy, was a presenter at Oberlin College in Ohio. During his speech, Wells spoke on the topic of business opportunities in the areas of sustainability, climate change and alternative energy sources.

Dow began piping methane gas, a renewable energy resource, from a local landfill to its Dalton, Georgia, latex manufacturing plant. Using LOMAX™ Technology, Dow expects to use approximately 240 billion BTUs per year of landfill gas instead of natural gas, to generate steam for the production of latex carpet backing. Capturing and burning the methane will help mitigate global warming. The amount of natural gas saved is equivalent to the electricity used in approximately 2,100 U.S. homes annually, and the annual reduction in CO_2 emissions – more than 27 million pounds – equates to keeping 2,300 cars off the road each year. Read more about this on dow.com

The second quarter of 2008 Energy Intensity performance was 3,825 BTUs/lb, or 97.6 percent of the 2005 baseline. Said differently, compared to 2005, this quarter's Energy Intensity is an improvement of 2.4 percent. This second quarter level is higher than our first quarter performance. The value year to date of 3,815 BTUs/lb is the combined average of the first two quarters.

Our corporate target Energy Intensity for the full year of 2008 is 3,624 BTUs/lb or 92.5 percent of value in 2005. Our goal is to achieve a 25 percent Energy Intensity improvement by 2015 compared to the 2005 base.

Energy Intensity Performance



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Contributing To Community Success

Community Investments

Improving the communities where we operate has long been a part of the Dow culture. In 1936, the Herbert H. and Grace A. Dow Foundation was established as a non-profit foundation to fund worthwhile community causes. In 1979, The Dow Chemical Company Foundation was created to further enhance community outreach by improving the understanding of science through science-related education projects and programs. The foundation continues today, investing in nonprofit organizations globally to improve quality of life in communities around the world.

Valuing Our Communities

- One of Dow's 2015 Sustainability Goals is Contributing to Community Success, which focuses on a more progressive model for defining community success, with objectives tied to improving a community's quality of life.
- Quality of life surveys will be taken in 10 strategic sites: Pittsburg, California; Terneuzen, the Netherlands; Zhangjiagang, China; Freeport, Texas; Plaquemine, Louisiana; Hahnville, Louisiana; Midland, Michigan; Stade, Germany; Rhine Center, Germany; and Aratu, Brazil. The survey results will create foundational data for the goal.

- Quality of life priorities are determined through community surveys and other community information. Our progress against the goal is data-driven, based on results gathered from the 10 strategic sites.
- All Dow sites have or will have Community Success Plans, which will help guide Dow and community leaders in their efforts to improve the quality of life in those communities.
- Environmental protection, economic growth and education are key quality of life issues for every community. Dow is working on all three fronts. For example, our site in Bahia Blanca, Argentina, sponsors the Dow Academy, which provides education and job training skills to address youth unemployment. In Pittsburg, California the Dow Wetlands Preserve enriches environmental appreciation and education for thousands of area students.
- Dow sponsors Community Advisory Panels at 38 sites in 13 countries to facilitate dialogue with community stakeholders, helping everyone understand the issues facing the community and the role Dow can play in it.
- Dow's philanthropy totaled $53.5 million in 2007, with more than $36 million used to support programs that contribute to community success, promote sustainability, foster science in society and stimulate innovation.
- Dow provides corporate support for United Way, and 48 locations in Dow actively participate with the agency's local chapters. Dow's North American support for the organization was more than $6.3 million in 2007.
- Since the early 1980s, Dow has helped Habitat for Humanity build and renovate homes for hundreds of thousands of people. Dow is involved with Habitat through house sponsorship funding, donations of STYROFOAM™ extruded polystyrene insulation and employee/customer volunteer work crews at builds around the world.
- Dow has a strong base of employees, employee families and retirees who volunteer for projects within their communities, to help improve the quality of life for themselves and their neighbors.
- *Corporate Responsibility Officer* magazine named Dow one of America's "100 Best Corporate Citizens" of 2008.

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How Dow Participates with Communities to Address Issues

The Benefit of a Plan

Community Success ensures that our resources (money, people and partnerships) are applied to specific objectives that yield the greatest breakthrough improvement in quality of life as defined by the community itself.

The goal states: "By 2015, 100 percent of Dow sites where we have a major presence will have achieved their individual community acceptance ratings which measure the community's favorability with how Dow plays a positive role in making the community a better place to live."

Dow's Position Statement

Understanding the needs of the communities where we have a major presence, and responding in a constructive and appropriate way is part of our role as a member of the community and one to which we are deeply committed. We believe that by focusing on quality of life needs and enabling them to be fulfilled, we can create sustainability for our communities and for Dow.

External Overview

Contributing to Community Success is about engaging with our communities around the world to establish open and transparent communication channels that lead to understanding. We value the knowledge and opinion of residents about how Dow can become part of the social fabric of the communities where we operate. Two-way dialogue allows us to proactively assess, plan and implement individual Community Success Plans that address local needs. Ultimately our goal is to make a positive contribution to the quality of life within communities where we have a presence so that the community is improved because of it.

Dow's History in the Area

Community relations have been an essential part of Dow's corporate practices since the founding of the company in 1897. Supporting the communities where we operate is part of the Dow culture. From the early 1930s with the Herbert H. and Grace A. Dow Foundation, and then later in the 1970s with The Dow Chemical Company Foundation, community engagement has been and continues to be a driving force within our company.

Balancing the impact economic growth has on society and the environment creates real challenges for global communities in attaining their desired quality of life. As the world continues to change, our attitude and approach must shift to seek innovative and collaborative solutions that will result in benefits for our communities. At Dow, Community Success has been an evolution in the way we think about our community interface. We have evolved from directing activities in local communities to an approach that sees us participating as a partner in addressing local quality of life concerns. It is this collaboration between company and community that enables us to tackle key issues in order to truly make a difference and create a sustainable community.

Dow's Actions and Commitments

Dow has taken or is taking the following actions:

- Assessing the strategic value of our locations around the world to determine our rightful role
- Established a community assessment process and associated tools to gather community input
- Collected baseline survey data for each of Dow's 10 strategic locations
- Created a process to develop Community Success plans tailored to the local community needs
- Implementing Community Success plans for most strategic locations
- Evaluating progress and making adjustments to address identified gaps

Conclusion

Sustainability requires every decision be made with the future in mind. It is about our relationship with the world around us – creating economic prosperity and social value while contributing to the preservation of our planet – and it demands that we be engaged corporate citizens globally and locally. We are collaborating with local businesses and citizens to create stronger, safer and sustainable communities – establishing joint goals and plans, and taking actions for the long-term success of all involved. Together we will work to help our communities succeed, and in doing so, we will be a positive influence for change.

For More Information

To learn more about Dow's Contributing to Community Success visit www.dow.com/commitments/goals/community.htm.

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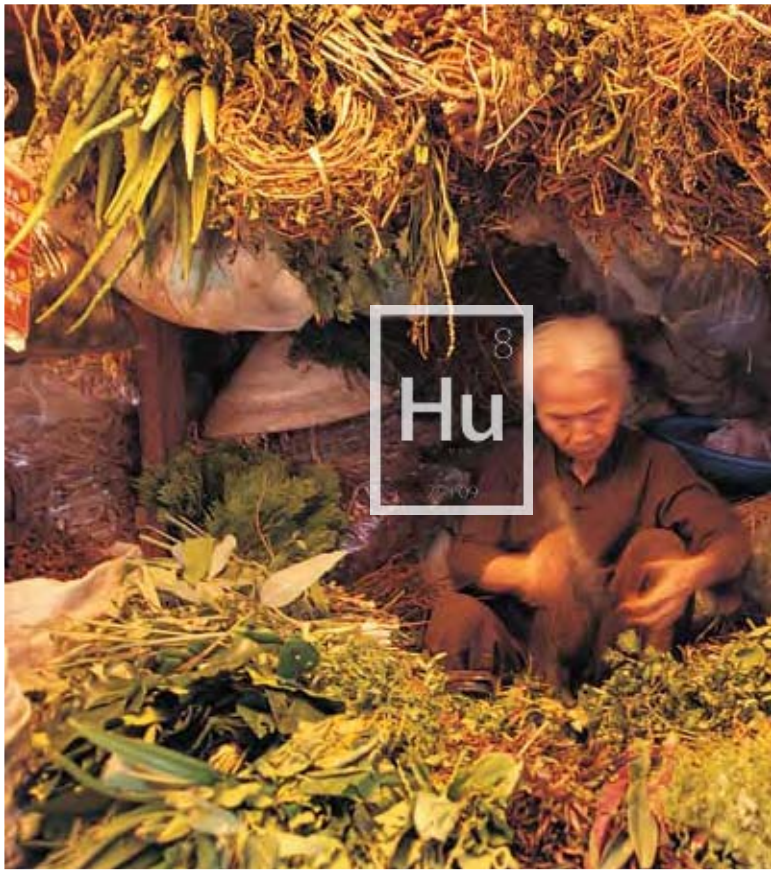
Introduction to Dow's Position on Sustainable Chemistry

Focus on Science

- Chemistry delivers over 95% of all products in society.
- Dow will focus its research and development and capital investments, including venture capital, on areas with promising sustainable chemistry contributions.
- Dow has received more U.S. Presidential Green Chemistry Awards than any other company.

Dow's Position Statement

As one of the largest chemical companies in the world, we are uniquely positioned to address the global challenges that live at the crossroads of greatest need and most significant business opportunity. Our 2015 Sustainability Goals serve as the yardstick to measure our progress in providing positive value and return for all of our stakeholders, and enhancing the quality of life of current and future generations. Specifically, the Sustainable Chemistry goal integrates the innovative application of science and technology with societal needs and challenges to identify, commercialize and deliver solutions.



Sustainable Chemistry encompasses a lifecycle view of our products and processes in using our resources efficiently to minimize our footprint and improve the quality of the environment. We will strive for improvements in greenhouse gas emissions, fresh water use, recycled materials as feedstocks, waste reduction, and renewable raw materials. The company challenges any activities that emit persistent, bioaccumulative and toxic substances (PBTs) that are listed in the Stockholm Convention. Dow will promote businesses whose products fill social needs for drinking water, affordable housing, food production, personal and public health, safety and economic development, particularly in developing countries.

Dow will use sustainable chemistry to address rising stakeholder expectations and to educate our employees about societal trends to ensure that we are making the right choices today that will deliver future innovations, improvements and profits for the long-term sustainability of Dow and our world.

External Overview

The predominant resource management model of mining, manufacturing, use and disposal must change. The world's resources are becoming scarce, greenhouse gases are increasing in the atmosphere, and water accessibility is a crisis in many areas. As the global population continues to grow and countries strive to improve conditions for the poor, the current model is clearly not sustainable.

Sustainable chemistry is our "cradle to cradle" concept that drives us to use resources more efficiently, to minimize our footprint, to provide value to our shareholders and stakeholders, to deliver solutions for customer needs and to enhance the quality of life of current and future generations.

Dow's History in the Area

- 1897 – Company founded; Herbert H. Dow and an associate designed a "Bleach Lifters Bonnet or Helmet" protective unit to protect workers from possible excessive exposure to chlorine vapors.
- 1906 – Dow partnered with George Westinghouse to develop energy-saving co-generation.
- 1933 – Dow's first toxicology research laboratory was established to study the effects of chemicals and chemical intermediates.
- 1935 – Dow's first industrial use of bacteria to degrade phenolic waste was started; effluent samples from chemical waste lines were collected and analyzed in an attempt to locate the source of effluents and to better refine and direct methods of waste treatment.
- 1970 – Dow publicly committed to a product stewardship role, which means assessing the environmental impact of products and then taking appropriate steps to protect employees, customers, and public and environmental health.
- 1986 – The Waste Reduction Always Pays (WRAP) program was launched to formalize the many programs already in place in different Dow locations to reduce waste; the overall goal was to reduce the total amount of waste from all Dow facilities by not producing waste if possible or by recycling or reusing that waste that could not be avoided; aggregate savings from the program to 2007 equaled almost $2 billion.
- 1987 – Dow committed to Responsible Care® in the U.S. after the initiative was launched in Canada. At the World Summit on Sustainable Development in 2002, UNEP commended Responsible Care as making a significant contribution to sustainable development.
- 1991 – Dow commissioned the Corporate Environmental Advisory Council (CEAC) to gain an external perspective on its policies and initiatives.
- 1995 – Dow launched its Environment, Health & Safety Goals for 2005, to dramatically reduce injuries, illnesses, environmental releases, chemical releases, and energy and water use.
- 2004 – Dow formalized its "Set the Standard for Sustainability" strategic theme as one of the pillars of the corporate strategy.
- 2006 – Dow's Sustainability Goals for 2015 were announced, including one focused on Sustainable Chemistry; this goal was considered key to the transformation of the company.
- 2008 – The U.S. Environmental Protection Agency (EPA) named Dow "Energy Star Partner of the Year."
- 2008 – Dow wins its sixth Presidential Green Chemistry Challenge Award

Dow's Commitments

- Dow will work with the value chain and other stakeholders to identify and advance sustainable chemistry solutions.
- Each year, Dow will report its Sustainable Chemistry Index (SCI) based on sales revenue.
- Dow will share the results of at least three externally validated, comprehensive life cycle assessments (LCAs) per year. These LCAs will focus on breakthrough technologies and quantify the benefits for our customers and the users of the finished products.
- Dow will publish an annual summary of promising areas of research and investments (including venture capital) and business growth in potential new products and solutions with sustainability advantages.
- Dow will produce an annual update on partnerships, which could involve universities, governmental organizations, intergovernmental organizations, and non-governmental organizations, to provide perspectives on our sustainable chemistry approach and our efforts to spur sustainable chemistry innovation.
- The Dow Sustainability Innovation Challenge Award program will promote sustainable chemistry internationally through student prizes, university partnerships and programs, and Dow employee awards.

Dow's Actions

- Dow has announced plans to produce polyethylene from sugar cane, an annually renewable resource, emitting 85 percent less CO_2 over the life cycle.
- Dow developed polyols, used in appliances, furniture, adhesives and insulation, from natural oils such as soybean oils. This new chemistry provides reduced environmental impact, compared to the manufacture of conventional polyols, as it uses less than half of the petroleum-based resources (fuel and raw materials) of current technology.
- Dow is using an innovative new process to produce liquid epoxy resins, which are used in marine protective, automotive and can coatings, as well as many other applications. This new process uses a renewable feedstock, reduces wastewater by over 70 percent and almost completely avoids by-product formation.
- Dow and BASF developed a new process for propylene oxide, a feedstock for a variety of products used in insulation, furniture, personal care products and brake fluids, which uses less water, less energy, and generates no co-products.
- DOWFROST™ inhibited propylene glycol-based heat transfer fluid is being used in Wal-Mart's experimental Supercenter store in Aurora, Colorado, in a secondary loop refrigeration system for meat, dairy, produce and other medium temperature-chilled foods. Compared to traditional refrigeration systems, secondary loop refrigeration systems have been proven to reduce energy consumption by up to 24 percent.
- Dow has begun piping methane gas, a renewable energy resource, from a local landfill to its Dalton, Georgia latex manufacturing plant. Using LOMAX™ technology, Dow expects to use approximately 240 billion BTU per year of landfill gas (that would otherwise be emitted into the atmosphere) instead of natural gas, to generate steam for the production of latex carpet backing.

More examples are available at http://www.dow.com/commitments/studies/index.htm.

Conclusion

Dow believes that Sustainable Chemistry goes well beyond mitigating the unintended consequences of chemistry. The world has seen incredible innovations from chemistry – from lighter cars, renewable fuels and sustainable water supplies, to energy efficient homes, computer chips, and life saving medicines. Chemistry is a defining factor in meeting critical human and environmental needs that will transform economic, environmental and social sustainability. We continue to deliver breakthrough improvements to existing Dow products and processes, and the next generation of chemical solutions and technologies. However, making our sustainability vision a reality will require unprecedented innovation and collaboration.

For More Information

To learn more about Dow's position on sustainable chemistry, visit http://www.dow.com/commitments/goals/chemistry.htm. Or learn about specific examples of more sustainable chemistry at Dow by visiting Sustainability Stories at http://www.dow.com/commitments/studies.

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How Dow Improves Our Communities

Adding Quality to Life

Dow is helping improve our communities, making them more viable economically, more vibrant culturally and more vigilant environmentally.

Dow entered into a sponsorship agreement with **Saginaw County, Michigan,** for the local civic arena in downtown Saginaw in an effort to help breathe new life into an economically depressed area of the city. The sponsorship allowed the center to complete renovations that had begun a few years earlier. In the few years since, The Dow Event Center has become more of a regional, rather than local, venue. The facility now hosts about 220 events each year, bringing in more than 200,000 visitors from around the state. The ongoing success of the "The Dow," as it is more commonly known, has spurred continued revitalization of the area.

To promote openness and understanding with the community, Dow Terneuzen organized two evenings of "Open Night Event" for the community, which marked the beginning of the National Day of Chemistry in **the Netherlands.** Government leaders, business officials and more than 2,000 community members participated in the after-dark event at Dow's second largest site in the world. In addition to a bus tour of the site, production and use of chemicals were shown through laser projections and all plants were festively illuminated. An exhibition of Dow products and their use in consumer products followed the tours.

In support of their Community Success Plan, Dow's **Pittsburg, California,** site hosted an Environmental Fair for area fourth graders, which included a first-ever Science Teacher Appreciation Dinner featuring oceanographer and explorer Jean-Michel Cousteau. More than 250 attendees – including 150 educators – gathered on the award-winning Dow Wetlands Preserve for a tour of the wetlands, a show of exhibits used by students, dinner and a presentation by Cousteau about climate change; the importance of science education; growing up with his father, Jacques Cousteau; and more. Specific features of the Community Success plan are designed to increase exposure to the wetlands and promote science education.

Dow in **Cartagena, Colombia,** created an integral program impacting four key areas: quality of public education, preparation of future leaders among young people in the community, sustainability projects and employee volunteerism. The projects include: programs to motivate children's interest in science; employee volunteerism to improve education management at schools and to carry out health journeys; nutrition programs; development of linguistic, social, cognitive, artistic and affective potentials in young people; and the preservation of the community's culture through dance and other artistic expressions. Dow develops its community program together with "Fundación Mamonal," a nonprofit association that promotes the social development of communities.

Reputation and contributing to community success are hallmarks of the Dow Sarnia legacy project. After announcing closure of the **Sarnia, Ontario, Canada** site, Dow committed to providing funds up to $1 million in support of a community project that would benefit a broad cross-section of the community. A multi-agency proposal to build and coordinate the delivery of services at a community center for youth development in the city was chosen for the project.

On behalf of Dow's Texas Operations, The Dow Chemical Company Foundation has made a significant pledge to establish The Dow Academic Center at Brazosport College in Texas. Brazosport College is critical to educating students in the **Freeport, Texas,** area and qualifying them for high-paying jobs at local companies like Dow. With more than 60 percent of high school graduates in Texas attending community colleges before going on to four-year universities, institutions like Brazosport College are essential to prepare young adults for future success. The 35,000 square-foot multi-use facility will allow for the expansion of the college's baccalaureate degrees and will offer flexible classrooms, state-of-the-art labs and large meeting spaces for both college and community use.

Dow Malaysia sponsored and helped to build a Visitor Information Center at the Ulu Geroh ecotourism area in **Perak, Malaysia.** Among efforts by Dow staff and family members was the creation of murals adorning the four walls of the center. The establishment of the ecotourism area allowed the indigenous Semai tribe to return to their cultural roots, protect the environment and make a living in the process. It is also ecologically important because the forest around the village houses a population of two globally threatened entities: the Rafflesia cantleyi, the world's largest and most distinctive smelling flower; and the Troides brookiana albescens, or Rajah Brooke's Birdwing butterfly.

The Kasaoka site in Japan has been contributing equipment and display boards to protect the breeding area of helmet crabs in Ikue Beach in Kasaoka City. In addition to the helmet crabs, the territory of the crabs on Ikue Beach was designated a national natural treasure in 1928. Dow's contribution program was carefully selected after a series of discussions with local government. The helmet crabs are known as a "living fossil." They flourished on this planet hundreds of millions of years ago. They are now disappearing from their habitat rapidly, but still live in several parts of the world including Japan, the U.S., China and Peninsular Malaysia.

More than 65 employees from **Dow's Louisiana Operations** partnered with Office of Emergency Preparedness representatives, the Iberville Parish (Louisiana) Sheriff's Office and the Iberville Fire Department, going door to door to visit about 1,400 neighbors and share information about emergency preparedness. During the visits, residents were asked if they had concerns about area industry and if they knew what to do when the parish Community Alert Broadcast System was activated.

Engineers and other employees from **West Virginia Operations** participate in an annual community event that provides food and raises money for Covenant House, a charitable organization that provides basic needs for the needy residents. Teams of engineers, contractors and architects build sculptures from thousands of cans of food that are later donated to the organization's food pantry. The sculptures are entered in a contest with various categories, one of them being the nutritional value of the food used.

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How Dow Cares About Our Communities

Strong Connections

Dow is interwoven with the communities where sites are located because Dow's people are part of those same communities. This Human Element reveals Dow and its culture to the community, while simultaneously revealing the community and its culture to Dow.

Summary

With manufacturing sites in 37 countries, Dow is a daily presence in towns and cities around the world as a neighbor, community leader, employer and manufacturer. As a corporate citizen, Dow has a daily responsibility to operate its facilities safely, treat people fairly and support the well-being of the communities in which it operates. Sustainability is about extending this responsibility for long-term well-being to ensure future generations of the community will have environmental, economic and social health.

By listening to the community, focusing on quality of life priority needs and supporting the fulfillment of those needs, Dow also ensures its own ability to maintain and grow operations. As Dow expands globally, we extend the knowledge and experience from our established regions to new and emerging geographies, while respecting local culture and heritage.

The Big Picture

Environmental Stewardship

Dow's 2005 Global Environment, Health and Safety Goals established high performance expectations that significantly reduced injuries and chemical emissions into the air, land and water. Dow's 2015 Sustainability Goals build on the progress that was made through those earlier goals. In working toward these goals, Dow has fostered a culture that values, above all else, the safety of people and the environment. That culture serves as a foundation on which to build a broader sense of responsibility to not only the environment, but also to society as a whole. Dow continuously works to ensure that the natural resources of the communities in which it operates are not compromised by its presence.

Economic Strength

Dow is an active participant in the global marketplace, offering goods and services that create value for our customers, and in turn, bring value to their customers. This value is borne in communities where employees and local economies support Dow manufacturing locations, so that value is created for the community through employment opportunities and greater economic prosperity. This demonstrates the connection of Dow's economic strength with that of the local community.

Education

An educated population is a critical competitive component within a community and a means to maintaining economic strength while attracting businesses that need skilled employees. A well-rounded education equips citizens with the confidence to engage in public issues, using their knowledge to make informed decisions that result in beneficial public policy and laws. Particularly for Dow, a scientifically literate population with a basic understanding of science and technology, and the associated issues, can better make decisions relating to Dow and others in the chemical industry. Highly educated and trained chemists and engineers, as well as others within the scientific community, enable Dow to drive innovative growth and establish our competitive edge in the marketplace.

Unique Community Considerations

In addition to the universal priorities of environment, economy and education, Dow understands that every community has issues that are a unique priority for them. Community success is about listening and learning from the community how Dow can support those priorities in ways that are meaningful and appropriate.

Dow's Stake in this Issue

Strong community engagement is an important contributor to a valued corporate reputation, one that establishes credibility and builds trust to work toward mutually beneficial outcomes for both the company and the community. For Dow, this corresponds to a license to operate within the community.

What Dow Is Doing Now

- Assessment of the strategic value of our locations around the world to determine our rightful role
- Evaluation of our Community Advisory Panels to ensure that they are an effective sounding board between Dow and the community
- Establishment of a community assessment process and associate tools to gather community input
- Collection of baseline survey data for each of Dow's 10 strategic locations: Aratu, Brazil; Zhangjiagang, China; Stade, Germany; Rhine Center (Rhinemeunster, Germany; Drusenheim, France); Terneuzen, The Netherlands; Pittsburg, California; Hahnville, Louisiana; Plaquemine, Louisiana; Midland, Michigan; Freeport, Texas
- Creation of a process to develop Community Success Plans tailored to the local community needs
- Implementation of Community Success Plans for most of Dow's strategic locations

Dow's Future Commitment

- Implementation of Community Success Plans for all locations
- Evaluation of progress and implementation of adjustments to address identified gaps

Dow's Long-Term Vision

As part of the evolution toward sustainability, Dow is implementing a progressive model for community success. Globally, Dow is partnering with local communities to effectively address community quality of life issues. The objective of community success is for the communities where we operate to not just recognize Dow as a part of their town, but to agree that Dow plays a significant role in appropriately enhancing the local quality of life today and long into the future.

Applying the Human Element

Our people are not just employees or retirees from our sites, but they are the neighbors, coaches, leaders, volunteers and parents who comprise the backbone of a community. They are the "face" of Dow, living our corporate values daily by making the community a better place to live, work and raise a family. It is this Human Element that defines Dow as a welcomed and valued corporate citizen.

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Key U.S. Innovation Elements: What are they and how do they interact?

U.S. innovation indicators tend to focus on measurable data sets which have been readily collected by governmental and private entities for many years. While policy makers have traditionally looked at patent production, R&D spending, science & engineering degrees conferred and scientific article citation, the U.S. "innovation ecosystem" is a more complex series of interrelated phenomena. ASTRA has created a ***Periodic Table of Innovation Elements*** suggesting how key innovation elements interact and seem to affect one another. The more recognized innovation elements depicted below are organized according to eight "element" groups: **Inputs, Process, Outputs, Impact, Macro-Economy, Policy, Infrastructure** and **Mindset**. The key innovation elements selected by ASTRA are organized and color-coded depending upon their primary role.

Periodic Table of Innovation Elements

R&D Expenditures														
R&D	Capital											Impact	Impact	MacroEcon
Patents	Gross Capital Formation											# Innovative Enterprise	Birth Rate New Enterprises	Average Hourly Earnings
Talent	Capital											Impact	Impact	MacroEcon
# Researchers	ICT Investment											S&T Employment	Net Change Enterprises	Gross Private Investment
Talent	Capital	Networks	Networks	Networks	Management	Prod Dev.	Process	Process	Output	Output	Output	Impact	MacroEcon	MacroEcon
No. with Higher Education	Initial Public Offerings	Broadband Penetration	SMEs with Cooperation Arrangements	# Business Incubators	Entrepre-neurship	# Approved Patents	# Cooperation Agreements	R&D Used From Overseas	Sales New to Market	# New Products Introduced	New Markets Created	Leading Competitiveness Indicators	Real GDP	Real Interest Rates
Talent	Capital	Networks	Networks	Networks	Management	Prod Dev.	Process	Process	Output	Output	Output	Impact	MacroEcon	
Verbal SAT	Angel Networks	Computer Use per Capita	Intern'l Alliances	# Internet Domains	Quality of Management	Time & Money to Develop	Early Stage Entrepreneurial. Activity	Innovation Expenditure	Sales New to Firm	Output per Sector	Export Sales	High Tech Jobs Gained & Lost	Real GDP per Capita	
Talent	Capital	Networks	Networks	Management	Management	Efficiency	Process	Process	Output	Output	Impact	Impact	MacroEcon	
Math SAT	SBIR Funding	Internet Use by Business	Federal Lab CRADAs	Shareholder Value	# of Ideas	Availability Competent Managers	Research Quality	Enterprises Innovating In-House	Royalty, License Fees	New Companies Created	High Tech Exports	Income per Capita	Inflation Rate	
Talent	Capital	Networks	Networks	Management	Prod Dev	Efficiency	Process	Process	Output	Output	Impact	*Future*	*New*	*Metrics*
Pop with Life Long Learning	Investment Risk	Broadband Costs	University Spinouts	Customer Satisfaction	Technology Absorption	Cost Reduction	Quality of University Collaboration	Product Launch Speed	Overall Productivity	Value Add of SMEs	Employment in High Tech Sector			

Innovation Element Groups (Families)*

Inputs	Process	Outputs	Impact
Macro-Economy	Policy	Infrastructure	Mindset

Policy	Policy	Policy	Policy	Policy	Infrastruc	Infrastruc	Infrastruc	Infrastruc	Mindset	Mindset	Mindset	*Future*	*New*	*Metrics*
Corporate Tax Rate	# New Taxes, Excises, Duties	Time Required to Start Business	Foreign Ownership Restrictions	Rule of Law Governance	IP Rights	Environment Governance	Legal Rights Index	Home Affordability	Public Source of S&T Information	Informed about Policy Issues	Value Place on Creativity			
Policy	Policy	Policy	Policy	Infrastruc	Infrastruc	Infrastruc	Infrastruc	Mindset	Mindset	Mindset	Mindset	*Future*	*New*	*Metrics*
Overall Tax Burden	# Procedures to Start Business	Trade Barriers	IP Protection	Judicial Independence	Infrastructure Quality	Openness to Competition	# of New Bldgs Designed	Youth Interest in Science	Public Interest in S&T	Science Literacy	Wish to Own Business			

The document
"Defining 'Innovation': A New Framework to Aid Policymakers"

Is unavailable in this document

Document is available at

http://www.usinnovation.org/files/Defining_Innovation807.pdf

Toward Human-Centered Innovation

Lewis J. Perelman
Senior Advisor, Delmarva Strategies LLC

for Innovation's Vital Signs Workshop, Washington DC, April 27, 2007*

** Conducted by ASTRA and the Center for Accelerating Innovation on behalf of the Technology Administration of the U.S. Department of Commerce*

Introduction

In regard to efforts on accelerating innovation—and particularly the project on Innovation's Vital Signs—there should be a greater focus on *human-centered innovation*, for at least two reasons. First, change and innovation are not desirable ends in themselves; in fact, some innovation is evidently wasteful and even destructive. Second, while further research is needed to determine the detailed nature of the trend, current business news strongly suggests that the leading edge of innovation today is increasingly driven by human-centered design.

This trend challenges much of the conventional wisdom underlying both public-sector and private, philanthropic efforts to promote innovation as a general economic good. Such efforts in many cases should be re-thought and adjusted to account for more than just the inputs to innovation, or the gross level of resulting innovation activity. Rather, initiatives to promote innovation need to assess and consider the net social value of the resulting outcomes.

Defining 'Human-Centered' Design and Innovation

Innovation traditionally was viewed as a linear process: from basic research to technology development and on to test/evaluation, demonstration, deployment, commercialization, and ultimately, market penetration. And perhaps, if successful, market saturation, obsolescence, and finally replacement. Human (and social) factors—needs, desires, demands, behavior—were considered either not at all or intuitively, anecdotally, coincidentally, mechanically, and often reactively. Innovation was driven, first, by hard science, engineering, and production, with marketing and sales trailing behind like army camp followers.

Potential new products would emerge serendipitously from exploratory R&D. Marketing would speculate on potential customers. Promising candidates for commercial products would be subjected to test markets to see if consumers would accept and demand them. If so, full-scale production and marketing would follow.

For well-known reasons we need not belabor here, that linear process was thrown topsy-turvy in the past quarter century or so as information technology both empowered consumers and hugely boosted the speed, agility, and volatility of design, production, and market processes. Two relevant artifacts of that market revolution have been the ascendance of personalization and of ever more intimate, nuanced, customer-supplier relationships.[1]

[1] Government innovation—that is, R&D by government for government acquisition—continues to follow a process largely insulated from market dynamics, driven by political demands and often turgid bureaucratic

The "New Coke" fiasco of 1985 may be as good a symptom as any to mark the watershed between the old producer-centered (production push) model of innovation and the new age of human-centered (not just demand-pull but people-pull) form that increasingly drives the global marketplace.

An important lesson from the New Coke innovation blunder is that it did not result simply from ignoring consumers. Indeed, the introduction of New Coke followed market research showing that Pepsi was gaining market share from Coke because a new generation of consumers preferred the sweeter taste of Pepsi. And blind market tests in fact indicated that a larger share of soft drink consumers liked the greater sweetness of the New Coke formulation to the drier flavor of the old Coke recipe.

But New Coke was rejected after its full-scale market introduction, and not just with disinterest but with anger bordering on outrage.

What the old, mechanistic and reactive form of market research had failed so ingloriously to anticipate was that Coca-Cola was not just something to drink but an important, almost sacred cultural icon.

Human-centered design and innovation, in contrast, do more than replace the simple linear model of innovation with the more elaborate web of the innovation ecosystem the Center for Accelerating Innovation has charted—they put human and social imperatives first and foremost. Moreover, they do not limit human factors to ergonomics and economic utility, but give acute attention to culture, meaning, and behavior.

While human-centered design appears to be pushing the leading edge of innovation today, it has deep historical roots. The basic conception of human-centered technical design began with the discovery of the "learning curve" in the 1920s, and then serially evolved through the development of "sociotechnical system design" at the Tavistock Institute in the 1950s, E.F. Schumacher's concurrent initiatives for "appropriate technology," and, later, movements for "total quality management" and "business process reengineering." While varying in focus and application, the essential theme of these challenges to Taylorism's mechanistic idiom of innovation was well expressed by the subtitle of Schumacher's popular book on small-scale systems: "Economics as if people mattered."

The current expression of human-centered innovation can be observed in the work of leading commercial design firms, which characteristically begin projects with exhaustive study of human and social factors before any technical designs are plotted. One example is the Opti Desktop PC, which won a gold award for China's Lenovo Group and its American design partner ZIBA Design in the latest annual industrial design excellence competition co-sponsored by *Business Week* and the Industrial Designers Society of America.

The team's design research, *Business Week* reported, was "dubbed 'Search for the Soul' of the Chinese customer," and aimed to help Lenovo compete on something more than just price. "Lenovo and ZIBA delved deeply into Chinese consumer culture to 'find out which design elements have meaning and value for specific groups of Chinese consumers'…. [They] spent months immersed in Chinese music, history, and objects of desire, such as cell phones, observing families as they lived, worked, and played." At the end, the team had identified five distinct 'technology tribes' in China and designed the Opti for the "Deep Immersers who seek escape through immersing themselves in games online."[2]

procedures that commonly are even more isolated from human user, organizational, and cultural engagement or considerations.

[2] "The Best Product Design of 2006," *Business Week*, July 10, 2006.

Innovation for What?

Mere boosterism may be satisfied with an agnostic notion of innovation—indifferent to innovation's actual consequences as long as they stimulate economic activity. But if value-free innovation is the benchmark for Innovation's Vital Signs, it follows that 'clusters' of global terror and criminal networks, such as Iraq's insurgents, are among the world's leading models of 'best practices.' As blogger John Robb reports:

> *Iraq's insurgency is a cooperative community arrangement between many diverse groups that operates much like open source development in the software industry. As an adjunct to this cooperative arrangement, micro-markets have formed around the arming and prosecution of specific forms of attack. These micro-markets enhance innovation, participation, and skill development.*
>
> *The best example of this is in the building and emplacement of IEDs[3], where guerrilla entrepreneurs have formed cells for hire that specialize in certain aspects of the IED operations chain (the IED, or homemade bomb, has become the weapon of choice for Iraqi guerrillas fighting US soldiers).*[4]

This won't do. The metaphor of 'vital signs' derives from the medical quest to save lives and improve health. Yet medical practice itself continues to be dogged by the nemesis of iatrogenic illness—the cure that is more destructive than the disease it aims to treat.

Health care reformers increasingly are attempting to redirect programs and practices to focus on tangible evidence of the actual outcomes of treatments and services, rather than just on inputs, intentions, and acquisition of the latest technical inventions. However, generic innovation boosters all too commonly plow ahead in blithe indifference to the ends and consequences of innovation, ignoring such benchmarks in the morbidly rich history of innovation-gone-awry as these:

- Theodore Kaczynski (mathematician), A.Q. Khan (physicist), Ayman al-Zawahiri and Josef Mengele (physicians), Shiro Ishii (microbiologist), Mohammed Atta (architect), Khalid Shaikh Mohammed and Ramzi Yousef (engineers), as well as the yet-anonymous crafter of the 2001 anthrax attacks on the United States are just a few stars in the copious rogues' gallery of Richard Florida's "creative class"[5] who applied their innovative intellectual skills to malignant ends.

- Long-Term Capital Management, a hedge fund founded In 1994 with two winners of the Nobel Prize in Economics on its board promised affluent investors that its arcane mathematical models would provide risk-free, extravagant returns. In 1998, the Federal Reserve had to round up a bailout of over $3.6 billion, fearing that LTCM's sudden collapse would spawn a global financial disaster. Enron Corp., founded on a gusher of, if anything, even more breathless technological hubris—promising to replace human-managed commodity markets with exotic automated trading exchanges—blew up in 2001 with even more disruptive economic and legal impacts.

- *The Careless Technology*, a 1972 collection of papers from a symposium on the ecological effects of international development, concluded that the great majority of projects sponsored by development organizations over the previous three decades had done more harm than good—a result of their narrow, technocratic specialization and lack of attendance to broad, ecosystem impacts.[6] Three decades later, William Easterly, with 16 years of experience as a senior economist at the World Bank, again concluded in two recent books that over a trillion dollars of technocratically managed aid to 'third world' countries had yielded little or no improvement in

[3] Improvised Explosive Devices.
[4] John Robb, "Journal: Iraq's IED micro-markets," *Global Guerillas*, Feb. 14, 2006 (http://globalguerrillas.typepad.com/globalguerrillas/2006/02/journal_more_in.html)
[5] Richard Florida, *The Rise of the Creative Class* (New York: Basic Books, 2002).
[6] M. Taghi Farvar and John P. Milton, eds., *The Careless Technology: Ecology and International Development* (New York: Doubleday, 1972).

the lot of the poor, often doing more harm than good—again, for lack of attention to how human ecology actually works.

So there is something more to human-centered innovation than just attending to human factors in production, ergonomics, or market demographics. Or even engaging the 'lead users' Eric Von Hippel celebrates. Those are all good practices, maybe even necessary, but are not sufficient.

However confounding it may be to innovation planning and metrics, "human-centered" has an implicit connotation of *humaneness*—which in turn demands some value standards to filter 'good' from 'bad' innovation.

Such a requirement does not fit well in the pristine framework of neoclassical economics and the arid econometric tools contrived to inform it—with their agnostic, rationally utilitarian notion of demand. Rather, we need to look to political economy and welfare economics to find ways to manage the human value of innovation.

There we find that managing development according to the value of its impacts and consequences is neither a new problem nor virgin territory. The techniques for doing so have been refined and applied for decades in such fields as environmental protection, resource management, and transportation, workplace, food, and drug safety.

The Trend

Anecdotal indicators suggest imminent decline of the more-of-the-same approach to accelerating innovation, that is: more inputs of money and people to education and training and to R&D; gauging progress by the gross volume of expense, activity, and intermediate artifacts (publications, patents, product announcements, etc.); and a 'land rush' mentality to stake out and defend sprawling haciendas of intellectual property. Among the limitations to this conventional approach to "innovation policy" *Business Week*[7] and other publications have noted are:

- China and India will increasingly out-compete the U.S. in sheer volume of educational output, producing technically skilled workers who can be employed at a fraction of U.S. wages.
- Because R&D, innovation, and venture capital are all mobile, they increasingly are flowing out toward these lower-cost centers of production.
- Incomes of U.S. college graduates with bachelor degrees actually declined some 8% in the past three years.
- Even though the U.S. has a prominent lead in medical research, for instance, the pharmaceutical, biotech, and medical devices industries have added only 19,000 workers in the past five years.
- With foreigners providing some 40% of the science and engineering graduate students in U.S. universities, expanding subsidies for domestic higher education to some extent simply enhances foreign competition.
- Since 2001, the health care sector added 1.7 million jobs to the U.S. economy. The rest of the private sector added none. The information technology sector lost more than 1.1 million jobs.
- Much of the mushrooming U.S. trade deficit may be attributed to borrowing from abroad to pay for the growing costs of health care.[8]

[7] Michael Mandel, "Can Anyone Steer This Economy?" *Business Week* (November 20, 2006).
[8] "What's Really Propping Up The Economy," *Business Week* (September 25, 2006).

Meanwhile, the specific *quality* of innovation—at the granular microeconomic, community, and even personal levels—seems increasingly to be becoming the definitive factor of competitive advantage. As *Fast Company* recently reported:

> Design, in short, is becoming an ever more important engine of corporate profit: It's no longer enough simply to outperform the competition; to thrive in a world of ceaseless and rapid change, businesspeople have to *outimagine* the competition as well. They must learn to think—to become—more like designers…
>
> Corporate types, by and large, seek to fuel growth by building from bulletproof, reproducible systems; designers generally attempt to do so by imagining something new, different, better.[9]

The Challenge

The primary challenge to promulgating a more human-centered approach to managing and accounting for innovation then is this:

- Can we encourage innovation that adds *net* social value? That is, whose benefits clearly outweigh its costs?
- At the same time, can we deter—or at least not encourage—innovation that serves malicious ends or that poses grave threats to humanity?

Certainly it is possible to posit various metrics of the social, economic, ecological, ethical, etc. value of diverse activities aimed at fomenting innovation, and of the potential opportunities and threats that they pose. Coming up with indicators that are demonstrably valid, reliable, and usable is a more demanding challenge.

While good attentions alone will not suffice, waiting for—or expecting—a perfect metric solution would be unrealistic. A practical solution is likely to be what Herbert Simon called a 'satisficing' one: not the hopelessly elusive 'best practice' but a program that is adequately on target and open to further refinement.

Inevitably the cautionary lessons of Public Choice theory will come into play: in particular, that 'rent-seeking' special interests invest and compete to steer public, political choices to provide parochial benefits, often at the expense of the general welfare. Indeed, the military-industrial complex whose distorting influence on public investment President Eisenhower warned about half a century ago has sprawled into a broader government-industrial complex that often steers innovation subsidies toward wasteful, anachronistic, or harmful results.

However, the same competitive, globalization trend noted earlier that is driving the imperative for more human-centered innovation is progressively curtailing the ability of national governments to insulate their domestic constituents from the demands of global market forces. The growing power of personalization and 'crowdsourcing'—as in the forms of the blogosphere, citizen journalism, open source systems, or globally networked consumer or civic insurgent cells—already have as much if not more influence on the trajectory of economic development than the Congress and its lobbyist courtiers. In this, Von Hippel's observations of the 'democratization' of innovation are certainly germane.

[9] Roger Martin, "Tough Love," *Fast Company* (October 2006). Emphasis added.

Towards a Strategy

One way to adapt Innovation's Vital Signs to emphasize human-centered innovation (and perhaps to curtail wasteful or destructive innovation) is to start with a management-by-exception approach.

That is, we may start by seeking to identify:

- Glaring *barriers* to human-centered innovation: policies, programs, and practices that discourage detailed attendance to human and social requirements.
- *Worst practices* that drive innovation efforts toward wasteful or destructive outcomes.
- *Warning signs* that innovation efforts are heading toward unintended, undesirable consequences.

While it is easier to identify worst practices (which are demonstrably morbid or lethal in their effects) than best practices (which are nearly impossible to identify unambiguously, are ever mutating, and once codified only assure mediocrity), it may be most feasible to try to identify and track certain *essential* features of human-centered innovation.

For instance, following the ZIBA example mentioned earlier: Programs that engage and invest in ethnographers, anthropologists, and other social and behavioral analysts to study user desires, expectations, behavior, and needs first, and then channel technical design based on the resulting insights, would seem at least more likely to respond successfully to human requirements than programs that simply engineer in a vacuum of social disinterest.

So, a positive corollary to management-by-exception may be to identify some of the essential 'habits' of highly effective, human-centered innovators, as in the approach taken by Jim Collins in his research for *Built to Last*.[10]

Another instructive lesson from Collins's work is this: He invested about a half million dollars in the research on which the book was based. A similar study of the requirements of human-centered innovation is likely to demand at least a comparable investment of resources.

ISO 'Good' Innovation

Even once we agree about the need to value the outcomes of innovation efforts, we need apt terminology for what we are aiming at. 'Human-centered' served to get our conversation going, but may not be clear enough or get traction. The most practical terminology may just be the simplest.

Getting back to our original premise, obviously, not all innovation is good or desirable. So the essential objective is to filter the good from the bad. That is:

- Reasonable people would prefer to invest in good innovation, and to not invest in or to even discourage bad innovation.
- To do that, one needs standards, criteria, metrics—to discriminate the good from the bad innovations.
- Then, to actually fertilize the good and weed out the bad, one needs to know the "generative factors" in innovation programs, practices, policies, etc. that cause either the good or bad outcomes.

I suggest then that we should describe the goal of our search as either simply "good innovation" or, to be a bit more technical-sounding, "constructive innovation" (as opposed to destructive).

[10] James C. Collins and Jerry I. Porras, *Built to Last: Successful Habits of Visionary Companies* (New York: HarperCollins, 1997).

What Is 'Good' Or 'Constructive' Innovation?

Before we get on to metrics, we need to have some defensible, philosophical definition of what we mean by 'good' or 'constructive.' At the moment, there appear to be three evident possibilities:

- Hippocratic = Do no harm.

This seems to me, literally, an ideal standard, but not a very practicable one for our purposes. Even in medical practice, where the adherence to the principle is deeply rooted, modern practice continually (increasingly perhaps) requires making choices between greater or lesser harm in pursuit of doing something good: e.g., using technology to prolong a life afflicted with unbearable pain and suffering vs. assisted suicide, among numerous other examples.

- Progressive = net social benefit = [(benefits - costs) > 0].

As I noted previously, this is the subject of welfare economics, rich in theory, methodology, and experience. This is less idealistic than the Hippocratic standard, but easier to accomplish conclusively in theory than in practice. I won't belabor the reasons here for the distortions of social welfare regulation, but will summarize them with one word: politics.

- Satisficing = pretty good = socially (i.e., politically) acceptable.

Satisficing is Herbert Simon's term for definitely non-ideal, practical choices between 'better' and 'worse.' (In this framework, the 'perfect' is proverbially held up as 'the enemy of the good'--a phrase that is problematical because it often is, conveniently, misapplied to choices that really are not between perfect and good but between good and bad.)

That said, I suggest that the Progressive standard should define our practical goal—because that is how satisficing solutions work in practice. I'm simply noticing a standard axiom of negotiating strategy: Ask for the moon and settle for a meteorite.

Metrics

The substance of our proposed investigation then is, first, identify and evaluate metrics ('vital signs') that discriminate good/bad or constructive/destructive innovations. I'm about to offer an initial list of possible candidates but must note that, to bring the study to a valid conclusion, we need to take a double-barreled approach to distill such a list.

That is, we need to begin by considering candidate indicators—assuming that whatever information each requires actually is available. It should be evident that there are facts about the outcomes of innovation that, if we knew them, would help us discriminate between good and bad, but that we cannot get in practice—either because the data have not been assembled yet, or because they are proprietary or classified or too costly or otherwise not immediately accessible. Nevertheless, since we would hope that further research may eventually stimulate the collection of the needed data, or open up its use for our purpose, we should not exclude potentially valuable indicators at the outset.

The second barrel then will be to assess and note which of the indicators we prefer are immediately available, which can and should be made available in the future, and which may not be practicable for the time being.

That said, here are several possible indicators of good or bad innovation for initial consideration, in no particular order:

- Market penetration (+)—more and faster is an indication of social value.
- J.D. Power rating = customer satisfaction (+).
- Recalls (-).
- Endurance—the proposition being that really great, socially valuable innovations tend to endure in the market for a long time because they are both essential and hard to beat (the wheel, the paper clip, Kleenex, the DC-3). Note that I'm talking about persistence-in-use here, not individual product durability. (+)

- Generations—a corollary to Endurance, but a bit different, is number of generations or versions, an indicator of the capacity for continual improvement to satisfy evolving demand. (+)

- Adaptations—another corollary is adaptation to different uses/applications than what the innovation was originally intended for; more being an indicator of greater social value. (If Generations are vertical, Adaptations are horizontal.) (+)

- Liability claims (-).

- Regulatory sanctions (-). One of these or the latter (liability) may be an anomaly; a slew of them is probably an indicator of something really bad.

- Cost of development—other things equal, a good innovation that costs less to create is better than one that costs more. (Even if other things are not entirely equal, it still might be better.) (+)

- Profitability—again, other things equal, a good innovation that is more profitable is better than one that is less so. Not just because it makes investors/vendors happier but because it provides the fuel for further (good) innovation.

- Abuse/misuse—pseudofed may be a boon for sinus sufferers, but its utility as a feedstock for illicit methamphetamine labs is a bad thing. This is the dark side of the Adaptation force. (-)

- Appropriateness—viz. E.F. Schumacher et al. (+)

- Resource efficiency (+).

Finally, for now, we can throw in these catch-alls:

- Collateral damage (-).

- Collateral benefits (+).

This list is certainly incomplete but may be adequate for now to illustrate the types of indicators we would assess and refine. And we don't need to get far into the second barrel to note at a glance that some of these data are evidently easier to get than others, and some are more concrete than others that are more ambiguous and challenging to measure.

Generative Factors

As I mentioned, to study and analyze the generative factors that enable some innovation programs/organizations/communities to produce 'good' innovations, while others spawn more or less ugly babies, I have begun to look into the research methodology used by Collins and Porras to produce their hugely bestselling and immensely profitable books, *Built to Last* and *Good to Great*. Broadly, they adapted the classic human psychology technique of studying twins separated at birth.

While that seems to have worked well for them to distinguish the generative factors that distinguish great from mediocre companies, it's not immediately clear how well that might work to differentiate those factors between good/great innovations and mediocre/bad innovations. However, given the success the technique has produced in their widely prized work, it a research approach worth considering.

There are at least some aspects of their approach that make sense to emulate. First, once we have devised a list of innovation value indicators, per above, we could copy their decision to focus on subjects that had been around long enough to go through a full life cycle of development. Then, just as they surveyed a variety of companies across a spectrum of different industries, we could apply our value vector to a wide variety of types of innovations in diverse markets.

At first blush, it might well be possible to come up with paired twins of innovations 'separated at birth,' as they did with companies, to compare the differentiating factors in the evolutionary paths of the 'good' and 'bad' twin respectively. If so, it could be quite interesting to try.

Still, we must recognize that innovations are different from companies—the latter are discrete entities while innovations are ideas that may be born and developed in several places/organizations at the same time, or at least concurrently. Intellectual property law, of course, does tie particular innovations to particular persons/companies for some time. But not all good/great innovations historically have been protected that way, and many at least have graduated at some point to the public domain. (It's not clear whether that is necessary to the criterion of a 'full life cycle,' since IP law lately has been stretched in some instances to preserve protection seemingly in perpetuity.)

So, in any case, whatever may come from the twin pairs analysis, we probably also should take a broad list of notable innovations, sort them into 'good' and 'bad' with our value vector, and then do at least a qualitative comparison, attempting to identify one or more hypothetical patterns that differ between the good and bad. To do the latter, we might choose some candidate innovations from each pile for which the history of their creation and development is well documented. At the very least we would produce a valuable collection of case studies. (That might follow the path taken by Peters and Waterman with *In Search of Excellence*, some 25 yrs ago.)

Beyond that, there likely are some more rigorous techniques that could differentiate some the generative factors in those histories.

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A NEW GENERATION OF AMERICAN INNOVATION

APRIL 2004

Executive Summary

America's economy leads the world because our system of private enterprise rewards innovation. Entrepreneurs, scientists, and skilled workers create and apply the technologies that are changing our world. President Bush believes that government must work to help create a new generation of American innovation and an atmosphere where innovation thrives.

On April 26, 2004, President Bush announced a series of specific measures to inspire a new generation of American innovation – policies to encourage clean and reliable energy, assure better delivery of health care, and expand access to high-speed Internet in every part of America. By giving our workers the best technology and the best training, we will make sure that the American economy remains the most flexible, advanced, and productive in the world.

1) Providing a Cleaner and More Secure Energy Future through Hydrogen Fuel Technology: The President announced that the Department of Energy has selected partners through a competitive process to fund new hydrogen research projects totaling $350 million ($575 million with private cost share) to overcome obstacles to a hydrogen economy. This represents nearly one-third of the President's $1.2 billion commitment in research funding to bring hydrogen and fuel cell technology from the laboratory to the showroom. The projects will include 28 awards to academia, industry, and national laboratories. The new hydrogen projects address four key areas:

- Creating effective hydrogen storage: Current hydrogen storage systems are inadequate for use in the wide range of vehicles that consumers demand. Exploratory research and development is needed to overcome the grand challenge for hydrogen storage.
- Conducting hydrogen vehicle and infrastructure "learning demonstrations": To complement laboratory research, automakers and energy companies need to work together to develop integrated technology solutions for a national infrastructure. These demonstrations will provide important performance, cost, and durability data on fuel cell vehicle and hydrogen refueling infrastructure. This new data will allow us to refocus research priorities as progress is made.
- Developing affordable and durable hydrogen fuel cells: Currently, fuel cells are as much as ten times more expensive than internal combustion engines. New cost-shared projects will be formed with five businesses to develop fuel cells for consumer electronic devices, and auxiliary power and off-road applications.
- Developing a Hydrogen Education Campaign: A new effort will aim to build the next generation workforce, engage students in science and technology, and overcome the public education and acceptance barriers to achieving the hydrogen economy.

2) Transforming Health Care through Health Information Technology: President Bush believes that innovations in electronic medical records and the secure exchange of medical information will help transform health care in America - improving health care quality, reducing health care costs, preventing medical errors, improving administrative efficiencies, reducing paperwork, and increasing access to affordable health care. The President has set an ambitious goal of assuring that most Americans have electronic health records within the next 10 years. To achieve his 10-year goal, the President is taking the following steps to urge coordinated public and private sector efforts that will accelerate broader adoption of health information technologies:

- Adopting Health Information Standards. The President called for the completion and adoption of standards, collaboratively developed with the private sector, that will allow medical information to be stored and shared electronically while assuring privacy and security.
- Doubling Funding to $100 Million for Demonstration Projects on Health Information Technology. To build upon the progress we have already made in the area of health care standardization, the President's

proposed FY 2005 budget includes $100 million for demonstration projects by hospitals and health care providers that will help us test the effectiveness of health information technology and establish best practices for more widespread adoption in the health care industry.

- o Fostering the Adoption of Health Information Technology. As one of the largest buyers of health care, the Federal Government can create incentives and opportunities for health care providers to use electronic records.
- o Creating a New, Sub-Cabinet Level Position of National Health Information Technology Coordinator. The President will charge the National Coordinator with working with government, industry, and experts in the field to help fulfill his vision of a health care system that is patient-centered and that gives patients information they need to make clinical and economic decisions – in consultation with dedicated health care professionals.

3) Promoting Innovation and Economic Security through Broadband Technology: The President has called for universal, affordable access for broadband technology by the year 2007 and wants to make sure we give Americans plenty of technology choices when it comes to purchasing broadband. Broadband technology will enhance our Nation's economic competitiveness and will help improve education and health care for all Americans. Broadband provides Americans with high-speed Internet access connections that improve the Nation's economic productivity and offer life-enhancing applications, such as distance learning, remote medical diagnostics, and the ability to work from home more effectively. The Bush Administration has implemented a wide range of policy directives to create economic incentives, remove regulatory barriers, and promote new technologies to help make broadband affordable. The President believes that lowering the cost of broadband will increase its use and availability.

- o Making broadband access tax-free will lower the cost to consumers. The President is calling on Congress to pass legislation making access to broadband permanently tax-free.
- o Working to enable the rollout of new broadband technologies. The Administration is acting aggressively to make additional spectrum available for wireless broadband and to create the technical standards needed to enable the widespread and responsible deployment of broadband over power lines.
- o The Federal Government must do its part to remove hurdles that slow the deployment of broadband. Broadband providers often have to cross or use Federal lands to reach consumers. To ensure that broadband providers can get timely responses from the Federal Government, the President has directed agencies to reform their practices to simplify and standardize their rights-of-way processes.

These initiatives outlined above complement the Bush Administration's other efforts to promote innovation and technology in America. President Bush has a proven track record of supporting America's innovation economy, including:

- o Helping Community Colleges Train 100,000 Additional Workers: The President's Jobs for the 21st Century Initiative, announced in the State of the Union Address, includes a $250 million proposal to help America's community colleges train 100,000 additional workers for the industries that are creating the most new jobs.
- o Doubling the Number of Workers Receiving Federal Job Training Assistance: The President has proposed to give governors more flexibility to get Federal training funds into the hands of workers in the form of Innovation Training Accounts (ITAs). These accounts give workers access to a range of training options that will help them compete for high-skill, high-demand jobs.
- o Increasing Federal R&D Funding: With President Bush's FY 2005 budget proposal, total Federal R&D investment during the first term will be increased 44 percent, to a record $132 billion in FY 2005, compared to $91 billion in FY 2001. Federal R&D spending in the FY 2005 budget represents the greatest share of GDP in over ten years.

- Supporting Nanotechnology Research: Since 2001, funding for nanotechnology R&D has more than doubled to $1 billion and funding for information technology R&D is up to $2 billion.
- Ensuring Better Health Care for All Americans: President Bush fulfilled a commitment by completing the historic doubling of the National Institutes of Health (NIH) budget by 2003, dramatically increasing medical research funded by NIH to speed cures and treatments for the diseases that plague our Nation and the world. The President's FY 2005 budget provides $28.6 billion for NIH, a $729 million increase, which will allow NIH to support a record total of nearly 40,000 research project grants.

Hydrogen Fuel Technology: a Cleaner and More Secure Energy Future

"With a new national commitment, our scientists and engineers will overcome obstacles to taking these (hydrogen fuel cell) cars from laboratory to showroom, so that the first car driven by a child born today could be powered by hydrogen, and pollution-free."

-- President George W. Bush, State of the Union Address, January 28, 2003

- For too long, environmental policy in America has been dominated by a sterile debate between those who believe that pollution is the price of progress, and those who believe that we must limit and scale back our progress. The President believes that progress, innovation, and technology can help America leapfrog beyond these false choices – and meet the energy needs of a growing economy in environmentally responsible ways.

- On April 26, 2004, President Bush announced that the Department of Energy (DOE) has selected partners through a competitive process to fund new hydrogen research projects totaling $350 million ($575 million when private sector cost-sharing is included) to overcome obstacles to the development of hydrogen fuel technology. This represents nearly one-third of the President's $1.2 billion commitment in research funding to bring hydrogen and fuel cell technology from the laboratory to the showroom. The projects will include 28 awards to academia, industry, and national laboratories. The new hydrogen projects address four key areas:

  - Creating effective hydrogen storage: Current hydrogen storage systems are inadequate for use in the wide range of vehicles that consumers demand. Exploratory research and development is needed to overcome the grand challenge for hydrogen storage: to store the amount of hydrogen required for a conventional driving range (more than 300 miles), within the vehicular constraints of weight, volume, efficiency, safety, and cost. The Department of Energy is working to develop three primary options (chemical hydrides, metal hydrides, and carbon materials) in addition to 15 individual projects to explore new materials for hydrogen storage. Over 45 organizations will be involved, including DOE national laboratories, universities, research institutes, and industry.

  - Conducting limited hydrogen vehicle and infrastructure "learning demonstrations": To complement laboratory research, automakers and energy companies need to work together to develop integrated technology solutions for a national infrastructure. Eight automakers and six energy companies (under five major awards) will work together with their teams under this project to demonstrate integrated and complete system solutions operating in real world environments. Government and industry are providing matching funds. Teams also include utilities, universities, and small businesses. These demonstrations will provide important data on fuel cell vehicle and hydrogen-refueling infrastructure performance, cost, and durability and allow refocusing of research priorities as progress is made. These demonstrations are critical so that all stakeholders (including Congress) can track progress towards a commercialization decision in 2015.

  - Developing affordable and durable hydrogen fuel cells: Currently, fuel cells and associated systems are as much as ten times more expensive than internal combustion engines. New cost-shared projects will be formed with five businesses to develop fuel cells for consumer electronic devices, and auxiliary power and off-road applications.

  - Developing a hydrogen education campaign: In direct response to the National Energy Policy, a hydrogen education effort will aim to build the next generation workforce, engage students in science and technology, and overcome the public education and acceptance barriers to achieving the hydrogen economy. Middle school and high school curricula and teacher training will be developed. These projects will complement current education efforts for public and safety officials at all levels.

Background – President Bush's Hydrogen Fuel Initiative

- In his 2003 State of the Union address, the President committed $1.2 billion over five years to accelerate research and development of hydrogen fuel cell and infrastructure technologies, including $720 million in new funding. The Hydrogen Fuel Initiative aims to help reverse America's growing dependence on foreign oil by developing the technology for commercially viable hydrogen-powered fuel cells that power cars, trucks, homes, and businesses that emit no pollution or greenhouse gases.

- Through partnerships with the private sector, the Hydrogen Fuel Initiative will make it practical and cost-effective for large numbers of Americans to choose to use clean, hydrogen fuel cell vehicles by 2020 – so the first car driven by a child born today could be powered by fuel cells. This will dramatically improve America's energy security by significantly reducing the need for imported oil, and help clean our air and reduce greenhouse gas emissions. The President's proposal has received broad, bipartisan support in Congress.

- The Hydrogen Fuel Initiative complements the President's existing FreedomCAR partnership, which is developing technologies needed for mass production of safe and affordable hydrogen-powered fuel cell vehicles, along with other advanced vehicle technologies. In total, President Bush has proposed $1.7 billion over five years for the Hydrogen Fuel and FreedomCAR initiatives.

Budget

- The President's FY 2005 budget proposes $228 million for the Hydrogen Fuel Initiative, a $69 million increase (43%) over the FY 2004 budget.

    - The FY 05 request includes $29 million for basic science within the DOE's Office of Science and $18 million for safety, codes, and standards activities – consistent with the program's needs and the recently released peer review report by the National Research Council.
    - The FY 05 budget request also includes an increasing emphasis on exploratory research for hydrogen production, storage, and fuel cell technologies and continued technology validation.
    - A mix of diverse energy feedstocks to produce hydrogen is needed to gradually make the transition to a secure, affordable, and environmentally safe hydrogen energy system; these include renewables, nuclear, and natural gas and coal with carbon management strategies.

Fuel Cell Technology

- Fuel cells are a proven technology: America's astronauts have used fuel cells to generate electricity since the 1960s, but more work is needed to make them cost-effective for use in cars, trucks, homes, or businesses. Additional research and development is needed to spur rapid commercialization of these technologies so they can provide clean, domestically produced energy for transportation and other uses.

- The President's initiatives seek to help the private sector overcome key technical and cost barriers for fuel cells:

    - Lowering the cost of hydrogen: Hydrogen is four times as expensive to produce as gasoline (when produced from its most affordable source, natural gas). The hydrogen fuel initiative seeks to lower that cost enough to make fuel cell cars cost-competitive with conventional gasoline-powered vehicles by 2015; and to advance the methods of producing hydrogen from renewable resources, nuclear energy, and even coal.
    - Creating effective hydrogen storage: Current hydrogen storage systems are inadequate for use in the wide range of vehicles that consumers demand. New technology is needed.

- Creating affordable hydrogen fuel cells: Fuel cell-based propulsion is now as much as ten times more expensive than internal combustion engines. The FreedomCAR initiative is working to reduce that cost to affordable levels.

- America's dependence on foreign oil is increasing:

  - America imports more than 55 percent of the oil it consumes; that is expected to grow to 70 percent by 2025.
  - Nearly all of our cars and trucks run on gasoline, and they are the main reason America imports so much oil. Two-thirds of the 20 million barrels of oil Americans use each day is used for transportation. Fuel cell vehicles offer the best hope of dramatically reducing our dependence on foreign oil.

- Hydrogen fuel will help reduce America's dependence on energy imports:

  - Through the Hydrogen Fuel and FreedomCAR initiatives, the Federal Government, automakers and energy companies will work together to overcome the technological and financial barriers to the successful development of commercially viable, emissions-free fuel cell vehicles that require no foreign oil.
  - Hydrogen is domestically available in abundant quantities as a component of natural gas, coal, biomass, and even water.
  - The Department of Energy estimates that the Hydrogen Fuel and FreedomCAR initiatives may help reduce our demand for petroleum by over 11 million barrels per day by 2040 – approximately the amount of oil America imports today.

- Fuel cells will improve air quality and dramatically reduce greenhouse gas emissions:

  - Vehicles are a significant source of air pollution in America. Hydrogen fuel cells create electricity to power cars without any tailpipe pollution.
  - The hydrogen fuel and FreedomCAR initiatives may reduce America's greenhouse gas emissions from transportation alone by more than 500 million metric tons of carbon equivalent each year by 2040. Additional emissions reductions could be achieved by using fuel cells in applications such as generating electricity for residential or commercial uses.

- Hydrogen is the key to a cleaner energy future:

  - It has the highest energy content per unit of weight of any known fuel.
  - When burned in an engine, hydrogen can produce effectively zero emissions; when powering a fuel cell, its only waste is water.
  - Hydrogen can be produced from abundant domestic resources including natural gas, coal, biomass, and even water.
  - Combined with other technologies such as carbon capture and storage, renewable energy, and fusion energy, fuel cells could help make an emissions-free energy future possible.

Transforming Health Care: The President's Health Information Technology Plan

"By computerizing health records, we can avoid dangerous medical mistakes, reduce costs, and improve care."

--President George W. Bush, State of the Union Address, January 20, 2004

- President Bush has outlined a plan to ensure that most Americans have electronic health records within the next 10 years. The President believes that better health information technology is essential to his vision of a health care system that puts the needs and the values of the patient first and gives patients information they need to make clinical and economic decisions – in consultation with dedicated health care professionals.

- The President's Health Information Technology Plan will address longstanding problems of preventable errors, uneven quality, and rising costs in the Nation's health care system.

<u>The Problem: Challenges to the U.S. Health Care System</u>

- The U.S. health care system has a long and distinguished history of innovation. Discoveries move from the laboratory bench to the bedside, as basic research results are translated into new understanding of diseases, better diagnostic tools, and innovative treatments.

- At the same time, our health care system faces major challenges. Health care spending and health insurance premiums continue to rise at rates much higher than the rate of inflation. Despite spending over $1.6 trillion on health care as a Nation, there are still serious concerns about preventable errors, uneven health care quality, and poor communication among doctors, hospitals, and many other health care providers involved in the care of any one person.

    - The Institute of Medicine estimates that between 44,000 and 98,000 Americans die each year from medical errors. Many more die or have permanent disability because of inappropriate treatments, mistreatments, or missed treatments in ambulatory settings. Studies have found that as much as $300 billion is spent each year on health care that does not improve patient outcomes – treatment that is unnecessary, inappropriate, inefficient, or ineffective.

- All these problems – high costs, uncertain value, medical errors, variable quality, administrative inefficiencies, and poor coordination – are closely connected to our failure to use health information technology as an integral part of medical care. The innovation that has made our medical care the world's best has not been applied to our health information systems. Other American industries have harnessed advanced information technologies, to the benefit of American consumers. Our air travel is safer than ever, and consumers now have ready and safe access to their financial information. Unlike these other industries, medicine still operates primarily with paper-based records. Our doctors and nurses have to manage 21st century medical technology and complex medical information with 19th century tools. America's medical professionals are the best and brightest in the world, and set the standard for the world. It is a testament to their skill that they are able to achieve high-quality care in this antiquated system. In this outdated, paper-based system:

    - A patient's vital medical information is scattered across medical records kept by many different caregivers in many different locations – and all of the patient's medical information is often unavailable at the time of care. For example, patients with medical emergencies too often are seen by doctors with no access to their critical medical information, such as allergies, current treatments or medications, and prior diagnoses.

- Physicians keep information about drugs, drug interactions, managed care formularies, clinical guidelines, and recent research in memory – a difficult task given the high volume of information.
- Medical orders and prescriptions are handwritten and are too often misunderstood or not followed in accordance with the physician's instructions.
- Consumers lack access to useful, credible health information about treatment alternatives, which hospitals and physicians are best for their needs, or their own health status.
- Physicians do not always have the best information to select the best treatments for their patients, resulting in an unacceptable lag time before new scientific advances are used in patient care. They also do not have ready access to complete information about their patients, do not know how other doctors are treating their same patients, or how other health care providers around the country treat patients with the same condition. These conditions set the stage for preventable medical errors.

<u>The Solution – Health Information Technology</u>

- Today, the President announced an ambitious goal of assuring that most Americans have electronic health records within the next 10 years.

  - Within the next 10 years, electronic health records will ensure that complete health care information is available for most Americans at the time and place of care, no matter where it originates. Participation by patients will be voluntary.
  - These electronic health records will be designed to share information privately and securely among and between health care providers when authorized by the patient.

- President Bush believes that innovations in electronic health records and the secure exchange of medical information will help transform health care in America - improving health care quality, preventing medical errors, reducing health care costs, improving administrative efficiencies, reducing paperwork, and increasing access to affordable health care.

- The steps we need to take across the Nation are already underway in some places. Health information technologies – electronic medical records, computerized ordering of prescriptions and other medical tests, clinical decision support tools, and secure exchange of authorized information – improve quality, reduce medical errors, and prevent deaths. In the past three years, some communities, hospitals, clinicians, patient groups, and information technology companies have acted to improve their health information systems. These pioneering communities are taking the initiative and showing that health care can and must be modernized.

- The President envisions a dramatically changed system:

  - ✓ When arriving at a physician's office, new patients do not have to enter their personal information, allergies, medications, or medical history, since it is already available.
  - ✓ A parent, who previously had to carry the child's medical records and x-rays in a large box when seeing a new physician, can now keep the most important medical history on a keychain, or simply authorize the new physician to retrieve the information electronically from previous health care providers.
  - ✓ Arriving at an emergency room, a senior with a chronic illness and memory difficulties authorizes her physicians to access her medical information from a recent hospitalization at another hospital - thus avoiding a potentially fatal drug interaction between the planned treatment and the patient's current medications.
  - ✓ Three patients with unusual sudden-onset fever and cough that would not individually be reported, show up at separate emergency rooms, and the trend is instantly reported to public health officials, who alert authorities of a possible disease outbreak or bioterror attack.

The President's Health Information Technology Plan

- To achieve his 10-year goal, the President is taking the following steps to urge coordinated public and private sector efforts that will accelerate broader adoption of health information technology:

  - Adopting Health Information Standards. The President called for the completion and adoption of standards that will allow medical information to be stored and shared electronically while assuring privacy and security. The necessary work is already well underway and much of it has already been completed. In the last several years, the Department of Health and Human Services (HHS) has been collaborating with the private sector and other Federal agencies to identify and endorse voluntary standards that are necessary for health information to be shared safely and securely among health care providers. Federal agencies are accelerating their use of these standards. As part of this effort, HHS has recently negotiated and licensed a comprehensive medical vocabulary and made it available to everyone in the Nation at no cost. The results of these projects include standards for:

    - Transmitting X-Rays Over the Internet: Today, a patient's chest x-ray can be sent electronically from a hospital or laboratory and read by the patient's doctor in his office.
    - Electronic Laboratory Results: Laboratory results can be sent electronically to the physician for immediate analysis, diagnosis and treatment, and could be automatically entered into the patient's electronic health record if one existed. For example, a doctor could retrieve this information for a hospitalized patient from his office, assuring a prompt response and eliminating errors and duplicative testing due to lost laboratory reports.
    - Electronic Prescriptions: Patients will save time because prescriptions can be sent electronically to their pharmacists. By eliminating illegible handwritten prescriptions, and because the technology automatically checks for possible allergies and harmful drug interactions with other drugs, standardized electronic prescriptions help to avoid serious medical errors. The technology also can generate automatic approval from a health insurer.

  - Doubling Funding to $100 Million for Demonstration Projects on Health Care Information Technology. To build upon the progress already made in the area of health information technology standards over the last several years, the President's proposed FY 2005 budget includes $100 million for demonstration projects that will help us test the effectiveness of health information technology and establish best practices for more widespread adoption in the health care industry.

    - This increase builds on the President's FY 2004 budget which included $50 million, and these new resources will support more local and regional grants so that pioneering communities, physicians, and hospitals can show that health care can be transformed by adopting and implementing health information technology.
    - In April 2004, more than 600 applications for funding were received for these grants, and HHS will be awarding grants this summer, following their peer-reviewed process for selecting grantees.

  - Using the Federal Government to Foster the Adoption of Health Information Technology. As one of the largest buyers of health care – in Medicare, Medicaid, the Community Health Centers program, the Federal Health Benefits program, Veterans medical care, and programs in the Department of Defense – the Federal Government can create incentives and opportunities for health care providers to use electronic records, much like the private sector is doing today. The President will direct these agencies to review their

policies and programs and propose modifications and new actions, and to forward the recommendations to him within 90 days.

- Creating a New, Sub-Cabinet Level Position of National Health Information Technology Coordinator. The President announced that he is creating a new sub-Cabinet level post at HHS, to provide national leadership and coordination necessary to achieve his 10-year goal. The individual will report directly to the HHS Secretary, and will be charged by the President with:

  - Guiding ongoing work on health information standards and working to identify and implement the various steps needed to support and encourage health information technology in the public and private health care delivery systems.
  - Coordinating partnerships between government agencies and private sector stakeholders to speed the adoption of health information technology.

Promoting Innovation and Economic Security Through Broadband Technology

"This country needs a national goal for…the spread of broadband technology. We ought to have…universal, affordable access for broadband technology by the year 2007, and then we ought to make sure as soon as possible thereafter, consumers have got plenty of choices when it comes to [their] broadband carrier."

--- President George W. Bush, March 26, 2004

- Broadband provides Americans with high-speed Internet access connections that improve the Nation's economic productivity and offer life-enhancing applications, such as distance learning, remote medical diagnostics, and the ability to work from home more effectively.

- Consistent with this vision, the Administration has a record of comprehensive and demonstrably effective broadband initiatives that are creating an economic and regulatory climate in which broadband can flourish. Developing the most competitive broadband market in the world will provide American consumers with the most affordable and highest quality broadband service in the world.

- Broadband technology will enhance our Nation's economic competitiveness and will help improve education and health care for all Americans. The Bush Administration has implemented a wide range of policy directives to create economic incentives, remove regulatory barriers, and promote new technologies, all of which are essential to making broadband competitively available and affordable.

Creating Economic Incentives

- In an effort to spur investment, the President signed into law a jobs and growth package that allowed companies to depreciate capital expenditures more quickly, including capital equipment used for broadband deployment. Companies are more likely to make important investments in broadband technology if they can depreciate the capital costs associated with broadband rollout more quickly.

- President Bush is committed to making broadband affordable. The President has signed into law a two-year extension of the Internet Access Tax moratorium and has called on Congress to pass legislation that would explicitly extend the moratorium to broadband and make the moratorium permanent. Taxing broadband access would increase the cost of broadband for consumers.

Removing Regulatory Barriers

- The Administration supports the Federal Communications Commission's (FCC) decision to free new fiber-to-the-home investments from legacy regulations. Deregulating new ultra-fast broadband infrastructure to the home removes a significant barrier to new capital investments.

- On April 26, 2004, the President signed an Executive Memorandum that implements Federal rights-of-way reforms to streamline the process for broadband providers to get access to Federal lands to build high-speed infrastructure. The reforms will help to minimize burdens on industry by simplifying and standardizing the rights-of-way process across all relevant agencies, while allowing agencies to use their resources wisely.

Promoting Innovation

- The Administration has made unprecedented strides in balancing the commercial spectrum needs of critical government agencies (including Department of Defense, Department of Transportation, and Department of Homeland Security) and commercial interests. The Administration has identified 90 MHz of spectrum to be auctioned for next generation wireless services.

  - Currently only one wireless carrier is offering wireless broadband. Once the 90 MHz is auctioned, multiple wireless carriers will have the opportunity to become broadband carriers – stimulating vigorous competition and bringing lower prices and improved services to consumers.
  - The Administration has nearly doubled the amount of spectrum available for innovative wireless broadband applications such as Wi-Fi and Wi-Max. These technologies can provide a range of new services from granting consumers broadband access in restaurants, airports and other public places, to providing an economically viable solution for providing broadband services in rural areas.
  - To ensure these technologies continue to develop, the Department of Commerce's National Institute of Standards and Technology is chairing the Wi-Max standard setting body.
  - To build on this record of success, the President has launched an initiative to create a Spectrum Policy for the 21st Century. The Department of Commerce is scheduled to deliver a report to the President this summer on how to improve spectrum management.

- The Administration is working to enable the rollout of broadband technology. The Department of Commerce is developing the technical specifications necessary to enable the widespread and responsible deployment of broadband over powerlines (BPL). Having conducted 10 million measurements of BPL systems, the Department of Commerce will be able to chart the clear technical path forward for BPL to coexist with other critical uses of spectrum. Once deployed, BPL has the potential to turn every electrical outlet into a broadband pipeline.

- The President supports investment in research and development and has proposed the largest Federal R&D budget in history, $132 billion in Fiscal Year 2005. Federal research and development help lay the foundation for advances in broadband technologies. In FY 2005, the National Information Technology Research and Development (NITRD) program is budgeted for $2.0 billion and includes research directly related to broadband technology. The President proposed making permanent the Research and Experimentation Tax Credit, which promotes private sector investment in new technologies such as broadband.

- Important Facts about Broadband:

  - ✓ Broadband is high-speed Internet access.
  - ✓ Broadband in the United States is "always-on," allowing a computer to remain connected to the Internet 24 hours a day.
  - ✓ Distance learning, remote medical procedures, interactive web teleconferencing, and real-time video and audio all require Internet speeds beyond what traditional dial-up service can offer.
  - ✓ Broadband has grown from just over 7 million subscriber lines in December 2000 to almost 24 million in June 2003, a 230 percent increase.
  - ✓ Consumers are adopting broadband faster than they have adopted other technologies such as color televisions, wireless phones, VCRs, and personal computers.
  - ✓ Approximately 90 percent of all U.S. zip codes have access to at least one form of wireline broadband connection (cable modem or DSL), up from just over 70 percent at the end of 2000.
  - ✓ 75 percent of zip codes in the United States have access to broadband through both cable modem and DSL.

Better Education for Better Jobs

- America's growing economy is a changing economy, and we must respond to these changes by helping more Americans gain the skills to find good jobs in our 21st Century economy.

- President Bush has announced a plan to better prepare students for success in higher education and the job market – including $33 million for expanded Pell Grants for low-income students who complete rigorous coursework in high school and scholarships for low-income students who pursue degrees in math and science.

- The President's plan will improve the quality of education at our Nation's high schools – including $100 million to help striving readers and $120 million to improve math education. The President's plan also strengthens and modernizes vocational and technical education, expands math and science education for all students, encourages students to take a rigorous high school curriculum, and enables educators to determine whether high schools are graduating students with the skills they need to succeed.

No Child Left Behind

- To help the youngest Americans receive a quality education and learn the basic skills they will need to succeed in the future, President Bush proposed and signed into law the No Child Left Behind Act. All skills begin with the basics of reading and math, which should be learned in the early grades. Yet for too long, for too many children, those skills were never mastered. With the bipartisan No Child Left Behind Act, we are making progress toward educational excellence for every child.

    - Requiring states to set clear standards for what every child should learn – and taking steps to help each child learn.
    - Holding schools accountable for student progress by regularly testing in the fundamental subjects of reading and math.
    - Reporting results to parents and ensuring they have better options when schools are not performing.
    - Providing more funding – a 49% increase in Federal support for elementary and secondary education since 2001.

The Next Steps in Helping Young Americans Get the Skills They Need to Succeed in the 21st Century

- The No Child Left Behind Act is providing accountability and resources to improve the achievement of America's elementary and secondary students. These reforms are already beginning to show results in elementary reading and math scores, but President Bush also wants to ensure that all high school students will be better prepared to pursue higher education or enter the workforce. Unfortunately, recent results from the National Assessment of Educational Progress (NAEP) demonstrate that, while achievement for our Nation's 4th and 8th graders is on the rise, scores for twelfth graders have declined in both reading and mathematics.

    - Only 24 states require at least three years of math, and only 21 states require at least three years of science.
    - Because their math and science education is lacking, young Americans stand to miss out on job opportunities, will lack the necessary skills for post-secondary study, or will not complete post-secondary study in a timely manner.
    - Students who fall behind in reading have a greater chance of dropping out of high school altogether. Nationally, of one-hundred ninth-graders, only 67 will graduate from high school on time, only 38 will directly enter college, only 26 are still enrolled their sophomore year, and only 18 will end up graduating from college.
    - U.S. 12th graders performed among the lowest of the 21 countries assessed in both math and science on the Third International Mathematics and Science Study.

The President's Solution

High School

- Striving Readers: The Administration is proposing a new $100 million Striving Readers Initiative that would make competitive grants to develop, implement, and evaluate effective reading interventions for middle or high school students reading significantly below grade level. This program would complement the Reading First State Grants program, which provides comprehensive reading instruction for children in kindergarten through third grade that is grounded in scientifically-based reading research. The proposal would provide funds to approximately 50 to 100 school districts for reading intervention programs to help middle and high school students catch up to their peers in reading.

- Math: The Administration is proposing a $120 million increase for the Mathematics and Science Partnership program authorized in the No Child Left Behind Act. The increase would support direct Federal competitive grants to partnerships to increase achievement in mathematics for secondary students. The new 3-year competitive grants would support projects that have significant potential to accelerate the mathematics achievement of all secondary students, but especially low-achieving students. The initiative would focus on ensuring that States and school districts implement professional development projects for mathematics teachers that are strongly grounded in research and that help mathematics teachers strengthen their skills.

- Advanced Placement: Advanced Placement programs not only encourage the growth of Advanced Placement (AP) and International Baccalaureate (IB) courses, but also serve as a mechanism for upgrading the entire high school curriculum for all students. The Administration is proposing a $28 million increase for the Advanced Placement program authorized in the No Child Left Behind Act bringing spending on it to nearly $52 million a year. The increase in funds will ensure that teachers in low-income schools are well-trained to teach AP and IB courses.

- Adjunct Teacher Corps: Many school districts need opportunities and the personnel to strengthen instruction in middle and high schools in the core academic subjects, especially mathematics and science. The Adjunct Teacher Corps would help alleviate this critical situation by bringing professionals with subject-matter knowledge and experience into the classroom. The Administration is proposing a new $40 million initiative to provide competitive grants to partnerships of school districts and public or private institutions to create opportunities for professionals to teach middle and high school courses in the core academic subjects, particularly in mathematics and science.

- State Scholars: The Administration proposes $12 million in funding for the State Scholars program to make grants available nationwide. In August 2002, President Bush announced the State Scholars Initiative, modeled on the successful Texas Scholars program, to encourage high school students to take more rigorous high school courses. Under the State Scholars Initiative, 12 States have already received assistance in developing and promoting strong courses of study, as well as providing special incentives for students enrolled in these programs.

- Strengthening and Modernizing Support for Vocational Education: The major federal program for vocational education, the Perkins Vocational Education program, has remained fundamentally unchanged since its founding in 1917; President Bush proposes to modernize this pre-World War I program to better serve the needs of the 21st century worker. The President's proposal redirects $1 billion in annual funding from the Perkins Vocational Education program into a new Secondary and Technical Education program (Sec Tech) and requires

that schools participating in the program offer 4 years of English, 3 years of math and science, and 3½ years of social studies as part of their vocational education curriculum.

- Assessing Whether High Schools Are Producing Educated Graduates: To ensure that students graduating from high school have the skills they need to succeed in post-secondary education or careers, the President's plan would include 12th graders in the National Assessment of Educational Progress (NAEP). Currently, states are required to participate in the NAEP in 4th and 8th grades in reading and math every two years. Extending this requirement to 12th grade will enable educators to assess whether high schools are meeting the needs of students so they can learn the skills they will need to succeed. It will also help to identify areas where they are not meeting the needs of students and to strengthen curricula to ensure improvement in those areas.

Higher Education

- Enhanced Pell Grants: The Bush Administration proposes to establish a $33 million program to enhance Pell Grants to reward low-income students who participate in the State Scholars Program by taking a rigorous high school curriculum. This program would provide up to an additional $1,000 per year to students in the first two years of college who complete the rigorous State Scholars curriculum in high school, enroll in college full time, and are Pell Grant recipients. Next year, approximately 36,000 low-income graduating high school seniors would be eligible to receive an enhanced Pell Grant under this proposal.

- Presidential Math and Science Scholars Fund: To ensure that America remains the world leader in the innovation economy – and to ensure that America's graduates have the training they need to compete for the best jobs of the 21st century – President Bush wants to expand opportunities for math and science education in colleges and universities. The President proposes establishing a new public-private partnership to provide $100 million in grants to low-income students who study math or science. Under this plan, approximately 20,000 low-income students would receive up to $5,000 each to study math or science. Students would have to be eligible for Pell Grants to receive this additional $5,000, although this new fund would be run separately from the Pell Grant program.

    - The cost of this new initiative would be offset by an important reform to the Pell Grant program. Currently, there is no limit on the number of years an individual can receive a Pell Grant to help pay for an undergraduate degree. The Administration proposes an 8-year equivalent time limit for a 4-year equivalent degree and a 4-year equivalent time limit for a 2-year equivalent degree. This reform would encourage students to finish sooner and eliminate abuse of the program where students extend their studies excessively.

Making Federal Job Training Work Better for America's Workers

- President Bush is committed to providing America's workers with better training for better jobs. Job training for American workers is more important than ever, and we need a new way of delivering job training in America.

- America's growing economy is a changing economy, and some workers need new skills to succeed. Today's economy is an innovation economy. Two-thirds of America's economic growth in the 1990s resulted from the introduction of new technologies – and 60% of the new jobs of the 21st century require skills held by only one-third of America's workforce. We need to close the skills gap in America. Not enough workers are being trained quickly enough to take advantage of many of the new jobs that are being created. The Federal government provides state and local governments $4 billion through the Workforce Investment Act (WIA), but only 206,000 adults were trained last year.

- President Bush has proposed significant reforms to Federal worker training programs to double the number of workers receiving job training, to ensure those programs work better for America's workers, and to close the skills gap so we fill every high growth job with a well-trained American worker. The President has proposed reforming major Federal job training programs to put strict limits on overhead to ensure tax dollars support training for workers who need it. And, he has called for giving workers personal job training accounts called Innovation Training Accounts (ITAs).

Background on the President's Job Training Initiative

- The Problem: Currently, the Federal government spends almost $23 billion for more than 30 programs spread across 10 departments and agencies. The result is a confusing hodgepodge of programs, some of which have remained fundamentally unchanged for decades, and administrative costs that prevent too many dollars from getting to the workers who need training the most.

    - Bureaucracy: The programs in place to train workers are out-of-date, overlapping, and ineffective. Too often, red tape and administrative costs eat up job training money before it even gets to workers. For example, the Department of Labor found that one of its One-Stop Career Centers was using less than 10% of its Federal money for training displaced workers. Most of the funds went to administrative costs—not training workers. *President Bush believes that every dollar spent on unnecessary bureaucracy is a dollar taken out of the pocket of a worker who needs job training.*
    - Complexity: Job training programs are set up with so many rules that many workers, potential employers, and local community colleges do not participate. For example, 30 states have been granted temporary relief from these requirements so they don't lose their link with community colleges. However, there are limits to what we can do under the current law. *President Bush recognizes that the best training is not filling out forms – it is learning on the job or at a community college.*
    - Limited Accountability: Currently, there is no clear standard or benchmark to measure the effectiveness of federal job training programs. Federal grants to states for job training have 17 different measurements of accountability. *President Bush proposes to refocus these programs on the end results that matter most to America's workers – Did you get a job? How long did you keep it? And how much are you being paid?*
    - Failure to teach skills in demand: Remarkably, even though the law requires it, many job training programs do not assess what skills are in demand for jobs in the worker's area. Instead, workers are moved through the system with little regard for whether they will have a realistic chance at a job when they complete training. *President Bush believes we should be training workers for jobs in sectors of the economy that are most likely to grow.*

The President's Solution

- Less Red Tape and More Help for Workers: The President's plan establishes a clear goal that the vast majority of job training dollars should go to the workers who need them – rather than to bureaucratic overhead. Currently, administrative expenses are capped at 15%, but regulatory loopholes allow too many of our training dollars to be spent on bureaucracy and other non-training services. The President's goal is to double the number of workers receiving job training by maximizing the available Federal dollars going to workers and eliminating unnecessary overhead costs.

- New Innovation Training Accounts (ITAs): The President proposes new Innovation Training Accounts to provide workers with more flexible and responsive assistance. Workers would have more job training choices – they would be able to use community colleges, private-sector training providers, local businesses, or community organizations – to get the help they need in the most effective and efficient way possible. These ITAs would give states considerable flexibility to tailor training programs to the unique economic conditions of each state. ITAs would consolidate 4 major training and employment grant programs totaling $4 billion into a single grant, eliminating unnecessary overhead costs and making Federal support more effective and efficient.

- More Accountability: Under the President's plan, states would be given more flexibility to design their own workforce training programs. But they would also be required to set clear goals and outcomes focused on the number of workers placed in jobs, the duration of the job placement, and the earnings of the job. The President proposes consolidating the number of state performance goals of the Federal job training system from 17 to 3. Under the new goals, accountability will be determined by asking these questions: *How many people are finding work? How much are workers earning in their new jobs? How long are they staying in these jobs?*

- Jobs for the 21st Century Initiative: The President's Jobs for the 21st Century Initiative, announced in the State of the Union Address, includes a $250 million proposal to help America's community colleges train 100,000 additional workers for the industries that are creating the most new jobs. This expands the Department of Labor's successful High Growth Job Training Initiative, launched under President Bush in 2001, which has provided $71 million in 38 partnerships nationwide between community colleges, public workforce agencies, and employers. These initiatives help community colleges produce graduates with the skills most in demand by local employers.

- Personal Reemployment Accounts: The President has also proposed $50 million for a pilot program of accounts of up to $3,000 for those unemployed workers who have the most difficulty finding jobs to use toward job training, transportation, childcare, or other assistance in obtaining a new job. Workers who found a job quickly would be able to keep the balance of the account as a reemployment bonus.

Panel 5
Private Sector Incentives for Investment in Research

THE NEW WORLDWIDE COMPETITIVE REALITY: PRIVATE SECTOR RECOMMENDATIONS TO IMPROVE THE UNITED STATES INNOVATION ECOSYSTEM

Wayne Johnson
Director, Strategic University Customer Relations Worldwide, Hewlett-Packard

Hewlett-Packard Company (H-P)[1] is pleased to have an opportunity to participate in today's National Science and Technology Summit panel discussion on "Private Sector Incentives for Investment in Research." Our White Paper is intended to identify key issues related to such incentives. Because Hewlett-Packard participates in many broader policy-oriented organizations and coalitions in the United States, we wish to make sure that some of the policy research conducted by H-P supported entities is also factored into today's discussion, given the limited time we have today, we hope to create a record of topics and issues that need to be considered for further analysis.

Coming from a worldwide perspective, it is our observation that effective national innovation policy is increasingly crucial in driving successful economic outcomes and high level job growth. Countries with an integrated, holistic strategy focused on "innovation ecosytems" are increasingly competitive and in some cases superior to the ad hoc and increasingly fragmented U. S. system. Ironically, much of their national strategy is the result of benchmarking the best pieces of our system and implementing them in a well funded and increasingly coherent manner.

Accordingly, Hewlett-Packard wishes to cite in particular a recent report issued by ASTRA (The Alliance for Science and Technology Research in America) entitled *Riding the Rising Tide: ASTRA's Strategy for Enhancing U.S. Competitiveness and Prosperity*. This report, which was contributed to and vetted by scientific and engineering societies, industry partners like H-P and academic institutions, proposes a *14-point Innovation Action Agenda* for the US which we believe is an important part of today's discussion.

[1]HP focuses on simplifying technology experiences for all of its customers – from individual consumers to the largest businesses. With a portfolio that spans printing, personal computing, software, services and IT infrastructure, HP is among the world's largest IT companies, with revenue totaling $110.4 billion for the four fiscal quarters ended April 30, 2008.

Overview: New Competitive Realities for the United States

Our comments today need to be seen in context of the new competitive realities for the United States. These include:

- Many nations are strengthening science and technology (S&T) capabilities
- China and India are rapidly becoming R&D leaders
- Our strategic competitors are building their talent bases and workforce skills to compete in science and technology enterprises in numbers that outstrip current U.S. capacities
- Emerging economies are showing rapid increases in S&T investments
- Global competitors are focused on physical science and engineering research
- Globalization of value chains require a new "nimbleness" and suggest that U.S. policy should be altered to insure that "investment in immobile assets should be emphasized because they confer more sustained advantages on the domestic economy and increase the ability to manage the more a mobile assets over a technology's life cycle."[2]
- Rapidly expanding global labor supply

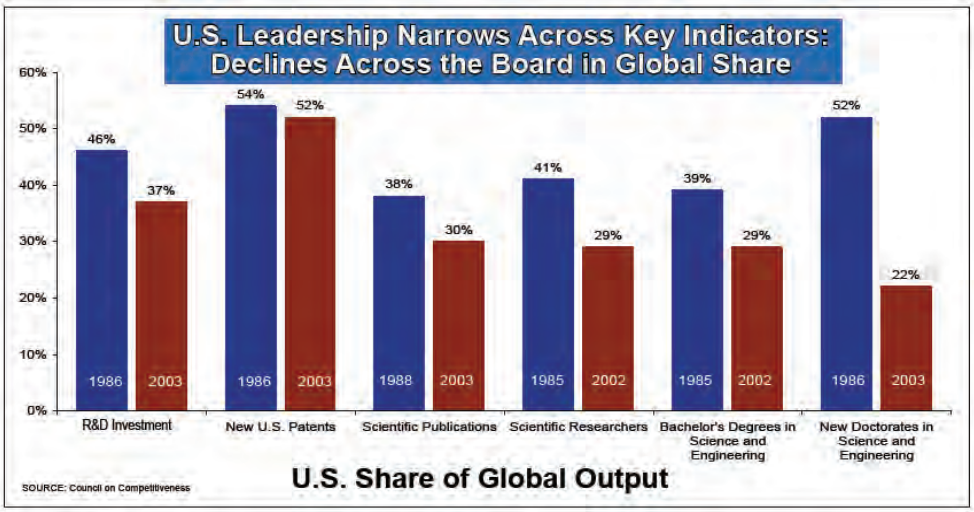
Global competitors benefit immensely from R&D performed in the U.S. as well as related business and design models developed within the U.S. They are adept at harvesting the best of U.S.-originated inventions and innovation, business design models, and even public policy ideas. This is further complicated by the fact that we in the U.S. find ourselves in competition not only with individuals, companies and private institutions, but also with governments and mixed government-private collaborations. Such entities are capable of using legitimate policy concerns, such as the standards-setting process, to thwart market entry by non-national interests. Many other non-trade barriers exist which stifle competition. While not a focus of this White Paper, U.S. trade policy should factor such behavior into multi- and bi-lateral trade agreements.

Many times, private U.S.-based interests find themselves in direct competition with foreign governments themselves and they have little recourse when aggrieved. U.S. policy makers need to better understand the consequences of these activities and the ways in which such barriers stifle global innovation while at the same time eroding U.S. competitiveness. Other concerns, such as the failure to respect and/or protect intellectual property, and the imposition of national policies that prevent U.S. firms' market access, have been detailed elsewhere.

H-P, along with our many partners in competition, chooses to compete globally because we must. There is no alternative. With less than 5% of the world's population, U.S.-based companies must go where the markets are. Paradoxically, the global

[2]Dr. Greg Tassey, Chief Economist at the National Institute of Standards and Technology, as quoted in Abstract to *Globalization of Technology Based Growth: The Technology Imperative*, pp. 14–15. May 2008.

innovation “ecosystem” in which we participate permeates all areas of economic activity, down to the local level in virtually every U.S. community. The growing interconnection of the global economy creates great opportunity, as well as the potential for increasing political and economic conflict as well. The world may be both “flat” and “spiky,” to paraphrase recent best-selling studies on this topic. As our White Paper tries to demonstrate, the implications global competition has are of immense importance to U.S. economic, military and political power — as well as every citizen’s standard of living and ability to prosper in a world of constant change.



The chart above epitomizes the challenge faced by U.S.-based interests. It compares U.S. leadership in terms of global market share in key innovation indicators between 1986 and 2003.

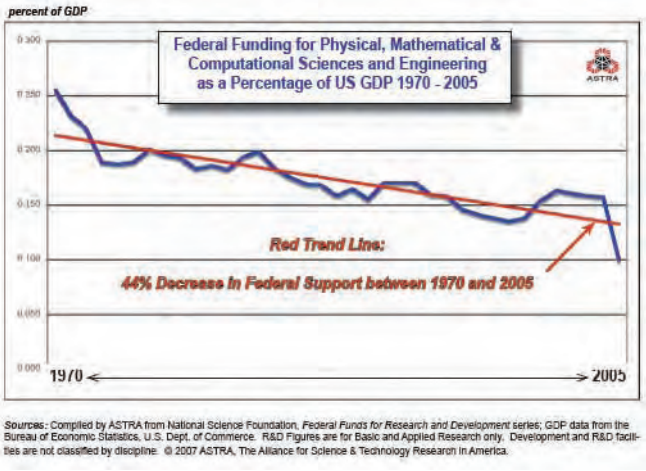
Recommendations

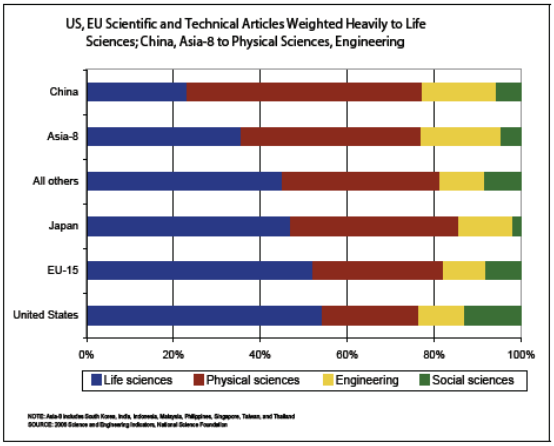
The following is a series of steps, influenced by the ASTRA report referred to above, that HP believes is a blueprint for beginning to remedy some of the problems that are serving to hamper our competitive potential and our long term viability as a leader in many fields of technology that have become the foundation of our modern economy.

They are presented here as an outline of critical issues that need to be addressed by our policy makers in Washington, and our innovation ecosystem as it has evolved throughout the nation, and indeed throughout the world.

1. INCREASE FEDERAL FUNDING FOR PHYSICAL SCIENCES AND ENGINEERING RESEARCH

The Congress and the Administration must fulfill the physical sciences and engineering R&D commitments made in President Bush’s American Competitiveness Initiative (ACI) and the America COMPETES Act of 2007. However, to ensure that funding expands beyond increases in inflation, the timetable for these investments should be accelerated. In addition, investment should be increased beyond the ACI recipient agencies.





2. *INCREASE AND STABILIZE FUNDING FOR APPLIED RESEARCH, INCLUDING SBIR AND TIP FUNDING*

The Federal government should increase and stabilize funding for applied research and advancing promising, high-risk technologies with substantial economic potential to bring them to a stage of maturity that is attractive for private sector investment. This includes funding for the new Technology Innovation Program (TIP) and other programs that meet this objective. In addition, the approach to SBIR funding should be reviewed to determine how this program could maximize its ability to contribute to the U.S. innovation base.[3]

Most business R&D is aimed at incremental improvements, and developing new and improved goods, services, and processes to capture faster returns to companies and shareholders. However, some results emerging from basic research— as well as early-stage technologies — are not sufficiently developed and, thus, too risky to attract investment from individual companies. In addition, few financial institutions, venture capitalists, and angel investors are willing to fund unproven, early stage technologies.

As a result, promising technologies may be ignored or developed too slowly to compete in rapidly changing world markets. The Federal government has made some investments to further the development of high-risk as well as generic technologies to bring them to a stage of maturity at which the private sector is able to invest to bring them to market. These investments have been carried out in programs such as the Commerce Department's Advanced Technology Program (ATP), the research agency-wide Small Business Innovation Research program (SBIR), and the investments of the Department of Energy in developing alternative energy technologies. For over a

[3]The *America COMPETES Act* eliminates the Advanced Technology Program (ATP) and authorizes a new Technology Innovation Program (TIP) at NIST. Many features of TIP are new; however, it retains the focus on investment in high-risk, high-payoff technologies offering substantial economic benefits for the nation. The most recent TIP competition has targeted "critical needs" areas for technology development. While the FY 2009 competition is very modest, about $9 million, this program should be ramped up in future Fiscal Years.

decade, funding for ATP has been uncertain. Meanwhile competitor nations have moved aggressively to develop programs supporting applied R&D, many modeled after successful U.S. programs. Having said this, there remain excellent examples of government sponsored research such as DARPA and NSF that have continued to exhibit an excellent track record in this space.

3. FOCUS R&D ON LEADING EDGE OF SCIENCE AND TECHNOLOGY

A larger share of Federal R&D investment should focus on the leading edge of science and technology, especially in fields expected to have revolutionary impacts — fields such as nanotechnology, biotechnology, high-performance computing, optical engineering and photonics, and areas of critical national need, including infrastructure improvement, energy self-sufficiency, and cyber security.

One of the interesting developments in how the U.S. conducts its R&D enterprise is the trend toward applied research and away from basic research, i.e., research that is conducted without a specific application in mind. Given their need to answer to shareholder concerns about near term profits, corporations no longer make this kind of research a priority. Instead, the conduct of basic research has fallen to the government-sponsored work that takes place in universities and at the national labs. Given this new reality, we need to ensure that these organizations, and the funding they receive, does not veer in the direction that corporate America has been forced to take. This shift of priorities has been especially true in the area of defense and national security research where there has been a radical shift from basic to applied research; so much so that Secretary Gates has noted this trend and established a special committee to examine the problem and develop approaches to shoring up the basic research enterprise at the Department. HP commends the Secretary for his foresight and suggest that other agencies conduct a similar review to redress a growing imbalance and excessive concentration on applied research.

4. STRENGTHEN, SIMPLIFY, AND MAKE PERMANENT THE R&E TAX CREDIT

The Federal government should strengthen the R&E tax credit for research performed in the U.S., and make it permanent. The data from other countries indicate that such tax incentives can be effective if they are properly targeted and not burdensome to implement and administer. In today's world of global markets and competition, there is a need to use all the policy tools available to drive desired activities and support the creation of an enhanced R&D capability in the U.S.

The R&E tax credit in the US has been ''temporary'' for 25 years and has been allowed to expire on several occasions. Today, the US has been without a tax incentive for research since it lapsed on December 31, 2007. To make matters worse, the US tax credit for research is not as generous as the incentives offered by many of our competitors. According to an OECD study, the US offered the most generous R&E tax credit during the 1980s, but by 2004 the US fell to 17th place among OECD nations.[i] Given the relative weakness of the credit and its temporary nature, the impact of the credit has fallen far short of realizing its stated objectives.

To have a significant impact on how a corporation such as HP conducts its research, a tax incentive should be focused on stimulating the amount of industry-funded R&D, as opposed to attempting to adjust the composition of such spending. Underinvestment problems at specific phases of the R&D cycle or for elements of industrial technologies with strong public good content (i.e., those with infrastructure character), can be addressed more effectively in most cases with direct government funding. However, if the U.S. policy objective is to create incentives to perform more research in this country, then there are a few simple steps that would assist in achieving that result. First, the tax credit must have an implementation schedule that is in keeping with corporate R&E planning horizons. Rather than constantly being subject to expiration and either renewed at the eleventh hour by Congress at the close of the legislative session, or allowed to lapse as is the case right now, the credit needs to be structured with at least a 5 year life where the term is extended every year. Ideally, the credit should be made permanent. That would make a difference for HP.

Similarly, the credit should be strengthened and simplified to provide a genuine incentive for research. Congress took the right step in 2006 by restructuring the credit and adopting the Alternative Simplified Credit (ASC), which resulted in a greater benefit to more companies. But as Congress works to renew the credit, it must further strengthen the ASC to provide an even greater incentive for US-based research.

5. INCREASE R&D TO SUPPORT THE GROWING SERVICES SECTOR

The Federal government should increase R&D to support the U.S. service economy, including support for services innovation, productivity, efficiency, competitiveness, and technical workforce development.

Section 1005 of the *America COMPETES Act of 2007* calls for a study and report to Congress on how the Federal government should support -- through research, education, and training -- the emerging management and learning discipline known as service science.

Measurement of service sector innovation is a significant weakness in the current structure of reporting on innovation. Innovation in the service sector comes in many guises, ranging from things such as patents, which are relatively easy to quantify, to items such as business model innovations that are highly productive and highly profitable for the firms that employ them, but largely unquantifiable. Given the large role services play in U.S. gross domestic output, as well as the rapidly growing R&D activities in this sector, this is an area of significant need.

6. INCREASE FOCUS ON INTERDISCIPLINARY AND MULTI-DISCIPLINARY RESEARCH, NEW FORMS OF COLLABORATION, AND NURTURING INNOVATIVE CAPACITY IN GEOGRAPHIC REGIONS WHERE INNOVATIVE CAPACITY EXISTS BUT IS UNDER-USED

While investigator-driven research remains the cornerstone of Federally supported academic R&D, the Federal government should increase attention to emerging opportunities for interdisciplinary and multidisciplinary research, including a focus on centers of research excellence where rapid development of innovations requires this type of collaboration. This includes reaching out to academic institutions in geographic

regions in which the potential for innovative capacity exists—such as high quality research and researchers—but needs further nurturing.

The United States has seen the clustering of companies, venture capital, and associated business services around geographic areas that have a strong R&D asset base. Most academic R&D is concentrated in relatively few of the 3,600 U.S. institutions of higher education. About 100 institutions account for 80 percent of academic R&D, and the top 200 institutions account for about 95%. The Federal government continues to provide nearly two-thirds of the funding for academic R&D. But the increasing success of "have" geographic regions and clusters and the frustration of "have not" technology regions should be a major focus of policy in this area. Lack of an adequate R&D asset base stymies economic development and contributes to growing income disparities within regions and states.

The "focus research center" concept is very important. Visiting researcher programs can enhance knowledge transfer between performers and users of research, as can joint seminars, colloquia and workshops. In addition, because a critical mass of research is taking place in a single location, such a research center can serve as a powerful magnet for: attracting businesses that could benefit from the research, investment for commercializing innovations emanating from the research, and scientific and technical personnel who are attracted to a center's research agenda.

7. PROVIDE INCENTIVES FOR BENEFITS OF FEDERAL R&D TO BE CAPTURED WITHIN THE U.S.

To ensure that the U.S. reaps the benefits of Federal R&D investments, the Federal government should examine what incentives can be put in place to enable adequate returns from public R&D to be captured domestically. For example, the U.S. should consider devoting a small part of the Federal research portfolio to investments in applied research, technology prototyping, demonstration projects, testing, pilot-scale production and other precompetitive activities to increase the likelihood of eventual commercialization on our shores.

There is growing concern about the potential for the migration of U.S.-based research assets to other countries, especially emerging economies where companies are attracted to rapid market growth. This concern arises from the increasing trend of companies locating manufacturing, services, and some R&D or technical services in close proximity to their markets. This concern also arises from the fact that science and technology flow easily around the world. However, new knowledge and technology are not well codified and, thus, more difficult to transfer.

8. PERFORM WHITE HOUSE REVIEW OF LAWS, REGULATIONS AND POLICIES; ADDRESS INHIBITORS TO INNOVATION

The next President should launch a White House level initiative to perform a comprehensive review of U.S. laws and regulations relating to the business climate for innovation. This would include regulations promoting human health and safety, standards for environmental protection, as well as tax, trade and antitrust policies, to

determine whether changes are needed to meet the nation's public policy goals while, at the same time, promoting innovation and competitiveness.[4]

While investment in R&D, and development of world-class scientific and engineering talent are necessary foundations of an innovation economy, investment in these assets alone is insufficient to ensure America remains the world's leading innovation economy. There are many factors that drive the transformation of knowledge into useful products and services, and value for society.

Today, innovation is increasingly a global, multidisciplinary, distributed, and interactive activity. While R&D is performed in academic, government laboratory, and business settings, business is the key player in moving technology from concept to commercial product or service. Successful innovation draws on many non-technical activities, such as organizational design, training, financial engineering, marketing and customer relationships. Entrepreneurs and innovating enterprises are the prime agents for transforming knowledge and commercializing products, services, and processes.

Government regulatory, tax, and trade policies can create an environment that encourages and rewards or serves as a barrier to innovation. In addition, the effects of external conditions, such as ever increasing health care costs, affect competitiveness. U.S. firms face higher compliance costs in labor, environmental, and other government regulatory areas than do many of their trading partners, particularly in the developing world. These costs can affect a firm's financial ability to invest in innovation, as well as its decisions about where to locate business activity and manufacturing. The need to comply with both Federal laws and often widely varying state and local approaches can discourage the location of research, engineering and production facilities in the United States. Regulatory approaches also can discourage the creation and deployment of more innovative technologies.

Innovating enterprises interact with an innovation "ecosystem" that includes: capital resources; industry codes and standards; government regulatory, tax, and trade policies; state and regional technology initiatives; entrepreneurial culture; telecommunications and social networks; and organizational, management, and business practices. Government regulatory, tax and trade policies can create a business environment that either encourages and rewards or serves as a barrier to innovation. The costs of doing business— including the costs of regulatory compliance—affect a firm's financial ability to invest in innovation, as well as its decisions about where to locate business activity and manufacturing. In addition, some times regulatory approaches can discourage the creation and deployment of more innovative technologies.

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[4]Section 1002 of the *America COMPETES Act of 2007* calls for a study that would include a review of: certain aspects of laws and regulations related to business financial reporting; the costs faced by U.S. businesses engaging in innovation compared to foreign competitors, including health care costs; Federal regulations that may discourage or encourage innovation; and provisions of the Federal tax code that discourage innovation.

To ensure U.S. technological leadership in today's global economy, the United States will need to attract leading edge R&D and business investment from around the world, and creating a welcoming pro-innovation business climate is an essential ingredient in attracting that investment. Because most U.S. tax, trade and regulatory policy was developed without innovation in mind, a comprehensive review of these regimes would be beneficial to ensure that other priority U.S. goals—such as ensuring human health and safety—are accomplished while, at the same time, promoting U.S. innovation leadership.

Capital resources are needed to invest in the innovation process, and new product, service, and market development. Large companies provide their own capital to finance technology development and commercialization — or use the process of "merger and acquisition" to accomplish strategic goals. Venture capital and angel investing play key roles in moving innovations in small companies from the laboratory to the marketplace.

Another way to strengthen the innovation climate in the country is to make the US the destination for the top scientific talent from around the world. Unfortunately, the current immigration system inhibits the ability of US companies to attract and retain high-skilled foreign workers, many of whom were educated at US universities. There is almost universal support for efforts to reform the existing laws governing high-skilled foreign workers, but this issue has become held hostage to the broader and more controversial debate over comprehensive immigration reform. These barriers must be removed to enable high-skilled foreign workers to remain in the US and continue to contribute to the innovation economy.

The existing patent system needs to be reformed to improve patent quality and eliminate speculative and wasteful litigation. Too many poor quality patents are being issued, and the current rules have created incentives for litigation in an effort to secure excessive damage awards or settlements. Genuine inventors and inventions should be protected, but speculative litigation works as a drain on innovation. Congress and the courts must remedy this situation.

9. DEVELOP A MEANINGFUL SET OF INNOVATION INDICATORS TO GUIDE U.S. INNOVATION POLICY AND STRATEGY

The Federal government should lead efforts to determine where the priorities are, and to begin the process of developing some high level indicators around the key drivers of innovation that are known and recognized.

Knowledge and innovation are increasingly important to the U.S. economy. Yet, many elements of our measurement systems were designed to measure an economy dominated by manufacturing and physical goods production. The United States needs to develop a portfolio of metrics to better understand the unfolding innovation economy, and the relative position of the United States and U.S.-based firms' competitiveness in the global economy.

In recognition of this need, ASTRA launched its *Innovation Vital Signs* project in 2007 which is important for future policy discussion in this area. ASTRA developed an

innovation framework that provides a foundation for understanding the processes and interrelationships of the innovation ecosystem, performed a comprehensive survey of public and private sector innovation indicator sources, and developed a systematic database of innovation indicators, including an analysis of the utility and quality of available indicators.

The *Innovation Vital Signs* project identified many key aspects of the innovation economy that are difficult to measure, or not measured at all. For example, measurement of intangibles in the economy is an area in need of significant improvement. The economic and statistical constructs of the United States—as represented in the economic and financial data gathered by government—are still largely focused on their roots in manufacturing. These measures largely focus on tangible assets—physical assets such as plant, equipment, and inventory; and financial assets, such as cash, securities, and investments. This bias needs to be addressed given how the economy has changed in the past 50 years, and how it is likely to change in the next 50 years. It has been estimated that investment in intangibles in the U.S. economy is as high as $1 trillion, about the same as investment in tangible capital.

At the national level, intangibles that are important in an innovation economy include patents and copyrights, the percent of the workforce with higher degrees in science and technology-related fields, the level of entrepreneurial activity, and the level and availability of venture capital. At the firm level, intangibles might include management leadership, the organization's technology and processes, human and intellectual capital, workplace organization and culture, and brand equity.

The measurement of intangibles is improving; we have a much better overall idea of the size and importance of intangibles to national and firm-level economic activity. However, our measures are still approximate estimates. Much more needs to be done to bring our economic measurement systems into the age of information, knowledge, and intangibles. Other areas where new systems of measurement is required include:

- It is generally acknowledged that much innovation occurs at the entrepreneurial and small firm level. But very little is being done to measure the innovation contribution made by these sectors of the U.S. economy. This would include a focus on angel investing, an investment component that is believed to have grown as large as the venture capital industry. Any effort to measure innovation and its impact on the economy must include the small business and entrepreneurial sectors.
- It is widely believed that, in all areas of academic and corporate research, there is an increasing focus on and need for multidisciplinary approaches to solving technical issues. This reflects an emerging and evolving research model that is far more complex than in the past. However, there is no effort ongoing to capture this change in the way research is being conducted.
- Of significant importance are the infrastructural conditions that support innovation. These enable individuals to benefit directly from their innovations through some form of commercialization. Components such as legal, financial, education, and energy systems are preconditions for successful innovation, and they vary country-to-country. Yet, no

attempt has been made to define, in a rigorous and quantitative way, these infrastructure conditions for innovation, though much of this data is currently compiled.

10. CREATE AND PROVIDE ADEQUATE SUPPORT FOR GOVERNMENT ANALYSIS OF U.S. AND FOREIGN INNOVATION SYSTEMS

The U.S. must create—and provide meaningful financial resources to—institutions within the Federal government capable of performing high quality analysis of U.S. and foreign innovation systems, and formulating a Federal innovation policy and investment agenda commensurate with the new economic realities and 21st century competitiveness challenges.

The current inventory of indicators and measurement methods does not adequately describe the dynamics of innovation today. The *Innovation Vital Signs* project found that there is not a commonly accepted framework for innovation indicators based on a widely accepted theory of innovation. Innovation is a very complex activity with many dimensions, a fact that makes a better understanding of innovation that much more important. Any potential innovation indicator, at best, provides only a partial and limited view of the innovation process; there is no single indicator that properly captures the complexity of the process. The *Innovation Vital Signs* project reviewed thousands of indicators, but found only a very limited number that can be said to have a strong connection to the measurement of innovation.

The United States needs to develop a structured system for capturing data, and routinely reporting on “innovation vital signs.” The purpose of such a system would be to provide policymakers a tool to evaluate the nation’s innovation capabilities and performance, and to better assess policy choices and potential impacts. This system should take a multi-dimensional and comprehensive view that recognizes the complexity of the innovation process and the context in which innovation takes place.

In addition, the Federal government lacks adequate capacity and resources devoted to innovation-related policy analysis and development. Over the past two decades, competitor nations have dramatically increased the level of national attention and resources devoted to research and analysis regarding the global economy, national systems of innovation, and development of strategies to promote technology development and commercialization. In contrast, the United States has downsized its innovation-related analytical and policy-making infrastructure, including the elimination of the Congressional Office of Technology Assessment in the mid-1990s, and the Technology Administration within the U.S. Department of Commerce in 2007.

The development of globalization in many markets, and the ongoing rapid shift to a knowledge economy, require that the United States have a better sense of where we are and where things are going. When today’s modern enterprise innovates, it rarely does it with only its own internal resources. Rather, innovating enterprises interact with an innovation “ecosystem,” a system made of many players, connections and linkages between customers, suppliers, government, education, research, and other economy actors.

The Federal government is an essential player in this process and significant changes in federal policy are needed if the U.S. is to meet its global challenges.

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FOREWORD

The Federal Laboratory Consortium for Technology Transfer (FLC) regularly reviews and updates its Strategic Plan, the purpose of which is to enhance the FLC's role as the nation's leader in technology transfer. The *FLC Strategic Plan for 2009*, which was approved by the Executive Board in July 2008, has helped the FLC accomplish this by ensuring that the Consortium provides the highest level of services to its members, as well as effective outreach to and coordination with all of its customers, including federal agencies and laboratories, industry, academia, state and local governments, and other nongovernmental technology transfer organizations.

In conjunction with the *FLC Strategic Plan for 2009*, the FLC, as part of an ongoing effort to improve its ability to meet the needs of its customers, developed a detailed "Execution Plan for the FLC Strategic Plan" that details how the goals and objectives identified in the Strategic Plan will be implemented. This focused approach will help the Consortium ensure that technology transfer remains a vital force in helping the U.S. economy maintain its leadership in the 21st century global economic environment.

The *FLC Strategic Plan for 2009*, and the "Execution Plan for the FLC Strategic Plan," were developed by the Planning and Policy Committee and approved for implementation by the Executive Board in July 2008.

J. Susan Sprake
Planning and Policy Committee Chair

July 2008

OVERVIEW

This document presents the Strategic Plan for the Federal Laboratory Consortium for Technology Transfer (FLC). It sets forth the FLC's vision, mission, goals and objectives. It includes an attached "Execution Plan for the FLC Strategic Plan," which details the action program, including specific activities, schedules, and responsible individuals, through which the FLC will implement its Strategic Plan.

VISION

The FLC, a nationwide network of more than 700 federal laboratories representing 17 departments and agencies, will be the nationally recognized leader for technology transfer. The FLC will provide the highest quality services and products to its membership so as to:

- Educate and train federal technology transfer professionals.
- Link technologies with laboratory missions and the marketplace.
- Enable federal laboratories to facilitate the transfer of federally funded technology to nonfederal sectors, such as U.S. business and state and local governments.
- Facilitate the effective and efficient application of federal research and development (R&D) resources to federal agency missions.
- Facilitate the use of incoming technology to help meet federal agency missions.
- Provide opportunities for its member laboratories to collaborate with the private and public sectors.

MISSION

The FLC was formally chartered in 1986 by the Federal Technology Transfer Act (P.L. 99-502) to help implement the nation's national technology transfer policy. In accordance with its legislative mandate, which is codified in 15 United States Code (USC) 3710, the FLC will facilitate federal technology transfer by providing the forum for education, training, and laboratory networking to enhance professional development and to encourage excellence in federal technology transfer in order to assist federal agencies, laboratories, and their partners in the private sector to accomplish the rapid integration of R&D resources into the mainstream of the U.S. economy.

The FLC activities authorized by the Federal Technology Transfer Act of 1986 and codified in 15 USC 3710(e) are:

- Develop and administer technology transfer techniques, training courses, and materials to increase the awareness of federal laboratory employees regarding the commercial potential of laboratory technology and innovations.
- Provide advice and assistance to federal agencies and laboratories for use in their technology transfer programs.

- Provide a clearinghouse for requests for technical assistance from state and local governments, business, industrial development organizations, and not-for-profit organizations, including universities, federal agencies and laboratories, and other persons.
- Facilitate communication and coordination between Offices of Technology Applications (ORTAs) at federal laboratories.
- Utilize the expertise and services of the National Science Foundation, the Department of Commerce, NASA, and other federal agencies as necessary.
- Facilitate the use of appropriate technology transfer mechanisms.
- Assist laboratories with establishing programs using technical volunteers to provide technical assistance to local communities.
- Facilitate communication and cooperation between federal laboratory ORTAs and regional, state, and local technology transfer organizations.
- Assist colleges and universities, businesses, nonprofit organizations, state and local governments, and regional organizations with establishing programs to stimulate research and to encourage technology transfer in such areas as:
  - Technology program development
  - Curriculum design
  - Long-term research planning
  - Personnel needs projections
  - Productivity assessments.
- Seek advice in each FLC region from representatives of state and local governments, large and small businesses, universities, and other appropriate persons on the effectiveness of the technology transfer program.
- Work with the Director of the National Institute on Disability and Rehabilitation Research to compile a compendium of current and projected federal laboratory technologies and projects with an impact on assistive technology for individuals with disabilities.

GOALS AND OBJECTIVES

To realize its vision and accomplish its mission, the FLC has developed strategic goals and objectives designed to provide the necessary environment, organization, and technology transfer mechanisms to facilitate the fullest possible use of federally sponsored R&D by potential users in the public and private sectors. The FLC's goals and objectives, which are fully detailed in the "Execution Plan for the FLC Strategic Plan," are summarized and described as follows:

- **Strategic Goal 1—Develop FLC Members to Be Leaders in Technology Transfer**

  - **Strategic Objective 1-1**—Provide and promote networking opportunities between FLC members and external organizations through national and regional meetings, partnering with other technology transfer organizations, and utilizing innovative networking tools.
  - **Strategic Objective 1-2**—Provide technology transfer education and training opportunities for FLC members by implementing national and regional education and training events, developing onsite and Internet-based technology transfer courses, providing technology transfer resource materials, developing a professional development curriculum, and developing and maintaining databases of education and training resources and technology transfer mechanisms and procedures.

- **Strategic Objective 1-3**—Promote a national and regional FLC technology transfer awards program recognizing outstanding technology transfer accomplishments by individuals and member laboratories/agencies.
- **Strategic Objective 1-4**—Provide a membership and communications program that optimizes awareness of the FLC and technology transfer by providing resources and services to enable members and partners to learn about the FLC, technology transfer, and member capabilities; and enhancing new member outreach efforts.

- **Strategic Goal 2—Foster the Environment for Technology Transfer**

  - **Strategic Objective 2-1**—Enhance access to federal technologies and facilities through participation in trade shows, publication of success stories, links to FLC contacts and resources, and promotion of laboratory events.
  - **Strategic Objective 2-2—**Maintain a comprehensive system of communications through a publications program for members, potential members and partners, including industry; annual reports to Congress on the FLC's technology transfer activities; a proactive outreach program to the communications media regarding technology transfer efforts and events; and enhancement of electronic communications activities, including the FLC website.
  - **Strategic Objective 2-3**—Assist state and local governments, regional organizations, and academia to encourage technology transfer by establishing a formal mechanism for interaction between states and federal laboratories, with the explicit mission of developing funded strategic technology-based economic development initiatives.; and creating a brand for federal laboratories as a key contributor to technology-based regional economic development.
  - **Strategic Objective 2-4**—Identify potential alliances by enhancing coordination/cooperation with professional organizations and trade unions and enhancing the FLC's efforts to develop national technology initiatives in partnership with external organizations.

- **Strategic Goal 3—Enhance the Professional Organization Structure of the FLC**

  - **Strategic Objective 3-1**—Increase FLC membership and participation through a formal membership committee structure, enhancing recordkeeping, increasing member involvement in the voting process, and increasing member participation in national and regional meetings.
  - **Strategic Objective 3-2—**Plan for leadership development by establishing criteria for leadership positions, examining potential changes to the FLC bylaws, and developing an FLC Leadership Training Plan.
  - **Strategic Objective 3-3—**Improve organizational structure by investigating engaging a full-time professional executive director and examining the benefits of reorganizing the Executive Board.
  - **Strategic Objective 3-4—**Improve the FLC's management process and communication by integrating strategic, operational, and financial planning activities; establishing an official calendar of regular, ongoing events, venues, and themes; and improving communication with the FLC's constituency, including Congress, Agency

Representatives, and laboratory directors.

EXECUTION PLAN FOR THE FLC STRATEGIC PLAN

In order to implement the Strategic Plan, the FLC developed an operational plan entitled the "Execution Plan for the FLC Strategic Plan," which provides a detailed, coordinated approach to the tasks required to implement the goals and objectives described in the Strategic Plan. The Execution Plan identifies each strategic goal and objective described in the Strategic Plan and the FLC executive responsible for its accomplishment; describes the actions ("action statement") required to implement the objective and identifies the responsible action leader; and spells out the detailed tasks ("execution action"), including start, due, and completion dates, required to accomplish the action statement.

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The Global Environmental Management Initiative (GEMI)

A Case for Corporate Leadership: Two Decades of Environmental, Health and Safety (EHS) and Sustainability Progress

GEMI®

In the Beginning

In 1990, a group of corporate environmental leaders from The Business Roundtable recognized the need for corporate environmental leadership around the world. They had a vision that it was possible for a wide array of business sectors to: work together; learn from each other; share what they had learned; and, improve the environment and the ways their companies operated around the world while at the same time increasing the value of their businesses. Their vision led to the creation of the Global Environmental Management Initiative (GEMI).

In the early years of the environmental movement many in the NGO community were attempting to pursue regulatory agendas that would mandate codes of conduct for corporate environmental activities. At the same time, some in the business community perceived environmental issues as nothing more than a regulatory burden that added costs, which were always at the expense of business. In response to this, many companies created environmental departments to address internal and external challenges, but they still needed a forum to work with others in business to create the tools that would help those departments support their companies.

Within this atmosphere of global mistrust and skepticism, a group of CEOs from the Roundtable stepped up and asked their corporations' environmental leaders to create an organization that could "get ahead" of the critics so that companies could effectively work together to improve the global environment, and do so in an economically and socially responsible way. *The core of those leaders came from a corporate "who's who" list of companies and included: Dorothy Bowers, Merck & Company; George Carpenter, The Procter & Gamble Company; Tom Davis, AT&T; Charles Goodman, Southern Company; and, Bill Sugar, Anheuser-Busch Companies.*

Those early GEMI leaders knew that no group was better positioned and capable of outlining the most effective ways for business to address environmental, heath and safety (EHS) issues than the companies themselves. It was also evident that if business did not step forward and address ways to ensure responsible environmental management, others—including NGOs—would step forward and fill the gap created, imposing external policies and effectively "telling" business how to operate.

That knowledge, recognition and commitment laid the foundation for the vision of the organization as it is today, *"To be globally recognized as a leader in providing strategies for business to achieve EHS excellence, economic success and corporate citizenship."* The mission of GEMI is: *"Business helping business improve EHS performance, shareholder value and corporate citizenship."*

GEMI was created as an organization that would not advocate or lobby on policy issues. Rather, GEMI was designed as a member driven, "sweat equity" organization that would identify tools that needed to be created, develop them with member leadership and then share those tools freely with the world. The BRT corporate environmental leaders selected Lee Thomas and Susan Moore as the first management team to support the GEMI membership.

GEMI Today

GEMI was designed to be, and has remained, a member-led and member-driven organization, using voluntary initiatives and the energy of the member companies to improve environmental management and address key corporate citizenship challenges and opportunities. Today, GEMI has 37 members from more than 22 diverse business sectors, all of whom bring unique insights to the discussion of the common challenges posed in environmental management. By working together and learning from each other, GEMI members are continually finding new ways to do their jobs better and in a way that provides value to their companies and the environment.

GEMI is led by a Board of Directors, which is elected annually by the membership, and meets quarterly to review GEMI's progress and to address strategies that will provide value to the members. The Board is comprised of a Chair, a Vice Chair, and the respective Chairs of the Committees, which include Finance, Tools, Membership, Communications & Marketing and Benchmarking. The Board also includes a representative from the Senior Advisory Council (SAC), and a Chair Emeritus, the former Chair of GEMI.

The majority of GEMI's work is conducted in Work Groups, chaired by and comprised of representatives from member companies. Each Work Group develops a budget, approved by the Board of Directors, to develop a tool from inception through to the end of the project plan—either a paper publication and/or an interactive web tool. GEMI's +28 tools, all products of the Work Groups, are discussed later in this article.

In addition to its Work Groups, GEMI has standing committees that work on procedural, administrative, and/or strategic issues, with direction from the Board of Directors. The committees include:

- **Benchmarking Committee:** The Benchmarking Committee identifies and benchmarks key environmental, health and safety and sustainability management practices. Examples of benchmarking topics include: interaction with corporate board of directors, EHS cost accounting practices, EHS auditing practices, relationships with suppliers/contractors, sustainability and community relations. GEMI typically completes three or four benchmark surveys per year at no additional cost to members beyond their annual dues. By comparison, if each company were to independently develop a benchmarking exercise, the cost per company could range from $10,000 to $20,000 per issue benchmarked. After one year, the benchmark survey results are posted on GEMI's web site, unless the membership requests and agrees that it should remain on the 'Members Only' site.

- **Communications & Marketing (C&M) Committee:** The C&M Committee is responsible for extending GEMI's presence abroad through national and international press relations. The committee establishes well-defined guidelines for the creation and use of GEMI materials and reviews publications as they are developed. It also oversees the development of the monthly member newsletter, GEMI NEWS. In addition, the Committee focuses on creating a simple, standard marketing plan for tools and approves materials to be posted on the GEMI web site. Articles about GEMI activities have appeared in numerous newsletters and publications including, but not limited to: *Business and the Environment* (BATE); *ECOSTATES*; *Financial Times; Greenbiz; Green@Work; Occupational Hazards*; and, *Sustainable Development International* (SDI).

- **Membership Development Committee:** The objective of the Membership Development Committee is to implement a strategic membership development plan, targeting environmentally responsible U.S. and non-U.S.-based companies. The Membership Development Committee also focuses on the needs of existing members to ensure that each year they will renew their membership in the organization. Despite the continuing fiscal challenges facing corporations, GEMI continues to grow and prosper; new members are consistently being brought into the Board of Directors as well as into leadership positions in the GEMI Committees, Networks and Work Groups.

- **Senior Advisory Council (SAC) Committee:** The SAC is comprised of the Vice President or the most senior EHS/sustainability representative of member companies. The SAC assists in the development of future GEMI project topics and activities. Though GEMI uses a broad array of resources to identify issues that should be addressed by the membership, the SAC is the primary source through which leading EHS, sustainability and corporate social responsibility (CSR) issues are identified and filtered. Most GEMI tools have been the direct result of member-driven ideas that came from initial discussions of the SAC committee. The SAC meets annually to review GEMI's progress and to identify issues or activities that are of specific interest to their companies. In 2007, the GEMI Senior Advisory Council (SAC) retained the Institute for the Future (IFTF) to develop a sustainability map for GEMI, the *Map*

of Future Forces Affecting Sustainability. The map is a strategic tool for identifying and understanding future trends that will affect the EHS and sustainability landscape and incorporating this knowledge into strategies that create business value.

In addition to its Work Groups and Committees, GEMI also has a series of Networks that conduct on-going discussions on topics of interest to GEMI members. Networks can serve as a prelude to a Work Group by helping to define or clarify a topic of interest, or as a postscript to a Work Group that has completed the development of a GEMI tool by facilitating continued learning and information sharing. Direction for the Networks comes from the GEMI Board of Directors and the membership and each Network is re-evaluated annually to determine if it will continue into the following year.

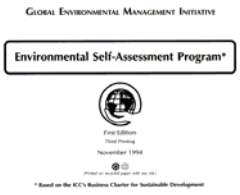
GEMI's current Networks include:

- **Emerging Issues Network:** The GEMI Emerging Issues Network meets throughout the year to learn more and share information about the emerging EHS and sustainability issues the members are addressing.
- **Metrics Users Network:** The Metrics User Network provides how-to knowledge in using the *GEMI Metrics Navigator*™, and to share best practices relative to sustainability metrics in business.
- **Pandemic Planning Network:** The GEMI Pandemic Planning Network is in its information gathering phase and meets quarterly to share lessons learned about the topic.

The 1990s: Fundamental Tools for EHS

The decade of the 1990s, from a development of GEMI tools perspective, focused on issues ranging from ways to self assess on EHS issues regarding total quality management, benchmarking, training, reporting and management systems.

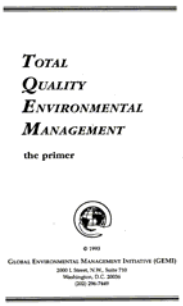
Year: 1992



The first GEMI tool, ***Environmental Self-Assessment Program (ESAP)*** used the 16 Environmental Management Principles of the International Chamber of Commerce (ICC) as a basis, or benchmark, against which to measure performance. The tool was designed so that businesses could pinpoint ways to increase the quality of environmental policy, planning, implementation and monitoring, and to allow them to prioritize environmental improvement opportunities. Though created in 1992, this tool remains an excellent resource for any entity that is just starting to better understand how to assess its company's environmental performance.

Year: 1993

The second GEMI tool, ***Total Quality Environmental Management: The Primer,*** was created in 1993 and reflected corporate trends and activities relating to how total quality management systems could positively impact how companies operated. What GEMI leaders did in the early years of GEMI's activities was to add environment to the total quality management business approach, thus the term Total Quality Environmental Management (TQEM). This primer was written for corporate environmental managers and takes a reader through the basic definitions and approaches of TQEM.



Year: 1994

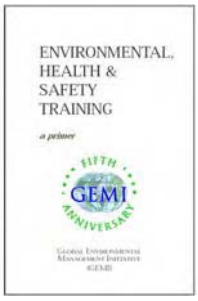
In 1994, as the concept of environmental management began to mature, GEMI created three tools.

The first expanded on the TQEM concept -- ***Environmental Reporting in a Total Quality Management Framework: A Primer*** was designed to help companies: identify problems before they occur; target key areas for management attention and possible expenses; provide support for needed improvements in existing management systems; and, provide a realistic basis for setting future performance expectations and holding line managers accountable.

The second tool focused on helping international companies find cost-effective pollution prevention initiatives by incorporating environmental costs into the business decision-making process. ***Finding Cost-Effective Pollution Prevention Initiatives: Incorporating Environmental Costs into Business Decision-Making*** includes topics such as identification and quantification of environmental costs and evaluating pollution prevention investments.

The third, ***Benchmarking for Continuous Environmental Improvement***, provides a format and structure for conducting benchmarking studies. It was designed to teach the reader how to make environmental improvements based on existing or publicly available information and resources.

Year: 1995

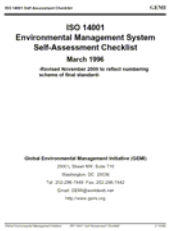


Environmental, Health & Safety Training: A Primer (1995) started a process that went from only learning about an issue or set of challenges, to training others in what was beginning to be a more professional EHS function within GEMI companies. This primer was designed to assist companies in training their site EH&S personnel and it included practical how-to examples, and advanced training techniques.

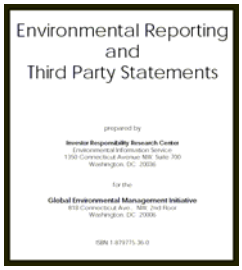
Year: 1996

In 1996, GEMI began looking at various ways to identify innovative programs and approaches that would help provide incentives for companies to improve their environmental, health and safety activities.

Incentives, Disincentives, Environmental Performance and Accountability for the 21st Century, Idea 21 Work Group Reports included three reports that looked at management systems, industry incentives and innovative programs within the United States and Europe. Two other reports were also created that year.



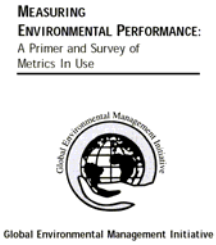
ISO 14001 Environmental Management System Self-Assessment Checklist was based on the ISO 14001 standard and allowed for a rapid self-assessment of an organization or facility to determine how closely existing management practices and procedures correspond to the elements of the standard.



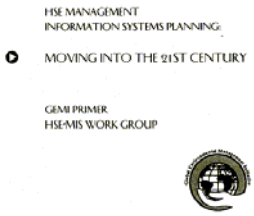
Environmental Reporting and Third Party Statements was designed to test whether third party attestation statements contained in voluntary corporate environmental reports added value in the eyes of external stakeholders. Other goals of the study included assessing which report elements contributed the most to communicating credibility, and evaluating the credibility of different types of organizations that perform certifications of corporate environmental reports.

Year: 1997

In 1997, the GEMI tools continued to expand their reach beyond just taking action on environmental activities into assessing the action being taken.



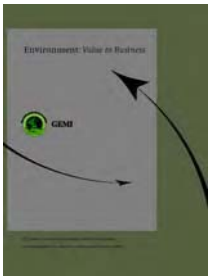
Measuring Environmental Performance: A Primer and Survey of Metrics in Use was designed to present a survey of environmental performance measurement tools and includes considerations for designing metrics programs, for selecting appropriate metrics, and for implementing, evaluating and improving such a program.



HSE Management, Information Systems Planning, Moving into the 21st Century was designed to help EH&S managers reach new levels of performance by partnering their expertise with that of professionals in information management, manufacturing, operations, marketing, research and development, finance and legal issues from across the company.

Year: 1998

Environment: Value to Business (EVTB) was the first primer that was designed to guide corporate environmental professionals in planning, creating, measuring and communicating the business value of environmental activities. This tool, developed in 1998, introduced the concept of Plan-Do-Check-Advance (PDCA) cycle of environmental management and offered suggestions for communicating business value to key internal and external stakeholders.

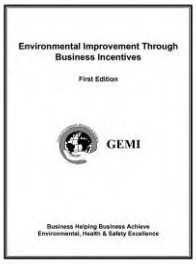


Year: 1999

As GEMI began its journey outside the parameters of the internal EH&S activities of individual companies, there was an increasing realization that many GEMI companies were global companies that were operating in a responsible way around the globe, including the developing world.

In 1999, GEMI created a new tool, ***Fostering Environmental Prosperity, Multinationals in Developing Countries***, which was a first of its kind report that linked economic data with case studies showing how multinational corporations are positive forces for both economic development and environmental, health and safety excellence in the developing countries in which they operate.

In 1999, as there was increased interest by many organizations in finding creative and effective ways to provide incentives, GEMI developed a new tool, ***Environmental Improvement Through Business Incentives***. This report assessed incentives that have working in governments and the private sector to encourage companies to set environmental goals beyond compliance with existing laws.



A New Decade: New Tools and Direction

With 10 years of experience and learning behind them, the members of GEMI began a new decade of activity and tool development in 2000 by expanding their discussions and the tools being developed to a range of general business issues that could be impacted by environmental, health and safety activities, including corporate citizenship.

Year: 2000

The first tool in the new decade was a guidance document that was designed to help identify new processes and ways of addressing the role of environmental initiatives within broader business objectives, and how those activities can provide "top line" value to companies. ***Environment: Value to the Top Line (EVTL)*** includes case studies of companies who have implemented successful projects linking environmental and business objectives.

Year: 2001

The second tool, published in 2001, focused on the important role that the supply chain plays in environmental, health and safety activities. ***New Paths to Business Value: Strategic Sourcing – Environment, Health, and Safety*** was designed to address the business value of managing EH&S in key procurement issues. The tool helps companies to identify when, why, and how to pursue added business value by addressing EH&S performance of suppliers and contractors, and to understand how suppliers' products and services can affect businesses and business planning.

Year: 2002

In 2002, GEMI created its first water sustainability tool, ***Connecting the Drops Towards Creative Water Strategies: A Water Sustainability Tool.*** This tool and its accompanying web site (www.gemi.org/water) were designed to help businesses build a well-tailored strategy that fits the business' needs and circumstances. Case studies are included that highlight ways that companies can create business value by pursuing the sustainable management of water resources.

In the same year, ***Exploring Pathways to a Sustainable Enterprise: SD Planner™*** was created. The ***SD Planner™*** is a detailed and comprehensive self-assessment tool designed to help companies evaluate, plan for and integrate sustainable development into business processes.

Year: 2004

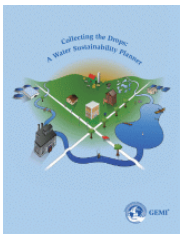
In 2004, GEMI reached in new external directions addressing issues that impact business often outside the fence line. ***Clear Advantage: Building Shareholder Value/Environment: Value to the Investor (EVI)***, is a tool that was designed to help provide businesses approaches on how to measure, manage and communicate EHS value to the financial community, thereby making "tangibles out of intangibles."

Forging New Links: Enhancing Supply Chain Value Through Environmental Excellence is a tool and website (www.gemi.org/supplychain) that was designed to identify and illustrate opportunities for EHS professionals, in collaboration with other functions within their companies, to enhance supply chain performance.

Transparency: A Path to Public Trust is a tool that provides approaches that companies can consider as they address transparency related challenges and opportunities.

Year: 2007

In 2007, GEMI launched ***Collecting the Drops: A Water Sustainability Planner*** (www.gemi.org/waterplanner). This tool guides a user through the process of taking a corporate water sustainability strategy and converting it into a site or unit strategy for water.



GEMI SD Planner™ and ***GEMI SD Gateway™*** (www.gemi.org/sd) is a detailed comprehensive planning tool that can be used to establish baseline performance, assess opportunities, set goals, develop action plans and evaluate progress towards a company's sustainable development objectives.

The ***GEMI Metrics Navigator™*** *(www.gemi.org/metricsnavigator)* is a tool to help organizations develop and implement metrics that provide insight into complex issues, support business strategies and contribute to business success. The tool presents a thorough, six-step process to select, implement and evaluate a set of critical few metrics that focus on an organization's success.

Year: 2008

The ***GEMI Business and Climate Change web site*** *(www.gemi.org/businessandclimate)* describes ways that businesses can incorporate climate change objectives in their decisions and operations. The site provides information and guidance for businesses in all stages of the strategic planning lifecycle for climate change.

The ***GEMI HSE Web Depot*** *(www.gemi.org/hsewebdepot)* is a web-based information resource that is a framework for health, safety & environment-management information systems (HSE-MIS) and is based on a Plan, Do, Check, Advance (PDCA) lifecycle. The HSE Web Depot presents a framework for HSE-MIS planning, development, system rollout and improvement; and, organizes company experiences within these areas.

Tools in Practice

GEMI's contribution to EHS management is evident in the reputation the organization has gained for itself over the past seventeen years, and in the caliber of the members who choose to participate and continue participation. GEMI tools have been cited by a wide range of media resources on sustainable development, supply chain management and outsourcing, corporate social responsibility, and others, in such news sources as *Fortune Magazine.* GEMI also participates in the annual UNEP Consultative Meeting on Business and Industry and has given several presentations over the years on the functional value of GEMI tools, and the importance of using such tools and case studies when addressing global EHS and sustainability issues.

- The devotion of member companies to EHS is evident in their internal EHS management strategies, many of which are detailed as case studies in GEMI tools. For example, in a piece entitled "The Role of Sustainability at 3M" in the *GEMI Metrics Navigator™*, the emphasis placed on environmental, social and economic sustainability by **3M** was demonstrated in the descriptions of its sustainability programs. The required use of a "Life Cycle Management (LCM)" platform in the development, manufacturing and distribution of all products helps to reduce the environmental, health, safety and energy impacts throughout the entire product life cycle; the Pollution Prevention Pays (3P) platform goes back thirty years, focusing on reducing pollution at its source, and is a cornerstone for process improvements to reduce waste and improve productivity. Says the piece, "a company is only as good as its employees," and 3M employees are devoted to responsible EHS and CSR practices. (*Metrics Navigator™*, 2007).

- **Bristol-Myers Squibb Company** is yet another example of a GEMI company being on the cutting edge of EHS policy and helping others to learn from its experience. The *Metrics Navigator™*, also detailed how Bristol-Myers Squibb was "an early leader in reporting EHS metrics…participated in developing the first draft of the Global Reporting Initiative (GRI) and was among the first to apply the GRI reporting standards." The Company developed "extensive infrastructure, including procedures and databases…for EHS data collection, verification and reporting," which has allowed it "to assess its potential impacts, to determine appropriate performance targets and to measure progress towards such targets." Though Bristol-Myers Squibb Company began EHS metrics reporting because of external pressure, the internal system has gone above and beyond—and provided tangible, internal business benefits at the same time. (*Metrics Navigator™*, 2007).

- **DuPont** also exemplifies the role many GEMI companies play in leading the industry towards more sustainable business practices without sacrificing productivity or profit. As a large energy user, DuPont has both high manufacturing cost and a large environmental footprint, particularly as regards greenhouse gas emissions. By committing to increase its use of renewable energy sources—targeting 10% renewable energy by 2010, in only three years—DuPont "is taking a leadership role in changing the market landscape by increasing the demand for renewable sources, demonstrating the use of renewable sources as a practical alternative in managing energy consumption and reducing their associated environmental impacts" (*Metrics Navigator™,* 2007).

- The **Dow Chemical Company** exemplified not only its commitment to the environment, but also to corporate citizenship in helping a client in Singapore to use water more efficiently. Using the FILMTEC system, the client implemented a system for reclaiming waste water, drastically reducing its environmental impact as regards water sustainability. Since 2000, an RO plant operation has been processing tertiary-treated wastewater effluent using FILMTEC fouling resistant elements and converting it to high-grade industrial water for Singapore's petrochemical industry. Since start-up, the Singapore client's reverse osmosis plant has performed well within the stringent operating conditions imposed. The high recovery of 86 percent pioneered by this project is now considered an industry benchmark in tertiary effluent wastewater reclamation. Operating costs are lower compared to older plants using membranes that are not designed to be resistant to fouling (*Collecting the Drops: A Water Sustainability Planner,* 2007).

- In the 2003 *Forging New Links: Enhancing Supply Chain Value Through Environmental Excellence*, even more examples of GEMI companies excelling as business leaders in EHS can be found. A case study of **Motorola**'s Inbound Discrepancy Reporting (IDR) System detailed how a collaborative effort by EHS, Logistics, Quality, Finance, Packaging, and Sourcing representatives to develop a comprehensive approach to packaging and pallets allowed the company to save over $1 million in the first year alone, and over $5 million in 2004. Not only did Motorola establish new guidelines for packaging and shipping, but they further implemented the IDR system as a way to track supplier compliance, update supplier scorecard performance, and quantify the cost of non-compliance for potential recovery costs due to supplier defects. Between the years 2002-2003, IDR realized a 58% reduction in pallet-related injuries, saving $400,000 in Workmen's Compensation cost; a 12% reduction in discarded pallets, equating to $120,000 of cost avoidance in new purchases; $400,000 savings in transportation expenses; $100,000 savings in reduced handling and storage of pallets; and a 16% improvement in recycling rate of non-hazardous wastes. Motorola took what was originally an EHS initiative—an effort to reduce injuries and decrease unnecessary waste and transportation—and developed it into an effective means of improving not only EHS and CSR practices, but also to focus on eliminating unnecessary spending and creating savings that could be passed along to consumers. (*Forging New Links*, 2003).

- **FedEx** has been similarly concerned with the environmental impact of its packaging, and has been a leader in the field in minimizing that impact as much as possible. In 1998, FedEx revolutionized its packaging system, changing the overnight envelopes from 100% virgin bleached fiber to 100% recycled materials in only a year. They also redesigned their basic envelopes, releasing a new packaging made of 100% recycled whiteboard in November of 1999, with 35% of the recycled material coming from post-consumer content. Though there was a slight increase in production cost—one that could not be passed along to the consumer, as FedEx envelopes are provided for free to customers—the company felt that its environmental initiatives were important in keeping the company a leader in the field, and worked over the next few years after the envelopes' release to reduce the unit cost back to its original level. (*Forging New Links*, 2003.)

These are but a few examples of the impressive advances GEMI members have been making in EHS management for nearly two decades. Each GEMI tool includes extensive reports and case studies from the GEMI membership. Almost as impressive is the overwhelming commitment of these and all

GEMI companies to helping others in the business community achieve similar levels of EHS excellence—truly bringing to life the GEMI mission of "business helping business."

GEMI members share their collective experience and expertise in EHS in a variety of ways. The case studies included in GEMI tools give concrete examples of how responsible environmental practices can be implemented without damaging profits, supplementing the strategic content of the tools with real-world evidence that the strategies work. GEMI held a series of conferences highlighting environmental concerns, rewarding progress and facilitating discussion of what remains to be done. Most recently, GEMI's 15th Year Anniversary conference in 2005, "Successes, Current Challenges, and Future Trends," featured a variety of keynote speakers discussing contemporary environmental issues, as well as panels discussing GEMI's past, present and future. Prior to that conference, GEMI held events such as the 2003 "Sustainability Through Strategic Partnerships" conference, the 2002 "Securing the Future—Paths Forward" conference, the 2001 "An Odyssey in Environmental Excellence" conference, and the 2000 "Environment and Business Conference."

GEMI and its member companies truly put into practice all aspects of their mission statement—they achieve EHS excellence and increase shareholder value themselves, and function as responsible corporate citizens helping business as a whole to share in the benefits of responsible EHS management strategies.

Collaborations and Partnerships

In addition to all of its other activities, GEMI has also entered into a number of very constructive collaborations and partnerships with external organizations.

Partnership Organizations

GEMI is a founding partner of the **Business Roundtable's S.E.E. Change initiative**, which was launched in 2005. Seeking to leverage the power of business as a force for good, Business Roundtable launched a sustainable growth initiative encouraging leading U.S. companies to embrace business strategies and projects that measurably improve Society, the Environment and the Economy. S.E.E. Change, encourages CEOs of the nation's leading companies to commit to business strategies that combine traditional corporate goals of higher profit and lower cost with a strong commitment to environmental stewardship and social improvement. Roundtable companies will be asked to set challenging goals that contribute to both the bottom line and improvements to the quality of life – now and for future generations.

As a Partner of S.E.E. Change, GEMI provides its tools to Roundtable members and participates in the S.E.E. Change Steering Committee.

Partnership Projects

GEMI has partnered with **Environmental Defense Fund** to develop a "Guide to Successful Corporate/NGO Partnerships," which we anticipate will be launched to the public in the summer of 2008. As social and environmental performance becomes increasingly important to the private sector and external stakeholders alike, some companies and non-governmental organizations (NGOs) are benefiting from collaborating rather then clashing around "green issues." This guide will seek to educate the public and private sectors on the potential for positive environmental and economic success through collaboration between corporations and NGOs.

Education Partners

GEMI partnered with the **National Council for Science and the Environment's (NCSE) Council of Environmental Deans and Directors (CEDD)** to conduct workshops to provide CEDD members with an understanding of GEMI and its tools with the intent and that they could be incorporated into course curriculum. Thirty-five schools attended the workshops. To-date, the following four schools have used the tools: Barnard College, Colleges of the Fenway, Duke University and Samford University.

Current Activities and Outreach

In addition to the efforts of its Work Groups, Committees and Networks, GEMI is currently working on further developing the "GEMI Brand," making the organization and the benefits it provides both better known and more widely marketed. The method for achieving this is threefold: emphasis is placed equally on education, tools and current members.

GEMI has identified three signature issues that it will be focusing its activities on for the next couple of years. GEMI is still in the discussion phase as to how best to address these issues to meet the needs of its members and the organization as a whole. The issues are: Climate and Energy; Supply Chain; and Water Sustainability.

GEMI has developed a catalogue of its tools, and continues to provide easy access to its tools, with all publications available electronically and without cost via its web site, www.gemi.org. GEMI also works cooperatively with a wide range of governmental organizations such as the United Nations, the U.S. State Department, the U.S. Environmental Protection Agency and the Department of Commerce.

GEMI is also continuing to build and develop relationships with colleges and universities, small/medium businesses and cooperative efforts with the government and NGO organizations to raise awareness of the issues in which GEMI is involved, its tools and of the organization itself.

GEMI members also participate in a wide range of international and domestic meetings and conferences, are speakers and panelists at various industry functions and are members of diverse

industry associations—all of which demonstrate the caliber of GEMI's members as leaders in EHS management, and promote the organization through those with whom it can be associated.

Looking Forward

The Global Environmental Management Initiative has grown and matured since its beginning in 1990, remaining constantly on the leading edge of EHS issues and development. The organization is strong with its membership continuing to grow and to create and develop new tools and discussion forums around emerging ideas and approaches. GEMI offers members the opportunity to work with many of the world's leading companies in developing and promoting the very best in global EHS and corporate citizenship strategies that can be applied around the world in a cost-effective manner. In addition, the cost savings and benefits derived from GEMI benchmarking further allow GEMI to share its knowledge as it continues to strive to help business help business to excel in EHS, shareholder value and corporate citizenship.

With the increased attention to a wide range of environmental, sustainability and climate-related issues, and with concerns being raised around the world by the realities of globalization, strong EHS and corporate citizenship leadership is vital if global companies' licenses to operate are to be continually renewed and welcomed. GEMI has both the experience and commitment to take on these issues as they develop, and the organization's continued growth and development are evidenced in the expansion of GEMI's focus to include key sustainability and corporate citizenship issues. GEMI strategies remain environmentally friendly, socially responsible, fiscally sound and a valuable resource for the business community.

Conclusion: GEMI Corporate Leadership – Looking Back, Moving Forward

GEMI was formed almost 20 years ago as a grassroots initiative by leaders in the business community, to be a nonprofit business association of "business helping business achieve EHS excellence, shareholder value, and corporate citizenship." GEMI has been and continues to be an organization that is member-driven, with "sweat equity" a key part of the organization's operations. In its seventeen-year lifetime, GEMI has produced 28 interactive tools promoting responsible EHS practices, in addition to all of its other internal and external activities.

GEMI's work is ongoing. Work Groups continue to develop creative and innovative methods for the improvement of EHS and sustainability practices. Networks continue to identify, discuss and address new emerging issues.

GEMI is comprised of environmental and sustainability professionals who are leaders and challenge solvers within their companies, striving each day to make the world a better place for the environment, for the economy and for society.

The organization, since its creation, has been committed to focusing on and merging environmental commitments, economic considerations and environmental leadership.

The results of almost 20 years of effort and commitment make it clear to all that the founders of GEMI would be pleased with how far GEMI has come, and with the important role that EHS ad sustainability issues will continue to play in a world where corporate citizenship has become a goal of all responsible global companies.

**** 2008 * Written by Steven B. Hellem, Executive Director and Amy M. Goldman, Director****

GEMI

Clear Advantage:

Building Shareholder Value

ENVIRONMENT: VALUE TO THE INVESTOR

Preface

February 2004

The mission of the Global Environmental Management Initiative (GEMI) is to support business helping business improve environment, health and safety (EHS) performance, shareholder value, and corporate citizenship. GEMI has produced a series of tools that demonstrate how excellence in EHS can add shareholder value to companies. The GEMI "Value" journey began with *Environment: Value to Business* published in 1998 and continued with *Environment: Value to the Top Line* published in 2001.

The purpose of *Clear Advantage: Building Shareholder Value*, GEMI's latest tool in the series, is to enable businesses to measure, manage and communicate EHS value to the financial community or, in the words of Bob Brady, retired fund manager at Citigroup, to *"turn the intangibles into tangibles."* EHS is among the intangible value drivers that are hidden sources of organizational power—from regulatory compliance that prevents liabilities, to proactively managing risk. Leveraging EHS resources can help create additional value for the enterprise through strategy execution, enhancing brand and reputation, boosting innovation and leadership.

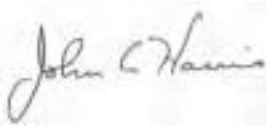
This tool is a resource and guide containing a variety of data and tools to assist managers in unlocking the value contained in activities they are required to perform but frequently regard as a cost of doing business—rather than as an opportunity to better position the enterprise with customers, investors and lenders, alliance partners and current or prospective employees. Case studies from GEMI members help illustrate these opportunities.

Clear Advantage provides compelling evidence of the link between EHS activities and shareholder value. Because an enterprise's EHS function cuts across many areas of business, this report covers the EHS function as well as related organizational activities: community involvement, stakeholder relations, governance, transparency, and business continuity. In a climate of increased focus on corporate governance and shareholder activism, these issues will only increase in importance.

Utilizing the value drivers identified, this report will demonstrate that strengths in EHS can add value to the enterprise. Specifically, this report will show how companies can measure and disclose the strategic contributions of EHS to enhanced market valuation and identify EHS-related indicators that are linked to intangible value drivers.

The intended audiences for this tool are senior company executives, including CEOs, CFOs, and Investor Relations (IR) professionals; mainstream financial analysts and fund managers; and EHS and other managers. It can also provide members of the socially responsible investment communities with useful data, as well as guidance for EHS executives on how to better advise managements with whom they are engaged.

Jim Thomas, *Novartis Corporation*



John Harris, *Ashland Inc.*

Co-Chairs, Environment: Value to the Investor Work Group

About The Global Environmental Management Initiative

The Global Environmental Management Initiative (GEMI) is a non-profit organization of leading companies dedicated to fostering environmental, health, and safety excellence and corporate citizenship worldwide. Through the collaborative efforts of its members, GEMI also promotes a worldwide business ethic for environmental, health and safety management and sustainable development through example and leadership.

The guidance included in this document is based on the professional judgment of the individual collaborators listed in the acknowledgements. The ideas in this document are those of the individual collaborators and not necessarily their organizations. Neither GEMI nor its consultants are responsible for any form of damage that may result from the application of the guidance contained in this document.

Global Environmental Management Initiative

GEMI Member Companies:

3M
Abbott Laboratories
Altria
Anheuser-Busch Inc.
Ashland Inc.
Aventis Pharmaceuticals Inc.
Bristol-Myers Squibb Co.
BNSF Railway Company
The Coca-Cola Company
ConAgra Foods
Dell Inc.
The Dow Chemical Company
Duke Energy
DuPont
Eastman Kodak Company
Eli Lilly and Company
FedEx Express
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Halliburton Company
Hewlett-Packard Company
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JohnsonDiversey, Inc.
Johnson & Johnson
Johnson Controls, Inc.
Koch Industries, Inc.
Lockheed Martin Corporation
Merck & Company, Inc.
Mirant Corporation
Motorola, Inc.
Novartis Corporation
Occidental Petroleum Corporation
Pfizer Inc
The Procter & Gamble Company
Schering-Plough Corporation
Smithfield Foods, Inc.
Southern Company
Temple-Inland Inc.
Texas Instruments Incorporated
Wyeth

Contents

Additional supporting information and resources, as well as an electronic version of this document, are available on the GEMI website, www.gemi.org.

Acknowledgements

Clear Advantage was developed in a collaborative process by GEMI's Environment: Value to the Investor Work Group. Jim Thomas of Novartis Corporation and John Harris of Ashland Inc. co-chaired the project. Jonathan Low and Pamela Cohen Kalafut of Cap Gemini Ernst & Young, Joseph Fiksel of Eco-Nomics LLC and Karina Funk of the Massachusetts Technology Collaborative created *Clear Advantage*. Cover art and overall graphic design were created by Laura McGoff. GEMI staff contributing to this document included Steve Hellem and Amy Goldman.

Special thanks:

During the course of the project Robert Brady of Citigroup (retired), Mark Brammer of Innovest, Beth Carty of the National Investor Relations Institute (NIRI), Suzanne Fallender of Institutional Shareholders' Services, Katie Fry Hester of SustainAbility, Elizabeth McGeveran of ISIS Asset Management and Marge Wyrwas of Knight Trading participated in a meeting to provide input on the draft document. Linda Descano of Citigroup, Peter Wilkes of Innovest, Tim Smith of Walden Asset Management, Stan Craig, formerly of Merrill Lynch, Tim Lankford of SAM USA Inc. and Peter Wall and Michael Gormley of FTSE4Good provided input and guidance during the early, formative stages of this project.

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Laura Bradford, *Bristol-Myers Squibb Company*
Don Brown, *Dell Inc.*
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Veronica Gliebe, *Aventis Pharmaceuticals*
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John Kindervater, *Eli Lilly and Company*
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David Lowy, *Altria*
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Norm Varney, *Lockheed Martin Corporation*
Lara Wallentine, *Texas Instruments Incorporated*
Terry Welch, *The Dow Chemical Company*
Jeff Werwie, *Johnson Controls, Inc.*
Robert Williams, *Dell Inc.*
Carl Wirdak, *Occidental Petroleum Corporation*
Pat Wood, *Georgia-Pacific Corporation*

For more information about this project, please contact GEMI at: 202-296-7449 or info@gemi.org.

Section 1
EXECUTIVE SUMMARY

To succeed in today's global marketplace, companies must respond to the various market forces that demand sound Environment, Health and Safety (EHS) policies and practices. The more successful companies will also understand how these EHS policies contribute to shareholder value.

Experts have argued that, in effect, superior EHS performance is a proxy indicator for superior management capability. As such, it can effectively communicate an organization's ability to manage risk, reduce volatility, enhance transparency and build stakeholder trust.

Risk management, transparency and trust are organizational characteristics that markets value, although they do not appear directly on financial statements. A substantial body of evidence exists on how EHS practices contribute to the bottom line, including reductions in operating costs, insurance premiums, and capital costs. It is the contention of this document that EHS practices contribute to shareholder value in a broader and more strategic way: by building critical organizational capabilities. As such, the markets value a company's EHS performance every day, whether it contributes to that valuation exercise consciously or not.

Thinking about EHS as merely a cost of doing business is an opportunity lost. Organizations have much to gain from measuring, managing and disclosing the positive impact of EHS performance on shareholder value. Some of the facts, detailed below, suggest that investors, senior executives and analysts constitute a market for information related to EHS performance:

- 50 to 90% of a firm's market value can be attributed to intangibles like EHS.
- 35% of institutional investors' portfolio allocation decisions are based on intangibles like EHS performance.
- 81% of Global 500 executives rate EHS issues among the top ten driving value in their businesses.

This document provides a guide to communicating the value of EHS excellence. The document's goal is to show how companies can develop forward-looking tools focused on measuring the strategic contributions of EHS to enhanced market valuation.

Section 2, Making the Case, provides evidence to support the correlation between EHS performance and financial outcomes. It may be of greatest benefit to Investor Relations Officers (IROs).

Section 3, A Closer Look, provides ten important EHS-related value drivers and related case studies from GEMI member companies.

Section 4, From Concept to Practice, provides a methodology for EHS and IR colleagues to apply this new knowledge and engage with senior executives in order to effectively measure, manage and disclose the competitive advantage derived from superior EHS performance. Sections 3, 4 and the Appendices are likely to be of value to all managers and EHS professionals.

EHS Performance is Linked to Shareholder Value

The late 1990's and early 2000's were a turbulent period for the global investment community, with vast amounts of shareholder wealth being created and destroyed. Both institutional and retail investors have learned some painful lessons, re-examined their assumptions about what constitutes tangible and intangible value, and broadened their scope to consider characteristics that can lead to longer-term financial success.

One area of corporate performance that has begun to capture the attention of investment professionals is environmental, health and safety (EHS): a set of responsibilities that contributes directly to an organization's risk management profile and is sometimes also linked with "corporate responsibility" or "sustainability." This report explores the linkage between EHS performance and shareholder value creation. There is considerable evidence that EHS contributes to shareholder value in a variety of ways—not only through "tangible" contributions such as risk reduction and profitability improvements, but also through "intangibles" such as brand equity, human capital and strategy execution. In the words of one Chief Financial Officer (CFO):

"Every corporation is under intense pressure to create ever-increasing shareholder value. Enhancing environmental and social performance are enormous business opportunities to do just that."

Gary M. Pfeiffer,
Sr. Vice President & CFO, DuPont

EHS is an Intangible Driver of Market Value

In order to understand the full potential for EHS value creation, it is first necessary to clarify the concept of *intangible value drivers.* The investment community increasingly recognizes the importance of intangibles in the shareholder value equation. Leadership, strategy execution, brand, human capital and EHS performance are all currencies in today's marketplace. A report on the Intangibles Economy to the European Commission noted that:

"Intangibles such as R&D, proprietary know-how, intellectual property and workforce skills, world-class supply networks and brands are now the key drivers of wealth production while physical and financial assets are increasingly regarded as commodities."[1]

The International Accounting Standards Board defines an intangible as an "identifiable, non-monetary asset without physical substance held for use in the production of goods or services, for rental to others or for administrative purposes."[2] This report adopts a broader view: "Intangibles" describes the human, intellectual, social and structural capital of an organization. Thus, intangibles include people, relationships, skills and ideas that add value but are not traditionally accounted for on the balance sheet.

According to the Organization for Economic Cooperation and Development (OECD), investment by public companies in intangibles such as brand, R&D and training has exceeded investment in tangibles like property, plant and equipment (PPE) since 1997.[3]

INTANGIBLE DRIVERS, OFTEN INCLUDING EHS, ACCOUNT FOR BETWEEN 50% AND 90% OF THE MARKET VALUE OF MOST FIRMS.[3]

Figure 2-1

Market Cap v. PPE Over Time[4]

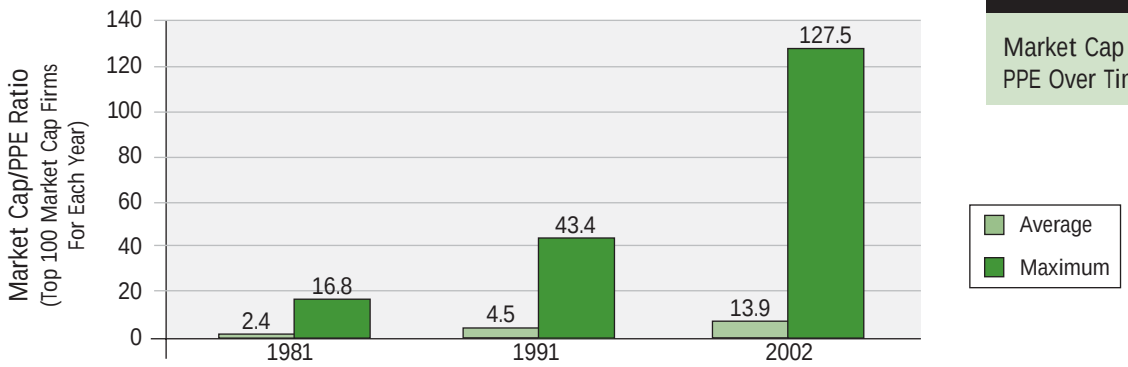


Figure 2-1 shows, further, that a company's market value has increasingly become decoupled from PPE and has increasingly been far outweighing companies' tangible asset bases.

Research shows that non-financial performance accounts for up to 35% of institutional investors' portfolio allocation decisions.[5] Further research in the U.S. and Europe demonstrates that between 50% and 90% of a company's market value can be explained by intangibles.[6] Yet, a majority of executives in every industry studied believed that there were disconnects between the value drivers they felt were critical to the company's success and what was actually being measured and reported.

For the purposes of this report, a value driver is defined as *a fundamental and persistent characteristic of a business enterprise that influences its market value*. The report focuses on the role of EHS in strengthening these value drivers, with an emphasis on the importance of measuring and monitoring the links between EHS activities and outcomes of interest to Investor Relations.

Adding confidence to the importance of identifying key value drivers and assessing their contributions to shareholder value creation, a 1996 study entitled *Measures That Matter* established that the correlation between intangibles and a company's price-to-earnings ratio varies according to industry. *Figure 2-2* depicts how a one unit change in a score for each intangible can be related to both a short-term and a long-term percentage change in an industry's price-to-earnings ratio.[7]

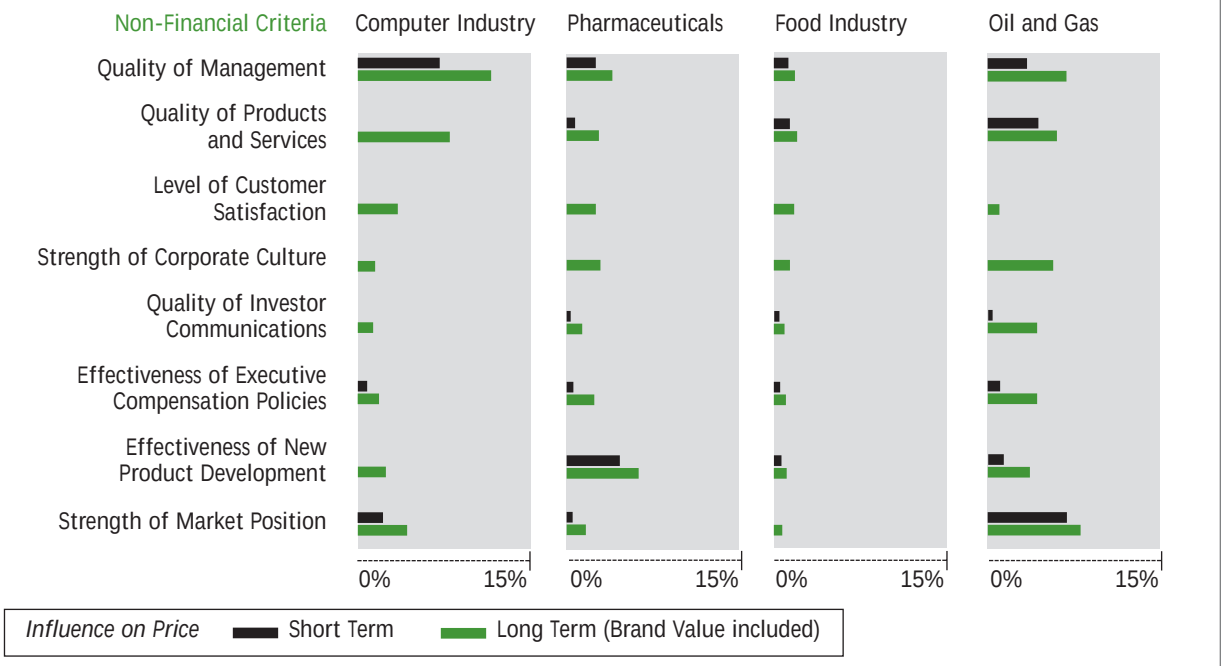
How EHS-Related Intangibles Become Tangible Outcomes for Investors

Past efforts to characterize EHS value contributions have focused largely on retrospective estimation of financial returns associated with EHS initiatives. That type of information may not be of interest to the investment community for several reasons:

- EHS financial returns are simply aggregated into common financial performance metrics (such as operating costs), and there is no benefit in singling out the relative contributions of specific departments.
- EHS contributions to the bottom line tend to be incremental in nature (such as converting wastes into by-products), and are generally seen as tactical rather than strategic.
- The more strategic contributions of EHS tend to be associated with non-financial value drivers, such as relationships and reputation, which provide a prospective, rather than retrospective, view of shareholder value.

35% OF INSTITUTIONAL INVESTORS' PORTFOLIO ALLOCATION DECISIONS ARE BASED ON INTANGIBLES LIKE EHS[5]

Figure 2-2 Relationship between Intangibles and P/E by Industry[8]



In contrast with past efforts, this report focuses on how improvements in EHS and social performance can strengthen a company's *intangible* assets in a number of ways that in turn lead to tangible shareholder value creation. The many pathways to shareholder value are illustrated in *Figure 2-3*; for example:

- Pro-active initiatives to address EHS issues can lead to new product innovation, development of new markets, and improved process technologies. For example, 3M and Bristol-Myers Squibb have incorporated product life cycle review into their new product development processes, resulting in faster times to market and reduced compliance burdens.
- Differentiation of a company through a reputation for corporate responsibility can enhance brand equity and strengthen its license to operate. For example, Dow and DuPont have been recognized as industry leaders through their initiatives to reduce air and water emissions in their global operations.

Corporate Initiatives Reflect the Demands of Global Capital Markets

The types of value creation opportunities cited above have existed for many years. Only recently, as a result of new forces in the business environment, has a broader awareness of these opportunities spread among leading multi-nationals, shareholders, regulatory bodies, non-governmental bodies and consortia. The evidence of growing interest in sustainability generally and EHS specifically is impressive.

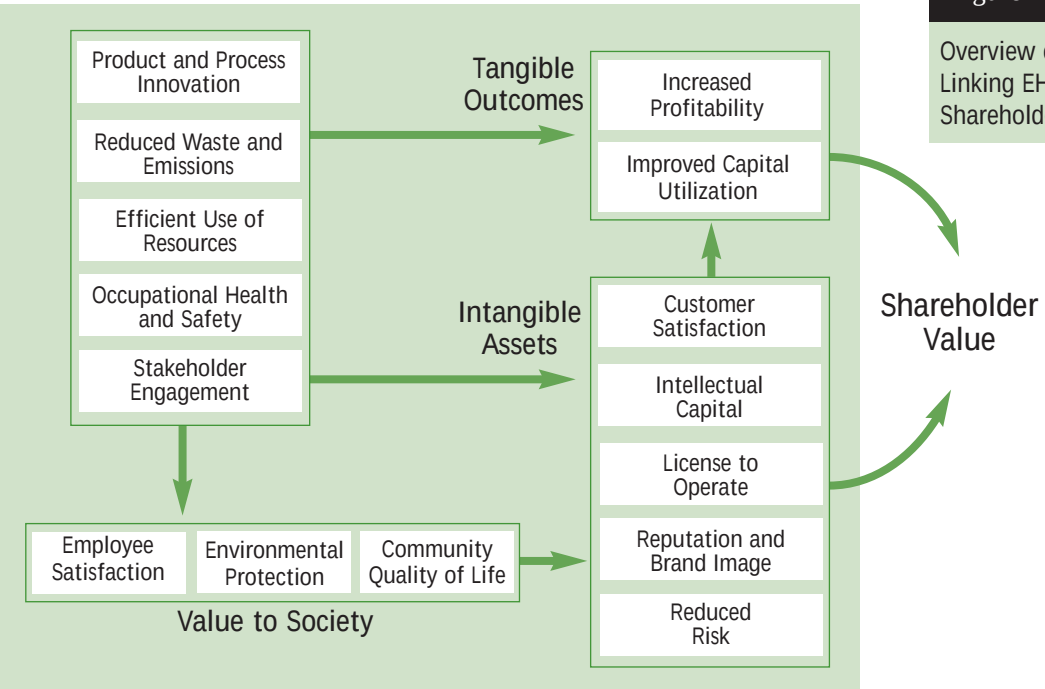
- 68% of the 100 largest global companies issue EHS reports [9]
- 487 companies published corporate sustainability reports in 2001, up from 194 in 1995 and 7 in 1990[10]
- 81% of Global 500 executives surveyed rate EHS issues among the top ten value drivers for their business[11]

These trends are partly attributable to increasing regulatory pressures, especially in

81% OF GLOBAL 500 EXECUTIVES SURVEYED RATE EHS ISSUES AMONG THE TOP TEN VALUE DRIVERS FOR THEIR BUSINESS[11]

Figure 2-3

Overview of Pathways Linking EHS to Shareholder Value

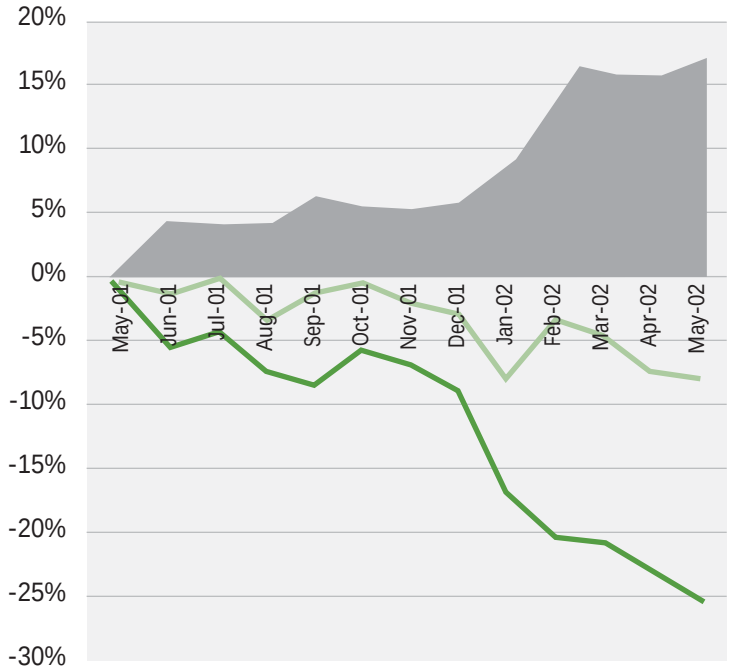


Europe. In April 2003, the New York Times reported that "the European Union is adopting environmental and consumer protection legislation that will go further in regulating corporate behavior than almost anything the United States government has enacted in decades."[12] However, it has become clear that being proactive about EHS and sustainability makes good business sense. In the words of William Stavropoulos, CEO of The Dow Chemical Company:

"There is no question in my mind that business and the free enterprise system are essential to making sustainability work. Our focus at Dow is on hard-wiring it into our company in the same way we have fully institutionalized environment, health and safety into our culture and into our work and people processes. Our challenge is to make sustainability sustainable. Ultimately, the world will judge our commitment to sustainability not by what we say, but by what we do."

Market demand for greater transparency, ethical behavior and corporate governance has led to an increase in voluntary disclosure, endorsed by the major exchanges in Europe and the U.S, as well as greater scrutiny from major investors. In addition to customers, shareholders and employees, there is a broader collection of stakeholders that can influence the success of a business and are interested in EHS performance. These include: suppliers and business partners; regulators and government officials at the local, state and federal levels; neighboring communities; religious groups, advocacy groups and other NGOs; academic and research organizations; and, of course, the media. Many leading companies have established stakeholder outreach programs, often including extensive dialogue sessions and formation of external advisory panels. Some corporations have gone a step further by establishing formal alliances with specific environmental or public interest groups—see page 20 for an example of how FedEx Express is working with Environmental Defense's Alliance for Environmental Innovation.

In short, EHS and social performance matter to stakeholders, whether it is diversity in the workforce to the labor markets, innovation and risk management to the capital markets, or pollution prevention to stakeholders in the



	May-01	Jun-01	July-01	Aug-01	Sept-01	Oct-01	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02
Difference	0.0%	4.0%	3.7%	3.9%	7.1%	5.8%	5.2%	5.9%	9.0%	16.9%	16.5%	15.5%	17.2%
Top Half Average	0.0%	-1.4%	-0.2%	-3.5%	-1.5%	-0.8%	-2.3%	-3.0%	-8.3%	-3.5%	-4.7%	-7.7%	-8.2%
Bottom Half Average	0.0%	-5.4%	-3.9%	-7.4%	-8.6%	-6.6%	-7.5%	-8.9%	-17.2%	-20.4%	-21.2%	-23.3%	-25.4%

Figure 2-4

Analysis of Pharmaceutical Industry Stock Performance Based on EcoValue21® Rating Index[13]

Chart courtesy of Innovest

community. The growing environmental and social concerns of stakeholders present a unique opportunity for companies to better leverage their EHS capabilities. This will enable companies to both measure and manage the contribution of EHS and social performance to shareholder value.

A Growing Awareness in the Financial Community

Despite the surge of interest in EHS and sustainability, the majority of company financial officers, institutional investors and fund managers are reluctant to address environmental and social performance. However, a growing minority of investment professionals believes that it is worthwhile to consider the relationship between market value, EHS and social performance. In particular, there is a heightened awareness of the contribution of non-financial performance to market value in such areas as corporate governance, transparency and business ethics.

EHS Excellence is an Indicator of Superior Management

Some analysts have argued that EHS performance is correlated with financial performance, and therefore that EHS excellence can be used as a proxy indicator for shareholder returns. The underlying logic is that effective management of EHS issues is a sign of good management, which drives good financial performance. For example, Innovest constructed an EHS management rating index called EcoValue21® as an investment analysis tool, and claims that it distinguishes companies with superior returns across a range of industries. *Figure 2-4* illustrates how, in the

VOTES RECEIVED IN FAVOR OF SHAREHOLDER RESOLUTIONS ON CORPORATE GOVERNANCE IN 2002 WERE TWICE THOSE RECEIVED IN 2001[18]

pharmaceutical industry, companies with above average ratings have outperformed companies with below average ratings by approximately 17 percentage points (1700 basis points) since May 2001.

Business Fundamentals go Beyond Audited Financials

The recent wave of accounting scandals in the U.S. has led investors and other corporate stakeholders to re-think their position on just what is "fundamental" to the valuation of a company. There is mounting evidence of the financial risks associated not only with corporate environmental liabilities, but of global problems such as climate change. Although analysts may not always speak the language of EHS and sustainability, Wall Street is gradually becoming aware of the importance of measurement and disclosure of non-financial elements of a business. For example, up to 86% of oil and gas industry analysts surveyed confirmed that company performance in regulatory compliance, employee health and safety, community service and lawsuits do indeed impact the value of a firm *(see Figure 2-5)*.[14]

Concerns about global warming are also making some of Europe's largest insurance companies keenly interested in greenhouse gas emissions. Insurers claim that in the next decade, the annual cost of global warming will rise to $150 billion a year.[15] In the absence of U.S. government mandates, several groups have formed, including the Energy Future Coalition and the Pew Business Environmental Leadership Council, to address the challenge of global warming. As financial executive Linda Descano of Citigroup noted,

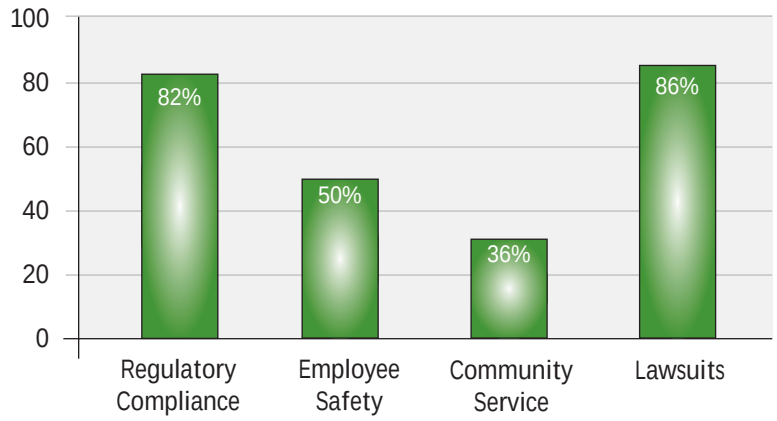
"These issues are no longer environmental and social issues but are now recognized as strategic business issues."[16]

Shareholder Advocacy is Mounting

Shareholder advocacy interests have also focused on the issue of disclosure beyond that required by law. A recent report by the Rose Foundation provides a thorough review of the evidence linking environmental performance to financial performance, and recommends that fiduciaries of pension funds, foundations and charitable trusts should take active steps to encourage disclosure of environmental performance information.[17]

There is mounting evidence that shareholder advocacy can succeed through a variety of mechanisms—the formal shareholder proxy process, private dialogue, public dialogue using

Figure 2-5 Percent of oil and gas industry analysts who feel that selected EHS indicators impact the value of a firm.[14]



the media, or litigation as a last resort. The New York Times reports that “shareholders have filed 31 global warming resolutions with 23 companies in the United States in 2003 and 5 in Canada. The companies include auto manufacturers, electric power companies and oil companies."[18] Over 800 resolutions were filed in 2002 concerning corporate governance issues. The votes received in favor of such resolutions were twice those received in 2001.

The stakes are increasing as multinationals in the finance community band together to support their arguments for EHS considerations in their finance portfolios. For example, ten leading banks from around the world announced in 2003 a set of voluntary guidelines called the “Equator Principles," whereby they intend to meet the International Finance Corporation's EHS guidelines in their projects in developing countries. This is an interesting and unprecedented expectation: banking clients must adhere to these principles, and this is relevant to *all* corporations. Principle #8 states that if a project goes out of environmental or social compliance, this constitutes grounds for a default on the loan.[55]

In 2002, the Corporation of London, in partnership with international financial services firms, put forth a set of guidelines called The London Principles designed to elucidate “the role of financial services in sustainable development." Given that London has 58% of the global foreign equity market and is arguably, after New York, the most important financial center in the world, this document is extraordinary. In addition, the principles were endorsed by British Prime Minister Tony Blair.[19]

The Growth of Socially Responsible Investing (SRI)

There are now over 200 mutual funds, run by over 800 portfolio managers and analysts, dedicated to socially or environmentally responsible investing. In sum, socially screened portfolios are now more than $2 *trillion*, over 10% of the $19.9 trillion assets currently under management in the U.S.[20] Different investment styles have emerged among funds using socially responsible, ethical or environmental criteria.[21] The majority of the $2 trillion figure consists of screened investments, but credible organizations in the past several years have been developing scoring and ranking tools that rate companies according to environmental, social and economic criteria. The Dow Jones Sustainability Index scores companies based largely upon their responses to extensive questionnaires,[22] while the FTSE4Good Index analyzes EHS and social responsibility activities, with the stated intent of promoting a stronger business commitment.[23] These indexes have generally performed in line with or have outperformed the broader market averages.[24]

Ten Intangible Value Drivers for Measuring EHS Performance

Identifying and improving upon a company's key value creation opportunities is only as useful as the ability to communicate these to interested stakeholders. To communicate more effectively the hidden value of EHS, the EHS community should adapt itself to the language and world-view of the investment community. In practice, the importance of specific EHS issues can vary greatly from company to company, and an EHS department needs to understand its company's business strategies and value drivers, and to develop its priorities accordingly. Effective communication between the EHS and the investor relations perspective can help focus on specific EHS value contributions in terms that are clear to investors.

The book *Invisible Advantage*[25] helps both individuals and companies better understand and communicate the profound degree to which intangibles are defining corporate value currently and revolutionizing the ways in which business is conducted. Key intangibles vary according to industry, but measures

related to management credibility, innovativeness, ability to attract talented employees and research leadership are consistently highly correlated with market value.[26] The GEMI EVI Work Group has identified ten intangible value drivers that reflect significant pathways for value creation through EHS and sustainability. These value drivers are listed in *Figure 2-6*, and form the basis for the subsequent sections of this report.

Utilizing these value drivers, this report demonstrates that (a) strengths in EHS and sustainability can add value to the enterprise, and (b) these strengths can be quantified in the form of an index that is relevant to company valuation. Specifically, this report shows how companies can develop a forward-looking tool that focuses on measuring the strategic contributions of EHS and social performance to enhanced market valuation. The identification of EHS-related indicators that are linked to intangible value drivers is the subject of the next section.

Figure 2-6 The Measures that Matter

Customer	The ability to develop customer relationships, satisfaction and loyalty.
Leadership and Strategy	Management capabilities, experience and leadership's vision for the future.
Transparency	Does management communicate honestly and openly? Are its communications believed and trusted? Does it hold itself accountable?
Brand Equity	Strength of market position. The ability to expand the market, perception of product/service quality and investor confidence.
Environmental and Social Reputation	How the company is viewed globally with regard to environmental concerns, community concerns, regulators' concerns, inclusion in "most admired company" lists and triple bottom line.
Alliance and Networks	Supply chain relationships, strategic alliances, partnerships.
Technology and Processes	Strategy execution, IT capabilities, inventory management, turnaround times, flexibility, reengineering, quality, internal transparency.
Human Capital	Talent acquisition, workforce retention, employee relations, compensation, what makes a "great place to work."
Innovation	The R&D pipeline, effectiveness of new-product development, patents, know-how, business secrets.
Risk	The ability to effectively manage the balance between potential liabilities and potential opportunities.

Section 3
A CLOSER LOOK

This section describes and illustrates each of the 10 intangible value drivers listed in *Figure 2-6*, and suggests performance indicators that can be used to quantify their EHS aspects.

These are summarized in *Figure 3-1*. The next section presents a process for companies to identify, measure, communicate, and manage these drivers of shareholder value.

Figure 3-1 Indicators that Contribute to EHS Intangible Value Drivers

Value Driver	Sample Performance Indicators
CUSTOMER	• Customer satisfaction with EHS performance • Extent of customer relationships across product life cycle • Collaboration with customers on EHS solutions
LEADERSHIP AND STRATEGY	• Commitment to EHS/sustainability principles and goals • Articulation and execution of EHS strategy • Expression of diverse EHS views at Board level • Level of reporting for EHS function
TRANSPARENCY	• Disclosure of governance policies & procedures • Stakeholder engagement • Timeliness of communications • Quality and depth of EHS/sustainability reporting
BRAND EQUITY	• Perception of brand as environmentally and socially responsible • Value-added due to product stewardship • Presence in environmentally or socially-screened investment funds
ENVIRONMENTAL AND SOCIAL REPUTATION	• Regulatory compliance record • Third-party recognition and awards • Participation in EHS/sustainability consortia • Community development and philanthropy
ALLIANCES AND NETWORKS	• Collaboration on EHS/sustainability throughout the supply chain • Partnerships with EHS/sustainability-oriented organizations • Participation in industrial ecology networks
TECHNOLOGY AND PROCESSES	• Leadership in EHS/sustainability technologies & business practices • Design for EHS/sustainability processes and results • Energy and material conservation • Ecosystem impact minimization
HUMAN CAPITAL	• Workforce diversity, employee benefits and compensation • Employee rights and empowerment • Perception and awards as a "great place to work"
INNOVATION	• Leadership and patent position in EHS technologies • Cost savings through EHS/sustainability innovation • EHS-related product or service differentiation
RISK	• Inherent product or process hazards • Effectiveness of risk prevention and risk management • Effective response to challenges and opportunities.

CUSTOMER The ability to develop customer relationships, satisfaction, and loyalty

- Customer satisfaction with EHS performance
- Extent of customer relationships across product life cycle
- Collaboration with customers on EHS solutions

Meeting basic customer expectations is no longer sufficient. When competitors are an arms-reach or a "click away," fostering solid customer relationships is essential. These relationships extend beyond the product or service transaction—many customers now expect environmental and social responsibility as well. For example, the U.S. Federal government, which purchases $200 billion annually in goods and services, has adopted Comprehensive Procurement Guidelines that give preference to energy efficient, environmentally effective, and bio-based products. Many large manufacturers have adopted similar EHS procurement criteria. In the European Union, "green" purchasing is becoming more common among consumers, backed by a policy directive that promotes sustainable consumption through reduced consumer packaging and energy efficiency.

The Philippines as Satisfied Customer: Mirant Corporation

Mirant's Philippine operations and involvement in the Philippine rural electrification program have earned the company many coveted environmental performance and corporate citizenship awards. They have also been recognized as a top employer in the Philippines. These accomplishments and corporate commitment have helped sustain a positive working partnership with the Philippine government. In ensuring a license to operate through corporate citizenship, Mirant can be more certain of a license to grow in the market when additional investments are warranted.

Measures related to EHS performance in enhancing customer relationships include:

- Extent of disclosure of the environmental/ social impacts of products and processes
- Customer loyalty and price tolerance attributable to EHS differentiation
- Extent of customer relationships throughout the life cycle of the product
- Third-party feedback and customer satisfaction awards
- Collaboration with customers on EHS-related innovations or customer solutions.

Customer Satisfaction through Environmental Services: Ashland Inc.

Ashland Distribution Company, a division of Ashland Inc., offers a one-source, 'closed-loop' process to not only supply chemicals, plastics and other materials, but also to manage hazardous and non-hazardous waste streams for customers. Ashland's Environmental Services group, leverages a value-added customer service from the in-house expertise and capabilities gained while handling these issues for Ashland's own chemical businesses. It offers a range of processing and treatment options, compliance assurance and industry-leading service throughout North America.

Key Intangibles:
Customer, Technology and Processes

Sample Leading Indicators:
- Customer cost of ownership for purchased chemicals
- Customer loyalty and retention
- Revenue from environmental management services

LEADERSHIP AND STRATEGY

Management capabilities, experience, vision for the future

- Commitment to EHS/sustainability principles and goals
- Articulation and execution of EHS strategy
- Expression of diverse EHS views at Board level
- Level of reporting for EHS function

"Environmental protection is a complex undertaking, but the laws of nature are simple. We will provide leadership on the journey to an environmentally sustainable future, with efficient products and creative recycling systems."[27]

Carly Fiorina
Chairman and Chief Executive Officer, HP

The growing importance of transparency and corporate responsibility has made EHS and sustainability commitment an essential element of corporate leadership and governance. Chief Executives and Boards of Directors are increasingly sensitive to the expectations of shareholders, employees, and other stakeholders.

Measures of EHS performance relevant to leadership and strategy include:

- Commitment and policies with regard to EHS/sustainability principles and goals
- Effectiveness of management in articulation and execution of EHS strategy, including dialogue and engagement with external stakeholders (see Transparency, page 13)
- Diversity and independence of the Board, including the number of outside Directors
- The level of reporting for the EHS/ sustainability function.

Integrating EHS into Business Strategy: DuPont

One of the world's foremost proponents of integrating EHS issues into business strategy is Chad Holliday, CEO of DuPont, who served as chair of the World Business Council for Sustainable Development (WBCSD). DuPont no longer views EHS and social performance as separate thrusts, but instead has woven them into its three corporate strategic priorities:

- Knowledge intensity - creating products and services that deliver greater value to customers and shareholders with less physical mass
- Productivity - improving operating efficiency and capital utilization while reducing the supply chain environmental footprint
- Integrated science - seeking technological innovations that improve quality of life, e.g., by enhancing safety, recyclability, or nutrition.

DuPont has effectively bridged the communications gap between EHS performance and financial performance by emphasizing the contributions of EHS to key intangible value drivers, such as innovation and technology.

Key Intangibles:
Leadership and Strategy, Innovation

Sample Leading Indicators:
- Shareholder value added per pound of product
- Operating efficiency improvements attributable to eco-efficiency
- Percent of new products with differentiated EHS/sustainability features

COMMUNICATION AND TRANSPARENCY

Does management communicate honestly and openly?
Are its communications believed and trusted?
Does management hold itself accountable?

- Disclosure of governance policies and procedures
- Stakeholder engagement
- Timeliness of communications
- Quality and depth of EHS/Sustainability reporting

Effective communication can be the linchpin of corporate reputations; negative impacts can be dramatic when stakeholders are not given the information or ability to make an informed choice.[28] Transparency has become a critical business issue. The Sarbanes-Oxley Act is the legislative incarnation of the spotlight that investors, consumers, and employees now shine on the financial statements of a company.[29] GEMI holds NGO transparency workshops and is developing a new tool to address transparency challenges.[30]

Indeed, companies may pay a price for *not* managing the disclosure of their information, given the ease with which consumers and regulators can now access information on corporate practices. When the Toxic Release Inventory (TRI), a U.S. EPA database of waste management activities, was first disclosed, shares of publicly-traded companies reporting data markedly declined in the short-term.[31] The implication is that investors updated their expectations of future returns for high TRI companies. This feedback from the market prompted change: The firms with the largest decline in market value subsequently responded by reducing emissions more than their industry peers.[32]

Companies stepping up to this demand for information disclose not only credible financial statements, but also their environmental and social policies and procedures. One recent study shows the relationship between companies that disclose more detailed information about their governance and higher shareholder return.[33] Though this correlation is not conclusive, it does underscore the validity of transparency in governance as a value driver.

Sample measures related to transparency and communication include:

- Disclosure of governance policies and procedures, including:
  - Disclosure of Director share ownership requirements
  - Issuance of reports, policies, guidelines, and procedures concerning EHS/Sustainability, dialogue meetings with stakeholders, disclosure of business process improvement initiatives
  - Stating how these policies relate to existing international standards
  - Tying executive and employee compensation to meeting or exceeding internal standards and guidelines
  - "Continuous" reporting or book-keeping; timeliness of financial and non-financial information disclosure beyond quarterly or annual filings
- Extent of stakeholder engagement and dialogue:
  - Number of community advisory panels at manufacturing sites
  - Cooperation or alliances with non-governmental organizations (NGOs)
  - Employee involvement in EHS/Sustainability policies and practices
- Timeliness of communications: e.g., responses to unplanned incidents or releases
- Quality and depth of EHS/Sustainability reporting:
  - Commitment to quantitative indicators and goals
  - Adherence to international reporting standards
  - Candidness about gaps and needed improvements

Transparency in Bioethics Policy: Bristol-Myers Squibb

Bristol-Myers Squibb (BMS), a global manufacturer of pharmaceuticals, recently recognized that an increasing number of clinical trials are being conducted in developing nations. In keeping with its social responsibility commitment, the company formed a Bioethics Committee and developed policies regarding ethical issues in clinical trials, such as readability of forms and informed consent on behalf of children or disadvantaged subjects. One important consideration is that clinical research should be done in a population that will derive benefit from that research, implying that the resulting products should be available to the patients in that region. Another example is the emerging area of protection of privacy in *pharmacogenetics*, which seeks to predict disease vulnerability or treatability in specific genetic groups. Since bioethics is an evolving area, the company continues to reconsider and refine its policies.

BMS was approached by the Calvert Group, a socially responsible investment firm, to learn more about its corporate responsibility and ethics programs. During a meeting between Calvert and BMS researchers, the bioethics policies were featured as an ethical research example. Calvert has lauded these policies as a pharmaceutical industry model. At their suggestion, rather than keeping its bioethics policies confidential, the company has decided to make them available upon request to interested stakeholders.

The transparency dialogue between Calvert and BMS supported Calvert's decision to include the company in the Calvert Social Index, which is used as a basis for inclusion into many of its mutual funds. As a result of its transparency and leadership in the area of ethical research policies, Bristol-Myers Squibb hopes to be recognized not only by the investment community, but also by the global populations that it serves. It is plausible to expect that governments, research institutions, and civil society will acknowledge the company as a trusted partner in the conduct of future clinical trials, and that this will translate into competitive advantage in growing international markets.

Key Intangibles:
Transparency, Environmental and Social Reputation

Sample Leading Indicators:
- Inclusion in socially responsible funds
- Penetration into international markets
- Clinical trials conducted in developing nations that will benefit from research

BRAND EQUITY

Strength of market position, the ability to expand the market, perception of product/service quality, investor confidence

- Perception of brand as environmentally and socially responsible
- Value-added due to product stewardship
- Presence in environmentally and socially-screened investment funds

Many GEMI companies (such as Coca-Cola, Intel and Johnson & Johnson) are household names, and there have been many attempts to calculate a monetary value of such brands. For example, these brand names consistently score high on Interbrand's annual ranking of the "World's Most Valuable Brands."[34] Some companies have successfully tied their brand to an environmentally-friendly image, and have leveraged this image to improve consumer awareness and customer loyalty. [35]

Measures of brand equity that relate to EHS and sustainability include:

- Perception of the brand as environmentally and socially responsible—this can influence customer loyalty, lender and investor scrutiny, cost of capital
- Value added due to product stewardship—the commitment of a company to support the safe and responsible use of its products throughout the life cycle
- Eco-labels and other certifications earned
- Inclusion of the company in environmental and social responsibility investor screens, such as Dow Jones Sustainability Index or FTSE4Good.

Sizing Up the Footprint: Hewlett-Packard (HP)

The merger of Hewlett-Packard (HP) and Compaq united two companies that had long pursued a commitment to EHS performance and sustainability. "HP strives to develop programs that reduce our environmental footprint, as well as those of our customers and partners," said Walt Rosenberg, Vice President, Corporate, Social and Environmental responsibility, HP Corporate Affairs. The company has incorporated "design for environment" methods into its product development processes and worked with suppliers to reduce EHS impacts associated with its products.

The EPA has awarded its 2003 Environmental Achievement Award for U.S. EPA Region 9 to HP's product recycling solutions facility in Roseville, California.

HP is the only technology company to have its own computer hardware recycling facilities in the United States. With its partners, HP operates one of the world's largest hardware recycling facilities. HP's environmentally sound management of end-of-life hardware turns unwanted products into valuable commodities that can be reused to produce new products, reducing the burden on the Earth's resources.[36]

Key Intangibles:
Brand Equity, Environmental and Social Reputation

Sample Leading Indicators:
- Reduction in emissions, waste, and energy consumption per product unit shipped
- Percent of product mass recovered and recycled at end-of-life

ENVIRONMENTAL AND SOCIAL REPUTATION

How the company is viewed globally in terms of environmental concerns, community concerns, regulators' concerns, inclusion in "most admired company" lists, triple bottom line

- Regulatory compliance record
- Third-party recognition and awards
- Participation in EHS/sustainability consortia
- Community development and philanthropy

A company's reputation for environmental and social responsibility can have an important impact on strategic issues, such as access to capital and global markets. While the primary negotiating levers for most businesses are based on economics, concern for EHS and sustainability can be a differentiator. Some host governments may even demand adherence to sustainable development principles as a price of entry. Measurement and reporting of EHS performance and corporate citizenship initiatives also help to build better relationships with stakeholders, especially at the local level.

Measures related to sustainability reputation include:[37]

- Regulatory compliance record (e.g., violations, penalties, incidents), as well as shareholder activism and public criticism
- Third party recognition and awards for corporate citizenship or EHS excellence
- Participation in consortia that promote EHS and sustainability, such as GEMI or the World Business Council for Sustainable Development (WBSCD)
- Community development and philanthropy, including donations, local investments, and voluntary in-kind assistance.

Building a Reputation for Sustainability: 3M

3M has a strong commitment to sustainable development through environmental protection, social responsibility and economic progress. Its sustainability policies and practices are directly linked to its four fundamental corporate values:

- Satisfying its customers with superior quality and value
- Providing investors an attractive return through sustained, high-quality growth
- Respecting its social and physical environment
- Being a company that employees are proud to be part of

3M has been recognized as a sustainability leader by the Dow Jones Sustainability Index and has achieved high rankings for quality of management and innovation. The Harris Annual Reputation Survey ranked 3M as the tenth most reputable U.S. company in 2002. 3M believes that its sustainability reputation translates into shareholder value by (a) demonstrating that 3M is a well-managed company that addresses both risks and opportunities, (b) enhancing brand preference amongst consumers, and (c) attracting and retaining a diverse and talented work force.

Key Intangibles:
Environmental and Social Reputation, Brand Equity, Human Capital

Sample Leading Indicators:
- Recognition as a sustainability leader by government, NGOs and business groups
- Inclusion in environmentally- or socially-screened funds
- Product preference by consumers

ALLIANCES AND NETWORKS

Supply chain relationships, strategic alliances, partnerships

- Collaboration on EHS/sustainability throughout the supply chain
- Partnerships with EHS/sustainability-oriented organizations
- Participation in industrial ecology networks

Businesses over the years have come to accept the claim that "to build a company or a capability without regard for the chain in which it is embedded is a recipe for disaster."[38] Scrutinizing a company's supply chain with an EHS lens can reveal the choices and opportunities a company has to cost-effectively improve performance. Raw materials and new technological concepts, for example, may demand choices between higher-polluting or cleaner-burning energy sources. Materials sourcing can lie squarely in the scope among other strategic considerations. Manufacturers can choose product designs that are upgradeable, with the potential for customer lock-in with a service relationship.

The Global Brand With a Local Reach: The Coca-Cola Company

The network of local businesses that Coca-Cola has built is as impressive as its global brand. In over 200 countries, Coca-Cola operates with local partners. Even in geographies far from its world headquarters such as in the Middle East, Coca-Cola employs 20,000 people directly and 200,000 including retail and supply jobs.[39] Their products are produced, sold, and distributed by authorized local bottling partners, employing one million local citizens.

Zahi Khouri, chairman of the National Beverage Company, a Middle Eastern bottler that is 15 percent owned by Coca-Cola, said in an interview with The Economist that Coca-Cola strongly supports local management of operations in other countries.[39] Coca-Cola is the second biggest corporate investor in the West Bank region.

Measures that indicate leverage of EHS/sustainability in alliances and networks include:

- Collaboration on EHS/sustainability improvement through supply chain relationships, including outsourcing, collaborative innovation, and procurement policies.
- Extent of outsourcing (e.g., cost of goods, materials, and services purchased)
- Percentage of suppliers that meet or exceed voluntary environmental performance standards
- Extent to which supplies are sourced locally versus globally
- Number of alliances and joint ventures
- Explicit use of EHS and sustainability criteria in selection of suppliers and business partners
- Partnerships with EHS/sustainability-oriented organizations, including NGOs, governments or other groups
- Participation in industrial ecology networks, in which waste byproducts of one company become feedstocks for another company.

GEMI's Supply Chain project is documenting how collaborative relationships between suppliers and customers can improve overall supply chain performance from both a financial and EHS perspective. These types of opportunities are also being explored by the Suppliers Partnership for the Environment (SP), a recently established automotive industry consortium.

The Michigan Source Reduction Initiative (MSRI): The Dow Chemical Company

In April 1999, Dow Chemical completed a two-year collaborative program with the Natural Resources Defense Council (NRDC) and five local activist groups to voluntarily reduce waste and emissions at the Michigan Operations site. The project fostered broader efforts within Dow to shift from traditional environmental compliance to pollution prevention and further integrate EHS concerns into business decision making.

MSRI was a participatory process involving direct collaboration between Dow managers and environmental activists to first establish reduction targets and then agree on pollution prevention actions. A full-time external expert was also retained by Dow to help identify the greatest opportunities for waste minimization and emission reduction and to provide a credible technical resource for the MSRI participants.

Results:

- Environmental

The MSRI project set an aggressive goal of 35% reduction in waste and emissions. This goal was actually exceeded—targeted emissions were reduced by 43%, and targeted wastes by 37%. The total reductions achieved were over 10 million pounds per year of wastes and about 1.5 million pounds per year of air emissions, and some waste streams, such as formaldehyde, were virtually eliminated. Consequently the TRI emissions from the Midland, Michigan site for 1998 were 41% lower than 1997.

- Economic

The cost savings and process improvements that MSRI delivered were exemplary. The reductions will be paid for in less than one year, which translates to an overall rate of return of 180%—a savings of over $5.4 million per year with a total one time capital expenditure of $3.1 million. Dow was the first company to harness the Six Sigma methodology to directly improve EHS performance.

- Social

MSRI involved a multi-stakeholder, participatory endeavor that enabled community participants to gain an understanding of Dow's decision-making process, and helped to establish common ground. Relationships with all stakeholders involved in the project improved dramatically.

Key Intangibles:
Alliances and Networks, Transparency

Sample Leading Indicators:

- Measures of company's ability to prevent pollution at its source, versus the capital required for pollution control
- Measures of the amount and quality of various stakeholder dialogues
- Environmental gains and competitive advantage due to process modifications

TECHNOLOGY AND PROCESSES

Strategy execution; IT capabilities, inventory management, turnaround times, flexibility, reengineering, quality, internal transparency

- Leadership in EHS/sustainability technologies *&* business practices
- Design for EHS/sustainability processes and results
- Energy and material conservation
- Ecosystem impact minimization

The ability to exploit new practices is a critical element of sustained competitive advantage.[40] In the past few decades, companies have begun to introduce strategic frameworks and processes that take environmental costs and benefits into account.

Design for Environment (DfE)[41] is one such tool, where environmental criteria are brought on board early in the product development stage. When combined with a Life Cycle Assessment (LCA), these tools can not only improve the environmental performance of a product during its use phase, but also simplify a product's end-of-life disassembly, reuse, recycling and disposal. Total cost assessment (TCA) has been another useful management tool since the late 1980's, and when combined with environmental considerations can give a candid picture of total costs and benefits (see Section 4 for further discussion on TCA).

Employing such tools at all levels of the organization takes a commitment either through the provision of information about the tool or process, or by employing incentives and compensation schemes. Companies that stand out as leaders in organizational technologies and processes will understand and quantify the benefits of such tools, and provide a combination of information and incentives to improve the measurable performance.[42]

Measures of superior technology and process performance include:

- Leadership in EHS/sustainability technologies:
  - Investment in alternative energy, bio-based products, etc.
  - Adoption of sustainable process technologies
- Leadership in EHS/sustainability business practices:
  - Speed and quality of EHS due diligence
  - Incentives to develop “beyond compliance" processes and technologies
- Design for EHS/sustainability processes and results:
  - Incorporation of EHS/sustainability criteria into product realization process
    Collaboration with suppliers on life cycle impact reduction
  - Materials and energy use reduction in product and process design
  - Reductions in pollution, greenhouse gas emissions, hazardous wastes, etc.
  - Improvements in product upgradeability, longevity, re-usability, etc.
  - Reduction in product maintenance requirements and cost of ownership
- Energy and material conservation:
  - Initiatives to use renewable energy sources and to increase energy efficiency
  - Percentage of the weight of products sold that is reclaimable at the end of the products' useful life and percentage that is actually reclaimed
- Ecosystem impact minimization:
  - Brownfields re-development initiatives
  - Land use policies and habitat restoration
  - Ecological footprint reduction

Excellence in technology does not necessarily require leading-edge innovation. In many cases it simply involves applying available expertise and know-how to devise beneficial, cost-effective solutions. Moreover, technology does not refer only to the “hard" technologies associated with product design and process engineering; it also includes the “soft" technologies associated with business processes and decision-making.

Utilizing Advanced Technology: FedEx Express

FedEx Express, the Memphis, Tennessee-based company that invented the express package delivery market, has been upgrading its ground-based delivery operations. In May 2003, FedEx Express announced it had agreed to purchase 20 hybrid delivery trucks, the vanguard in a program that has the potential to eventually replace its fleet of 30,000 medium-duty express delivery vans. FedEx Express is the first U.S. company to adapt the technology for diesel delivery vehicles on such a large scale.

Hybrids, which combine a high-efficiency diesel or gas engine with an electric motor, have both financial and environmental advantages. They require less maintenance because they run cleaner, and the braking systems last longer because the motor itself helps to decelerate the vehicle while recapturing kinetic energy. Through a combination of fuel savings and lower maintenance costs, FedEx Express expects to recoup some of the higher acquisition costs of the hybrid vans. As production levels rise, these costs will come down (and savings increase). FedEx Express is working with Environmental Defense's Alliance for Environmental Innovation to develop the environmental performance specifications for the new vehicles.

The scale of FedEx Express' commitment is likely to transform the economics of hybrid commercial vehicles, potentially enabling them to be mass-produced and more affordable for smaller companies. Thus, FedEx Express is helping to jump-start a technology that could have widespread economic and environmental benefits. In a recent report, consumer consultant J.D. Power & Associates Inc. estimated there will be more than 500,000 hybrid vehicles on the road by 2008 with trucks accounting for 40% of that number.

Key Intangibles:
Technology and Processes, Innovation, Alliances and Networks

Sample Leading Indicators:
- Percent of fleet utilizing alternative engine technology
- Life cycle operating and maintenance costs per vehicle
- Energy consumption per vehicle mile

HUMAN CAPITAL

Talent acquisition, workforce retention, employee relations, compensation, what makes a "great place to work"

- Workforce diversity, employee benefits and compensation
- Employee rights and empowerment
- Perception and awards as a "great place to work"

In a service-oriented economy, human capital is critical to organizational success, whether a company is product or service-oriented. Researchers have begun to quantify, in various ways, the effects of investment in human capital. For example:

- A study of 405 public companies found that a well-managed workforce can add up to 30% to a company's market value.[43]
- A study of 40 companies found those ranking in the top half for training expenditures per employee had higher net sales and higher gross profit per employee than those in the bottom half; they also had a higher and faster-growing market-to-book ratio.[44]
- A study of 29 professional service firms in 15 countries indicated that raising employee satisfaction by 20% can boost financial performance more than 40%.[45]

Measures of EHS contributions to human capital include:

- Workforce diversity, employee benefits and compensation:
  - Composition of senior management and governance bodies, including female/male ratio and other indicators of diversity as culturally appropriate.
  - Net employment creation and average turnover
  - Employee benefits beyond those legally mandated
  - Clear organizational goals, incentives and performance measures
- Employee rights and empowerment:
  - Freedom of expression and tolerance for individuality
  - Average training investment per employee per year
  - Incentives for employee volunteerism, education and career development
  - Culture of continuous improvement, including employee health and safety.
- Perception and awards as a “Great Place to Work."

Commitment to Employees: Intel Corporation

Intel was ranked number three in *Business Ethics* 2003 list of best corporate citizens. The magazine explains that ethics at Intel "include careful attention to employee safety—so much that CEO Craig Barrett insists he be sent an e-mail report within 24 hours any time one of his firm's 80,000 employees loses a single day of work to injury. 'This policy allows us to look at the root causes of all accidents and figure out what we can do to prevent them from occurring again,'" said Dave Stangis, Intel's Director of Corporate Responsibility. In 2000, Intel's worldwide injury rate was just 0.27 injuries per 100 employees, compared to an industry average of 6.7.

Key Intangibles:
Human Capital, Environmental and Social Reputation

Sample Leading Indicators:
- Awards and recognition
- Employee satisfaction surveys
- Employee health and safety statistics

INNOVATION

The R&D pipeline, effectiveness of new-product development, patents, know-how, business secrets

- Leadership and patent position in EHS technologies
- Cost savings through EHS/sustainability innovation
- EHS-related product or service differentiation

Service, product and process innovations can all improve EHS performance as well as add overall value to a corporation. Devising innovative ways to meet or beat compliance targets may not only help reduce costs; it has also helped steer environmental regulation in a direction beneficial to producers as well as to social/environmental well-being. [46]

Measures of EHS/sustainability contributions to innovation include:

- Leadership and patent position in EHS technologies:
  - Level of R&D investment in addressing regulatory requirements
  - Licensing revenues from EHS technologies
- Cost savings through EHS/sustainability innovations, including operating costs, capital costs, service and support costs, or product takeback costs
- EHS-related product or service differentiation, e.g., ability to extract a higher margin.

Innovation and Environmental Benefits: Johnson Controls, Inc.

Johnson Controls, Inc. (JCI) is the world's largest manufacturer of automotive interiors and automobile batteries, and a global leader in control systems and commercial facility management. JCI has achieved growth through innovation, while remaining committed to its values, including integrity, customer satisfaction and EHS excellence.

JCI began decades ago to promote battery recycling and develop a reverse logistics infrastructure. Today, the recycling rate of battery lead exceeds 93%, far higher than any other commodity, and 48 states require lead-acid batteries to be recovered. In addition, lead and plastic process wastes are recycled for re-use in new batteries and other products such as X-ray shielding. Continuing innovations in battery technology include design for disassembly and development of higher voltage batteries to support electronic control systems that will improve fuel efficiency and reduce emissions in future vehicles.

As a leader in facility management, JCI focuses on making commercial buildings more energy efficient, safe, secure and comfortable. For example, in building control systems, JCI's mercury-free thermostats provide a competitive advantage in many applications (e.g., schools, hospitals). One important innovation was the Energy Saving Performance Contracting approach, in which energy efficiency upgrades are financed through JCI and repaid through energy savings. This approach is projected to achieve $95 billion in energy savings and 1.3 billion tons of carbon dioxide emission reductions between 1990 and 2020.

Key Intangibles:
Innovation, Risk

Sample Leading Indicators:
- Energy/materials use per consumer product unit
- Competitive advantage in bidding for contracts
- Reduced cost of ownership and liability risks for customers

RISK The ability to effectively manage the balance between potential liabilities and potential opportunities

- Inherent product or process hazards
- Effectiveness of risk prevention and risk management
- Effective response to challenges and opportunities

Proactive investing in environmental measures beyond those required by law can be good for the bottom line, while limiting downside risk.[47] Damages and hefty litigation fees are incentive enough to manage proactively the risk of unplanned incidents such as spills, workplace accidents or product-related injuries. More importantly, such incidents may result in costly business interruptions as well as adverse publicity that can compromise brand equity and reputation.

Risk management also has a positive aspect—the ability of a firm to pursue promising business opportunities that involve uncertainty. A company that is able to rapidly and effectively discern potential obstacles or liabilities, e.g., through a due diligence process for acquisition of new assets, is better equipped to enhance long-term shareholder returns. Likewise, a company that exercises product stewardship, while advising customers and suppliers on how to minimize hazards in their own operations, enhances both its own risk profile and its perceived value as a business partner.

Insurance Companies Re-think Risk Profiles

Swiss Re believes that companies that have poor compliance records or are lacking in plans to mitigate climate change risks, are more likely to attract shareholder lawsuits. Accordingly, the insurance giant has stated that it may drop insurance for the directors and officers of those companies who may be specifically targeted by shareholders.

On the positive side, the effective risk management program of Occidental Petroleum Corporation has been recognized by insurance companies, resulting in Occidental being offered access to additional insurance capacity at preferred rates.

Measures related to effectiveness in EHS/sustainability exposure and risk include:

- Intrinsic product and process hazards, such as presence of toxic constituents
- Effectiveness of risk prevention and risk management, including:
  - Prevention of risks
    - Frequency of internal audits
    - Investment in meeting upcoming regulatory requirements
    - Accrued environmental liabilities, fines, warnings and penalties
    - Rate of worker days lost per 200,000 hours
  - Mitigation of impacts
    - Crisis response and crisis management performance
    - Waste recovery and recycling programs, whether in compliance with or in addition to regulatory initiatives
    - Workers compensation case management costs
    - Costs of unplanned business interruptions
- Effective responses to challenges and opportunities:
  - Proactive policies to address regulatory initiatives and consumer preferences, e.g., policies to prepare for climate change pressures, use of emissions trading schemes, product take-back regulations and consumer privacy issues
  - Proactive experimentation with environmental technologies such as joint implementation, emissions trading, pollution-prevention technologies
  - Corporate citizenship and stakeholder engagement initiatives

Assuring Business Continuity: Novartis

Novartis is one of the world's leading healthcare companies. The company has had a long history of risk management, using a variety of tools to assess risks associated with new projects and acquisitions, as well as ongoing operations. For example, Novartis sites are required to annually maintain a "risk portfolio," a matrix that screens various risks in terms of their potential impacts and level of control. This information is rolled up to the Group level, and is used to improve management awareness and support priority-setting in resource allocation.

Novartis has initiated a new program that addresses *business continuity* by assuring that all business interruption risks are properly anticipated and managed. Costly business interruptions can potentially be triggered by a variety of circumstances, from an unintentional release of hazardous materials to a failure of critical information systems. The Health, Safety and Environmental Department has the responsibility to develop a framework for assuring business continuity, including risk identification, contingency planning, crisis management and disaster recovery. In addition, looking beyond the fenceline, Novartis has established a product stewardship program to anticipate potential risks associated with design, material acquisition, distribution and use of its products; for example, the company might choose to eliminate chemical constituents with undesirable properties.

Key Intangibles:
Risk, Environmental and Social Reputation

Sample Leading Indicators:

- Number of risks classified "high" for each business unit
- Percent completion of business continuity plans
- Percent of product stewardship risk analyses completed

Section 4
FROM CONCEPT TO PRACTICE

Through identification of important EHS-related value drivers, companies can improve their competitive position and financial performance over the long run. However, EHS value contributions are not meaningful to the investor unless they are properly articulated and communicated.

Section 2 “Making the Case" and Section 3 “A Closer Look" are relevant for senior company executives, mainstream financial analysts or fund managers, and investor relations professionals. This section is intended as a practical primer for the EHS professional, working in collaboration with other corporate functions. This section, “From Concept to Practice" presents a step-by-step process for identifying, measuring, communicating and managing these value drivers. The intent of the process is to help EHS professionals and their companies gain recognition for EHS excellence from their own internal investor relations function, from the investment community and from other stakeholders.

Linkage Between EHS and IR

In its “Standards of Practice for Investor Relations," the National Investor Relations Institute (NIRI) defines Investor Relations as:

“. . . a strategic corporate marketing activity combining the disciplines of communications and finance that provides present and potential investors with an accurate portrayal of a company's performance and prospect…Marketing in this context does not mean 'selling' a company's securities, but rather a process of identifying target audiences and educating them about the present and potential value of those securities."

The NIRI document further notes that the importance of quality of management to investors suggests that those investors need to know whether management can articulate a vision and whether they have the resources to accomplish that vision. To the extent that EHS excellence can logically be understood to be part of that vision, there is a clear role for EHS professionals to assist the Investor Relations Officer (IRO), the CFO and the company in achieving its goals.

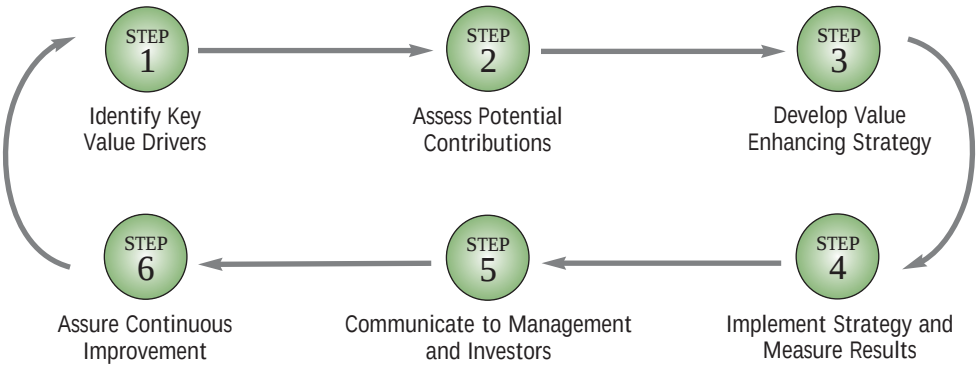
The *Clear Advantage* Process

Communicating EHS excellence as part of a corporate vision requires a systematic process that enables companies to recognize and take advantage of opportunities for value creation. This section presents the *Clear Advantage* process that has been developed to address the needs of GEMI's participating member companies (see page II). The design of this *Clear Advantage* process is deliberately generic, so that it can be adapted by virtually any manufacturing or service enterprise.

The *Clear Advantage* process, depicted in *Figure 4-1*, consists of six cyclical steps, and follows the familiar pattern of “plan, do, check, act" that underlies most contemporary business process designs. Therefore, it will be simple for companies to incorporate the desirable features of *Clear Advantage* into their existing value creation processes.

It is recommended that the *Clear Advantage* process be carried out by a cross-functional “value creation team," under the guidance of an “EHS value champion." The value champion for this type of initiative is frequently from EHS management, although a champion from another senior management function (e.g., CFO) could yield wider acceptance and greater legitimacy. In addition to EHS and IR, other functions that may participate on this team include strategic planning, new product development, marketing, operations, finance, engineering and human resources.

Figure 4-1 The *Clear Advantage* Process



STEP 1 - Identify Key Value Drivers

Identification of value drivers is the starting point for any effort to enhance shareholder value. As described in Section 2 “Making the Case," a value driver is defined as *a fundamental and persistent characteristic of a business enterprise that influences its market value*. Authentic value drivers are *fundamental* in that they represent a strong, intrinsic characteristic of an enterprise. They are *persistent* in that they will have a lasting impact on value regardless of market fluctuations.

The nature and relative importance of these value drivers varies by industry, geography and economic setting. It is likely that the strategic planning and/or investor relations groups within a company will be able to provide an initial list of perceived value drivers.

The following are guidelines for identifying your company's value drivers and related EHS contributions:

Action Items

✓ With the help of internal strategic planning, investor relations, and other groups, develop a generally accepted list of key value drivers for your company. It is best to perform this exercise without preconceptions about where EHS improvements might contribute the greatest value. The value drivers that have been identified by GEMI members in *Figure 2-6* may provide a useful starting point. These are believed to be the most common but the list is not all-inclusive

✓ Based on the team's expertise and insights, evaluate how EHS activities contribute to these key value drivers

✓ Develop a generally agreed upon ranking or clustering of the list of key drivers in terms of relative importance. Two ways of achieving this are through informal consensus or having team members rank the drivers and calculate averages

✓ To the extent possible, develop an understanding of your company's strengths or weaknesses in these driver categories vis-à-vis competitors. Are there particular value drivers for which improvement would be particularly advantageous?

For Your Toolkit

Perform an Intangibles Assessment

It may be helpful to assess the relative strength of your company's intangible assets through simple surveying techniques. There are a number of approaches; one example is an existing tool called the “Invisible Advantage Diagnostic" (available at http://www.predictiv.net). Such questions may be adapted in order to help assess the relevance of EHS to each intangible value driver. For example, the following hypothetical question explores how EHS capabilities are linked to the Innovation process.

Illustrative example of a diagnostic question

To what extent does your organization leverage its EHS capabilities to support product and process innovation?

- EHS capabilities are not linked to the innovation processes in a systematic way
- EHS considerations occasionally motivate adoption of new technologies aimed at emission control and/or waste reduction
- EHS knowledge is incorporated into facility engineering to systematically improve operating efficiency and safety, or
- EHS knowledge is applied systematically to encourage innovation in both facility engineering and new product development

STEP 2 - Assess Potential Contributions

In order to identify the highest leverage opportunities, a company needs to move beyond the qualitative identification of intangible value drivers and develop an understanding of the relative magnitude of each.

A variety of different conceptual frameworks have been developed for characterizing the tangible and intangible assets that drive long-term performance. If a company has already adopted one, then it makes sense to utilize that framework to further explore EHS opportunities. The following *Figures 4-2* and *4-3* summarize two frameworks that are in common use today.[48]

One of the most widely used frameworks is the "Balanced Scorecard," popularized by Kaplan and Norton,[49] which proposes broadening financial performance measurement to include three major non-financial perspectives that are leading indicators of financial success: Learning and Growth, Internal Business Process Excellence, and Customer Relationships. This framework is illustrated in *Figure 4-2*.

Another important framework is the "intellectual capital" model developed by Stewart[50] and others, which includes the following categories of intangible assets:

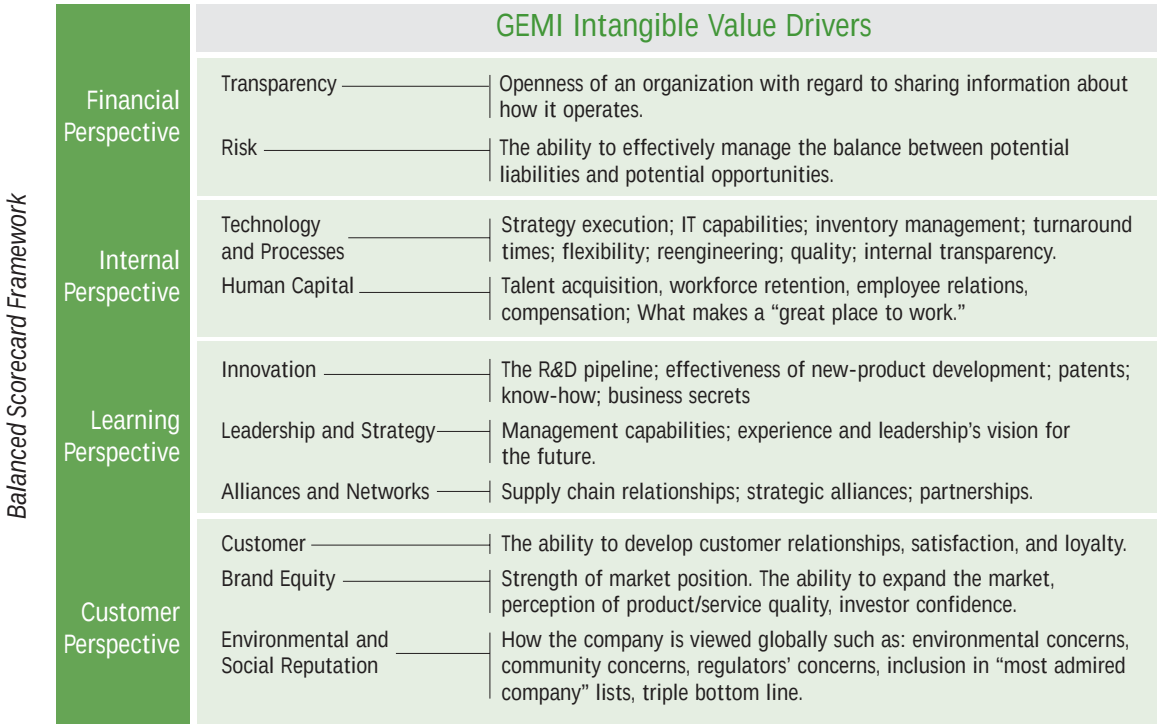
- Human Capital - skills and knowledge of management and employees
- Structural Capital - patents and proprietary data, methodologies or processes
- Relationship Capital - bonds with customers and suppliers, and brand identity

Leading companies such as DuPont and General Electric have systematically worked to substitute intellectual capital for physical capital in order to increase shareholder value—this is in line with a notion that intangible assets are less expensive to maintain than tangible ones. The EHS value drivers in Section 3 can be mapped into the intellectual capital framework using an approach similar to the Balanced Scorecard example (see *Figure 4-3)*.

While the frameworks discussed are extremely robust and flexible, they do not provide guidance to practitioners on what intangibles need to be emphasized within each of these

Figure 4-2 Balanced Scorecard Framework

Figure 4-3 How GEMI Intangible Value Drivers Populate the Balanced Scorecard Framework



broad perspectives. In particular, they do not provide explicit linkages between the strength of a company's intangibles and the financial performance of interest to investors. Step 3 will focus on measurement of financial value drivers and account for the impact of intangible assets.

For this step in the *Clear Advantage* process, EHS management should assess how it can make the greatest contribution to value. This is ultimately a creative exercise. The following action items are by no means exhaustive, but they should help to articulate and assess the most promising opportunities.

Action Items

- ✓ Create a set of hypotheses about areas of EHS performance that represent significant opportunities for value creation
- ✓ For each hypothesis, identify the value driver or drivers from *Figure 2-6* that can be improved (e.g., customer satisfaction)
- ✓ State the specific contribution and value outcome (e.g., design changes to a product line resulting in customer benefits such as lower cost, convenience, etc.)
- ✓ Repeat steps, this time starting with *Figure 2-6* and brainstorming the value drivers that can be affected by EHS performance.

For Your Toolkit

Assess Total Costs

A helpful tool for identifying value creation opportunities is total cost assessment (TCA), a method for quantifying all EHS costs, both internal and external, associated with a business decision.[51] TCA is a comprehensive process to identify potentially hidden environmental and health costs and to mitigate future risks and contingent costs for industrial processes, products or facilities. Costs that may not have been previously considered are generally associated with allocated overhead charges and/or potential future costs, including hidden impacts on the environment and human health, as well as internal intangible costs. For example, the potential future costs associated with carbon dioxide emissions can be considered in developing a strategy for carbon management.

STEP 3 - Develop Value-Enhancing Strategy

The next step in the *Clear Advantage* process is the development of a strategy for capturing new opportunities to enhance shareholder value. Given an initial set of hypotheses about value creation opportunities, it is important to consider each in a strategic business context. The box below describes some frameworks that attempt to do so by linking value-based indicators to shareholder returns. The intangible value contributions described in this tool may be considered in addition to other value-based management models.

EHS Intangibles as Leading Indicators

Steps 1 and 2 helped to identify and rank the important drivers for creating and sustaining value and competitive advantage. These insights can then be applied to develop a unique model for an individual company. As illustrated in *Figure 4-4*, many of the EHS performance indicators discussed in Section 3 can be configured as inputs to a company-specific model of intangible value creation.

It is likely that most public companies already have approximately 70 percent of the information required to begin constructing such a model. These data almost always reside

VALUE ENHANCING STRATEGY FRAMEWORK *examples*

Value-Based Management and Intangibles Valuation

The 1990s saw a growing strategic emphasis on frameworks for value-based management - i.e., the realization of corporate value through identification, measurement and management of the drivers of customer value and shareholder returns. These methodologies included economic value added (EVA) measures that are claimed to approximate shareholder returns, and strategic management accounting systems that provide information concerning the current and expected states of strategic uncertainties.

EVA has been a popular value-based indicator—approximately 40% of Fortune 500 firms have used EVA or some variant for strategic planning purposes.[52] Other mechanisms like EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) and pro forma statements of earnings have also gained widespread use. Research suggests that as many as 65 percent of *Fortune 500* companies have experimented with such models.[53] All three approaches have supporters and detractors. They are mentioned here because of the recognition they enjoy, not because they are recommended.

The past two decades have also witnessed new experimentation with intangible asset valuation. Both financial and non-financial value drivers were determined from organizational strategy and value chain analysis and hypothetical models were created by fitting together these drivers and estimating their impact on one another. This enabled assessment of how changes in value drivers impact financial results and shareholder value. PriceWaterhouseCoopers, Cap Gemini Ernst & Young and New York University Professor Baruch Lev have all developed such models.

Intangible Assets and Hard Financial Outcomes

Adding confidence to the importance of identifying key value drivers and assessing their potential contributions in Steps 1 and 2, *Decisions That Matter*, a study published in 2001, identified critical drivers of long-term economic value from the point of view of senior corporate financial executives.[54] The study also assessed the performance consequences of gaps between measures for internal decision-making and external reporting. More than 80% of executives surveyed perceived a gap between the information they received from their own companies and what they actually believed was critical to measure. Moreover, the size of gaps within companies (i.e., the difference between what companies measure and what they believe is important) was strongly correlated with stock price, market value and other "hard" performance data.

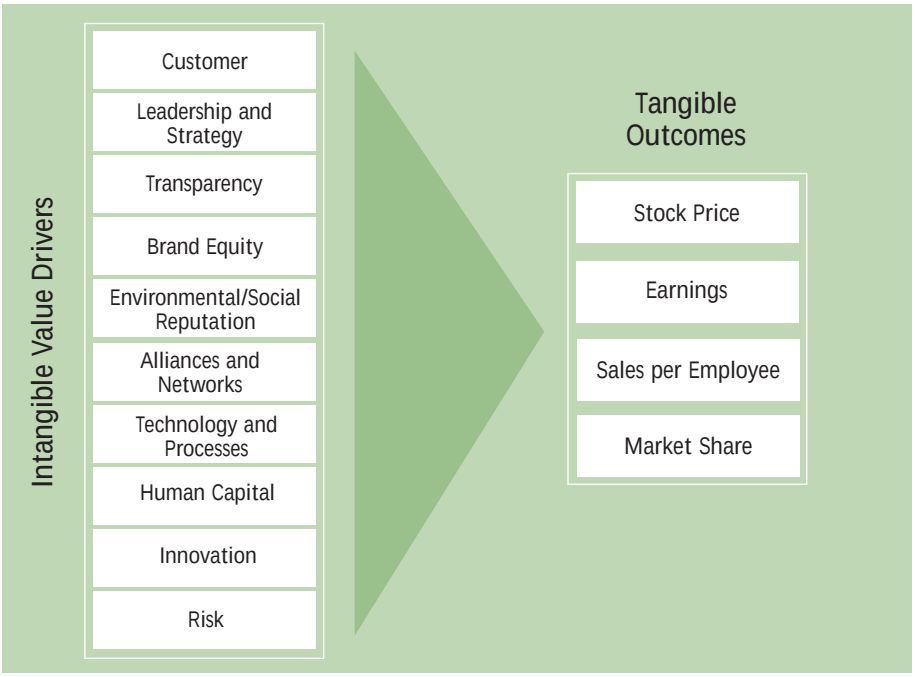


Figure 4-4

Conceptual Model of Intangible Value Creation

in operational databases controlled at the business unit or functional staff level, rather than in corporate financial databases. By mining what is already known from a host of qualitative evidence and quantitative measures, and seeking to identify indicators of EHS excellence that cut across all their business functions (procurement, supplier relations, product design, etc.), companies can obtain a more comprehensive view of EHS value creation. The model characterizes the potential contributions of EHS function to a spectrum of intangible assets, and thus shows how EHS results are linked to financial outcomes.

The advantage of this sort of quantitative modeling is that it permits more informed communication between EHS, Investor Relations, Treasury and Chief Financial Officer staffs about the expected impact of investments in EHS activities, and underscores the linkage between the intangible value drivers and firm performance. It conducts the dialogue in the language of finance, which is first and foremost, in monetary terms.

Action Items

- ✓ In a collaborative setting, consider the opportunities selected in the first 2 steps and then state goals for influencing particular value drivers
- ✓ Justify these goals in terms of expected outcomes (e.g., customer loyalty)
- ✓ Identify specific, measurable indicators of improvement for both the value drivers and anticipated outcomes
- ✓ Evaluate the costs, risks, and benefits associated with the strategy, in comparison to the risks of maintaining status quo
- ✓ Develop an action plan, with clear accountabilities, for realizing the proposed improvements and assure compatibility with existing business priorities.

For Your Toolkit

Determine Metrics

Make a list of the types of information/data your organization is currently collecting to support those drivers, including where they reside in your organization. While many organizations collect data to be used in the measurement and monitoring of progress, most of it tends to reside

in disparate parts of the organization and is never collectively compiled. What concepts are explained well by current measurement systems? Where are they lacking? Chances are it is the drivers of intangible value that are most neglected.

Of available data, determine which can be used as proxies to represent the EHS drivers. These proxies should be measurable, comprehensive, and generally accepted as reliable indicators toward the understanding of a particular concept. Multiple measures should be gathered for each intangible driver to aid in its robustness. And, keep in mind that even if these measures are less than ideal, they can likely be used as a good starting point to help you and other key management understand where your organization currently stands with regard to these value drivers.

STEP 4 - Implement Strategy and Measure Results

The strategy developed in Step 3 provides a basis for launching implementation. Armed with this sort of framework, a company can identify, measure and begin to manage the ways in which its EHS/Sustainability activities affect other operations and outcomes. Used in concert with cases, anecdotes and historical trend data, the quantitative model presents a comprehensive picture to senior executives, investment professionals and to all of an organization's concerned constituencies. It enables informed discussion of (a) how EHS can improve financial performance, and (b) the magnitude of financial improvements that can be expected. Thus, a company can begin to meaningfully analyze the return on its investment in EHS resources.

Action Items

- ✓ Identify and secure the needed resources, including senior management endorsement and cross-functional collaboration
- ✓ Gather needed data to measure both the effectiveness of internal process changes designed to influence value and outcomes
- ✓ Expand the strategy previously developed to assign detailed implementation responsibilities to value creation teams
- ✓ Convene periodic team meetings to evaluate progress and adjust the ongoing action plans as appropriate
- ✓ Remain watchful for signals of change that may run contrary to previously conceived strategic assumptions and rationale.

For Your Toolkit

Benchmark Your Performance

Once you have a baseline of strategically important EHS factors defined, it is important to understand where your company stands currently and benchmark against competitors. Starting with a snapshot of your present organization relative to these factors, you can assess your position relative to your competitors. Once EHS contributions to market value are measured, organizations have a much better sense of where they stand and what needs to be changed in order to improve.

STEP 5 - Communicate to Management and Investors

Realization of shareholder value through EHS improvements requires recognition of value by the investment community. Therefore, effective communication is an essential component of the *Clear Advantage* process. The subject of intangible value drivers in general, and of EHS contributions in particular, is still relatively new. Environmental and social performance messages fall outside of mainstream investor communications. Accordingly, careful design of these value creation messages is needed to assure that they are both easily understood and responsive to investor interests.

Apart from coordinating the *Clear Advantage* process, the EHS value champion (and/or internal alliance, industry coalition, etc.) must play a critical advocacy role in bringing the value creation opportunities and results to the attention of internal management.

The format and language in which the value creation message is framed must be carefully chosen. In addition to assisting in the construction of these messages, the EHS value creation team may need to assist in the development of supporting materials for investor communication.

Action Items

- ✓ Monitor quantitative and qualitative implementation results to capture evidence of successful value creation
- ✓ Develop internal communications regarding successful outcomes for presentation to senior management and investor relations
- ✓ Advocate incorporation of the EHS value message into investor communications
- ✓ Support development of investor communication materials as needed
- ✓ Establish a mechanism to record EHS contributions and to validate the long-term impacts on value drivers and market valuation.

For Your Toolkit

The returns to transparency far outweigh the returns to secrecy. Communicate the changes that you are making both within the organization and outside.

While information itself is of limited competitive value, what you do with that information can make a great difference to your key stakeholders. Now, more than ever, companies need to help their stakeholders, both internal and external, rebuild a sense of trust through the actions and commitments of corporate leaders. Transparent communication to employees, customers, suppliers, industry groups, investors and Wall Street analysts about intangible valuation can have many positive outcomes. After all, it is not just having particular information but rather what you do with it that is truly important. If you can show why a certain EHS factor is critical, and if you can improve your company's performance in this area as well as measure its impact on performance outcomes, you will gain critical credibility in the eyes of key stakeholders.

STEP 6 - Assure Continuous Improvement

The final step in the *Clear Advantage* process is, in reality, an ongoing process - assuring that the initial promise of EHS value creation is realized through systematic monitoring and continuous improvement. This can be designed and carried out by members of the EHS value creation team.

Action Items

- ✓ Monitor the execution of the value creation strategy and capture lessons learned
- ✓ Promote regular evaluation and refinement of the strategy, including selected value creation opportunities, goals, and mechanisms for action
- ✓ Research and understand company experience with investor communications that address EHS value creation and recommend improvements
- ✓ Monitor changes in the competitive landscape and company characteristics that might prompt adjustment of the *Clear Advantage* process
- ✓ Monitor the selected company performance indicators and remain alert for leading indicators of significant changes
- ✓ Review and re-consider key value drivers, hypothesized pathways to value, and business rationale, as appropriate
- ✓ Conduct periodic, informal surveys of internal staff to assure that the *Clear Advantage* process is operating effectively and efficiently.

Section 5

CONCLUSION

Clear Advantage provides compelling evidence of the link between EHS activities and shareholder value. Because an enterprise's EHS function cuts across many areas of business, this report covers the EHS function as well as related organizational activities: community involvement, stakeholder relations, governance, transparency and business continuity. In a climate of increased focus on corporate governance and shareholder activism, these issues will only increase in importance.

Risk management and trust are among the characteristics influenced by the organizational activities noted above. The capital markets value them, although they do not appear directly on financial statements. A substantial body of evidence exists on how EHS practices specficially contribute to the bottom line, including reductions in operating costs, insurance premiums and capital costs. It is the contention of this document that EHS practices contribute to shareholder value in a broader and more strategic way: by building critical organizational capabilities.

This report also serves as a practical primer for the EHS professional, working in collaboration with other corporate functions, by providing a step-by-step process for identifying, measuring, communicating and managing value drivers. The intent of this process is to help EHS professionals and their companies gain recognition for EHS excellence from their own internal investor relations function, from the investment community and from other stakeholders. Hopefully this enables companies to recognize and take advantage of opportunities to create a *Clear Advantage* for their company and *Build Shareholder Value*.

Appendix A
DISCUSSION GUIDE

These questions are intended to serve as guidelines in a discussion between staff members of corporate Environment, Health & Safety and Investor Relations.

1) Please rate your level of familiarity with the record of your company's Environmental, Health and Safety programs.
(1 to 10 scale from "not at all" to "extremely").

NOT AT ALL									EXTREMELY
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

2) If you answered 4 or above to Question 1, have you ever communicated this record to members of the sell or buy side investment communities as part of your corporate IR strategy?
   - A ☐ Yes
   - B ☐ No

3) If yes, please describe the reaction you received.
(1 = indifference, 10 = great interest).

INDIFFERENCE									GREAT INTEREST
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

4) If no, was it because
   - A ☐ You think the securities analysts and portfolio managers don't care
   - B ☐ You think the story is too negative
   - C ☐ You think it is too risky to share this sort of information
   - D ☐ Other stories about the company are more central to the corporate strategy
   - E ☐ You believe you need to know more yourself before disclosing this material

5) Would you be interested in learning more about the evidence of the positive correlation between EHS programs and financial performance like stock price, P/E ratio?
   - A ☐ Yes
   - B ☐ No

6) If yes, what sort of information would you like?
   - A ☐ Quantitative data
   - B ☐ Case studies
   - C ☐ Narrative examples
   - D ☐ Other, please explain

7) If no, why not?
   - A ☐ You think the securities analysts and portfolio managers don't care
   - B ☐ You think the story is too negative
   - C ☐ You think it is too risky to share this sort of information
   - D ☐ Other stories about the company are more central to the corporate strategy
   - E ☐ You believe you need to know more yourself before disclosing this material

8) Please rate your level of interest in working with the EHS executives in your corporation to incorporate the value creation message into your company's IR strategy.
(1 to 10 scale from "not at all" to "extremely" interested).

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NOT AT ALL									EXTREMELY
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

9) If you answered 4 or above to Question 6, would you want to:

A ☐ Incorporate this material into a larger message about the effect of various intangible on corporate value creation
B ☐ Focus solely on EHS or
C ☐ Both

10) To what degree do you think that socially responsible investing has a significant impact in investment decision-making?
(1 to 10 scale from "not at all" to "extremely").

NOT AT ALL									EXTREMELY
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

11) Over the next five years, to what degree do you think that socially responsible investment will become a more significant issue in investment decision-making?
(1 to 10 scale from "not at all" to "extremely").

NOT AT ALL									EXTREMELY
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

12) Would you like to learn more about what other companies are doing about disclosing this sort of information?

A ☐ Yes
B ☐ No

If yes, please describe your particular interests.

_____

_____

_____

_____

_____

_____

_____

_____

Appendix B
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Appendix C
GLOSSARY AND ACRONYMS

Analyst. Employee of a brokerage or fund management house who studies companies and makes buy-and-sell recommendations on their stocks. Most specialize in a specific industry.

Balance sheet. Also called the statement of financial condition, it is a summary of the assets, liabilities, and owners' equity.

Book value. A company's book value is its total assets minus intangible assets and liabilities, such as debt.

Brand equity. An intangible value-added aspect of particular goods otherwise not considered unique.

Business case. A rationale for making a business decision, usually involving quantitative analysis of costs, benefits and trade-offs.

Buy side analyst. A financial analyst employed by a non-brokerage firm, typically one of the larger money management firms that purchase securities on their own accounts.

Cash flow. Earnings before depreciation, amortization and non-cash charges (sometimes called cash earnings).

Corporate citizenship. Company activities concerned with treating the stakeholders of the firm ethically and in a socially responsible manner.

Corporate governance. The system by which business corporations are directed and controlled. The corporate governance structure specifies the distribution of rights and responsibilities among different participants in the corporation.

Corporate Social Responsibility (CSR). Commitment to uphold the rights of citizens and communities, behave according to accepted ethical standards, and contribute to socio-economic development and quality of life.

Correlation. A statistical correspondence between two or more variables.

Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA). An indicator of a company's financial performance calculated as revenues less expenses, excluding tax, interest, depreciation, and amortization.

Earnings Per Share (EPS). A commonly used financial indicator, calculated by dividing a company's net income by its number of outstanding shares.

Eco-efficiency. A measure of the resource intensity of a company's operations, including the inputs of materials and energy required to manufacture and deliver a unit of output.

Environmental performance. The performance of a business or facility according to selected indicators of environmental impact.

Environment, Health and Safety (EHS). A professional discipline concerned with protection of the environment, human health, and safety through the application of scientific, engineering, and management methods.

Full disclosure. A policy under which publicly held companies must disclose all material information that might affect investment decisions to all investors at the same time (implemented in SEC Regulation FD—Fair Disclosure).

Generally Accepted Accounting Principles (GAAP). A technical accounting term that encompasses the conventions, rules, and procedures necessary to define accepted accounting practice at a particular time.

Global warming. Gradual increase in average temperatures at the earth's suface, believed to result from the “greenhouse effect" due to increased atmospheric concentrations of carbon dioxide and other gases.

Human capital. The set of skills which employees acquire on the job, through training and experience, and which increase their value in the marketplace.

Income statement. A statement showing the revenues, expenses, and income (the difference between revenues and expenses) of a corporation over some period of time.

Institutional investor. An investor that is not an individual and may be a foundation, endowment, pension fund, or the like.

Intangible asset. A non-monetary asset, including people, ideas, networks, and processes, which is not traditionally accounted for on the balance sheet.

Intellectual capital. Knowledge that can be exploited for some money-making or other useful purpose, including the skills and knowledge that a company has developed about how to make its goods or services.

Investor Relations (IR). A strategic corporate marketing activity, combining the disciplines of

communications and finance, that provides present and potential investors with an accurate portrayal of a company's performance and prospects.

Leading indicator. A predictive indicator of anticipated performance that can be observed prior to the period of performance.

Liability. A financial obligation, or the cash outlay that must be made at a specific time to satisfy the contractual terms of such an obligation.

License to operate. The ability of a corporation or business to continue operations based on ongoing acceptance by external stakeholder groups.

Market value. (1) The price at which a security is trading and could be purchased or sold. (2) The value investors believe a firm is worth; calculated by multiplying the number of shares outstanding by the current market price of a firm's shares.

Net present value. The amount of cash today that is equivalent in value to a payment, or to a stream of future cash flows minus the cost.

Non-financial performance. The performance of a business measured in terms of non-financial aspects such as environmental and social responsibility.

Performance. The percentage change in a portfolio's value over a specified period.

Price elasticity. A measure of price-sensitivity in the marketplace: the percentage change in the quantity of a product divided by the percentage change in the price.

Price-to-Earnings ratio (P/E). The multiple of earnings at which a stock sells, determined by dividing current stock price by current earnings per share (adjusted for stock splits).

Proxy. Document intended to provide shareholders with information necessary to vote in an informed manner on matters to be brought up at a stockholders' meeting.

Return on Investment (ROI). A measure of a corporation's profitability, equal to a fiscal year's income divided by common stock and preferred stock equity plus long-term debt. ROI measures how effectively the firm uses its capital to generate profit.

Risk. (1) The possibility of losing rather than gaining. (2) A measure of price fluctuation relative to a broad market gauge. (3) The possibility of an adverse incident due to the presence of hazards or uncertainties.

Screened portfolio investing. The application of social criteria to conventional investments, such as stocks, bonds, and mutual funds.

Sell side analyst. a financial analyst who works for a brokerage firm and whose recommendations are passed on to the brokerage firm's customers.

Shareholder resolution. A recommendation or requirement, proposed by a shareholder, that a company and/or its board of directors take action presented for a vote at the company's general shareholders' meeting.

Socially Responsible Investing (SRI). The incorporation of an investor's social, ethical, or religious criteria into the investment decision-making process.

Stakeholder. Any party that has an interest, financial or otherwise, in a firm - stockholders, creditors, bondholders, employees, customers, management, the community, and the government.

Supply chain. A sequence of suppliers and customers that add value in the form of materials, components, or services, ultimately resulting in a final product.

Sustainability. Conditions or characteristics supportive of sustainable development, encompassing the environmental, social, and economic aspects of a corporation.

Tangible asset. An asset whose value depends on particular physical properties, including reproducible assets such as buildings and non-reproducible assets such as land.

Transparency. Openness of an organization with regard to sharing information about how it operates. Transparency is enhanced by using a process of two-way, responsive dialogue.

Triple bottom line. A framework for sustainable development that defines three fundamental aspects of corporate performance—economic, environmental, and social.

Value creation. Activities that generate shareholder value for a company, e.g., value-based management.

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Global Environmental Management Initiative (GEMI).

Appendix D

FOOTNOTES

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19 The Principles are as follows:

1. Provide access to finance and risk management products for investment, innovation and the most efficient use of existing assets
2. Promote transparency and high standards of corporate governance in themselves and in the activities being financed
3. Reflect the cost of environmental and social risks in the pricing of financial and risk management products
4. Exercise equity ownership to promote efficient and sustainable asset use and risk management
5. Provide access to finance for the development of environmentally beneficial technologies
6. Exercise equity ownership to promote high standards of corporate social responsibility by the activities being financed
7. Provide access to market finance and risk management products to businesses in disadvantaged communities and developing economies.

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21 Distinct investment styles include environmentally effective investing (e.g., Winslow Management), socially responsible investing (e.g., companies screened by FTSE4Good Index), and sustainability investing (e.g., companies screened by Dow Jones Sustainability Group Index or ranked by Innovest EcoValue'21).

22 More information at http://www.sustainability-index.com/

23 More information at http://www.ftse.com/ftse4good/index.jsp

24 Recent research reveals that there was no statistically significant difference between the risk-adjusted returns of socially responsible or ethical funds in the US, Germany and the UK and those of conventional funds during the time period of January 1990 through March 2001. See "International Evidence on Ethical Mutual Fund Performance and Investment Style".

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54 Ibid.

55 More information at http://www.equator-principles.com

"Every corporation is under intense pressure to create ever-increasing shareholder value. Enhancing environmental and social performance are enormous business opportunities to do just that."

Gary Pfeiffer, *Senior Vice President and Chief Financial Officer, DuPont*

"These issues are no longer environmental and social issues but are now recognized as strategic business issues."

Linda Descano, *Chief Operating Officer, Women & Co., Citigroup*

"Environmental protection is a complex undertaking, but the laws of nature are simple. We will provide leadership on the journey to an environmentally sustainable future, with efficient products and creative recycling systems."

Carly Fiorina, *Chief Executive Officer, Hewlett-Packard Company*

"There is no question in my mind that business and the free enterprise system are essential to making sustainability work. Our focus at Dow is on hard-wiring it into our company in the same way we have fully institutionalized environment, health and safety into our culture and into our work and people processes. Our challenge is to make sustainability sustainable. Ultimately, the world will judge our commitment to sustainability not by what we say, but by what we do."

William Stavropoulos, *Chief Executive Officer, The Dow Chemical Company*

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The Metrics Navigator™
GEMI

About the Global Environmental Management Initiative

The Global Environmental Management Initiative (GEMI) is a non-profit organization of leading companies dedicated to fostering environmental, health and safety excellence and corporate citizenship worldwide. Through the collaborative efforts of its members, GEMI also promotes a worldwide business ethic for environmental, health and safety management and sustainable development through example and leadership.

The guidance included in this document is based on the professional judgment of the individual collaborators listed in the acknowledgements. The ideas in this document are those of the individual collaborators and not necessarily their organizations. Neither GEMI nor its consultants are responsible for any form of damage that may result from the application of the guidance contained in this document.

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Preface

Preface

In business, numbers drive performance. Companies use a wide variety of metrics to gauge how well they are meeting the needs of their customers, investors, and other stakeholders. Society is becoming more aware of the social and environmental impacts of business activities, and, thus, more interested in the relationship between the performance of a business in these areas and its market value and financial performance. This has generated a deluge of stakeholder information requests of companies. While much has been done to define 'sustainability' and sustainability-related metrics for business, there has been less focus on aligning metrics with business strategy. Doing so can add significant and long-term value to the business.

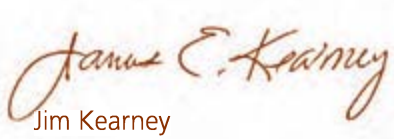
Progressive companies recognize that their performance is judged on many levels, not just their financial success. Using appropriate metrics to describe programs or back up statements of progress can enhance business' credibility. This tool was designed to look at indicators of performance and put the numbers into a context that goes beyond traditional financial metrics. It provides a roadmap for companies to identify key metrics for those actions that drive long-term sustainability and a rational, thoughtful basis for decision-making.

This tool uses a planning process that can help uncover relevant and material indicators and prioritize among those that are the most effective at driving and communicating performance, both internally and externally. Through its application, companies can demonstrate their basis for selecting metrics and enhance their value for management decisions. For example, are employee retention, greenhouse gas management, community involvement, or water resources important to your business strategy? Why or why not? How are they measured? These are the kinds of questions that the tool can help your organization explore.

The GEMI *Metrics Navigator*™ is the product of a two-year, collaborative journey by GEMI members, withthe support of the BRIDGES to Sustainability team of Golder Associates, and a number of other experts in the fields of sustainability, metrics, and organizational change management. Over the course of three workshops in the US and UK, participants from 25 external organizations and several GEMI companies discussed strategic performance measurement and evaluation; the challenges of sustainability and related metrics that drive business value, innovation and growth; and intangible financial drivers. We are deeply grateful to all who participated in this process for their invaluable contributions.

This tool does not recommend any particular path for a company to take, nor does it advocate a common set of indicators for industry. Organizations may wish to use the tool's six-step process in full, or may simply use it as a reference to fine tune existing efforts. In either case, its use should bring to light opportunities to better set goals and communicate performance around company values and strategy.

We hope this approach and the case for non-financial metrics helps your company to better navigate the landscape of corporate citizenship. Let us know if it does at **info@gemi.org**.



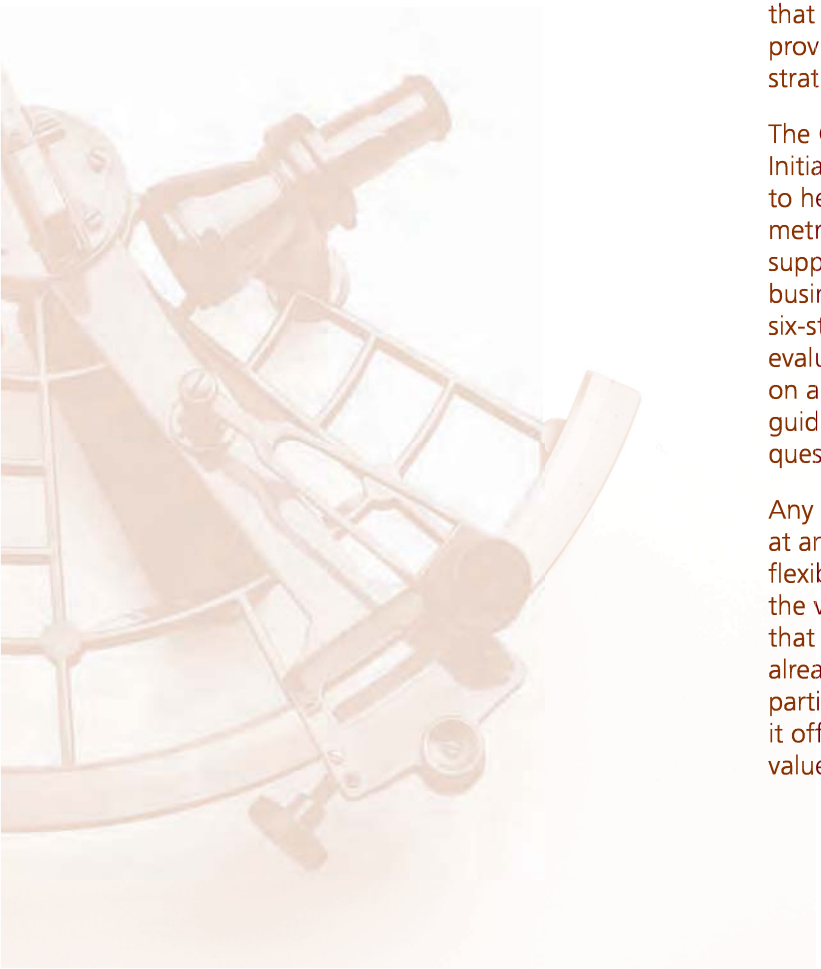
Jim Kearney
Bristol-Myers Squibb Company

Leslie Montgomery
Southern Company

Co-chairs, GEMI Metrics Work Group

March 2007

Executive Summary



Executive Summary

Traditionally, business objectives have been defined and measured in financial terms. Yet, to realize the value of addressing environmental, social and broader economic issues, non-financial metrics can also drive success in the organization by indicating how well it executes on its values and beliefs. These metrics are needed to complement traditional financial measurement systems and help organizations manage long-term business opportunities and future uncertainty and risks.

The challenge is to use the right mix of metrics that provides value to the organization – by providing meaningful information, informing strategy and supporting decision-making.

The Global Environmental Management Initiative's (GEMI) *Metrics Navigator*™ is a tool to help organizations develop and implement metrics that provide insight into complex issues, support business strategy and contribute to business success. The tool presents a thorough, six-step process to select, implement and evaluate a set of 'critical few' metrics that focus on an organization's success. Each step provides guidance in the form of a worksheet, series of questions or checklist.

Any organization can use the tool and apply it at any organizational level. The process is very flexible and does not dictate how to complete the worksheets. In fact, the tool does not require that worksheets be used at all, if an organization already uses proven internal processes for particular steps. The strength of the tool is that it offers a rigorous thought process. The greatest value is in how it helps individuals, groups or entire organizations think through the process - the logical flow of the six steps - and not in the methods included. The summary worksheet (on page 5) provides an overview of the process and captures the critical conclusions from the six steps.

In a very practical way, the GEMI *Metrics Navigator*™ helps the user to:

- determine what is material – ask the right questions, prioritize issues, identify objectives and understand potential consequences at several decision points
- decide what and how to measure – understand the interactions between economic, social and environmental issues and sort through an array of possible metrics
- implement a metrics program

Once the metrics have been chosen, this tool helps the user analyze how effectively the non-financial metrics:

- inform business decisions and leadership
- align environmental, social and economic issues with business strategy
- respond to issues identified by employees and external stakeholders
- help integrate holistic thinking into the organization's culture
- reflect business values and yield business benefits

The principal benefit of using this tool is to advance business performance through the development and use of non-financial measurements.

WORKSHEET: SUMMARY OF KEY POINTS	
What is material	Key business objectives (from Step 1)
	Environmental, social and economic elements support business objectives (current and future) (from Step 1)
	Key employees and external stakeholders in this effort (from Step 2)
	Critical few material issues (from Step 2)
	Key objectives which relate to the material issues (from Step 3)
What and how to measure	Expected uses of the metrics and by whom (from Step 4)
	KPIs and related metrics, what they are and how well they meet the criteria (from Step 4)
How to assure effectiveness	Degree of integration of metrics into management systems (from Step 5)
	Effectiveness of metrics communication to users (from Step 5)
	Expected organizational behavior (from Step 6)
	Expected change in personal behavior (from Step 6)
	Use of metrics to support the business case and refine business strategy (from Step 6)
	Expected business value (from Step 6)

Introduction

Economic, environmental and social concerns interact in fundamental ways, many of which are not well understood… Businesses exist within societies, and societal values expressed formally (through laws and regulations) and informally (through values and culture) affect all aspects of a company's operations.

— Kirvil Skinnarland

Introduction

Performance measurement is critical in managing complex issues that are core to the business. ***Metrics*** are essential not only for managing the organization, but also for informing business strategies. Without relevant metrics, it is difficult - if not impossible - to understand how and if complex issues advance business success (***see the Glossary on page 56 for the definitions of italicized words, in bold***).

Sustainable development* is a complex issue that emerged as a business concept in the 1990s. Since then it has gained credence as an important driver of business strategy. Yet, to realize the value of addressing environmental, social and broader economic issues, non-financial metrics are needed to complement traditional, financial measurement systems and help organizations manage long-term business opportunities and future uncertainty and risks.

The challenge is to use the right mix of metrics that provides value to the organization – by providing meaningful information, informing strategy and supporting decision-making.

GEMI's *Metrics Navigator*™ is a tool to help organizations develop and implement metrics that provide insight into complex issues, support business strategy and contribute to business success. The tool presents a thorough, six-step process to select, implement and evaluate a set of 'critical few' metrics that address:

- What performance best reflects that which is material to the organization and important to stakeholders?
- How can performance for these issues be measured?
- Which metrics are most effective in decision-making?
- Who will use them?
- How can performance evaluation improve the organization's strategic direction?

Sustainability as a Business Issue

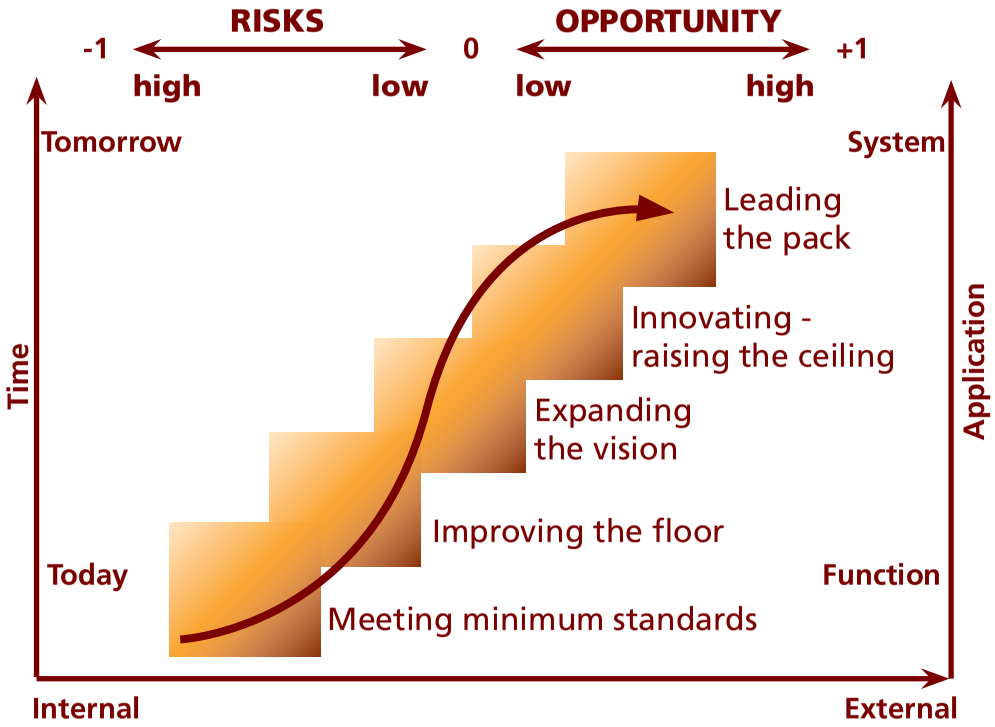
Early corporate applications of sustainability approaches were typically marketing-focused and applied to single issues – such as 'green' products. However, for several years, there has been growing recognition that a holistic approach to managing risks and opportunities creates business value.

Figure 1 (on page 7) illustrates the evolution of integrating sustainability thinking into an organization. First steps typically include initiatives to manage environment, health and safety (EHS) risk by moving beyond compliance through developing internal policies or adhering to voluntary standards.

As organizations have evolved from focusing on EHS strategies to sustainability strategies, goals and objectives have become more complex. At the same time, given the broad spectrum of issues that fall under the sustainability umbrella, potential stakeholders have multiplied and grown more diverse. In this setting, the need for a clear, results-oriented strategy has gained increasing importance for organizations. And, because organizations cannot afford to address every aspect to the same degree and on the same schedule, choices must be made and a strategic direction set.

* For purposes of this tool, GEMI considers the terms and varied definitions 'sustainability', 'triple-bottom-line', 'corporate social responsibility', 'corporate citizenship', 'corporate responsibility' and 'sustainable development' to be interchangeable, and to involve the elements of environmental stewardship, economic development and social progress.

Figure 1. Evolution of Integrating Sustainability Thinking into an Organization



A New Generation of Metrics

Organizations use metrics to judge progress in implementing strategies and to improve operations. Traditionally, business objectives have been defined and measured in financial terms.

Organizations have relied on ***lagging metrics*** which reflect past outcomes of organizational performance. While lagging metrics help organizations manage impacts, the effective management of non-financial issues requires the use of both leading and lagging indicators of performance.

As the value of addressing environmental and social issues increases, it is important for metrics to gauge an organization's success more holistically. A new generation of metrics is needed to complement traditional measurement systems and help managers deal with long-term business opportunities and future uncertainty and risk.

Leading metrics are valuable because they tend to reflect causation and can be used to predict performance. However, because leading metrics often reflect intangible assets of business, they can be difficult to identify.

The challenge is to find the right mix of leading and lagging metrics, for issues that are critically important, i.e., material. These metrics must accurately depict progress towards goals and be effective in communicating information to different audiences. Further, the metrics should provide value to the organization without creating significant operational burdens. [(1)]

Several tools developed by GEMI highlight the importance of metrics **(see list of Resources in Online Appendix)**. GEMI's *Clear Advantage: Building Shareholder Value* helps to provide businesses approaches on how to measure, manage and communicate EHS value to the financial community. GEMI's *Transparency: A Path to Public Trust* underscores performance reporting to establish integrity, build credibility, earn respect and develop trust with stakeholders. Metrics help 'close the loop' in the sustainability plan one develops using the GEMI's *Exploring Pathways to a Sustainable Enterprise: SD Planner*™. Considerations for the development of metrics have been previously discussed in a 1997 GEMI publication, *Measuring Environmental Performance*.

The GEMI *Metrics Navigator*™ builds on these and other tools, but focuses exclusively on a process companies can use to develop relevant sustainability metrics.

Strategic Metrics Development Process: Overview

What is the GEMI *Metrics Navigator*™?

The tool is in the form of a workbook that guides the user through a series of worksheets to arrive at metrics that support business strategy, enhance decision-making and contribute to managing business success in the following areas:

- *Inform strategy* – by measuring the ability of the organization to meet its goals and ***targets***.
- *Drive improved performance* – by:
  - establishing base-line performance
  - tracking performance over time, including management system performance
  - providing insights into hidden aspects of performance
  - supporting decision-making
  - identifying performance improvement opportunities
- *Measure what is right* – Organizations face stakeholder pressure to account publicly their performance relative to a growing list of sustainability-related principles, standards and indicators. Often it is difficult to meet varying expectations and determine which frameworks to use and what to measure. By developing metrics that are aligned with business strategy this tool ensures that an organization measures what is right for itself and measures things the right way.
- *Provide meaningful information* – Organizations can be overwhelmed by data and information. This tool helps the user decide which information really matters, how to cost-effectively convert it into metrics and how to communicate data and results to the right people.
- *Communicate effectively* – Metrics mean little without the context of how they will be used to improve performance and organizational alignment. This tool highlights how metrics are defined and influenced by the uses and users of metrics. Further, the tool helps the user choose the type and number of metrics given the audience.

What is Unique about the Tool?

While there are many published resources on metrics, this tool incorporates diverse perspectives into a comprehensive framework that links non-financial program metrics to an organization's business strategy in a practical way that helps the user to:

- ask the right questions, prioritize issues, identify objectives and understand potential consequences at several decision points
- better understand the interactions between economic, social and environmental issues
- align environmental and social issues with business strategy
- advance business performance using non-financial measurements

The tool does not recommend specific metrics, but its application will lead an organization through the process of developing company-specific metrics.

Methodology - How the Tool was Developed

This tool was developed through consultation between the GEMI Metrics Work Group and the Golder team, and with input from External Advisory Groups (EAGs) comprised of key thought leaders with expertise ranging from corporate strategy to stakeholder engagement processes to performance measurement. These experts participated in at least one of three workshops which addressed selected issues embedded in the tool. Contributions from several EAG experts are included in the tool as 'EAG Perspectives'. The detailed perspectives in the online appendix can enhance understanding of certain key points or be used to make the business case for taking similar steps.

Case examples, written by GEMI members, illustrate opportunities and challenges in developing and using metrics. While there are many environmental cases, there is widespread recognition of the need for more work in developing social and economic metrics. Often social issues are more readily managed and accounted for at the local level, making it difficult to aggregate or 'roll-up' performance into a single metric. Therein lies a key challenge that this tool attempts to address.

Who Should Use it?

The tool is intended for use by managers and environmental, health and safety, and sustainable development practitioners. The tool can be applied to any type of business and applied at any organizational level. The process is flexible and adaptable so that individuals or teams can tailor it to meet their specific needs.

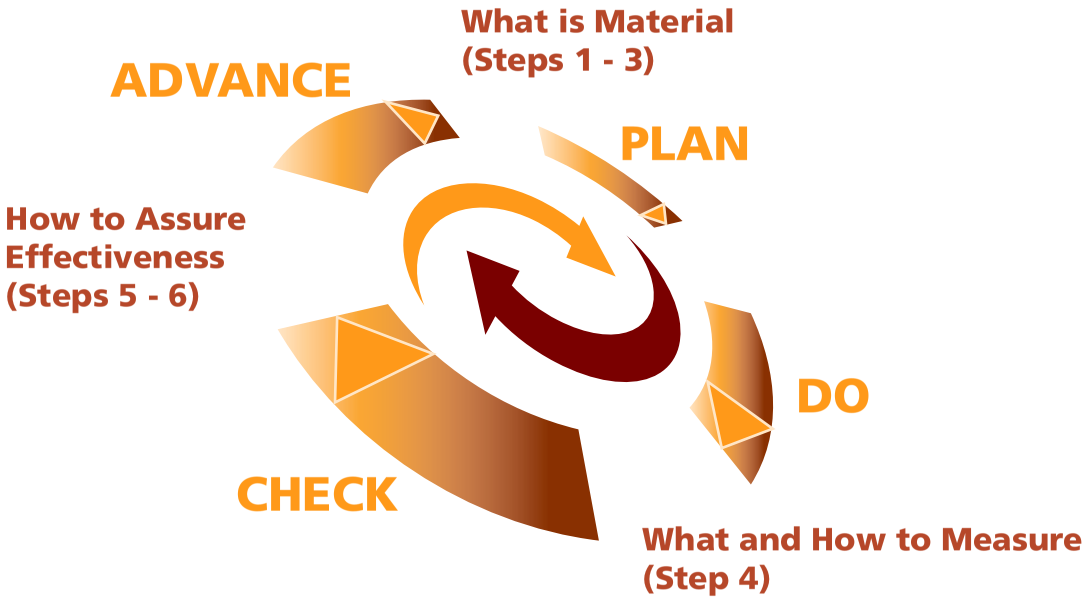
How to Use the Tool

The process described in the tool is sequential and represents the recommended approach to metrics development, but users may enter at any step and move between steps as necessary. Each step of the GEMI *Metrics Navigator*™ provides guidance in the form of a worksheet, series of questions or checklist of evaluation criteria. To illustrate the continuous nature of the metrics development process, the six steps are shown, in Figure 2, in a Plan, Do, Check, Advance cycle.

A hypothetical organization called 'XYZ Nutritional Beverage' is used as an example throughout most of the six-step process. GEMI member companies populated some tables and worksheets based on their own experiences, providing more illustrative examples than could be achieved through any hypothetical model. The tool also includes references and resources that further support the metrics development process.

Due to space limitations in the published version, the electronic PDF version of the tool, which can be found on GEMI's website, **www.gemi.org/metricsnavigator**, includes elaborations on EAG Perspectives, additional resources and blank worksheets in usable format.

Figure 2. Strategic Metrics Development Process



The Six Steps

This section of the tool outlines the six-step metrics development process. To increase the effectiveness and value of the metrics, information is collected and decisions are made to respond to three guiding statements:

- What is material
- What and how to measure
- How to assure effectiveness

Steps 1–3: What is Material?

Steps 1-3 of the process help identify what is material to an organization. ***Materiality*** is defined as the relevance and substantiality of an issue to the organization. This early focus on materiality ensures that the organization is measuring that which is right for them.

A number of organizations have developed criteria for defining materiality for various purposes, including financial reporting [2], sustainability reporting [3], stakeholder engagement [4] and auditing [5]. This process uses the following criteria for assessing an issue's materiality:

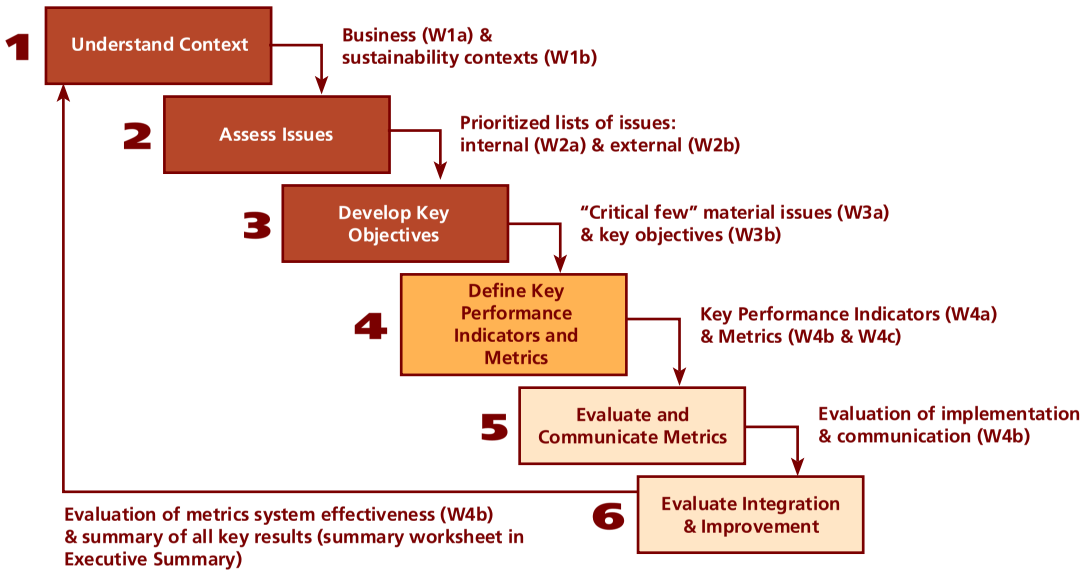
- relevance to the business strategy
- significance of the organization's environmental, social and/or economic impacts
- level of concern to external stakeholders
- ability of the organization to control or influence

Step 4: What and How to Measure

Step 4 defines ***Key Performance Indicators*** (KPIs), i.e., as a general statement of what to measure and develops metrics, i.e., as the specific measurement accompanied by clear descriptions of how it is measured. This step helps sort through the array of possible metrics to select the strategic metrics that focus on business success. This step briefly looks at tactical metrics at the operational level.

Step 4 includes a reality-check to ensure the chosen metrics are effectively fulfilling their intended purpose. Part of this step is to ensure the validity of the metrics in terms of reliability, relevance to the business, accuracy and other criteria.

Figure 3. Strategic Metrics Development Process and Associated Worksheets



Steps 5–6: How to Assure Effectiveness

Step 5 focuses on distilling data into useful and manageable information that is meaningful to the intended users. This implementation step encourages the user to work with existing management and information systems. This section also cautions on the use of metrics that can be misleading or misunderstood.

Step 6 is a critical assessment of the metrics and the effectiveness of the development process itself. This step encourages reflection on the five previous steps and checks if the metrics inform the business strategy. Doing so assures that the metrics have met their goals and result in business value for the organization. Additionally, it fosters the development of a high level summary of results (see summary worksheet on page 5).

Figure 3 shows a schematic of the six steps of the Strategic Metrics Development Process and the associated worksheets.

Step 1
What is Material

STEP 1

Expected Outcomes

- Understanding of the organization's business strategy and existing performance measurement systems
- Understanding of how the organization currently addresses environmental, social and economic aspects

1. Understanding the Context for Metrics Development

The GEMI *Metrics Navigator*™ is designed to help users develop non-traditional metrics that complement the organization's existing performance measurement system. The metrics development process begins with:

- articulating the organization's business strategy, business objectives and performance measurement system
- mapping how the organization currently addresses environmental, economic and social aspects

This ensures that the metrics support what is important to the organization and can advance business performance by leveraging the interactions between economic, social and environmental issues.

Define the Organizational Scope

The tool is applicable to organizations of various scales and levels. An organization is defined as an entity "that has its own function and administration."[6] Examples of an organization for this tool include an entire corporation, a business unit and a single site or operation.

Understand the Business Success Factors

An organization sets direction through strategy and uses measurements to stay on track. Measurements developed outside of the organization's strategic business success factors will not drive the results identified in the strategy. [7]

Describing the organization's business strategy is the essential first step in understanding the business success factors for developing new metrics. Many organizations articulate their strategy through vision and mission statements as well as clearly stated business objectives. Some also develop core values to reflect characteristics that are important to the organization.

Measure Business Performance

Traditional measurement schemes track performance towards financial and operational goals. In addition to financial metrics many organizations use non-financial measurements in emerging areas, such as resource management, workplace and board diversity and corporate governance. Measuring ***intangibles***, e.g., reputation, is increasingly recognized as assessing hidden value that has been created by an organization.

Organizations may use a variety of measurement models to integrate non-financial and financial measurements including: The Balanced Scorecard, Economic Value Add, Intellectual Capital Approaches, Value Explorer® and Value Chain Scoreboard™. [8]

EAG Perspective

What Is the Measurement Challenge?

Businesses have done an excellent job in implementing rigorous financial measurements ('what we understand') and, to some extent, process measurements ('what we think we understand'). The challenge is to move toward a dynamic and multi-dimensional system that incorporates measurements of 'what we do not understand' (see table below). Jim Ritchie-Dunham of the Institute of Strategic Clarity explores this online at **www.gemi.org/metricsnavigator**.

Strategic Measurement	What We Understand	What We Think We Understand	What We Do Not Understand
What we want *(mission / vision)*	One financial measure	One mission - driven measure	One integrative measure
Who cares *(stakeholders)*	Shareholder value	Supply chain value	Multiple stakeholder value
What is needed *(resources)*	Cost drivers	Value drivers	Resource dynamics
How we each contribute *(functions)*	Profit center contribution	Process contribution	Systemic contribution
How we influence each other *(relationships)*	Profit and loss contributions	Handoffs in process	Relationship dynamics
What happens then *(system)*	Single indicator of financial health	Multiple indicators of process health	Multiple indicators of system health

Link Measurement to Strategy

By developing metrics that are aligned with business strategy this tool ensures that an organization measures what is right for them and measures things the right way. Further, an organization can identify and implement metrics in the context of where the organization is headed, not solely based on where it has been. [9]

Describe the Business Success Factors – Worksheet 1a

Worksheet 1a (on page 13) provides a template for documenting the organization's business strategy and performance measurement system. The completed worksheet will:

- define the organizational scope for which future metrics will be developed
- articulate 'high-level' goals
- outline the business strategy, business objectives and strategic performance measurement system to which new metrics should relate

1. Understanding the Context for Metrics Development

WORKSHEET 1a: UNDERSTAND THE BUSINESS SUCCESS FACTORS *(XYZ Nutritional Beverage Example)*	
Organization: *The organizational unit under consideration for metrics development*	XYZ Nutritional Beverage (a division of XYZ Food Products, Inc.)
Mission: *The mission statement for the organizational unit (or its parent)*	Providing our customers nutritious food and beverage products of the highest quality that are produced in an environmentally-sensitive manner, while consistently exceeding shareholder expectation.
Core values:	• Superior financial performance • Nutritious products of the highest quality • Safe and healthy work environment • Responsible environmental practices • Enriching the communities in which we operate
Vision for product / process:	Superior nutritional beverage brand which consumers embrace for its quality, taste and innovation.
Define the market environment:	Food and Beverage / Natural Foods Industry. Consumers fall into three categories: diet and healthy living, lactose alternative and organic.
Business objectives:	• Increase market share • Increase revenue • Reduce cost
Business risks and opportunities:	Availability and consistency of raw product. Building relationships and partnerships with organic farmers. Focusing on emerging markets by building brand recognition and educating consumers on health benefits of nutritional beverage.
Business performance measurement:	Balanced Scorecard (financial, customers, business operations and learning and growth perspectives). Cascaded from corporate down to each business division and individual manager.

What Sustainability Means to the Organization

In developing the sustainability context, a business should look beyond financial performance to see how environmental, economic and social issues currently are, or will be, addressed within the organization.

The tangible and intangible business values that can result from addressing non-financial issues have been discussed in GEMI's *Clear Advantage* tool (see Resources in Online Appendix). The case example by FedEx Corporation demonstrates how their corporate values reflect the capabilities of its core operations and values of its employees.

Various frameworks and methods exist to help identify issues an organization currently addresses, including:

- the GEMI *SD Planner*™ – can help document the status for environmental, social or economic issues and the gaps between an organization's current and desired position
- the BRIDGES Sustainability Framework [10] – illustrated in Figure 4 (on page 15), this framework offers a model to identify aspects and impacts that need to be considered in developing metrics

Case examples by 3M and Eastman Kodak Company (on pages 16 & 17) illustrate how an organization's commitment to a sustainability vision directly supports the business context.

FedEx

Response to Hurricane Katrina

The values of FedEx Corp. and its employees are reflected in how it uses its capabilities in response to a disaster. Corporate values are crafted on six principles: People, Service, Innovation, Integrity, Responsibility and Loyalty. Their execution underpinned the company's planning and response to Hurricane Katrina's devastation of the Gulf Coast region in 2005.

The nature of the transportation industry can be volatile, making contingency planning crucial to a successful business. Variables such as weather patterns, mechanical difficulties and last-minute customer needs routinely affect the system.

FedEx, as part of its normal operations, maintains a complex logistics network to pinpoint and resolve problems before they impact service. For example, emergency relief kits containing two tons of operational supplies are constantly on standby for any facility with an emergency. Five empty FedEx flights operate nightly, ready to substitute for out-of-service aircraft or help with a surge in airlift demand.

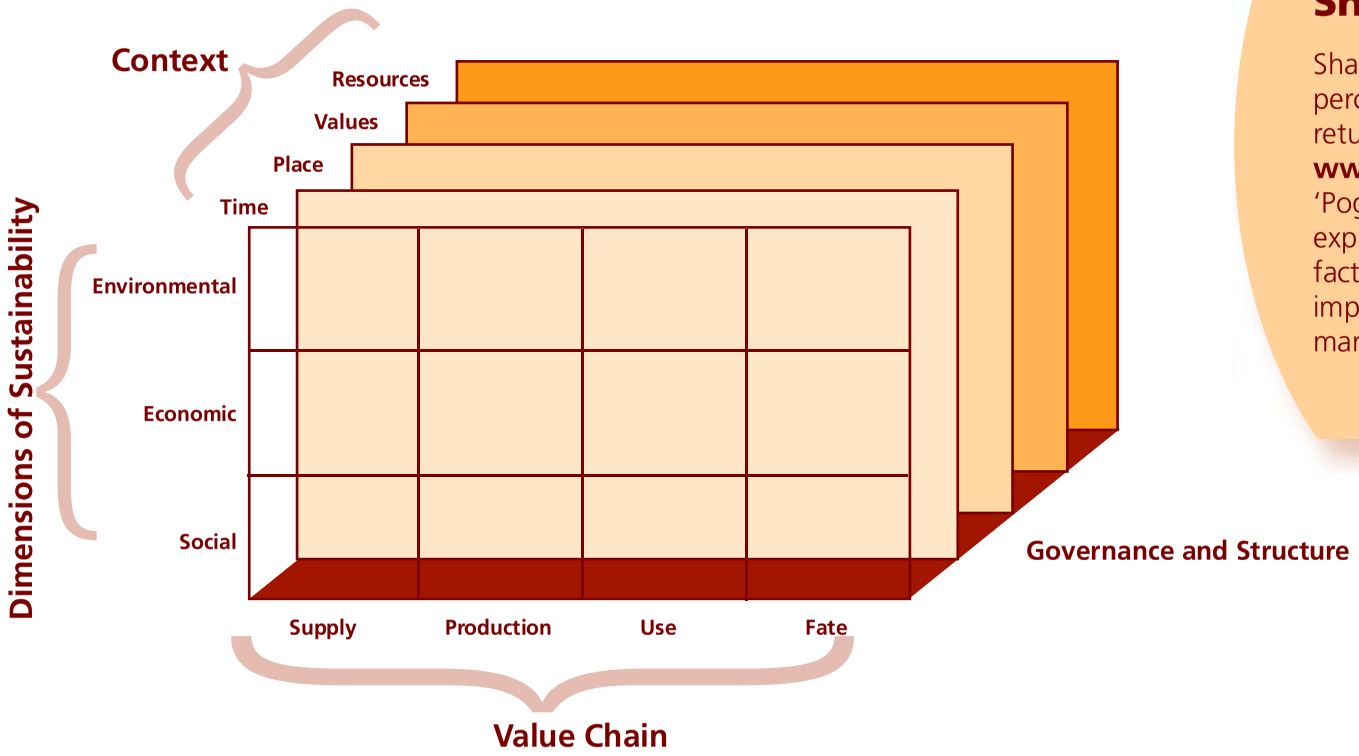
In addition, disaster response drills are incorporated into the business model. As a result, disaster planning and response are core competencies that serve broader humanitarian needs. Hurricane Katrina demonstrated this principle when it devastated the U.S. Gulf Coast region.

In anticipation of Katrina's landfall, FedEx pre-positioned supplies, including 30,000 gallons of water, 85,000 home generators and four 4,000-lb. facility repair kits, near Baton Rouge and Tallahassee so they could quickly be transported to the point of need. The company joined forces with the Red Cross, a longtime disaster relief partner, to deliver medical supplies. And, FedEx Kinko's delivered office supplies to government relief workers working onsite.

The values that underlie these actions extended to individual employees. Mike Mitchell, a senior technical advisor at FedEx Express, took independent action to deliver a generator and technical equipment to relief workers who desperately needed a functioning communications system. His action enabled relief teams to use a FedEx communications installation that had survived the storm.

Although Mitchell's actions were of his own initiative, they were consistent with corporate philosophy. Just as important, his success was rooted in the skills and training which are indispensable to the success of FedEx as a business.

Figure 4. BRIDGES Sustainability Framework



The BRIDGES Sustainability Framework offers a model to identify aspects and impacts that need to be considered in developing metrics. The framework recognizes that this requires looking at the triple-bottom-line, not only within the company's fence line, but also along its value chain. Each frame serves as a set of lenses through which the scope of the issues can be defined and the relevant risks and opportunities associated with environmental, social and economic considerations can be determined. The most common context frames of time, place, values and resources define and refine the scope of each issue.

EAG Perspective

What Contributes to Shareholder Value?

Shareholder value is derived from the market's perception of a business' ability to generate returns today and in the future. Online at **www.gemi.org/metricsnavigator**, Jean 'Pogo' Davis, formerly of ConocoPhillips, explains how environmental and societal factors can contribute to shareholder value by improving short-term returns and exceeding the market's expectations of future performance.

3M

The Role of Sustainability at 3M

The three legs of sustainability (economic, environmental and social) are interdependent at 3M. This is evident from its corporate business imperatives:

1) Corporate values

2) Sustainable growth

3) Productivity

4) Talent management

The first business imperative, 3M's six fundamental corporate values are reflected in its sustainability policies and practices. The company's commitment to corporate governance and its sustainability vision to "actively contribute to sustainable development through environmental protection, social responsibility and economic progress" are direct reflections of the fundamental corporate values.

Sustainable growth and productivity include two of the company's main sustainability platforms: Life Cycle Management (LCM) and Pollution Prevention Pays (3P). LCM is a required process in the development, manufacturing and distribution for all products to reduce the environmental, health, safety and energy impacts throughout the entire product life cycle. 3P is a 30-year-old program focused at reducing pollution at its source, which is a cornerstone for process improvements to reduce waste and improve productivity.

Lastly, a company is only as good as its employees. 3M's business imperative for talent management supports its social sustainability strategy of meeting employee and community needs as a socially-responsible company. Specific objectives have been developed around attracting and retaining a diverse and talented workforce, supporting continuous learning and knowledge-sharing and providing meaningful employment in a work environment that respects the dignity of individuals.

Current Sustainability Focus – Worksheet 1b

Worksheet 1b (on page 18) provides a template for identifying where the organization currently focuses, or plans to focus, its efforts with respect to environmental, social and economic issues and initiatives. The organization should be able to describe:

- the organization's current focus with respect to issues impacting both the organization's business and society at large
- the programs and initiatives that are in place
- which corporate functions are involved in these programs and initiatives
- where efforts are focused in the value chain

Consider Diverse Perspectives

To collect comprehensive information for Worksheet 1b, representatives from relevant internal functional areas might be consulted. This cross-functional approach will provide diverse perspectives on what issues are being addressed and the initiatives underway in the organization. Worksheet 1b provides examples to illustrate how environmental, social and economic issues can be managed by various business functions.

This exercise may also provide insight into emerging and environmental, social or economic issues that are being overlooked. This information should begin to illustrate how responsible corporate behavior supports the business and contributes to shareholder value.

Eastman Kodak Company

Supporting Business Transition through Responsible Growth

Kodak is transforming its traditional imaging products and services to compete in the digital market. The transition to digital technologies has changed the nature of Kodak's business and presented new challenges and opportunities for responsible growth. Early in this transition, Kodak developed a set of Responsible Growth Principles, which established goals to support business objectives for continued digital expansion and the company's commitment to health, safety, environment and global sustainability.

The digital business is more equipment-intensive compared to traditional imaging, making life-cycle planning and product stewardship critically important. Therefore, Kodak has set, as part of its new Responsible Growth goals, a product stewardship goal of improving the environmental attributes of Kodak products throughout their life cycle. This goal is supported by Kodak's comprehensive Product Stewardship Strategy, which includes a set of standards based on considerations such as pending legislation, risk assessment data, potential environmental conditions, product safety/electromagnetic compatibility, use of restricted materials and end-of-life considerations.

The Kodak Picture Kiosk provides an example of the company's commitment to product stewardship and continuous improvement during the transition from traditional to digital technologies. Since 2000, Kodak's Picture Kiosks have achieved environmental improvements while delivering a larger variety of prints at faster throughputs. As the kiosk evolves, product stewardship standards are applied at each development gate/phase from ideation to final design. The result has been environmental improvements in each successive generation, such as a reduced material and packaging use and U.S. EPA ENERGY STAR® compliance. These environmental improvements in the Picture Kiosk reflect Kodak's heritage of product stewardship, while improved performance capabilities in printing speed solidify its position of growth and innovation in the digital world.

WORKSHEET 1b: IDENTIFY THE FOCUS ON ENVIRONMENTAL, SOCIAL AND ECONOMIC ISSUES AND INITIATIVES

(XYZ Nutritional Beverage Example)

Organization's Sustainability Definition:	Brundtland Commission [11] definition

VALUE CHAIN STAGES:
S = Supply; C = Company Operations; D = Distribution; U = Customer Use of Product / Service; E = End of Life

Value Chain		Environmental	Social	Economic
S	**Resource Extraction, Raw Material Development & Supply**	• Impact on biodiversity	• Compensation and human rights of supplier's employees	• Meet business contract obligations as customer
C	**Research & Development**	• Sourcing from environmentally-sensitive areas • Regulatory compliance • Consider environmental impact of new products	• Clinical study ethics (e.g., Declaration of Helsinki) • Talent retention / attraction	• Patent and intellectual property protection ethics • Responsible environmental practices • Enriching the communities in which we operate
	Manufacturing / Operations	• Regulatory compliance • Meeting sustainability goals	• Fair compensation and benefits; practices on freedom to organize • Relationship to communities surrounding operations	• Meet production and cost goals while conforming to the company code of conduct
	Marketing & Sales	• Regulatory compliance	• Access to products in developing world (F)	• Pricing • Consumer advertising
D	**Distribution**	• Regulatory compliance • GHG impact of shipping / transportation	• Compensation and human rights of supplier's employees or those of third party distribution company • Relationship to communities	• On-time deliveries that meet patient demands
U	**Customer Use of Product / Service**	• Safety data complete • Minimize packaging • Proper disposal guidelines	• Warnings of potential product abuse • Emphasis on healthy lifestyles, not product use (F)	• Over-prescribing
E	**End of Life**	• Proper disposal verified	• Easy disposal options	• Returned product practices

NOTE: annotate future (F) or planned considerations

Step 2
What is Material

2. Assess Issues from Stakeholders' Perspectives

STEP 2

Expected Outcomes

- Identification and prioritization of issues from the perspectives of employees and key external stakeholders

The purpose of Step 2 is to identify and assess the environmental, social and economic issues of importance to stakeholders. It will help determine material issues for the organization and result in prioritized lists of issues based on employees' and external stakeholders' perspectives.

Internal - Identifying and Engaging Employees

Assessing which issues are important or material to an organization begins with identifying and engaging key employees and managers from various functional areas. To determine what is important internally, the organization should bring together or reach out to employees who have the most experience in addressing environmental, social and economic concerns. Many internal initiatives deal with one or several dimensions of corporate responsibility but there may be little coordination or collaboration. This can be an opportunity for the organization to look holistically and draw upon expertise regardless of where in the organization it is found. It can also be a way to find and inspire champions in the organization.

Table 1 (on page 20) demonstrates how employees offer diverse and cross-functional perspectives on issues that present risks and/or opportunities for the organization.

In engaging employees who are not necessarily versed in the concepts of sustainability, it is valuable to identify and understand their context, so as to communicate effectively and gain needed support. It may also be useful to characterize the degree to which they support the concepts of sustainability or ***corporate social responsibility*** **(CSR)**.

EAG Perspective

How Can One Develop 'Sustainability Leaders'?

It is all about people. Many companies lack a plan to develop the understanding and commitment for sustainability thinking in leaders at all levels of the organization. An important first step is to identify the champions, doubters and those in-between (i.e., 'green, red, and yellow dots') within the organization and understand how to involve them. This is discussed by Paul Tebo, formerly of DuPont, online at **www.gemi.org/metricsnavigator** in the context of developing current and future leaders.

Internal - Identifying Current and Emerging Issues

Once key employees are selected, the organization can then identify and evaluate their issues of concern. There are many ways to collect information from employees ranging from desktop research to interviewing or conducting informal surveys, to bringing a team together to brainstorm. Various internal sources are available to help identify issues, including: internal risk analysis; company annual and financial reports; employee surveys; environmental management system control plan; stakeholder engagement plan and shareholder resolutions.

TABLE 1. EXAMPLES OF POTENTIAL ENVIRONMENTAL, SOCIAL AND ECONOMIC INTERNAL PERSPECTIVES				
Value Chain	Business Function	Environmental	Social	Economic
S	Logistics / Supply Chain Management (Procurement)	Purchase from environmentally-responsible suppliers	Purchase from suppliers who observe fair labor laws and guidelines	Help stimulate local economic development through purchasing
	Executive Management	Develop vision and policies	Develop vision and policies	Develop vision and policies
	Finance & Investor Relations	Link environmental practices to lower financial risk	Relate socially-responsible practices to lower financial risk	Include company in Socially Responsible Investing (SRI) funds
	Business Management	Develop goals	Develop goals	Develop goals
	Legal	Compliance Defend against litigation regarding environmental practices	Compliance Defend against litigation regarding labor or other social actions	Compliance
	Research & Development	Develop environmentally-friendly product / service	Develop product / services that meet society's needs equitably	Stimulate innovation and new market ideas
C	Manufacturing / Operations	Eco-efficiency: reducing environmental impacts per unit of output	Address concerns of local community	Provide jobs
	Environmental, Health & Safety	Mitigate environmental risk Manage / reduce EHS footprint	Manage health and safety risk, engage colleagues to adopt change	Demonstrate savings through pollution prevention initiatives and accident reduction programs
	Human Resources	Promote programs to help employees save energy at work	Enhance employee health and well-being	Create jobs in the community Minimize outsourcing of labor
	Marketing & Sales	Market environmental benefits of products and services	Understand related customer needs	Market socially-responsible management and environmentally-friendly product and services
	Communications (PR)	Feature environmentally-responsible behavior	Engage local stakeholder community	Link socially-responsible behavior to company value
D	Logistics/ SCM (Distribution)	Require shippers to meet environmental laws	Increase spending with women and minority-owned suppliers	Optimize supply and demand over time
U	Communications (Customer Service, PR)	Communicate environmental benefits and risks	Use focus groups on customer service	Evaluate return on investment of communication efforts
E	Product Stewardship	Introduce recyclable packaging Minimize product's lifecycle impacts	Use local waste service companies	Expand product development / packaging take-back policy

Note: VALUE CHAIN STAGES: S = Supply; C = Company Operations; D = Distribution; U = Customer Use of Product / Service; E = End of Life

2. Assess Issues from Stakeholders' Perspectives

Among the best ways to identify both current and future issues of concern is through effective employee engagement. Employees are the organization's 'ears-to-the-ground' and form a very perceptive early-warning system. When issues are identified, they may not be material today but may need to be considered in the future.

Worksheet 2a – Prioritizing Employees' Issues

Worksheet 2a provides a template to rate and prioritize issues identified by an internal team. This allows users to rate the issues identified at each value chain stage based on two criteria used to assess relevance to business, including:

- importance to business success factors (y-axis) – Is the issue important to the organization, business strategy, objectives and values?
- significance of organization's impacts (x-axis) – Does the organization have current or potential impacts to the outside world with respect to the environmental, social and/or economic issue?

Worksheet 2a plots ratings for each issue based on the combination of the two criteria. Color coding demonstrates how the issues rate in terms of overall relevance to business. For example, an issue that rates highly on both criteria is determined to have high relevance to business. Also this consolidates issues identified at all value chain stages. Notice that issues may receive different ratings at different stages of the value chain, e.g., energy use at the distribution stage receives a higher rating than energy use at the supply and corporate operation stages.

WORKSHEET 2a: INTERNAL – PRIORITIZE EMPLOYEES' ISSUES OF RELEVANCE TO THE BUSINESS

(XYZ Nutritional Beverage Example)

INSTRUCTIONS: Plot the potential and current issues identified by employees. Rate each issue as High (H), Medium (M), or Low (L) according to the following considerations:

Organization's Impacts
- Do the organization's activities currently or have the potential to impact the issue?
- Are the current / potential impacts significant in comparison to other industries or peers in the same sector?

Importance to Business Success Factors
- Are there short- or long-term business risks or opportunities associated with the issue?
- Would addressing the risks / opportunities support the organization's business strategy and objectives?

VALUE CHAIN STAGES:
S = Supply; C = Company Operations; D = Distribution; U = Customer Use of Product / Service; E = End of Life

Importance to Business Success Factors	L	M	H
H		• Energy use (S, C) • Employee Health and Safety (C) • Impact on local communities (S, C) • Talent retention (C)	• Water use (S, C) • Organic products (S, U) • Nutrition content (U) • Energy use (D)
M	• Immigration policy (C)	• Use of alternative energy (S, C, D) • Community outreach (C) • Education (U, E) • Local homeless population (D	• Local economic development (S, C) • Farming run-offs (S)
L	• Transportation infrastructure (D)	• Taxes paid (C)	• Air emissions (D)

Organization's Impacts

Issues (examples):	Reasoning behind Rating:
Energy use (D)	High impacts, distribution is major contributor to energy use and associated costs
Energy use (S, C)	Medium energy intensity in supply and company operations
Use of alternative energy sources (S, C, D)	Medium potential impacts and opportunity for industry leadership
Farming run-offs (S)	Significant current impacts, medium business risk
Employee Health and Safety (C)	Medium current impacts, but important as part of core value
Local economic development (C)	Opportunity to integrate into local fabric, with high impact but medium importance to business
Taxes paid (C)	Standard business procedure
Transportation infrastructure (D)	Relevant but not important to business, with limited organization's impacts

External - Identifying Stakeholders

Concerns of key external stakeholders have been a historic driver for the internal management of emerging social and environmental issues, as illustrated by the case example of Bristol-Myers Squibb (on page 23).

In addition to the stakeholder engagement processes already practiced in an organization, there are several methods to identify which external groups could play a key role in identifying and rating issues. GEMI's *Transparency: A Path to Public Trust* provides guidance in:

- identifying significant stakeholders that interact with the organization
- gathering key information regarding stakeholders' expectations and motivations, as well as the current state of the organization's relationship with them
- deciding which stakeholders are 'significant' or key to the organization

The tool further classifies stakeholders as 'significant' when they: [12]

- supply resources that are critical to the success of the organization
- have something at risk; their welfare is directly affected by the performance of the organization
- have sufficient power to affect the performance of the organization, either favorably or unfavorably

External - Engaging Stakeholders

How the organization chooses to engage stakeholders should begin with understanding the existing relationship. An organization may choose to establish different 'rules of engagement' for a hostile stakeholder versus a supportive and committed one. The GEMI *Transparency* tool outlines a method for assessing stakeholder relationships and how that relationship may affect engagement. The case example by The Scotts Company (on page 23) shows how issues can be identified from customer calls.

Incorporating External Stakeholders' Perspectives

Incorporating external stakeholder perspectives can include a survey of a cross-section of employees knowledgeable of external stakeholder concerns. As the GEMI *Transparency* tool points out, various stakeholder concerns are often known by employees. Nevertheless, direct engagement of the significant stakeholders may be necessary to further identify, assess or confirm their concerns. This ensures that the material issues identified through this process incorporate the expectations and needs of all stakeholders.

Bristol-Myers Squibb Company

External Reporting and Internal Management of Metrics

Bristol-Myers Squibb is an early leader in reporting environmental, health and safety (EHS) metrics. With respect to government and media reports of environmental data, and to communities' inquiries regarding local operations, the company began to report environmental performance data in the 1990s. In addition, the company participated in developing the first draft of the Global Reporting Initiative (GRI) and was among the first to apply the GRI reporting standards.

While reporting EHS metrics began as part of Bristol-Myers Squibb's effort to meet external stakeholder expectations, it has driven the development of an organizational capacity for tracking and managing non-regulatory metrics. An extensive infrastructure, including procedures and databases, were developed for EHS data collection, verification and reporting. In spite of the external reporting focus, the metrics resulted in a range of internal management benefits, including:

- ability to assess the company's potential environmental impacts
- identification of cost-saving opportunities
- cross-functional involvement and company-wide awareness of sustainability issues

In short, the system enabled Bristol-Myers Squibb to assess its potential impacts, to determine appropriate performance targets and to measure progress towards such targets. It provided much of the capacity for the development and tracking of the company's 2010 sustainability goals.

Today, Bristol-Myers Squibb tracks 60 environmental parameters in about 50 facilities worldwide and has produced sustainability reports since 2001. Maintaining and further developing metrics and reporting systems, however, do come with challenges. First, data collection and verification can be costly, especially in terms of human resources, and need to be effectively managed. Further, in external reporting, it is critical to understand that information may be used by the public in ways which were not intended.

In summary, though initially driven by external requests, Bristol-Myers Squibb's EHS metrics and reporting system has brought tangible, internal business benefits.

The Scotts Company

Identifying Issues from Consumer Calls

One effective way for identifying issues of importance to customers is the consumer calls made to the company. Scotts has established a process for identifying business issues raised through consumer calls, communicating the information to the various business functions and translating it into actions.

Scotts' Consumer Call Center receives roughly one million calls annually from consumers for all of its product lines. Every incoming call is logged into a database, along with key information such as consumer concerns, products affected and the geographic location of the call. The database is routinely analyzed and compared to previous periods to identify trends and anomalies. The analysis is then reported to various departments where it can be further examined to identify issues that require the company's attention.

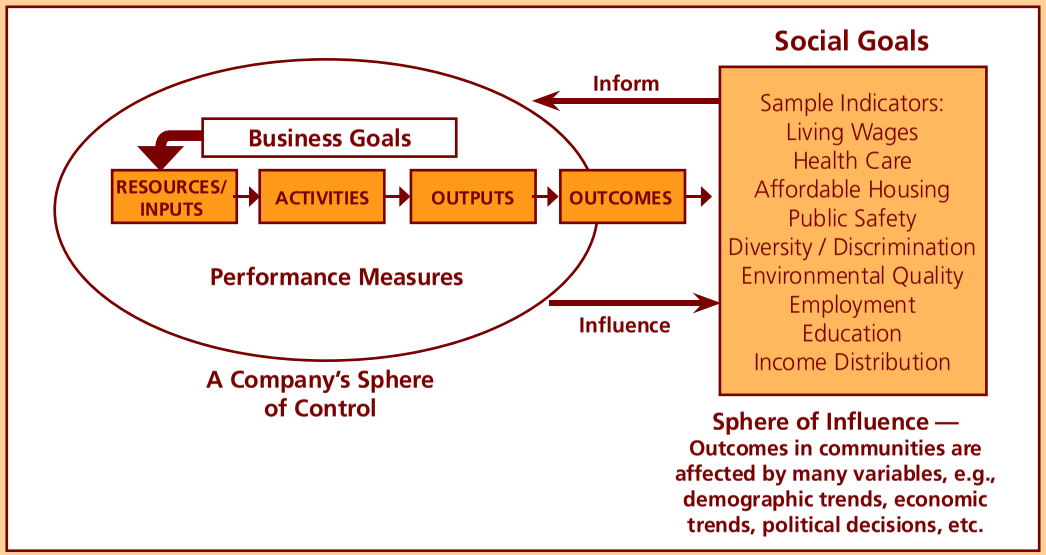
The database is designed to facilitate collaboration between various internal departments, such as quality assurance, marketing, research & development and environmental stewardship, to develop strategies to improve Scotts' products. The consumer call data have been effective in identifying risks. Even one call related to a serious safety issue, for example, has led to a product being pulled out of the market and/or re-engineered for improved safety performance. That change resulted in a Consumer Safety Award from the Home Safety Council for product innovation.

Opportunities for products that address environmental concerns have also been identified through consumer calls. The desire for phosphorous-free fertilizer as an option for use around sensitive waterways and Canadian market demand for natural products are among consumer issues that have led to new products.

EAG Perspective

Are Social Goals Relevant to Business?

Community indicator programs can provide insights into what is important to the local community. While social / community goals are typically outside a company's sphere of control, they are influenced by local business policies and practices (see figure below). Online at **www.gemi.org/metricsnavigator**, Kirvil Skinnarland of Sustainable Seattle and Trilogy, LLC, explores how community indicators can help inform a company in determining what is material and in shaping its business goals.



Worksheets 2b – Prioritizing External Issues

Worksheet 2b (on page 25) provides a template to rate and prioritize issues of concern to external stakeholders. This allows users to rate the issues identified at for each value chain stage based on two criteria:

- level of concern to stakeholders (x-axis) – Is the issue is of high current or potential concern to key external stakeholders?
- organization's ability to control or influence (y-axis) – Are there actions the organization can take to control or influence the issue?

Concerns of employees and external stakeholders should reflect both current and emerging issues even if they are not of high concern or within the company's ability to control today. They may represent future issues to be considered today or at least 'parked' for consideration in the future. Together, these two criteria determine the significance of the external concerns.

Worksheet 2b plots issues' ratings based on the combination of the two criteria and the color coding demonstrates how the issues rate in terms of overall significance. An issue rated highly on both criteria is considered to be of high significance of external concern.

Some of the issues listed in are identical to those identified earlier from the perspective of employees (Worksheet 2a). Other issues, however, may be identified only through the perspective of external stakeholders.

Completing Step 2 will result in prioritized lists of issues from the perspectives of employees and external stakeholders. The next step will outline how to consolidate these to produce a short list of material issues.

WORKSHEET 2b: EXTERNAL – PRIORITIZE ISSUES OF CONCERN TO EXTERNAL STAKEHOLDERS

(XYZ Nutritional Beverage Example)

INSTRUCTIONS: Plot the potential and current issues identified by external stakeholders. Rate each issue as High (H), Medium (M) or Low (L) according to the following considerations:

Level of Concern to Stakeholders
- How strongly does each key stakeholder group care about the issue?

Organization's Ability to Control or Influence
- Does the organization have control or influence over the value-chain stages affecting the issue?
- Are there actions the organization can take to affect the issue directly or indirectly?

VALUE CHAIN STAGES:
S = Supply; C = Company Operations; D = Distribution; U = Customer Use of Product / Service; E = End of Life

Organization's Ability to Control or Influence	Level of Concern to Stakeholders: L	Level of Concern to Stakeholders: M	Level of Concern to Stakeholders: H
H	• Energy use (S, C) • Water use (C)	• Education (U, E) • Community outreach (C) • Immigration policy (C)	• Nutrition content (U) • Organic products (S, U) • Impact on local communities (S, C)
M	• Taxes paid (C)	• Use of alternative energy (S, C, D) • Employee Health & Safety (C) • Energy use (D) • Animal rights (S)	• Water use (S) • Farming run-offs (S) • Local economic development (S, C) • Air emissions (D)
L	• Local homeless population (D) • Talent retention (C)	• Transportation infrastructure (D)	• Global security (S, C, D)

Issues (examples):
Nutrition content (U)
Organic products (S, U)
Use of alternative energy (S, C, D)
Global security (S, C, D)

Reasoning behind Rating:
High level of stakeholder concern, well within organization's ability to control
Important to customers, organization can expand portfolio and modify sourcing
Concern to some stakeholders, organization can influence supply chain
High level of stakeholder concern, but limited organization's ability to control or influence

Note: the issues of global security and animal rights were added by external stakeholders, not included by employees in Worksheet 2a

Step 3
What is Material

3. Develop Key Objectives

STEP 3

Expected Outcomes

- Material issues for consideration in developing metrics
- Critical few key objectives

The purpose of Step 3 is to:

- consolidate the internal and external issues to produce a short list of issues most material to the organization
- identify potential objectives, i.e., what the organization may want to achieve in addressing the material issues
- select the critical few key objectives based on the business and societal value of addressing the material issues

This is a critical synthesis of material issues and their evaluation against the business success factors outlined in Step 1. Step 3 worksheets list material issues and selected key objectives for which KPIs and metrics will be developed.

Selecting Material Issues – Worksheet 3a

Materiality is examined in this tool through the four criteria discussed in the Overview. Two of these criteria were applied in Worksheet 2a (on page 21) to prioritize issues for their relevance to business:

- importance to the business success factors
- significance of environmental, social and/or economic impacts from the organization

The remaining two criteria were applied in Worksheet 2b (on page 25) to prioritize issues for significance of external concerns:

- level of concern to external stakeholders
- the organization's ability to control or influence

Worksheet 3a (on page 27) serves as a mechanism for selecting and summarizing material issues from both internal and external stakeholder perspectives. The issues will be plotted according to relevance to business (Worksheet 2a) and significance of concern (Worksheet 2b). For the example of XYZ Nutritional Beverage, community outreach is of high concern to external stakeholders but of medium relevance to the business, resulting in a medium materiality in Worksheet 3a.

This follows the same format and color-coding as previous worksheets. Issues that fall into the high materiality rating in Worksheet 3a are important internally and externally and can be the basis for key objectives.

Issues that fall into the medium materiality rating also warrant consideration for key objectives. This includes issues of high priority from the internal perspectives that the external stakeholders have not yet recognized, or vice versa. In fact, issues of high priority to external stakeholders that have not been recognized internally may constitute emerging issues for the organization.

Issues that receive low ratings are not material issues and may not require immediate attention. For XYZ Nutritional Beverage, these include border control, transportation infrastructure and animal rights.

Similar materiality ratings are used by some companies. Abbott, as illustrated in its case example (on page 28), rates issues by high, medium, and low priority.

WORKSHEET 3a: SELECT MATERIAL ISSUES

(XYZ Nutritional Beverage Example)

INSTRUCTIONS: Plot the issues according to ratings received in Worksheet 2a (Relevance to Business) and Worksheet 2b (Significance of Concern).
H/H =H; H/M=H; H/L = L or M; M/M=M; M/L = L; L/L = L

For example, Energy Use (S, C) was plotted in the dark-shaded area in Worksheet 2a and receives a high rating on the Relevance to the Business axis in Worksheet 3a. Energy Use (S, C) was plotted in the medium-shaded area in Worksheet 2b and receives a medium rating on the Significance of Concern axis in Worksheet 3a. The overall rating is high (dark shaded) in this combined worksheet.

VALUE CHAIN STAGES:
S = Supply; C = Company Operations; D = Distribution; U = Customer Use of Product / Service; E = End of Life

Significance of Concern (Worksheet 2b)

	L	M	H
H	• Immigration policy (C)	• Community outreach (C) • Education (U, E) • Air emissions (D)	• Nutrition content (U) • Organic products (S, U) • Water use (S) • Impact on local communities (S, C) • Local economic development (S, C) • Farming run-offs (S)
M	• Global security (S,C,D) • Animal rights (S)	• Use of alternative energy (S, C, D)	• Energy use (S, C, D) • Water use (C) • Employee Health & Safety (C)
L	• Taxes paid (C) • Transportation infrastructure (D)	• Local homeless population (D)	• Talent retention (C)

Relevance to the Business (Worksheet 2a)

Abbott

Managing Emerging Business Issues

Abbott's strategy for managing emerging business issues relies on a three-phase process of assessment, prioritization and implementation.

The assessment phase yields an inventory of environmental, economic and social issues. The issues are identified through interviews of internal parties and external stakeholder engagement and research. Approximately 50 business and functional leaders are involved in this phase.

The issues are then prioritized by a team of 25 corporate Vice Presidents and Directors. Each issue is scored for its impact on Abbott and the opportunity for action and mapped. 'High Priority' issues identified have a proactive strategy and dedicated resources and people support implementation. Issues that are 'Medium Priority' require Abbott not only to monitor with appropriate managers kept informed, but also to have positions developed and know where third-party support exists. 'Low Priority' issues require only monitoring and managers be kept informed. Other issues that are not necessarily managed are placed in a 'Parking Lot' for future consideration.

The implementation phase involves aligning existing teams with the policy committee and determining action plans and responsibilities. Tools to support Abbott's emerging issues' strategy, including partnerships and communication avenues, are also identified.

This three-phase process is designed to provide value at several management levels. The assessment phase provides an opportunity for business leaders to be informed about key issues and meet to discuss issues and channel information through a coordinated process. The prioritization phase leads to better planning and helps create a common purpose around what is important and what Abbott can address first. The implementation phase encourages cross-functional action, improves discussion of accountability, and orients people towards the results and how the emerging issues can affect the corporation.

Developing Key Objectives

Once a material issue has been selected, the next task is to determine:

- what does the organization want to do about, and achieve with, the material issue, i.e., what are the potential objectives
- is there sufficient value in addressing the material issue to be the basis for a key objective

To be developed as a key objective the material issue must provide value and support the business strategy identified in Step1. There are three considerations that influence the selection of a key objective and form the basis of Worksheet 3b:

- relevant components - factors that influence the material issue or related issues that can be clustered and addressed collectively with the material issue
- potential objectives - the desired outcomes defined in terms of the organization's objectives
- value proposition - the expected business and societal value generated in meeting the potential objectives

Relevant Components

The relevant components include factors that influence the material issue as well as affect the organization's impacts on the issue. For example, if the material issue is greenhouse gas (GHG) emissions, a factor affecting the material issue would be energy use and the organization's impact on the issue could be its use of alternative energy.

Multiple material issues can share some of the same relevant components. For example, if GHG emissions and the use of alternative energy are both material issues they could both be affected by rising energy prices. A material issue can also be a relevant component for other material issues. For example, the public's concern over GHG emissions is a relevant component that could influence the material issue of the use of alternative energy (the example in Worksheet 3b demonstrates how relevant components may influence a material issue).

The DuPont case example illustrates how the material issue of energy can be managed through two of its relevant components: annual consumption and use of renewable sources.

Potential Objective

The potential objective is the outcome or goal that the organization wants to achieve in addressing the material issue. There can be more than one potential objective for each material issue.

DuPont

Managing Energy

Energy is a material issue for DuPont. At a consumption rate of 233 trillion BTUs per year, DuPont is a large energy user. Energy contributes significantly to the cost of manufacturing as well as to the company's environmental footprint, including greenhouse gas emissions. Therefore, managing energy consumption is important not only to reduce costs but also to address impacts of concern to external stakeholders.

Two strategic metrics are used by DuPont to manage energy use: the total annual consumption and percent energy from renewable sources. For total annual consumption, DuPont set a target of keeping energy use flat at the 1990 baseline in the face of the company's growth. DuPont has achieved this target over the past ten years, and in fact, reduced total energy use by about six percent, while increasing production by 41 percent over the same period. This resulted in more than $3 billion of energy cost avoidance.

Using renewable energy, on the other hand, poses an opportunity for industry leadership. The lack of both cost-effective technologies and sufficient market demand has long hindered the advance of renewable energy usage in the marketplace. By setting a target of achieving ten percent of its energy use from renewable sources by 2010, DuPont is taking a leadership role in changing the market landscape by increasing the demand for renewable sources, demonstrating the use of renewable sources as a practical alternative in managing energy consumption and reducing their associated environmental impacts.

The Dow Chemical Company

Developing Dow's 2015 Sustainability Goals

Dow set its corporate vision to be "the largest, most profitable and most respected chemical company in the world". That means, it aspires to have the scale and scope to do things others cannot; to offer great shareholder value; and to earn the reputation of an industry leader in meeting and staying ahead of stakeholders' expectations. Dow's 2015 Sustainability Goals, announced in 2006, are intended to help the company achieve this vision.

Completion of Dow's 2005 Environmental, Health and Safety (EHS) Goals has demonstrated its ability to use real, measurable and long-term goals to motivate employees, drive innovations and achieve performance improvements. To continue to meet and exceed stakeholders' expectations, Dow recognized the need to expand the parameters of its new 10-year goals beyond EHS to include other aspects of its relationship with the world.

A stakeholder engagement process, started in 2003 involving executives, employees, its Corporate Environmental Advisory Council and external stakeholder representatives, identified three areas for its new set of goals:

- improving local corporate citizenship
- increasing commitment to product stewardship
- reducing global footprint

'Critical few' goals with significance and impacts on all its stakeholders were identified for each of the three areas through discussions at a level of detail appropriate to each stakeholder group.

Dow's 2015 Sustainability goals extend beyond minimizing the risks in its current operations towards proactive contribution to the global community. Specifically, it includes the goal of achieving by 2015 at least three breakthroughs that will significantly improve the world's ability to solve the challenges such as identified in the United Nations Millennium Development Goals.

The 2015 Sustainability Goals also balance the needs for constancy and flexibility. It includes specific numerical targets, such as reducing energy intensity by 25 percent, as well as qualitative targets, such as commitments to participate in certain voluntary programs and to establish local community goals.

Value Proposition

Evaluating the value proposition determines which of the potential objectives could be addressed as strategic key objectives for the organization.

Both business and societal values should be articulated for each potential objective(s) developed for each material issue. In assessing the business value, one should consider whether a potential objective supports the business strategy. Less tangible effects, such as brand image and improved reputation, should also be considered. The case example by Dow Chemical Company illustrates how goals and metrics are developed to support a company's business mission.

Societal values are understood broadly as benefits the organization can bring to society, the environment and the larger economic system through meeting the potential objectives.

Value proposition is the most important consideration in determining whether a potential objective should be selected as a key objective. These potential values can be regarded as the final screen of materiality that consolidates the four criteria discussed earlier in the step.

Selecting the Key Objectives – Worksheet 3b

Worksheet 3b (on page 32) provides a template for documenting the considerations that go into the selection of a key objective. Beginning with the material issues identified in Worksheet 3a, a stepwise analysis of the relevant components, potential objectives and value propositions is performed and documented in Worksheet 3b.

To be selected as a key objective, a potential objective must present a clear value proposition. The key objectives should be few in number, representing the critical few areas where the organization will focus its attention and efforts. Interrelated issues can often be addressed through one key objective.

A potential objective may not be selected as a key objective for a variety of reasons, including:

- lack of clear business or societal value
- less immediate value compared to other potential objectives, and thus postponed for future considerations
- achievable as part of addressing another material issue that has been selected as a key objective and can be included as a lower-level (more tactical) objective
- inability of the business to influence it

Completing Step 3 results in the prioritization of material issues and selection of key objectives for which KPIs, metrics and targets are to be developed.

EAG Perspective

How Can One Align Environmental, Social and Business Values?

The community, environment and private sector all benefit when business and sustainability interests are the same. Paul Tebo, formerly of DuPont, explores how to unleash the power of sustainability thinking in business by aligning business objectives and environmental and social values. The approach, outlined online at **www.gemi.org/metricsnavigator**, will integrate sustainability into all aspects of business.

WORKSHEET 3b: SELECT KEY OBJECTIVES *(XYZ Nutritional Beverage Example)*

INSTRUCTIONS: Document considerations that lead to the selection of key objectives (**in bold**), including the listing of:

- Material Issue: 'high' and 'medium' material issues from Worksheet 3a
- Relevant Components: factors that influence the material issue or the organization's impact on the material issue
- Potential Objective: objective(s) or goal(s) to be achieved in addressing each material issue
- Value Proposition: business and societal value of the potential objectives

VALUE CHAIN STAGES:
S = Supply; C = Company Operations; D = Distribution; U = Customer Use of Product / Service; E = End of Life

Material Issue	Relevant Components	Potential Objective	Value Proposition		Select as Key Objective?
			Business Value	Societal Value	
Educational outreach (U, E)	• Lack of awareness of healthy diet, especially among school children • Lack of awareness of recycling, how & why	Increase involvement in educational outreach programs for school children	• Access to key market demographic • Brand value	• Promote healthy diet • Promote reduction of packaging & recycling	No; while important, it is part of the objective of becoming a provider of choice for school breakfast beverage
GHG emissions (S, C, D)	• Energy use • Use of alternative energy • Best-practice technologies • Energy cost • Public concern on GHG emissions	**Reduce GHG emissions along value chain**	• Reduce energy cost in value chain • Marketing benefits	• Contributing to energy security • Societal benefits associated with GHG reduction; reduction in global climate change	Yes; significant benefits & addresses multiple issues
Use of alternative energy (S, C, D)	• Energy use • GHG emissions • Energy cost • Public concern on GHG emissions	**Increase use of alternative energy sources**	• Cost, may decrease or increase • Marketing benefits	• Contributing to energy security • Societal benefits associated with GHG reduction; reduction in global climate change	No; it is a supporting objective under the key objective, GHG reduction
Organic products (S, U)	• Farming runoffs • Local economic development (rural communities) • Market for organic products	Increase organic product portfolio and sales	• Capture a fast growing food & beverage market • Marketing benefits	• Reduce environmental impacts from farming • Increase jobs in rural America	Yes; significant benefits & addresses multiple material issues
Nutrition content (U)	• Market for balanced nutrition products • Concern over children's nutrition, especially in public school	Develop soy-based dietary supplement beverages	• Capture a potentially developing market	• A dietary supplement choice for lactose intolerant persons	No; significance of benefits unclear
		Become provider of choice of balanced nutritional breakfast products for children	• Growth in key market demographic • Brand value	• Address lack of healthy choice for children, especially schoolchildren	Yes; significant benefits to business and society

Step 4
What and How to Measure

4. Define Key Performance Indicators and Metrics

STEP 4

Expected Outcomes

- Established set of Key Performance Indicator (KPIs)
- Understanding of uses and users of metrics
- Measurements that define and support KPIs
- Clear targets for the metrics

Step 4 builds upon the critical few key objectives selected in Step 3 and creates the Key Performance Indicators (KPIs) and related strategic metrics.

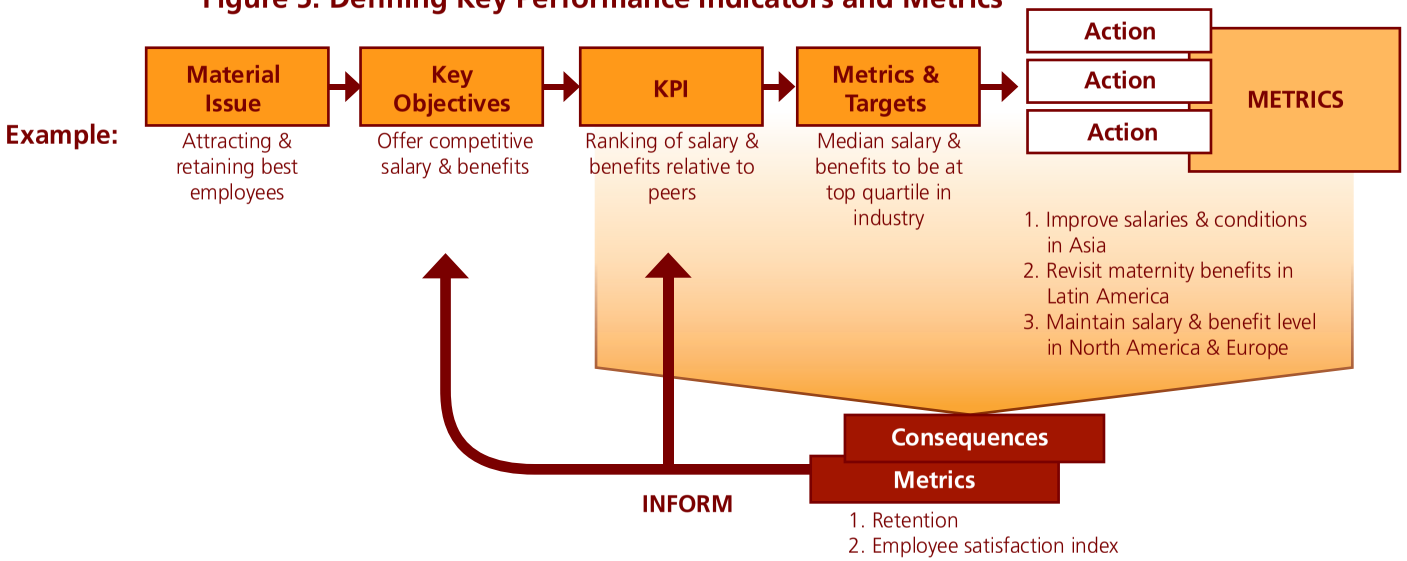
For purposes of this tool, GEMI defines a KPI as a general statement of what to measure; and a metric as the specific measurement accompanied by clear descriptions of how it is measured.

KPIs and metrics are closely related, but they represent two distinct levels. A KPI can be defined to represent what the organization should measure to reflect performance against a key objective. A metric is a quantitative measure, i.e., a number which is given meaning in the context of the KPI. A KPI can be applied consistently throughout the organization, but as a metric can be expressed differently depending on uses and users.

The process for defining KPIs and metrics is depicted in Figure 5, with an example. At the strategic level, material issues and key objectives determine the KPIs and metrics along with their associated targets. These strategic-level metrics are used to drive actions throughout the organization and will result in business and societal consequences, including longer-term effects. More tactical metrics can be developed to track the immediate actions. The consequences of applying the metrics and/or meeting the targets can also be measured, potentially becoming new metrics, to inform the refinement and development of the next generation of key objectives and KPIs.

This tool is focused primarily on KPIs and metrics at the strategic level, reflecting the critical few key objectives most material to the organization. Nevertheless, the approach presented here can be applied at various levels of uses, from strategic to tactical.

Figure 5. Defining Key Performance Indicators and Metrics



Framework for Measurement Considerations

Considering drivers and consequences as part of the KPIs and metrics helps develop leading measurements as well as measurements of achieving the key objectives. Drivers include processes, actions and other factors that lead to the intended outcome. For example, using renewable energy sources can reduce GHG emissions, and thus, can be regarded as one of the drivers that affect that intended outcome.

Consequences include immediate, medium-term and long-term effects of achieving the intended outcome. Energy cost avoidance, for example, is an immediate consequence of reducing energy use. Longer-term consequences include potential innovations in technology development and business models, along with the associated benefits to the society such as reduction in GHGs. Some of the consequences derived from the business and societal values are identified in Worksheet 3b (on page 32).

A KPI typically measures the outcome or result intended by the key objective. It is sometimes useful to establish measurements for either the drivers or consequences of the outcomes as part of the organization's system of KPIs and metrics.

Defining the Key Performance Indicators – Worksheet 4a

Worksheet 4a provides the template for examining drivers and consequences in order to define the KPIs and identify other measurement considerations that later are developed into metrics.

While a KPI is usually an outcome measure derived from the key objective, that is not always the case. If necessary, more than one KPI can be defined for a key objective.

WORKSHEET 4a: DEFINE THE KEY PERFORMANCE INDICATORS *(XYZ Nutritional Beverage Example)*

INSTRUCTIONS: Identify the drivers that affect the key objective and potential consequences (for the business and for society) in meeting the key objective. This information informs the decision as to what to track as KPIs. Indicate other measurement considerations related to the KPI that can be developed into metrics in later stages. Key Objectives were identified earlier in Worksheet 3b.

Material Issue	Key Objective	Drivers	Consequences	Key Performance Indicator (KPI)	Other Measurement Considerations
GHG emissions (S, C, D)	Reduce GHG emissions along value chain	• Energy efficiency • Use of renewable energy • Implementation of best practice technology and processes	• Energy cost reduction • Innovations: technology & business model	• Energy cost reduction • Innovations: technology & business model	• Percent energy from renewable resources • Best practice implementation • Energy cost-saving
Organic products (S, U)	Increase organic product portfolio and sales	• New organic product development • Marketing of organic products • Relationship with organic farmers	• Increased sales • Brand image • Driving more sustainable agriculture	• Percent revenue from organic products	• Implementation of organic farmers program • Customer perception • Avoidance in pesticide run-offs
Nutrition content (U)	Become provider of choice of balanced-nutritional breakfast products for children	• Children nutrition awareness campaign at schools • Nutrition content in products	• Increased sales • Brand image • Contributing to children's health	• School children reached in nutrition awareness campaign	• Nutrition content

4. Define Key Performance Indicators and Metrics

The examples included in Worksheet 4a continue from the key objectives identified in Worksheet 3b for the hypothetical 'XYZ Nutritional Beverage' business. For the GHG reduction objectives, two KPIs were determined to be equally important: net GHG emissions (an outcome measure) and energy use (a driver for GHG emissions). For the objective of becoming the provider of choice for balanced-nutritional breakfast for children, the KPI is chosen to reflect one of the causal factors, i.e., the number of schoolchildren reached in nutrition awareness campaign. In this case, the driver was considered the critical part of meeting the key objective as well as more suitable to measure.

KPIs and other measurement considerations identified in Worksheet 4a inform the development of metrics for various uses and users in the organization.

Uses and Users of Metrics

The uses and users of metrics influence how they are defined. Metrics by themselves mean little outside of the context of how they will be used to improve performance and organizational integration.

Table 2 lists the various uses of metrics which generally are grouped into four categories [13]:

- learning – produce understanding and insights into opportunities for improvement through the identification and assessment of aspects, impacts and issues
- decision-making – generate insights to support decision-making
- accountability – provide information to judge individuals' or units' performance
- demonstration – convince or reassure stakeholders about organization's performance and trends, including demonstrating the connection between environmental, social and financial performance

Metrics can be used by several functional areas in the organization as shown in Table 2. In Step 2, examples demonstrated how decisions are made in numerous functional areas using environmental, social and economic information. In determining who will use the metrics consider:

- where within the organization decisions involving KPIs are made
- which people are responsible for meeting the key objective
- what information will be needed to inform those decisions

Table 2. EXAMPLES OF USES AND USERS OF METRICS

Uses of Metrics	Management	Operations	Financial	Environment Health Safety	Research and Development	Human Resources	Public Relations	Investor Relations
Learning • Benchmark Internally	✓			✓				
• Evaluate Alternatives		✓		✓	✓			
Decision-Making • Identify Improvement Options		✓		✓	✓	✓		
Accountability • Report to Stakeholders	✓		✓				✓	✓
• Track Performance		✓		✓		✓		
Demonstration • Build the Business Case	✓		✓	✓	✓			✓
• Promote SD	✓			✓			✓	

How a metric is defined and presented, however, can differ among uses and users. Metrics used for management progress tracking, external communication and Research & Development decision-making, for example, may involve different definitions in terms of boundaries, data sources and level of ***specificity***.

Types of Metrics

The framework described earlier provides a way to categorize the types of metrics. Descriptions of these categories follow and examples are shown in Table 3 (on page 37).

Outcome Metrics

Outcome metrics are measurements of results. Many of the existing metrics standards, such as the Global Reporting Initiative (GRI), have largely focused on outcome metrics. Outcome metrics typically include:

- *One-dimensional metrics* - often expressed as the absolute magnitude of the organization's impacts per time period
- *Cross-cutting metrics (Integrated Performance Metrics)* - express two or more dimensions of performance, usually as ratios. Eco-efficiency and socio-efficiency metrics are examples of cross-cutting indicators

Both one-dimensional and cross-cutting metrics can be effective measurements of outcomes. The choice is based largely on what it is to be measured. A KPI usually points to an outcome metric, measuring the outcome intended by the key objective.

Process Metrics

Process metrics measure the actions or processes that drive the intended outcomes i.e.,the causes, and are usually tied to the action plans to achieve targets. They include metrics that measure the performance of management processes as well as technical and operational processes put in place to produce the intended outcomes.

Process metrics can be used as effective leading metrics. For example, if the performance objective for an organization is to reduce the number of non-compliance complaints, the outcome metric is the number of non-compliance complaints. However, a cause-effect analysis might reveal that lack of appropriate training is the driver of non-compliance. In this case, an appropriate process metric might include the number of employees that have received compliance training or the number of employees who have changed their behavior as a result of training. This process metric, in addition to the outcome metric, will provide the organization with greater insight into the material issue and the actions to achieve objectives.

Process metrics can be quantitative or qualitative. For example, in measuring the process of stakeholder engagement, one can use quantitative measurements, such as the number of stakeholders engaged, or qualitative measurements, such as stakeholder satisfaction and perceived effectiveness.

Consequence Metrics

Consequence metrics reflect the consequences or effects on the broader system of the intended outcomes. These types of metrics may include:

- *Business consequence metrics* measure the business and financial consequences of the intended outcomes. These can capture benefits to the organization, both tangible and intangible. For example, an ethical reputation index can inform an organization how its business is perceived.
- *Societal consequence metrics* connect actions and activities to the broader economic, environmental and social systems within which they operate. An example of a societal value metric might be the number of acres of habitat an organization created in proportion to the number of acres of habitat created in the region.

Examples of the different types of metrics are shown in Table 3.

All types of metrics have the potential to be relevant to most uses and users, so they should all be considered in building the metrics. However, certain types are more applicable to certain uses. For example, Research & Development decision-making typically relies on outcome and, to a lesser extent, consequence metrics. Process metrics, on the other hand, are useful to manage and track progress towards goals, i.e., accountability, along with outcome metrics.

Consequence metrics are particularly useful in demonstrating the value of an organization's efforts. Case examples by The Procter & Gamble Company and Intel Corporation (on page 38) provide examples of metrics that may be used to manage, track and communicate a company's impacts on the society.

TABLE 3. EXAMPLES OF ENVIRONMENTAL, SOCIAL AND ECONOMIC METRICS			
Metric Types	**Environmental**	**Social**	**Economic**
Outcome			
One-dimensional	• Energy consumption per year • Percent raw materials recycled from customers	• Lost-time incident frequency • Community perception index	• Dollars in salaries and tax benefits flowing to the local community
Cross-cutting	• Energy consumption per unit of value add • Total raw materials per unit of value add	• Number of community complaints per unit of value add to the company	• Economic benefits to the community per unit of value add to the company
Process			
Management & Operations	• Number of energy review activities conducted • Percent facilities participating in resource-efficiency training • Incorporation of energy-efficient technologies in facilities	• Percent of business units that have human rights policy and procedures regarding child labor • Number or percent of contractors and suppliers audited for use of child labor	• Number of executive review meetings on socioeconomic risks and challenges
Consequence			
Business	• Cost reduction from energy savings program	• Employee retention index • Reputation index	• Potential cost of legal liability related to community actions
Societal	• Land area of ecosystem saved due to reduction in raw material use	• Number of quality-adjusted life years saved by product use	• Company's contribution to local economic development

The Procter & Gamble Company (P&G)

Exploring New Value-Creation Metrics

The Procter & Gamble Company's (P&G's) vision of sustainable development incorporates not only reducing costs and impacts but also creating value and business growth through sales, new markets, new consumers and new businesses. This can be achieved when societal challenges, such as those identified in the United Nations' Millennium Development Goals, intersect P&G's ability to innovate.

P&G has identified a number of areas for its contribution to sustainable development. These include safe water, improved hygiene and quality of life of children and women. To measure the performance of these new initiatives, traditional business and environmental metrics no longer suffice. Instead, they need to be measured by new 'value-creation' metrics, such as disease avoided, lives saved, the number of children who reach their full development potential and ways in which women's lives are improved as a result of P&G product and/or service innovations.

P&G's water purifiers, for example, present significant opportunities to improve and even save lives in developing countries. With this safe water technology, P&G can accurately track the consumption and repeat use of the product and the estimated volume of water treated. Measuring and reporting on disease avoided and lives saved by an innovation at the company level, however, is relatively new. Nevertheless, researchers and non-governmental organizations (NGOs) have measured the water purifiers' effects in terms of percent diarrhea reduction and the number of diarrhea episodes averted in certain regions. These metrics are important for P&G to evaluate and communicate the effectiveness of the product.

In developing value-creation metrics that are credible and transparent to stakeholders, the metrics need to be aligned with those used by NGOs, governments, research and health organizations who are long-standing members of the public health communities. Partnerships with these groups allow P&G to gain experience in its approach to health and development and in the use of value-creation metrics. Ultimately, this can lead to the development of specific goals to guide the company's sustainability actions.

Intel Corporation

Assessing Performance of Education Programs

Intel strives to be a trusted partner to educators and governments worldwide. Integral to the company's mission is a focus on "success for all," providing programs and resources that improve teaching and learning to everyone including women, under-represented minorities and those with little or no access to technology.

Several distinct programs work in concert to achieve Intel's education mission in both developed and developing countries. Annual goals are set for these programs, allowing Intel to continually assess its performance. For 2006, the goals include, for example:

- Extend its teachers' professional development program to reach an additional 900,000 teachers and five new countries
- Grow its after-school programs in government-funded community technology centers with the goal of reaching an additional 150,000 learners and adding three new countries

In China, Intel recently announced in 2006 a new plan to train one million elementary and middle school teachers over the next five years, helping them use information technologies in teaching. More than 10,000 personal computers will be provided to China's rural schools by 2008.

The effects of Intel's effort are evident in Minas Gerais, a Brazilian state previously identified as having the lowest computer literacy rate in the country. Intel provided over 2,400 schools in the state a complete technology infrastructure with computers in school labs, libraries and administrative offices. The program also involves training teachers with the necessary skills to fully realize the potential of the technology. Ultimately, this will help teachers integrate technology into the regular curriculum and enhance student's learning capacity in the classroom. By the end of 2006, approximately 170,000 teachers and 2.5 million students in Minas Gerais will benefit from this project.

4. Define Key Performance Indicators and Metrics

Metrics Criteria – Worksheet 4b

To drive improvement and organizational integration, a metric should meet many of the following criteria:

- relevant to business - aligned with business objectives and reflect issues that are material to the organization
- transformative - will lead to positive consequences
- accurate - reflect what it is intended to measure
- reliable - reproducible and comparable across reporting periods and organizational units
- meaningful and useful - can be related to actions and effective for its intended use and users
- understandable - communicated within context that generates insights for decision-making
- cost-effective - can be developed and implemented with reasonable costs

DuPont illustrates in its case example how some of the above criteria apply in developing metrics.

In addition, there are criteria that apply to the suite of metrics:

- few in number - concentrate on the critical few to focus organizational effort and implement a cost-effective metrics program
- balanced - include the right mix of leading and lagging metrics, different types of metrics and the social, environmental and economic dimensions to drive improvement and organizational integration
- valuable - the suite of metrics results in tangible and intangible value for the organization

3M case example (on page 41) discusses the process and considerations in developing an effective suite of key metrics (its 'EHS scorecard').

Worksheet 4b (on page 40) provides a checklist of criteria in defining the KPIs and metrics (in the first column). The criteria are applied again in the implementation of the metrics (in the second column for Step 5) and in assessing their effectiveness (in the third column for Step 6).

DuPont

Metrics to Drive Sustainable Growth

Sustainable growth is the strategic mission of DuPont. To measure sustainable growth, DuPont previously developed 'shareholder value add (SVA) per pound of production' as a single metric that combines multiple environmental and economic considerations in one number. As mass of product is generally correlated with environmental impacts, the SVA/lb metric was designed to drive environmental footprint reduction as well as to move the company toward more knowledge-intensive, higher-value products and services. This metric has proven useful for planning and strategic discussions. Nevertheless, DuPont found the metric to be overly sensitive to factors that had little effect on the state of the environment, including market price fluctuations and business acquisitions and divestitures.

Therefore, DuPont has focused on another set of marketplace and footprint reduction metrics to drive sustainable growth in its operations. One example is the 'revenue from non-depletable resources'. This metric is calculated from the revenue generated from DuPont's businesses that rely primarily on renewable resources (such as seed, soy and bio-based polymer businesses) or the company's human resources and knowledge base (such as safety consulting services and technology licensing). DuPont has set the goal of nearly doubling its revenues from non-depletable resources to at least $8 billion by 2015.

Like SVA/lb, the metric is intended to drive the company toward a lower environmental footprint and more knowledge-intensive services. The metric was selected as a focus for DuPont as it makes sense to all three legs of the triple-bottom-line. Economically, it reduces exposure to market volatility associated with petroleum and other depletable resources. At the same time, it addresses stakeholders' concerns regarding the depletion of natural resources and related environmental impacts.

WORKSHEET 4b: EVALUATE METRICS EFFECTIVENESS CHECKLIST *(to be used in Steps 4-6)*

Criteria		Considerations		
		Step 4 Define KPIs and Metrics	**Step 5 Implement Metrics**	**Step 6 Evaluate Improvement & Integration**
For individual metrics	**Relevant to Business**	• Reflect key objectives	• Integrated into existing management system	• Support business objectives • Relevant to assessing future performance • Align staff and management on strategy
	Transformative	• Will lead to positive consequences • Potential for unintended negative consequences is considered and addressed as necessary • Require actions or behavior changes beyond business as usual • Targets are inspirational	• Lead to the intended and other positive behavior changes	• Drive performance improvement • Stretch organization to innovate in reaching goals • Broaden internal involvement and engagement • Change the mindsets / attitudes of employees toward the importance of addressing the issues
	Accurate	• Measure what was intended to measure • Include key risks and opportunities within the metric's boundaries	• Accuracy of the metric and underlying data are verifiable • Calculated based on credible data	N/A
	Reliable	• Reproducible and comparable across organization and reporting periods • Supported by standardized definition and procedures for data collection and calculation	• Definition and procedures are clearly understood and can be followed by users • Comparable data are collected across organizational units	N/A
	Meaningful & Useful	• Relevant to the intended users and uses • Can be related to action plan and accountable targets • Can be scaled as desired across value chain and organizational levels • Provide sufficient precision and granularity to be useful	• Effective in use and in supporting decision-making process • Link operational metrics to strategic metrics • Timely in terms of the periodic collection of data relative to key decisions	• Provide relevant, timely and reliable information to decision-makers • Meet the intended uses for the intended users
	Understandable	• Expressed in terms that is understandable to the intended audience	• Communicated in context that support use and insights • Can be visually presented to intuitively demonstrate trends and directions (e.g., using a 'dashboard')	N/A
For the suite of metrics	**Cost-Effective**	• Can be developed from available data, whenever possible • Reasonable and cost-effective levels of granularity and precision	• Data are calculated cost-effectively, in a usable manner, without extensive manual intervention	N/A
	Few in Number	• Based on the 'critical few' key objectives • Combine multiple metrics, as appropriate	N/A	N/A
	Balanced	• Include leading and lagging indicators, as appropriate	N/A	• Complement traditional financial measurements • Set of metrics reflect social, environmental and economic considerations, whenever applicable
	Valuable	N/A	N/A	• Metrics link to business value, both tangible and intangible

4. Define Key Performance Indicators and Metrics

Building the Metrics

The uses and users, types of metrics and criteria discussed earlier are important considerations for defining a metric. A number of steps are involved in defining a metric:

- setting the boundary
- defining the form the metric takes
- assessing potential data sources
- determining the necessary level of precision and specificity

Each of these steps is necessary for coming up with a rigorous definition and formula or guidelines for how they will be calculated.

Setting the Boundary

Metrics may encompass one or more stages in the organization's value chain. In defining a metric, one needs to set the boundary for what the metric is to include. This is important to ensure its accuracy - everything that should be measured as part of the metric is to be included within the metric's boundary.

Consider the example in Worksheet 3b (on page 32) where one of the key objectives is to reduce energy cost and the organization's exposure to the climate change issue. Related to a GHG emission KPI identified for this key objective, the metric should include estimated emissions from heat and power generation, regardless of whether they are within the organization's fence-line. Focusing solely on GHG emissions from within the fence-line can be misleading. For example, outsourcing power generation, especially to a less efficient entity, can improve a metric limited to the organization's direct operations (from within the fence-line) while actually leading to increased indirect emissions from purchased electricity. Emissions have simply been shifted or transferred outside the fence-line, and total GHG emissions to the environment may have actually increased.

Step 2's assessment of issues should provide the basis for determining the relevant value chain stages to be included in the metric. Boundaries may vary from one metric to another.

3M

Scorecard to Drive Performance

3M's Environmental, Health and Safety (EHS) Scorecard is an important tool for driving the company's EHS performance. Each scorecard is produced quarterly for all facilities, divisions (i.e., business units) and countries where 3M operates. The scorecard contains a set of metrics with a pre-determined goal that is measured each year and uses a green, yellow, and red color scheme to track performance toward the goal. The intent is to ensure key metrics are defined and tracked and that performance relative to the targets is reported.

Scorecard metrics are reviewed and selected annually by a team of corporate and business EHS professionals. Each metric is evaluated for a variety of parameters to determine its applicability on the next calendar year scorecard. Some of these parameters include: desired EHS outcome, leading / lagging status, reporting frequency and length of implementation. Scorecard metrics generally require global applicability and are balanced between leading and lagging indicators. Leading indicators, such as EHS plans, Pollution Prevention Pays (3P) program implementation and EHS self-assessment performance, are measures of opportunities that will result in improved EHS outcomes. These metrics are critical to providing flexibility for facilities to address their individual needs and opportunities, without using a 'one size fits all' approach. Lagging indicators, such as incident rate and air emissions, are measures of how effectively opportunities were addressed during the year.

The overall outcome of the 3M EHS Scorecard is increased performance and accountability. 3M expects all of its facilities to have high levels of EHS performance. The 3M EHS Scorecard provides visibility at all levels of the organization to ensure that everyone is working to meet these expectations and that they have the resources and management support to do so.

A metric needs to be sufficiently precise and specific to be meaningful and usable.

Defining the Form of the Metric

There are many forms a metric can take. Some can be expressed in absolute form, i.e., in the form it is collected, such as total occurrences of a specific type of incident per year. Metrics, however, are often expressed in ratios, indices and other forms that provide context and enable more effective comparison over time and across the organization. The form of a metric contributes to how meaningful and useful the metric is for its intended uses and users.

In forming a metric, one should consider the following:

- Inclusion of quantitative and qualitative measurements - While metrics are generally regarded as quantitative, some measure qualitative parameters. Examples commonly are found in the social area and include indices of employee morale and customer satisfaction, calculated from qualitative (or subjective) survey results. While qualitative measurements can capture more subjective attributes such as satisfaction, attitude, sense of well-being, importance of issue, etc., they can be interpreted numerically by applying ranking or scoring methods
- Normalization - Normalization can produce ratios that provide better context and more effective scale for comparison. Some denominators for normalization include:
  - o production throughput - Suitable for a manufacturing organization that makes products of similar characteristics and economic value, e.g., a single product facility, this denominator is seldom effective for more diverse or service-oriented organizations
  - o financial measurements of value - Financial measurements, such as revenue, shareholder value add (SVA) and economic value add (EVA), are applied to normalize the organization's impacts. Examples are eco-efficiency and socio-efficiency metrics, such as job creation per dollar SVA. Value-add measurements are often more appropriate in representing the financial value directly related to the impacts

In addition to conventional measurements of value-add, a sustainable value-add can be defined. Figure 6 (on page 43) illustrates a sustainable value-add calculated as the difference between revenue and the costs of natural capital. This includes not only economic profit but also the company's contribution to the development of human / social capital.

- Indexes and composite indices - A metric may also take the form of a composite index - a combined measure encompassing various other metrics. Examples include:
  - o Total cost - sum of internal and external monetary costs of environmental and social impacts
  - o Ecological footprint - a combined estimate of environmental impacts expressed in terms of equivalent land area impacted and other ecological indices
  - o Disability-Adjusted Life Years (DALY), Quality-Adjusted Life Years (QALY) and other health-based indices for weighting impacts in terms of human health
  - o Semi-quantitative composite score weighted by importance to stakeholders, such as outlined in the ISO-14040 series of standards for life-cycle assessment

- Locally normalized metrics could include wages as a ratio to prevailing local wages or water use as a ratio to annual volume locally allocated for industry use
- Composite indices developed by investment analysis and research organizations

Representatives from Ethical Investment Research Services (EIRIS), Sustainable Asset Management (SAM) and Investor Responsibility Research Center (IRRC) participated in the GEMI EAG sessions. Both EIRIS and SAM have developed and applied composite indices to assess corporate sustainability practices based on company questionnaires and analysis of public information. IRRC pointed out the value-chain perspective that analysts increasingly apply, considering risks beyond the company's immediate sphere of control (see the EAG perspective, Are Social Goals Relevant to Business? on page 24).

Difficulty in combining various metrics into composite indices varies. Total cost, for example, yields valuable results but often requires the laborious and uncertain process of monetizing aspects having uncertain financial value. The use of semi-quantitative scores, on the other hand, can proceed once a consensus is reached on how each metric is normalized and a weight assigned to each metric.

In determining the form and what is included within the metric, the organization also needs to determine whether the metric can be meaningful and useful at the different organizational levels.

Potential Data Sources and Levels of Precision / Specificity

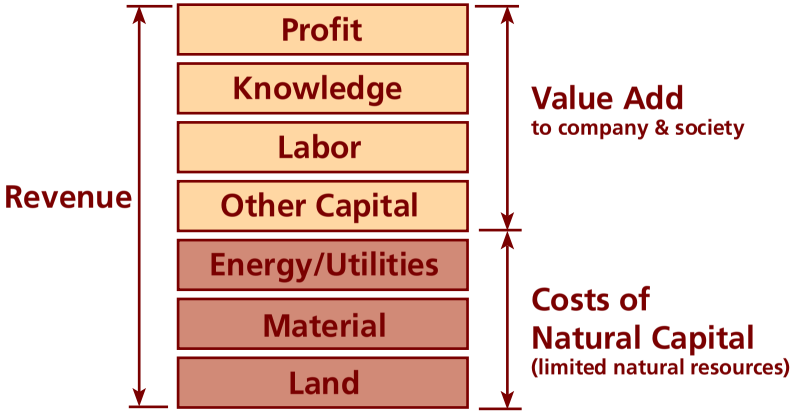
The availability of data sources is an important consideration in determining whether the metric can be developed in a cost-effective manner. The metric can be obtained through various means, including:

- directly calculated from available data
- estimated or modeled from available data
- calculated, estimated, or modeled from data not currently collected by the organization

To minimize cost, consider using available data or data that can be collected using the existing data collection system. When data are not available to directly calculate the metric, consider whether estimation from available data is sufficient. For example, a GHG metric is commonly estimated from available energy-use data.

Data sources and availability are tightly linked with the level of precision and specificity needed for the metric. Specificity refers to the lowest level of the organization to which the metric is reported. Wastewater data, for example, may be readily available for an entire large manufacturing facility, but not for the individual process units within the facility. A metric needs to be sufficiently precise and specific to be meaningful and usable. However, greater precision and specificity than are necessary may make data collection and calculation cost-prohibitive.

Figure 6. 'Sustainable Value-Add' to Company and Society



Sustainable Value-Add = Revenue – Costs of Natural Capital
Costs of energy and utilities, materials, and land (if significant) are used as proxies for the costs of natural capital. The Value Add represents contributions to the development of financial / built capital and human / social capital.

Setting Targets

Targets are performance goals that are relevant to the organization's key objectives. An organization can set environmental and social targets in much the same way that it sets financial targets. To contribute to performance improvement, a target should be:

- **S**pecific - focused on a specific objective and the outcome that is expected
- **M**easurable - through measurements defined in the metrics
- **A**chievable - knowledge, tools and resources should be available to achieve targets
- **R**ealistic - with actions the organization can take to achieve targets
- **T**ime-specific - with timeline attached to a target

Targets meeting the above criteria are commonly known as the 'SMART' targets, reflecting the initial letters of the criteria. Targets can be incremental or stretch.

Incremental targets are set to achieve gradual change and usually to meet a threshold essential to remaining operational. ***Stretch targets*** are more revolutionary targets. A stretch target is set with less understanding of how it will be met. Stretch targets are meant to spark organizational change by stimulating innovation, encouraging employees to push traditional boundaries and challenging the current ways of doing business. Thus, they are usually set for a longer term, allowing time for changes and innovation. Nevertheless, setting stretch targets is a challenging task. Decisions must be made as to how far to stretch a target, while keeping it credible.

DuPont's case example summarizes its considerations and process for developing stretch targets. Southern Company's zero injury target, (on page 45) is an example of a stretch target designed to change an organization's mindset.

DuPont

Setting 'Achievably Stretched' Targets

Corporate environmental and sustainability goals at DuPont are set on a nine-to-ten-year timeframe. This longer period allows the corporation to set more challenging (i.e., 'stretched') goals and sufficient time to innovate and find creative solutions that are better for the business as well as the environment.

After issues are identified and prioritized, the following generic process is used to set the corporate goals:

- develop a baseline on where the company currently stands on the issues
- determine what the company intends to do about the issues
- estimate the levels of improvement that can be reasonably expected based on existing technologies, current Research & Development efforts and anticipated changes in the marketplace
- decide on specific targets that can sufficiently challenge the company

Ultimately, setting targets is a process that requires not only quantitative and qualitative analysis, but also a strong leadership role. In addition to determining targets that will adequately challenge the company, leadership must ensure that the targets set are feasible, lest the company's credibility may be harmed. Furthermore, leadership must ensure that the targets will benefit the environment and society while also making economic sense for the company.

Internal metrics, or 'milestones', are developed to benchmark the company's progress toward the goals. To assure continuous improvement, more immediate two-to-three-year targets are set and managed at DuPont's individual business units.

To "nearly double revenues from non-depletable resources to at least $8 billion by 2015" is an example of a longer-term goal set at DuPont. Such goals are valuable in stimulating new ideas, especially in Research & Development and ways to market products and services. They challenge employees to create a more sustainable company that will provide measurable societal value.

4. Define Key Performance Indicators and Metrics

Southern Company

'Target Zero' to Change Employees' Mindsets

Southern Company is an overall leader in the United States power industry. Yet, collective 2002-2004 results for all utilities in the company's region placed its safety performance in the third quartile. This was attributable to a culture that believed incidents were unavoidable and acceptable. To achieve world class safety performance that the company desires, this mindset had to change.

Southern Company historically has been effective in accomplishing corporate goals that it sets for itself. Nevertheless, past safety goals have not brought the excellence expected of a leadership company. Thus, effective in 2005, Southern Company set a new safety goal – 'Target Zero' – to achieve zero injuries every day on every job.

One may question whether a zero goal is realistic. The key, however, is to embed into the organization the beliefs, expectations and performance standards inherent in 'Target Zero.' A set of principles recently adopted by the company's Central Safety Committee clarifies three values critical for the company's success in achieving the goal:

- 'Believe it!' – employees must firmly believe that all injuries and occupational illnesses are preventable and every task can be planned and completed safely
- 'Expect it!' – employees must understand that working safely is a condition for employment; and managers, supervisors and individuals are held accountable for unsafe behaviors and conditions
- 'Live it!' – employees must commit to health and safety rules and to continuous improvement; and leaders must recognize and reward successes

A culture will change only with time. Management is first responsible for demonstrating the change and creating the environment for safety excellence. There are currently organizations within Southern Company that are becoming world class performers. That should become the new norm for safety. The results so far are encouraging. In the first year of implementation, Southern Company reduced recordable injuries by 25 percent and lost work time injuries by 40 percent.

Build Metrics and Set Targets – Worksheet 4c

Worksheet 4c (on page 46) provides a template to summarize the set of metrics that support the KPIs and includes: the formula for each metric, the protocol, i.e., procedure for measuring and calculating the metric and any assumptions that go into the calculation.

The Need for Complementary Metrics

In addition to the strategic metrics that directly reflect the KPIs, additional metrics can be developed to address specific needs. These metrics are complementary to the critical few measurements and can include metrics that:

- emphasize certain components of the strategic metrics, e.g., mass of toxic raw materials emphasizes an element of an overall material consumption metric
- include components not accounted for in the strategic metrics, e.g., transportation energy metric complements an energy metric for the company's operations
- provide additional insights to the strategic metrics, e.g., toxicity rating complements the total mass of toxics released
- support the strategic metrics' implementation and evaluation, e.g., number of people who received metrics and best-practice trainings

WORKSHEET 4c: BUILD METRICS AND SET TARGETS *(XYZ Nutritional Beverage Example)*		
Material Issue(s) Material issue(s) addressed by key objective	GHG emissions, energy use and use of alternative energy	
Key Objective A selected key objective	Reduce GHG emissions along value chain	
KPIs Description of the measure(s) of performance toward a key objective(s)	GHG emissions	Energy reduction relative to growth
Use & Users	Diverse users	Diverse users
Metric Definitions Measurements that further define and support the KPI – The 'how-to' of KPI	GHG emissions from relevant value chain stages, expressed per sales revenue	Energy use per sales revenue
Metric Boundary	Farming, transportation, heat & power generation, company's operations	Company's operations and transportation
Reporting Level	Business Unit	Business Unit
Formula	Sum of GHG emissions from each value chain stages (CO_2- equiv/yr) per US$ sales	Annual energy use (MJ/year) per US$ sales
Protocols & Assumptions	• GHG from farming (upstream): Estimate using US average for conventional and organic soy bean farming • GHG from incoming transportation and from distribution: Estimate from logistics data using WBCSD guidelines for calculating GHG from transportation • GHG from heat and power generation: Calculate from electricity and steam use at facilities and GHG emission factors from suppliers • Non-CO_2 GHG emissions converted into CO_2 equivalents following IPCC 20-year horizon • Sales revenue: follow financial accounting calculation	• Energy use calculated as fuel equivalence (in MJ) • For purchased electricity and steam, report as the equivalence of fuel required to generate and deliver the energy • Sales revenue: follow financial accounting calculation
Data Sources	See calculation protocols & assumptions above	Utility data; transportation records GHG emissions along value chain
Frequency	Annual	Quarterly
Target	Reduce 30 percent in 5 years	Reduce 10 percent in 5 years

5. Evaluate and Communicate Metrics

Step 5
How to Assure Effectiveness

STEP 5

Expected Outcomes

- Regular communication and feedback based on performance against targets

Step 5 outlines how to implement the metrics and integrate them into existing information and management systems. This step will confirm that the organization has a systematic approach to measuring key financial and non-financial performance and ensure that the information generated is reliable, complete, comparable and relevant.

The systematic integration of metrics into management and information systems can link strategy and operations to produce insights for decision-makers and translate important information to key stakeholders. Implementation is not only about the mechanics of systems, but also about the effectiveness of communication. The metrics need to be meaningful and understandable to the intended audience.

Integration into Existing Systems

In interviewing U.S. senior executives and major governments, KPMG LLP identified organizational benefits by developing and implementing a measurement system that is aligned with an organization's strategy. This alignment ensures that, whatever metrics an organization uses, they are measuring what is right for them, as well as measuring things the right way. The alignment further translates metrics into specific action steps that generally benefit the organization. The research also found that for measurement to provide a competitive advantage, it needs to be considered as a core organizational process [14].

To embed the metrics into existing practices and systems, one needs to:

- identify those accountable for the metrics process
- develop a formal implementation approach
- establish an implementation team
- develop a written procedure or guidance document based on the metrics definition
- integrate into the existing data collection and information management system, whenever possible
- integrate into planning, budgeting or other relevant business processes
- incorporate the use of metrics into job performance evaluation criteria
- establish a process for reviewing, refining and retiring metrics

Data Management

The data needed to calculate the chosen metrics are identified in Step 4, along with consideration of whether the metrics can be calculated or estimated from available data. In integrating the newly developed metrics into existing information system, one needs to ask:

- Where do (or will) the necessary data reside?
- Who is (or will be) responsible for the data?
- How often are the data (or will be) collected?
- How are (or can) the data be verified for accuracy?
- Are the data (or will the data be) comparable across facilities or organizational units for the purpose of the metric?

Obtaining comparable data can be challenging across a large organization. Environmental, health and safety data, in particular, are typically collected to satisfy local regulatory requirements that vary across the different jurisdictions that an organization operates.

Clarity in definitions and boundaries can improve the comparability of metrics. For example, instead of measuring emissions from a uniform set of substances, the metric can be re-defined in terms of substances of concern to the local context.

Use of an automated information management system can effectively reduce the cost and human resources required to support data collection and verification and reporting in a timely manner. One such tool is the ***GEMI HSE Web Depot***, an EHS management information systems tool that can be found at **www.gemi.org/hsewebdepot.org**.

Johnson Controls Inc. provides a case example of a web-based information management system to manage energy and greenhouse gas data.

Integration into Business Processes

Metrics can have multiple uses and users. In implementing the metrics, one needs to ask whether:

- guidelines and instructions associated with the metrics are effectively communicated and are understandable to the users
- users recognize the value of the metrics

Various communication venues, such as an internal company's website and short courses, may be used to disseminate information relating to the metrics and examples of issues and successes in the metrics' implementation.

One should also consider whether the metrics program can be integrated into existing processes, such as Six Sigma as demonstrated in the 3M case example (on page 49).

Communicating Results

Metrics should be communicated in ways that provide meaningful insights and are understandable to decision-makers and other audiences that can benefit from them. To achieve that, consider the:

- level of roll-up and details required for different audiences
- context in which the metrics are presented
- visual depiction of the metric

In addition to composite indices that combine multiple measurements, metrics can be rolled-up or aggregated organizationally and geographically, such as from a business unit to the regional company and then worldwide. Judicious use of such metrics can be effective in communicating the bigger picture, especially to managers looking for a general trend in the organization. However, one must exercise caution in making decisions on such bird's-eye-view metrics. Details need to be available to support the use of composite indices and rolled-up metrics and considered in producing insights from such metrics.

Not all metrics are suitable for roll-up. Local community issues, while important at the corporate level, need to have metrics managed at

Johnson Controls, Inc.

Managing Energy and Greenhouse Gas Data

Energy use management is an important part of reducing greenhouse gases (GHGs) and a core business of Johnson Controls, Inc. To assist businesses in managing energy and GHG data inventory, tracking, and reporting, Johnson Controls, Inc. developed a Utility Bill Payment & Management Reporting System.

The system features accurate, consistent, cost-effective, time saving, credible, flexible and understandable approach for managing the data. These features include:

- Accurate Baseline Development – a modular and scalable system that simplifies calculations at facility and corporate levels and accounts for changing boundaries due to mergers, acquisitions and disposals
- Simplified Emissions Reporting – provides GHG and other emission factors that meet various public reporting requirements for direct and indirect emissions
- Expert Emissions Information Management – manages data in a secure and verifiable Web application that facilitates data entry, automatic calculation of derived data, and analysis of trends, efficiency and cost reduction opportunities

Users, including Johnson Controls, Inc. and its customers, can easily collect emissions data from multiple facilities worldwide and use the system to support sound decision-making.

the local level or they can lose some of their value if rolled- up [15] , e.g., water use in a water-stressed region on the world.

Metrics also need to be communicated in context, relative to:

- historical performance to demonstrate trends
- targets to demonstrate progress
- industry benchmarks to assess competitive standing
- similar organizational units (e.g., similar facilities in a corporation) to identify best practices
- other entities in the value chain to identify where to focus efforts

From the standpoint of visually depicting metrics so that they readily convey information, the use of charts and graphics can effectively reinforce the context and facilitate insights from the metrics. The case example by Johnson & Johnson (on page 50) demonstrates the use of a dashboard to drive actions and communicate progress towards EHS goals.

3M

Moving Toward Sustainability through Six Sigma

Six Sigma not only drives businesses process improvement, but helps move 3M further toward its vision of sustainability. In 2001, 3M embraced Six Sigma to help the company analyze and improve its critical business processes and, over the last few years, Six Sigma has become ingrained in all of 3M's business practices. In particular, it has become an important tool in helping 3M achieve its sustainability goals.

3M has a long-standing commitment to sustainable development through environmental protection, social responsibility and economic progress. More then 30 years ago, 3M's former Vice President of Environmental Engineering and Pollution Control, Dr. Joe Ling, created 3M's Pollution Prevention Pays or 3P program because he believed that, "pollution is waste, and waste today leads to shortages tomorrow." Dr. Ling knew then, what many companies are just beginning to embrace, that pollution prevention is more environmentally effective, technically sound and economical than conventional pollution control equipment.

Six Sigma is, essentially, a continuation of Dr. Ling's philosophy about reducing waste and inefficiency. At 3M, Six Sigma has proved that fundamental process change leads to higher quality output, increased productivity and energized employees. When coupled, pollution prevention and Six Sigma add up to big numbers in cost savings and environmental performance. Both programs strengthen 3M's core business processes and can promote the production of more products and services that use fewer resources and have less environmental impact.

In addition, Six Sigma is helping the company improve its social programs. In 2005, 3M implemented a Six Sigma project to analyze and improve its mechanisms for stakeholder engagement at its U.S. facilities. Six Sigma's tools to drive continuous improvement and better understand the customer, or in this case the stakeholder, were instrumental in allowing 3M to better a process for facilities to anticipate and respond to stakeholder concerns and establish a consistent, documented and proactive system to drive implementation.

Evaluation of Implementation & Communication-Worksheet 4b

The second column of Worksheet 4b (on page 40) provides a checklist of criteria to evaluate the metrics' effectiveness in implementation. In addition, one can revisit Table 2 (on page 35) and assess the effectiveness of metrics implementation and communication for each of the uses and users. Do the metrics support the intended use, and if they are meaningful and understandable to the user, given their perspectives and level of commitment.

If any of the criteria shown in Worksheet 4b cannot be confirmed in the implementation stage, refine the metrics procedure and guidelines or return to the metrics development process in Step 4 to redefine the metrics.

Misuses of Metrics

Metrics and targets can sometimes be used for purposes for which they are not intended. One common misuse is to hold people accountable for metrics not designed for accountability. For example, there is a potential to under report safety statistics if an organization focuses strictly on a reportable number. Metrics developed for internal learning, for instance, are often not appropriate for accountability. Similarly, stretch targets intended to drive innovation should not be associated with penalties for not meeting the targets.

Johnson & Johnson

Communicating Progress toward Goals

Johnson & Johnson recently marked the endpoint of its 2000-2005 Next Generation Goals – a set of management and environmental performance goals implemented across the company's diverse operations in 57 countries.

The Environmental Performance Dashboard (see Figure) was an important tool in communicating the performance goals to employees and managers. It is designed to provide insights on performance and can be used at multiple organizational levels: from a facility, business unit, region, to the worldwide corporation. Progress toward each goal category is displayed as green ('On-Target'), yellow ('Caution'), or red ('Needs Attention') (shown in the accompanying Figure as light, medium, and dark shades, respectively).

Performance is rated using both process metrics (e.g., best practice implementation) and outcome metrics (e.g., percent avoidance in packaging use). Composite indices were also used to combine multiple performance metrics and criteria into single scores. Thresholds were set for the different color-coded ratings. To allow effective roll-up, the criteria may vary from one organizational level to the next. For instance, for the Compliance/Risk Management category, a green On-Target rating for a facility requires ISO 14001 certification, along with a few other process requirements. At the business unit level, however, the same rating requires that a certain percentage of its facilities meet facility-level green rating.

The Environmental Performance Dashboards were posted prominently in all facilities and reviewed semi-annually by Johnson & Johnson's Worldwide Environmental Steering Committee chaired by one of its Vice Chairmen. Similar Dashboards will also be used to track and communicate progress toward the company's new Healthy Planet 2010 Goals.

Johnson & Johnson Environmental Performance Dashboard (Example)

Next Generation Goal	Progress	Reasons / Comments
Compliance / Risk Management		3 Noncompliance events
Mgt Systems / ISO 14001		ISO certified, MAARS rating = 2, MAP not reviewed and signed, 100% of MAP items on time, CCO plan ongoing & on schedule
New Product/Process Review		100% of New Products/Processes/Packaging reviewed using the DfE tool or equivalent.
External Manufacturing		76% EM with EHS contract language, 40% EM audits on schedule, 100% EM audited before use, 0 unacceptable EM, 0 Marginal EM
Energy Use		93% Enhanced Best Practices implemented
Water Use		81% Best practices implemented. Cumulative PBA = 7.15, Water Usage = 502,386 m^3, Avoided = 35,897 m^3
Raw Material Use		Total avoidance: 1,589,456 Total usage: 53,165,445 (PBA: 3.0)
Packaging Use		Packaging avoidance = 726,489 Packaging Use = 13,592,000 (5.4 PBA)
Waste Reduction (NPO)	1 2 3 4	1. Non-haz NPO avoided = 1,275,194 Total Non-haz NPO = 81,095,432 (1.57 PBA) 2. Haz NPO avoided = 14,146,302 Total Haz NPO = 109,443,578 (12.9 PBA) 3. Toxic NPO avoided = 1, 914,000 Total Toxic NPO = 32,403,396 (5.9 PBA) 4. Use of Preferred Waste Mgmt Method = 16% decrease from 2000

Metrics can also be effective for one use but not others. For example, some metrics that rely on forecasted data are effective for planning or engineering decision-making using forecasted data. However, to use them for day-to-day progress tracking may prove ineffective due to poor data quality and reliability. Also, exercise caution with metrics developed for external stakeholders. While transparency typically brings value to the organization, consider potential misuse or misinterpretation by third-parties, which can affect the company's competitiveness or security of its operations.

Retiring Metrics

A metric should be considered for retirement when it no longer serves its purpose. A metric may no longer satisfy the evaluation criteria used in Worksheet 4 due to various factors, including:

- successes - it is no longer meaningful in driving actions as the targets have been achieved; it is no longer transformative as the new behavior becomes the norm
- shortcomings - it results in unintended adverse actions and consequences; it requires greater resources and is less cost-effective than anticipated
- changes in the organization and/or external business environment - it is no longer relevant as the business objectives have changed

If any of these prove true, return to the beginning of the Strategic Metrics Development Process and define a new metric.

Achieving the target and other objectives associated with a metric, however, should not automatically lead to a metric's retirement. To assure continuous improvement and organizational integration, one should consider alternatives such as:

- updating the target
- continuing to monitor the metric
- refining the metric

For example, a metric on the total number of safety incidents may lose its effectiveness in driving improvements as an organization approaches the target of zero incidents. In fact, it may drive the wrong behavior, e.g., moving away from collaborating on solutions to simply blaming the unit where the incident occurred. This signals the need for new metrics. Retiring a metric, however, typically requires management and key stakeholder input, as well as replacement metrics and a transition plan. Metrics on the total number of incidents may be replaced by process metrics reflecting the causes behind the incidents, and thus provide more in-depth analysis. They serve as the new set of metrics on which the organization focuses.

Step 6
How to Assure Effectiveness

6. Evaluate Improvement and Integration

STEP 6
Expected Outcomes

- Assessment of how metrics are driving improvement and organizational alignment and creating business benefits

A focus group of employees from across functional areas is most likely to understand the direct and indirect, tangible and intangible values that are being, and can be, derived.

Step 6 is a critical assessment of the metrics, reflecting on the five previous steps of the tool. While there are vital connections between each of the earlier steps, nowhere will the linkages and the importance of cycling back between previous steps be more evident than in this final step. Here the focus is on how effectively the non-financial metrics:

- inform business decisions, promote learning and leadership and demonstrate the business case
- support the business strategy
- engage employees and external stakeholders
- respond to issues identified by stakeholders
- change the behavior and attitude change of individuals within the organization
- help integrate sustainability thinking into the organization's culture
- reflect business values and yield business benefits

Ultimately this analysis will determine the business value that has been achieved through the metrics development process.

Criteria for Measuring Success

The benefits provided by this tool can be evaluated by a few system metrics that address the following questions.

- Are the aspects, issues and metrics relevant to the business? Are they reflected in business objectives and strategies? Are they incorporated into the programs designed to address them? Is that relevance accepted by key employees? Do you have their buy-in?
- Are the metrics meaningful and useful? Do they support management decision-making? Do they meet the intended uses for the intended users? Do they produce meaningful results for the business?
- Are they transformative? Have they been integrated into the culture of the company? Have they changed mindsets, attitudes and behavior?
- Are they balanced in terms of interrelating environmental, social and economic issues and results? Do they link across functions and from strategy to operations?
- Are they valuable to the organization? Do the metrics drive the right performance and do they result in better business performance? Does this lead to greater business value, tangible and/or intangible?
- Have the metrics been misused or manipulated in unintended ways? Are the metrics accessible to those who intend to use them against the organization?

Determining the degree to which the metrics system meets the criteria (the third column of Worksheet 4b on page 40) should provide insights into where the system will need to be revised. It is the feedback loop to earlier steps and provides an opportunity to reflect on the process and rate the effectiveness of the process and its results.

Case examples by the Occidental Petroleum Corporation (on page 53) and Pfizer Inc. (on page 54) illustrate the evaluation of metric systems to assure their effectiveness and in developing the next generation of metrics.

Occidental Petroleum Corporation

Periodic Review of Metrics and the Management System

The environment, health and safety (EHS) management system of Occidental Petroleum relies upon the use of metrics to pursue continuous performance improvement. Along with ongoing quarterly and annual business unit (BU) reviews of performance, Occidental includes an assessment of metrics in its periodic management systems review, which is conducted at the direction of Occidental's EHS Committee of the Board of Directors.

Known as the Program Review, the evaluation provides an overall opinion about the ability of the BU's management team and system to achieve the performance goals specified in the corporation's EHS policy and procedures. It confirms that BU leaders are integrating EHS considerations into business planning and decision-making processes. Focusing on five key management dimensions – Leadership, Business Integration, Planning, Management Systems and Resources – the Program Review checks for conformance with EHS policy, assesses the impact of personnel changes and reorganizations, determines the status of prior Program Review issues and opportunities for improvement and identifies new opportunities for system enhancement.

The basic tenet of EHS leadership is that executive and line managers are the primary owners of the EHS program and are accountable for EHS compliance and continuous improvement. Year-over-year EHS performance relative to the metrics (lagging and leading) established by the BU provides a key benchmark for progress. Interviews of executive and line management, as well as members of various business unit staff departments, test personal understanding of and accountability for achieving goals. Metrics are also assessed for their relevance (Is there a connection to the goal?), effectiveness (Do they motivate performance?) and the degree to which they are embedded into core business processes. The review confirms that the measures being used contribute to organizational alignment and reinforce the roles of teams and individuals through established recognition and compensation systems.

At the conclusion of the review, the business unit CEO meets with Occidental's EHS Board Committee to discuss the results of the review, including important performance trends / issues and planned actions. Periodic follow-up of planned actions, as well as regular evaluation of performance against metrics and milestones serve to close the management systems loop.

EAG Perspective

How Can One Form an Effective 'Picture' for Different Users of Metrics?

A metrics program is effective when it is relevant to the decision-makers and can help them form an accurate picture of where the organization is and where it is heading. Online at **www.gemi.org/metricsnavigator**, Jim Ritchie-Dunham of the Institute of Strategic Clarity explores ways to communicate effectively with different groups of users, depending on whether they understand sustainability and whether they want to understand it.

Evaluating Effectiveness of the Process

There are numerous ways to evaluate effectiveness of the process:

- **Buy-in** – The process is only as good as the people who are involved, believe it to be, and are satisfied with the results. If there is limited or no buy-in from the stakeholders in the process and/or results, then revisit the metrics. If there is a high degree of buy-in but the results do not reflect it, look at the management system and metrics to determine where the problem lies. For example, stakeholder surveys that rate the effectiveness of the process and satisfaction that the results reflect stakeholder input can be considered.

Pfizer Inc

Evaluating Company-Wide Goals

Pfizer has established company-wide environment, health and safety (EHS) goals on climate change and energy, which are:

- To reduce CO2 emissions by 35 percent per million dollars of sales by 2007 from the baseline year 2000
- To meet 35 percent of its global electricity needs by 2010 through 'clean' energy sources, including co-generation, solar, and wind power

By 2006, Pfizer is close to achieving the 35 percent reduction target for CO2 emissions and is on track towards its clean energy goal. As it approaches the 2007 target year for CO2 emission reduction, Pfizer is evaluating its current goals and targets in preparation for developing the next set.

The company-wide climate change and energy goals were developed to capture existing interests and project ideas by Pfizer staff, reflect management's concern on risks and opportunities and meet external stakeholders' expectations. As a pharmaceutical company, Pfizer's carbon footprint is relatively small and energy remains a small fraction of the cost of goods sold. However, the goals are regarded as important in strengthening the company's reputation as an industry leader.

The goals have been effective in raising awareness on the issues and providing targets in developing improvement projects. Establishing corporate goals helped energy reduction and clean energy projects in competing for capital. While these projects are often disadvantaged due to low return on investment, employees and management have now learned that they involve very low risk and are worth doing.

In evaluating company-wide goals and targets, Pfizer is assessing metrics used for the targets, performance targets to set for the next generation's goals and other issues that may become material and require company-wide EHS goals. This includes revisiting the boundaries and denominators used in the present set of metrics and identifying other possible measures that can better capture what is material internally and externally.

- **Behavior change** – The degree to which the metrics and their underlying logic help inform a relevant, accurate and valuable picture for the employees is important in evaluating the success of the metrics program developed. Successfully informing, and therefore shifting attitudes, mindsets and behaviors from 'those who do not get sustainability and do not want to' to 'those who get sustainability and want to' is critical to the success of any metrics program. Further, assessing the understanding and commitment of both senior leaders and the entire organization is important to the success in building a sustainability culture and the measure of such a culture.

Therefore, periodically surveying the employees to assess how their attitudes and behaviors are changing to recognize the value of sustainability thinking is another way to assess the degree to which the metrics effort is driving change.

- **Organizational integration & change** – How well the issues, objectives and related metrics are integrated into the organization and drive organizational change is another category for evaluation. To assess the transformative nature of the metrics and the process behind them, consider the underlying attributes of a complex learning organization. Does the organization support and reward learning behavior? Does it have an innovation culture? Does it encourage cross-functional teaming and reward leadership in new areas? A self-assessment by employees which rates the company's attributes as a learning organization will shed some light on how well the organization can learn from embracing the challenges inherent in sustainability actions.

- **Metrics results** – The performance of the metrics is also important, although these results will take time to realize. Are the metrics driving the right performance of the system? What are the results relative to the targets? If the results are considered poor, ask: Are the targets reasonable? Are the metrics the right ones? Do they in fact support the uses for which they were developed? Are they being used by the intended parties? Does the management system support the achievement of those targets?
- **Business value** – Lastly, the metrics process and resulting metrics will only be useful if the effort has beneficial and valuable results for the business organization. In the final analysis, what benefits can be derived from an integration of these issues, objectives and metrics into the business? What is the value proposition? A focus group of employees from across functional areas is most likely to understand the direct and indirect, tangible and intangible, values that are being, and can be derived. These people should be asked what underlying value is achieved through adopting sustainability concepts and whether the metrics demonstrate this benefit. This evaluation is the most important, as it is all about people and how they recognize value.

Values that can be considered and perhaps ranked or rated include:

- o ability to assess impacts in terms of tangible and intangible business value
- o identification of cost-saving and revenue-generating opportunities
- o risk reduction
- o informed / improved decision-making
- o mutually beneficial relationships with external stakeholders
- o strengthened license to operate in the community
- o opportunity to build alliances with others (non-government organizations, government agencies, communities, other businesses)
- o entrance to, and expansion of, markets
- o enhanced reputation
- o enhanced ability to attract and retain top talent
- o ability to forecast issues
- o industry leadership and competitive advantage

In Conclusion

Regardless of how this tool is used, it should generate meaningful conclusions. The summary worksheet (on page 5) captures the few critical conclusions from each step and is a logical framework for communicating the 'what' and 'why' of metrics. It can be used to generate a summary for senior management which demonstrates the metrics development process and outcomes, including the business rationale.

This tool does not recommend specific metrics; rather, it provides a framework for identifying and managing environmental, social and economic issues, and a process for developing the critical few metrics which measure performance. The strength of the tool is that it offers a rigorous thought process. The greatest value is in how it helps individuals, groups or entire organizations think through the process - the logical flow of the six steps – with suggested methods to develop or augment in-house approaches. The principal benefit of using the tool is to advance business performance through the development and use of non-financial measurements.

EAG Perspective

What are the Characteristics of a Learning Organization?

A learning organization is one that is able to change its behaviors and mindsets as a result of experience. Such an organization allows individuals to thrive and engage in legitimate explorations of the space of possibilities and is able to adapt to external changes. A fuller description of the characteristics of a learning organization, as summarized by Eve Mittleton-Kelly of London School of Economics and the Society of Organizational Learning – UK, can be found online at **www.gemi.org/metricsnavigator**.

EAG Perspective

Do Your Metrics Drive Innovation?

The need for strategic metrics cannot be understated, for they ultimately help determine where investments are made and what the overall strategic direction of the firm is going to be in a very dynamic marketplace. Mark Milstein of Center for Sustainable Global Enterprise, challenges organizations to answer, "Do your metrics match your stated intentions to get beyond incremental innovation?" online at **www.gemi.org/metricsnavigator**.

Glossary

Glossary

Consequence Metrics – reflect the consequences or effects on the broader system of the intended outcomes.

Corporate Social Responsibility (CSR) – is a commitment to uphold human rights, behave according to accepted ethical standards and contribute to socio-economic development and quality of life. (16)

Incremental Targets – are set to achieve gradual change.

Intangibles – are non-monetary assets, including people, ideas, networks and processes, which are not traditionally accounted for on the balance sheet.

Key Performance Indicator (KPI) – is an indicator of performance toward a key objective(s), i.e., what to measure.

Lagging Metrics – is a measure which reflects past outcomes of performance.

Leading Metrics – is a predictive measure of anticipated performance that can be observed prior to the period of performance.

Materiality – is defined as the relevance and substantiality of an issue to the organization.

Metric – is a quantitative measure, i.e., what to measure. While KPIs are strategic metrics that must be tied to a key objective and a target, a metric is a number which is given meaning in the context of the KPI.

Outcome Metrics – are measurements of results.

Process Metrics – measure the actions or processes that drive the intended outcomes, i.e., the causes, and are usually tied to the action plans put in place to achieve targets.

Specificity – refers to the lowest level of the organization to which the metric is reported.

Stretch Targets – are more revolutionary targets. A stretch target is set with less understanding of how it will be met.

Targets – are quantifiable performance goals that are relevant to the organization's objectives and derived from its KPI's. A target is expressed as a tangible measurable objective, against which actual achievement can be compared. (17)

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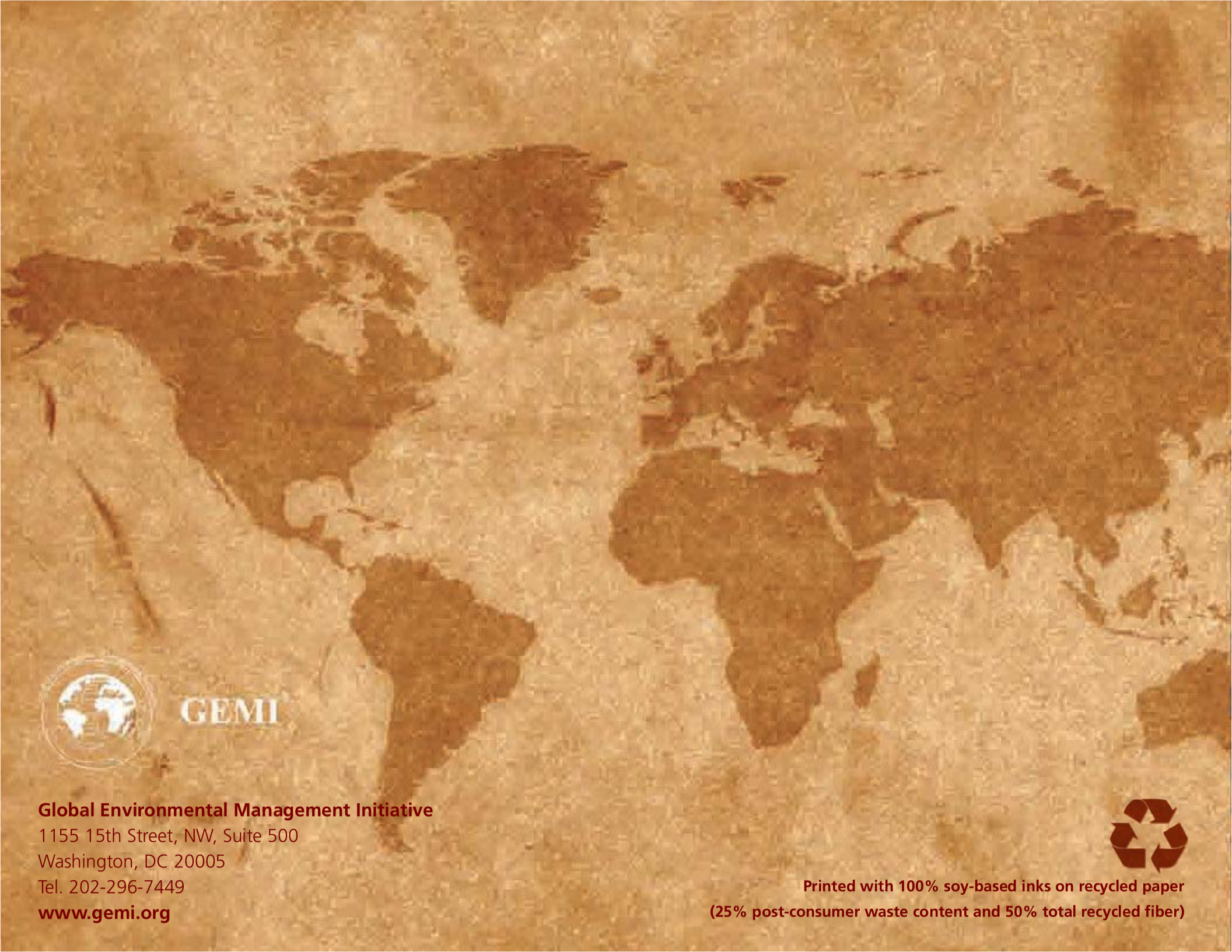

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"To be globally recognized as a leader in providing strategies for businesses to achieve EHS excellence, economic success, and corporate citizenship."

Mission:

"Business helping business improve EHS performance, shareholder value, and corporate citizenship."

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What Does GEMI Do?

- Help senior-level EHS practitioners become more globally effective & relevant in their business by focusing on:
  - Achieving & maintaining EHS excellence
  - Integrating EHS with broader corporate agendas
  - Driving business value (i.e., the value EHS brings to the 'business of the business')
- Provide programs to help members learn from one another & from EHS/CSR thought leaders across diverse business sectors
  - Formats include: meetings, focused dialogues, networking, Webinars, benchmarking, tools, reports & other work products

Governance

- **Senior Advisory Council**
  - Comprised of member companies' Vice Presidents (or most senior EHS representative); meet annually
  - Sets vision and assists in developing future project topics & activities
- **Board of Directors**
  - Comprised of member company employees; elected annually
  - Develop strategic plan, provide fiduciary responsibility & assist with daily operations of the organization
- **Chairpersons**
  - **Work Groups**: develop focused tools (from concept to finished product) with designated resources
  - **Networks:** conduct ongoing discussions on member-driven topics; may serve as prelude or postscript to a Work Group
  - **Committees**: work on procedural, administrative or strategic issues as directed by the Board

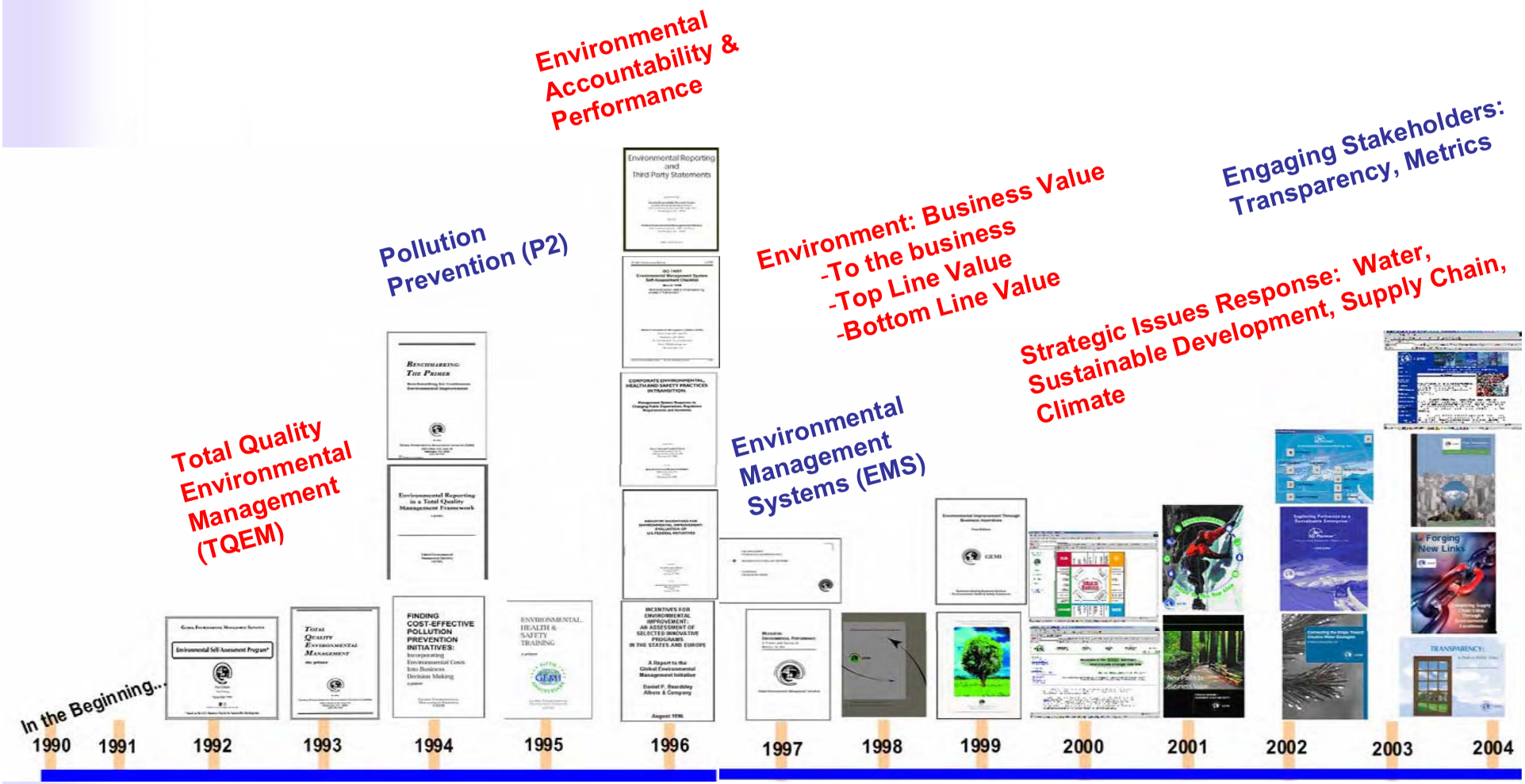
Value of GEMI

- **Fills a Unique Niche**
  - Develops useful business tools to respond effectively to current & emerging issues
  - Provides multi-sector approach for common, strategic business issues
  - Promotes sharing of 'best practices' across diverse industry sectors
  - Focuses on effective process self-assessment tools *(Note: does **NOT** promote a "one-size-fits-all" approach to managing EHS & CSR issues)*
- **Leveraged Resources**
  - Any single tool or benchmark survey cost exceeds annual membership dues
  - Invaluable intellectual capital of participants is shared *(Note: antitrust guidelines to keep discussions focused appropriately)*

Value of GEMI (cont'd)

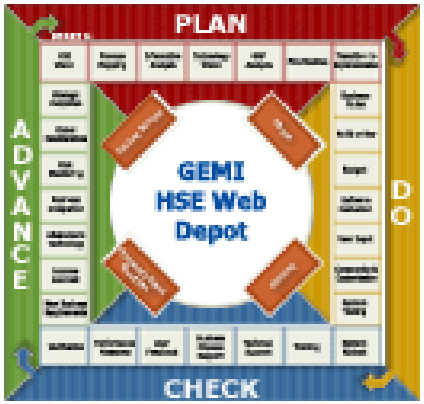
- **Recognition & Exposure**
  - Globally recognized as a credible association of leading companies & EHS/CSR practitioners
  - Member company case examples highlighted in all publications
  - Opportunity to engage with respected national & international organizations to improve the environment *(provides a 'safe space' for engagement)*
- **Member-Driven Activities**
  - Provides tangible, actionable ideas and tools that can be implemented at home
  - Membership has significant input on the topics addressed
  - Opportunity for individual leadership development exists

GEMI® *A Legacy of Value-Driven, Integrated Tools*



Recent Tools

www.gemi.org/waterplanner



www.gemi.org/*hsewebdepot*

www.gemi.org/*businessandclimate*

www.gemi.org/metricsnavigator

www.gemi.org/sd

"Map of Future Forces Affecting Sustainability"

Innovations in 2008: New Tools

- **Launch of new tools:**
  - GEMI-Environmental Defense ***'Guide to Successful Corporate/NGO Partnerships'*** ***(Target release: Summer)***
  - The Institute for the Future's ***"Map of Future Forces Affecting Sustainability"*** ***(Target release: Summer)***

- **Launch updated web sites:**
  - **GEMI.org** ***(Released March 2008)***
  - **HSEWebDepot.org** ***(Released March 2008)***
  - **BusinessandClimate.org** (***Released January 2008)***

Signature Issues

- **Water Sustainability**
  - Facilitate process for developing corporate and localized water use strategies, including sharing best practices and experiences
- **Global Climate & Energy**
  - Providing tips and tools to help integrate climate & energy issues into EHS/CSR efforts worldwide
- **Supply Chain**
  - Focus on implementing targeted EHS-related changes across the value chain that reinforce brand equities upon which the brand has been established
- **Emerging Issues**
  - Share ideas, tools and techniques for anticipating, identifying, understanding & managing emerging issues

Innovations in 2008: GEMI Forum

Each GEMI Forum Day has a different topic, aligned with the emerging GEMI strategy:

1. EHS excellence
2. Integrating with the broader corporate agenda (product, services, non-EHS aspects of sustainability, etc.) and with the relevant parts of company organization
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BusinessWeek
IN Focus September 11, 2008

Can America Invent Its Way Back?

"Innovation economics" shows how smart ideas can turn into jobs and growth—and keep the U.S. competitive

by Michael Mandel

Will 2009 be the year of innovation economics?

Pessimism about America's future is growing. People worry about the long-term impact of the housing crisis, global competition, and expensive energy. And the policy solutions offered by Republicans and Democrats—mainly tax cuts and government spending programs—seem insufficient.

Yet beneath the gloom, economists and business leaders across the political spectrum are slowly coming to an agreement: Innovation is the best—and maybe the only—way the U.S. can get out of its economic hole. New products, services, and ways of doing business can create enough growth to enable Americans to prosper over the long run.

Certainly the Presidential candidates are taking the idea seriously. John McCain has proposed a $300 million prize for the person or company that creates a better battery technology to power cars. Barack Obama has called for spending $150 billion over the next 10 years on clean-energy technologies. The hoped-for outcome: more jobs, more competitive trade, less dependence on foreign oil.

But here's the conundrum: If money alone were enough to guarantee successful innovation, the U.S. would be in much better shape than it is today. Since 2000, the nation's public and private sectors have poured almost $5 trillion into research and development and higher education, the key contributors to innovation. Nevertheless, employment in most technologically advanced industries has stagnated or even fallen. The number of domestic jobs in the computer and electronics sector continues to plunge while pharmaceutical and biotech companies lay off as many workers as they hire. And even the industry category that includes Google (GOOG)—Internet publishing and Web search portals—has added only 15,000 jobs since 2003.

The new field of innovation economics addresses this gap between spending and results. Economists are increasingly studying what drives successful innovation to learn how companies can get more bang from the bucks spent on R&D and higher education. At the same time, they're collecting new data on American R&D initiatives to understand what's working in the U.S. and what's not. And most important, economists are making concrete proposals about how to turn smart ideas into jobs and growth.

DISAPPOINTING BIOTECH AND NANOTECH

This focus on innovation as a crucial way to develop a competitive edge is a big change from the past. While a handful of economists have studied technological change, the main focus of policy-minded economists has, until recently, been on traditional topics such as taxes, government spending, and trade.

Now some of the brightest minds in the field, including Daron Acemoglu of Massachusetts Institute of Technology, winner of the 2005 John Bates Clark Medal for the top economist under 40, are paying a lot more attention. His work examines how government and business decisions such as outsourcing can influence the direction of technological change.

But theorizing isn't enough without good data. That's why government statisticians such as Lynda Carlson of the National Science Foundation are trying to find new ways to quantify innovation and its impacts on business. In January the NSF will launch an annual survey of 40,000 companies asking how much they spend on R&D in the U.S. and overseas, by type of business and country. "For the first time, we'll have a clear picture of what kind of research companies are doing globally and what benefits they are getting from their spending," says Carlson, who is spearheading the survey.

Economists are also suggesting how to use new tools to boost innovation. They're studying when prizes for technological advances make sense. They're proposing ways state and local governments can best encourage innovation-based economic development. And they're exploring how to make optimal use of the billions of dollars' worth of research conducted in government-funded national labs.

It's possible the longstanding partisan debate over tax rates and budget deficits may soon become a sideshow. "The main purpose of economic policy should be to spur innovation and growth," argues economist Robert Atkinson, head of the Information Technology & Innovation Foundation (ITIF), a nonpartisan think tank in Washington. "This is not an issue either party owns."

Historically, technological change has been the biggest force for productivity growth in the U.S. The latest figures show that "multifactor productivity"—a category that includes technological change and other improvements in business processes—accounted for 45% of productivity gains between 1987 and 2007. "Ninety-five percent of economists agree that innovation is the most important thing for long-run growth," says Acemoglu of MIT.

What's more, the best way to keep the U.S. competitive is to bank on promising new ideas. America still is a leader in resources devoted to innovation, as measured by the share of gross domestic product spent on R&D and higher education. But it can't compete with China, India, and other developing countries on labor costs. And it's unlikely the U.S. can depend on cheap capital because it borrows so much money from overseas. Indeed, personal, corporate, and government savings combined total only 14% of GDP in the U.S., vs. an average 22% among other industrialized nations.

But innovation has fallen short of its promise in recent years. While some info tech corporations are still thriving, other sectors that were supposed to drive growth have faltered.

Biotech companies have produced new drugs, but so far no real breakthroughs. And nanotechnology has been slow to generate commercial products.

Worse, the historic link between jobs and innovation seems to have vanished, at least for now. In the past, pioneering industries such as automobile manufacturing and aerospace were big job creators. Today, jobs in cutting-edge sectors are down 12% since their 2001 peak. (Those industries include computer and communications hardware, software and computer-systems design, aircraft, drugs and medical devices, telecom, and Internet outfits such as Google and Yahoo! (YHOO))

Until recently, economists had few good remedies when innovation stopped producing enough tangible benefits. Thats because technological progress—the discovery of penicillin or the invention of the laser—was viewed mainly as the product of science and serendipity, and therefore not very responsive to economic forces.

As a result, economists had only one blunt tool for stimulating innovation: larger government research grants and tax breaks for businesses. Economists for the most part treated R&D spending as an investment in a physical asset, just like an office building or truck.

DO PRIZES WORK?

But there were always some who saw beyond this narrow view. In the 1940s, Joseph Schumpeter of Harvard University coined the phrase creative destruction to describe the necessary turmoil caused by innovation. Robert Solow of MIT won a Nobel Prize for economics for his work on technological progress and growth. And Dale Jorgenson of Harvard and William Baumol of New York University have been mentioned as potential Nobel laureates for their work in areas such as technological change and entrepreneurship.

Economists began taking a broader interest in innovation during the New Economy boom of the 1990s, which was driven by breakthroughs in information technology. At the same time, economist Paul Romer, now at Stanford University, showed how spending on innovation was different from the usual sort of capital investment because the gains from new ideas and discoveries could be shared by everyone.

Today, researchers are focusing on ways to make those undertakings more efficient. "Innovation is not just exerting effort and spending money, it's problem-solving," says Karim Lakhani, a professor at Harvard Business School. Lakhani has been studying what is called distributed innovation, in which solutions to a business or technical problem are solicited from a wide variety of people. Open-source software or companies like InnoCentive, which encourages outside researchers to work on corporate problems, are good examples. By contrast, most companies are unwilling to draw on outside expertise. "It's the broadcast of the problem that is important," argues Lakhani. "By publicizing a problem, we can get access to better ideas."

Lakhani is encouraged by the growing number of prizes for innovative products, such as the Progressive Automotive X prize ($10 million for a car that gets 100 mpg). However, offering more—and smaller—prizes would allow a wider range of people to take on a challenge, he argues. "We want diversity of eyeballs."

One way to attract broader attention to a problem is to conduct more R&D overseas. In part, that's because scientists and engineers in India, China, and Eastern Europe are cheaper than their American counterparts. In addition, global collaboration can improve results by bringing in more diverse perspectives.

But globalizing research and production can also alter the direction of technological change—with potentially negative effects on U.S. prosperity. MIT's Acemoglu, who holds dual American and Turkish citizenship, argues in his work that in the past U.S. companies directed their research to take advantage of the well-educated American workforce. Now, as more multinationals move operations overseas, they are developing technologies adapted for their less skilled foreign workforces. In other words, offshoring is affecting the direction of innovation in ways that are more favorable to countries such as China and India. In particular, says Acemoglu, "China is going to have a major effect on technology."

Measuring the impact of outsourcing and other factors on innovation will require far better statistics than are now available. That's why the NSF is pushing hard to collect greatly improved data on R&D and innovation, a tough task. Its new study aims to provide useful information for both businesses and policymakers, says Carlson, who helped create the government's statistics on energy consumption before she joined NSF in 2000. The survey will ask a wide range of questions, including whether companies are using their research to create new products or simply to improve existing ones. "The new statistics will provide benchmarks for companies," says Carlson, "and allow them to see how their R&D and innovation performance compares to the rest of their industry."

Even as better data are collected, the government is also upgrading the system of economic statistics it uses to produce GDP figures. The goal: to shed more light on innovation and other drivers of growth. Late this year, the Bureau of Economic Analysis plans to publish a "blueprint for innovation" showing how the government stats can better capture innovation-related expenses such as education and R&D, says BEA director J. Steve Landefeld.

ACADEMIC AND CORPORATE ALLIANCES

What kinds of policies can improve the performance of U.S. innovation? Since 2000, the Bush Administration has boosted spending on nondefense R&D by roughly 40%, after adjusting for inflation. Still, more could be done. Democrat Obama wants to double federal funding for basic research, which in real terms is up just about 20% since 2000. Both the GOPs McCain and Obama want to boost support for the development of less polluting technologies.

But a big point of innovation economics is that money alone is not enough. Atkinson, of the think tank ITIF, argues that the R&D tax credit needs to be reworked to encourage collaboration. He suggests giving companies credit on their tax returns for 40% of the money they spend on research partnerships with universities and government laboratories, not just for their increased spending, as the current law allows.

Atkinson also advocates creating a national foundation, similar to the NSF, with the mission of promoting innovation. The idea has some support: In June, Senators Hillary Clinton (D-

N.Y.) and Susan Collins (R-Maine) introduced legislation to set up a National Innovation Council.

One of the hottest areas in the field is the use of government aid to cultivate "innovation clusters," or collections of local companies and academic institutions working together to create new products and processes. Ideally, those alliances would build on existing expertise in a region.

Last November, for example, Maine voters passed a $50 million bond issue to help finance groundbreaking local business initiatives. In early August, grants totalling $29 million were announced, including funds to renovate a commercial pulp mill by adding a pilot plant to produce ethanol—without reducing the mill's usual output.

Will innovation economics keep America growing? Proponents are upbeat about the long-term technological possibilities, despite the current pullback. "Like the 1970s, people are going to assume that a short-term slowdown means the trend is slower as well," says Stanford's Romer. "But the arguments for long-run optimism are as strong as they have ever been."

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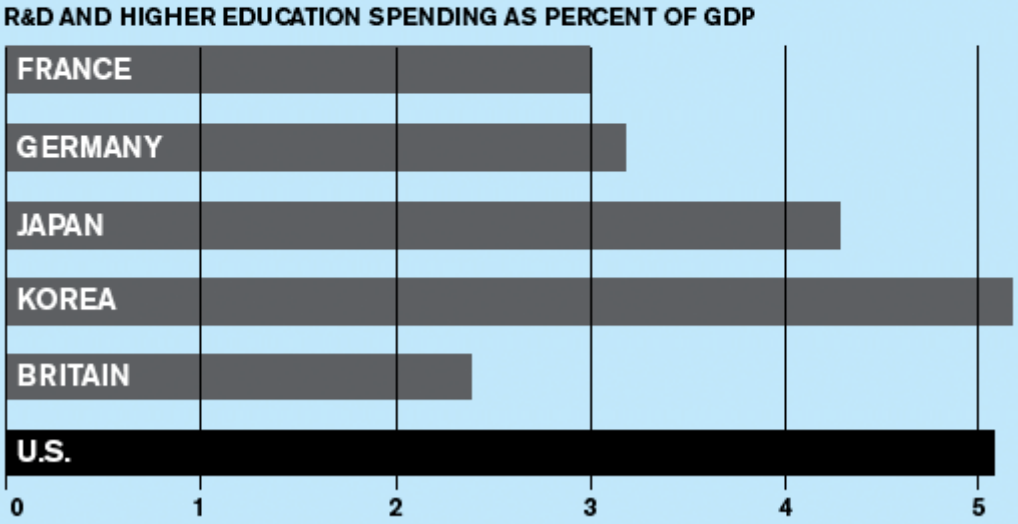
Race You to the Moon

Hoping to kick-start a new era of privately funded space exploration, the X Prize Foundation teamed up with Google year to announce the Google Lunar X Prize. The partners award $20 million to the first team that lands a robot explorer the moon and beams back pictures and video. (NASA and government-run space programs need not apply.) Speaking from Google's Mountain View (Calif.) headquarters on Sep. 19, 2007, Peter H. Diamandis, CEO of the X Prize Foundation, described his organization's role in spurring innovation in such things as genomics, superefficient cars, and spaceships.

BusinessWeek

AMERICA OUTSPENDS IN R&D AND HIGHER EDUCATION...

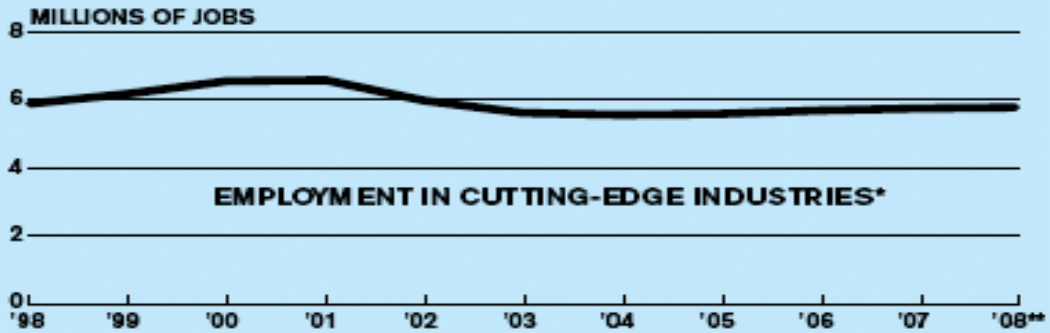
The U.S. spends heavily on research and development and higher education



Data: Organization of Economic Co-operation & Development

...BUT THE PAYOFF ISN'T CLEAR

Jobs in innovative industries have stagnated



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**12-MONTH AVERAGE ENDING JUNE 2008

Data: Bureau of Labor Statistics, *BusinessWeek*

BusinessWeek
IN Technology September 11, 2008

Los Alamos and Sandia: R&D Treasures

How the famous weapons labs, Los Alamos and Sandia, are aiding corporations and spinning off startups

by Pete Engardio

For decades, Procter & Gamble (PG) has been creating petroleum-derived materials that are engineering marvels. Tide bottles that don't explode if dropped from a high shelf onto a Wal-Mart (WMT) floor. Shampoo emulsions that don't separate, whether they're shipped by plane at 30,000 feet or warehoused at temperatures of 120F. Billions of disposable diapers that absorb, breathe, and stretch exactly the same way—wrapped in packages that never fade.

Now P&G is joining the "go green" bandwagon. The problem, says Thomas J. Lange, the company's director of modeling and simulation: "Natural materials may not be as pure, as strong, or as stable over time" as petro-plastics. And developing replacements for them takes deep science that is beyond the ken of most companies.

Enter Los Alamos National Laboratory and Sandia National Laboratories. That's right, the fabled weapons-research centers in New Mexico that spawned America's nuclear arsenal. In a partnership that has lasted 14 years, P&G is tapping the labs' supercomputers and immense brain trusts to create new eco-friendly materials for consumer products. "These are the only places I can go in the world that have such a range of world-class physicists, chemists, biologists, production engineers, and computational scientists," says Lange. "These labs are national treasures."

Public-private collaborations such as P&G's are earning praise in many quarters. They're just what Congress had in mind two decades ago when it began pushing the nation's hundreds of national labs to transfer more of their knowhow to U.S. companies. Many of the facilities, which are dedicated to security, space, health, and energy research, jumped at the challenge. For one, they were eager to earn contract-research fees from corporations. And it was a chance to test their world-beating computer systems and software in some of the most demanding business settings.

After a burst of deals in the late 1990s, however, the number of new research collaborations and commercial spin-offs declined. Scientists say the joint ventures and startups suffered from too much red tape. They also faced a drop in federal subsidies, the bursting of the tech bubble, and the task of coaxing scientists to think in business terms.

"Without market signals, the labs have shown a predictable capacity to be overtaken by bureaucracy," says Carl J. Schramm, president of the Ewing Marion Kauffman Foundation, which focuses on entrepreneurship. The casualties, Schramm says, are "speed, effectiveness, and inventiveness."

Now, as the idea of "innovation economics" gains currency in Washington, executives are once again turning to the national labs, especially those such as Sandia, Los Alamos, Lawrence Livermore, and others that belong to the Energy Dept. These centers are still committed to national security. But at a time when U.S. industries are under pressure to address America's energy crisis while facing ever-tougher competition abroad, the labs understand they have an important role to play.

Companies, for their part, know they can save on research costs when they partner with the labs. Together, Sandia and Los Alamos employ about 4,000 PhD scientists and thousands of engineers, and they have a long legacy of innovation in everything from biofuels and microelectronics to medical devices. P&G's collaboration with Los Alamos in computer simulation has saved the company upwards of $1 billion. Goodyear Tire & Rubber (GT) says Sandia helped radically speed up product launches, a key to its recent financial turnaround.

The labs aren't simply collaborating. They're spinning off new tech companies amid the mesas and deserts of New Mexico. An industrial park on 240 acres abutting Sandia's sprawling Albuquerque compound boasts 27 startups that employ 2,184 people and have attracted $234 million in investment capital. All of these companies were founded by former Sandia scientists or rely on technology licensed from the lab. Los Alamos has helped spawn 54 spin-offs since 1997. A recent one, APJeT, is trying to commercialize an ionized gas known as atmospheric plasma, which was first developed by Los Alamos to kill anthrax spores. The company now uses the process to make fabrics water-resistant. Another of Los Alamos' affiliate, CNT Technologies of Seattle, is turning tiny carbon nanotubes into strong yarns that can be woven into sporting goods, aircraft parts, and artificial limbs.

Goodyear and Sandia have been working together since 1993, when the Akron company enlisted the lab to help design and test new car tires. At the time, the company was running through at least four physical prototypes for each model of tire, which then would have to be tested over thousands of miles—a process that took three years on average. In exchange for fees that can run several million dollars a year, Sandia gave Goodyear access to supercomputers and software code it had developed to simulate explosions, design weapons systems components, or model the stresses on a bridge. Over the next decade more than a dozen Sandia scientists worked on software to assist Goodyear engineers. The code helped them to accurately predict how each design tweak would affect traction, pressure, and rubber wear under a range of road conditions and speeds. "It all adds up to a fairly nasty problem you have to solve," says Benjamin Spencer, a Sandia software developer who works with Goodyear. But there's a side benefit, Spencer says: The collaboration is "making our code more robust."

The Goodyear project culminated in the Assurance TripleTred, which launched in 2005. It's a tire with three different treads for driving on icy, wet, and dry pavement. The program also enabled Goodyear designers to make use of such materials as volcanic pumice and glass microfibers, which aid the tire in gripping slick surfaces. The Assurance became one of Goodyear's best-selling tires, and the company has adopted virtual design for each of the several hundred new tires it develops every year for vehicles ranging from sports cars to garbage trucks to earth movers. The development cycle, which now often requires just a single prototype, has shrunk to as little as eight months, says Surendra Chawla, Goodyear's head of commercial tire research. The portion of the company's annual R&D budget consumed by testing and building molds for tire manufacturing has dropped from 40% to 15% since 2001, he says.

Despite the obvious benefits that have flowed to Goodyear and P&G, however, only a handful of corporations have forged this sort of long-term collaboration. Companies complain that it takes too long—up to a year—to negotiate a joint R&D project or license technology from a federal lab. Officials at the labs have their own complaints: They say U.S. companies mainly want off-the-shelf technology they can use immediately, as opposed to investing in research that won't pay off for three to five years.

Bureaucracy also is slowing the spin-off of startups. Unlike at universities, scientists at federal labs are barred from serving as paid consultants. And as long as they're on the government payroll, they can't hold equity stakes in companies that license their research. Moreover, few hard-core scientists want to trade secure posts at premier labs for risky jobs in industry. This is a stark contrast to Silicon Valley, where "people are spring-loaded to leave and begin their next startup," says Gary Ebersole, a serial entrepreneur from the San Francisco Bay area who moved to Santa Fe and licensed software from Los Alamos to start a social networking company.

The National Labs want to lower the hurdles to entrepreneurship. They're offering staff two-year "entrepreneurial leaves" to give them a taste of life outside. They also understand that Congress wants to see scientists and their spin-offs succeed. So Los Alamos set up a fund that doles out $350,000 a year in seed capital to startups. Both Sandia and Los Alamos are experimenting with ways to let departing scientists maintain access to their facilities while working at startups. They even offer courses to familiarize their staff with entrepreneurship. "We don't yet have a model that is tuned to the nation's needs," says Sandia Chief Technology Officer Richard H. Stulen. "But we're getting better."

PRESIDENTIAL ADDRESS

Science and Technology for Sustainable Well-Being

John P. Holdren

The American Association for the Advancement of Science (AAAS) is not about the advancement of science just for science's sake. Rather, as indicated by the Association's motto, "Advancing Science, Serving Society," it is about advancing science in the context of a desire to improve the human condition. This mission necessarily entails attention to the social as well as natural sciences; attention to the embodiment of science in technology through engineering; and attention to the processes by which understandings from the natural sciences, the social sciences, and engineering influence—or fail to influence—public policy. All of these long-standing preoccupations of the AAAS are integral to the theme of the 2007 Annual Meeting and of this essay, "Science and Technology for Sustainable Well-Being."

I begin my exploration of that theme with some premises and definitions relating to well-being and sustainability, before turning to a taxonomy of shortfalls in sustainable well-being and a rough quantification of those that are reflected in morbidity and mortality. I then address the status of five specific challenges in which science and technology (S&T) have particularly important roles to play: meeting the basic needs of the poor; managing the competition for the land, water, and terrestrial biota of the planet; maintaining the integrity of the oceans; mastering the energy-economy-environment dilemma; and moving toward a nuclear weapon–free world. I close with some thoughts on what more is needed in order to improve the pace of progress, including what the AAAS is doing and can do and what individual scientists and engineers can do.

Well-Being and Sustainability

Human well-being rests on a foundation of three pillars, the preservation and enhancement of all three of which constitute the core responsibilities of society:

•*Economic conditions and processes*, such as production, employment, income, wealth, markets, trade, and the technologies that facilitate all of these;

•*Sociopolitical conditions and processes*, such as national and personal security, liberty, justice, the rule of law, education, health care, the pursuit of science and the arts, and other aspects of civil society and culture; and

•*Environmental conditions and processes*, including our planet's air, water, soils, mineral resources, biota, and climate, and all of the natural and anthropogenic processes that affect them.

Arguments about which of the three pillars is "most important" are pointless, in part because each of the three is indispensable: Just as a three-legged stool falls down if any leg fails, so is human well-being dependent on the integrity of all three pillars.

The futility of attempts to strengthen any one of the pillars in ways that dangerously weaken one or both of the others is underlined by their interdependence. The economic system cannot function without inputs from the environmental system, nor can it function without elements of societal stability and order provided by the sociopolitical system. And societal stability itself cannot be maintained in the face of environmental disaster, as the effect of Hurricane Katrina on New Orleans demonstrated is true even in the most economically prosperous and technologically capable country in the world.

This understanding about the elements of well-being leads, when combined with the proposition that improvements in well-being are most meaningful if they can be sustained, to a set of definitions that embody the essence of the sustainable-well-being challenge (*1*):

•*Development* means improving the human condition in all of its aspects, not only economic but also sociopolitical and environmental;

•*Sustainable development* means doing so by means and to end points that are consistent with maintaining the improved conditions indefinitely; and

•*Sustainable well-being*, in my lexicon, entails pursuing sustainable development to achieve well-being where it is now most conspicuously absent, as well as converting to a sustainable basis the maintenance and expansion of well-being where it already exists but is being provided by unsustainable means.

Shortfalls

Persistent shortfalls in the pursuit of sustainable well-being are evident across a range of dimensions of the human condition, including (*2*):

•*Poverty*, afflicting not only the 2.5 billion people in the poorest countries who live on less than the equivalent of $2 per day, but also hundreds of millions in addition who have much more but still cannot afford many of the ingredients of a decent existence in the more prosperous settings in which they live;

•*Preventable disease*, which keeps infant and child mortality high and life expectancy low, especially in Africa but among the very poor everywhere;

•*Impoverishment of the environment*, meaning progressive erosion of the environmental underpinnings of well-being in the qualities of air, water, soil, biota, and climate;

•*Pervasiveness of organized violence*, manifested in the well over 100 instances of armed conflict since World War II (nearly all of them in the South, with a total loss of life in the tens of millions), as well as in the global rise of terrorism;

•*Oppression of human rights* in other ways (for the preceding items are also forms of such oppression), denying human beings their dignity, their liberty, their personal security, and their possibilities for shaping their own destinies; and

•*Wastage of human potential*, resulting from all of the foregoing and the despair and apathy that accompany them, from shortfalls in education, and from the loss of cultural diversity.

Underlying these shortfalls is an array of driving forces and aggravating factors, among them:

•*Non-use, ineffective use, and misuse of S&T*, including misuses both intentional (as in the development and deployment of weapons of mass destruction) and inadvertent (as manifested in the side effects of broad-spectrum herbicides, pesticides, and antibiotics);

•*Maldistribution of consumption and investment*, where the maldistribution is of three kinds: between rich and poor as the beneficiaries of both consumption and investment; between military and civilian forms of consumption and investment ["too much for warfare, too little for welfare" (*3*)]; and between the two activities themselves; i.e., between too

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much consumption and too little investment;

•*Incompetence, mismanagement, and corruption*, which although sometimes attributed to developing countries particularly are in fact pervasive in industrialized and developing countries alike;

•*Continuing population growth*, which, while not the sole cause of any of the shortfalls listed, makes the remedy of all of them more difficult (*4*); and

•*Ignorance, apathy, and denial*, the first consisting of lack of exposure to information and the second and third of having the information but lacking the conviction or optimism or understanding to act on it.

The magnitudes of the contributions to premature mortality of a number of the shortfalls and their respective contributing factors are shown in Table 1, which is adapted from a remarkable compilation of the underlying causes of premature death produced by the World Health Organization (WHO) (*5*–*7*).

How Can S&T Help?

Table 1 underlines the role, in global mortality, of shortfalls in the deployment if not always the development of adequate technologies for food production, clean water and sanitation, and clean and efficient energy supply. I would characterize the roles of S&T in addressing the challenges of sustainable well-being in broader terms as follows:

•Advances in science improve our understanding of shortfalls, dangers, and possibilities and enable advances in technology.

•Advances in technology help meet basic human needs and drive economic growth through increased productivity, reduced costs, reduced resource use and environmental impact, and new or improved products and services.

•S&T together provide the basis for integrated assessment of challenges and opportunities, advice to decision-makers and the public about these, and formal and informal education toward a more S&T-literate (and therefore more informed and capable) society.

The need to do better with S&T applied to the goal of sustainable well-being is particularly compelling in relation to the five specific challenges mentioned above, and I turn to these now.

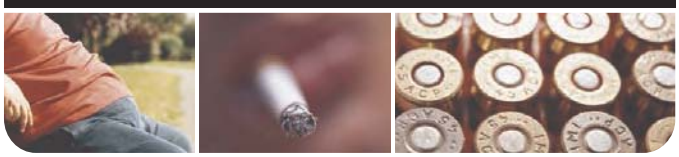
Meeting the Basic Needs of the Poor

The contemporary effort to address this most fundamental of sustainable-development needs is cataloged and chronicled in the Millennium Development Goals (MDG) project of the United Nations (UN). The MDGs, consisting of eight overarching goals and specific targets for the pace of progress to be made on them, were officially adopted in 2000. The goals, targets, and some indicators of the extent of progress on them are summarized in Table 2. The MDG picture is clearly mixed. Many regions are on track to meet many of the targets, but other regions—and above all sub-Saharan Africa—are projected to fall short on most of them. What is worse, while the MDGs appear ambitious in terms of the pace of improvement embodied in the targets, they are really very modest when viewed in terms of the immense shortfalls in well-being that would persist into 2015 and beyond even if the targets were met. Where the targets do seem likely to be met for the world as a whole, moreover, as is the case for access to safe drinking water, regional shortfalls still loom large (*8*).

The considerable progress that has been made in some important respects (such as in life expectancy, which has been improving virtually everywhere other than sub-Saharan Africa and the former Soviet Union) has been the result of a combination of economic and social factors, but improvements in technology appear to have been the most important (*9*). Among other advances, widespread gains in the productivity of agriculture, which played a crucial role in improving nutrition and health in the developing world, were driven above all by investments in agricultural S&T that yielded, in strictly economic terms, enormous rates of return; and export-led economic growth, providing the means with which the public and private sectors in many developing countries have contributed to lifting portions of their populations out of poverty, has likewise been driven strongly by technology (*9*).

Relatively simple and inexpensive technologies can have large positive impacts on the most fundamental aspects of well-being, such as public health, as was initially demonstrated in today's industrialized countries when they first introduced simple water-treatment technologies (*8*) and has been shown more recently in developing countries with such simple innovations as oral rehydration therapy for diarrheal diseases, which has sharply lowered death rates even in circumstances where incomes were not rising (*9*). A current example of large "bang for the buck" in the public health domain is the rapid expansion in the use of insecticide-treated bed nets to combat malaria, particularly in Africa, funded by a combination of private, governmental, and multilateral initiatives (*10*).

These insights and examples only serve to underline how much better we could be doing with the application of S&T to meeting basic



1 CONTRIBUTORS TO GLOBAL MORTALITY IN 2000

Fundamental cause	Primary shortfalls and drivers	Millions of years of life lost
Childhood and maternal malnutrition	Poverty, technology, apathy	200
High blood pressure, cholesterol, overweight, low physical activity	Consumption, denial	150
Unsafe sex	Ignorance, denial	80
Tobacco	Denial	50
Unsafe water	Poverty, technology, apathy	50
War and revolution (20th-century average)	Violence	40
Indoor smoke from solid fuels	Poverty. technology	35
Alcohol	Wasted potential, ignorance, denial	30
Urban air pollution	Consumption, technology	6
Global climate change	Consumption, technology, denial	5

Table 1. Contributors to global mortality in 2000, categorized by fundamental causes. Units in column three are millions of years of life lost to premature deaths in the year 2000 (= numbers of premature deaths in 2000 from the indicated cause × average loss of life expectancy per death from that cause). The categorization of fundamental causes and associated lost-life estimates are from WHO (*5*), except for "war and revolution"; that figure is the author's estimate for the 20th-century annual average, based on a UN figure of about 100 million conflict-related deaths in the 20th century (*6*) and the author's guess of 40 years of lost life expectancy per conflict-related death. Attributions of relevant "shortfalls and drivers" are the author's (*7*).

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human needs if a more respectable effort were being devoted to this aim. The dimension of the shortfall is suggested by the figures for official development assistance (ODA) from the Organization for Economic Cooperation and Development (OECD): A recent upturn in ODA has brought the total back only to the 1990 level of 0.33% of the gross national income of the donor countries (this despite long-standing international agreement on a target of 1%, which itself seems pathetically small in relation to both the needs and the opportunities) (*11*). The United States, by far the richest country in the world in gross national income, is the stingiest among all the OECD countries in the fraction of it, 0.2%, devoted to ODA. [Americans spend 3.5 times more on tobacco and 20 times more on defense (*12*).]

Land, Water, and Terrestrial Biota

Turning to the environmental dimension of sustainable well-being, a central challenge is how to manage the intensifying competition among human uses for the land, water, and biota of the planet. Those uses fall mainly into three categories:

•Land and water for housing, commerce, industry, and infrastructure (energy, transport, and communications).

•Land, water, and net primary productivity (NPP) for the production of food, feed for domestic animals, fiber, biofuels, and chemical feedstocks.

•Land, water, and biota (plants, animals, and microorganisms) for recreation, beauty, the solace of unspoiled nature, and other "ecosystem services."

The term "ecosystem services" refers to functions of ecosystems that underpin human well-being, including, besides those already separately mentioned, regulation of water flows; detoxification and purification of soil, water, and air; nutrient cycling; soil formation and maintenance; controls on the populations and distribution of pests and pathogens; pollination of flowers and crops; maintenance of biodiversity; and regulation of climate (through, e.g., evapotranspiration, reflectivity, and carbon sequestration) (*13*, *14*).

The competition among these uses for the limited supplies of land and water and the biota that these can support is being intensified by rising population and affluence, with affluence providing a particularly powerful multiplier in the demand for land and water for agriculture and pasture as rising incomes translate into higher consumption of meat. Also contributing to the intensification of the competition is global climate change (about which more will be said below), which is sharply increasing the demand for both biofuels and carbon sequestration in intact forests (*15*) at the same time as it stresses farms and forests in many parts of the world with increased heat, drought, and wildfires (*16*).

A number of other factors complicate the challenge of managing the competing uses of land, water, and biota. One is the rising tide of toxic spillovers from energy supply, industry, and agriculture, which reduce the usability of water and otherwise directly stress managed and unmanaged ecosystems alike (more about this below, too). Another is the prevalence of haphazard, unintegrated, and short-range planning in relation to society's uses of land and water. A third—and one of the primary causes of the preceding two—is the frequent failure to charge a reasonable price (or any price at all) for the use of environmental resources or the degradation of environmental conditions and services.

A quantitative picture of world water supply and demand is presented in Table 3 (*17*). A key point is that only about a quarter of total runoff and recharge is actually available for human use (after uncaptured storm runoff and remote areas are subtracted), and nearly 40% of the globally available amount is already being used. (Irrigated agriculture is by far the largest user, and it is the fastest-growing—driven above all by rising demand for grain to feed to animals and now, in the United States especially, for corn to convert to ethanol.) There is a difference of a factor of 40 in current annual water withdrawals per person between the poorest and richest countries, which bodes ill for future water demand in relation to supply as incomes and populations continue to rise.

The widespread supposition that humans can use all of the "available" runoff is in error, moreover. Enough flow must be left in rivers to meet ecological needs. Taking these ecological flow require-

2 MDG'S, TARGETS, AND PACE OF PROGRESS

Goal	Target	Progress
Eradicate extreme poverty and hunger	Proportion of people living on less than $1 per day to be halved between 1990 and 2015	Target already met in East and Southeast Asia, but other developing regions are behind pace needed to meet it by 2015
Achieve universal primary education	Full course of primary schooling for boys and girls everywhere by 2005	Southern Asia, northern Africa, and Latin America on track to meet target; other developing regions behind
Promote gender equality and empower women	Eliminate gender disparities at all levels of education by 2015	Nearly all developing regions far off pace needed to meet target
Reduce child mortality	Reduce under-5 mortality rate by 2/3 between 1990 and 2015	East and Southeast Asia, northern Africa, and Latin American on track to meet target; other developing regions far behind
Improve maternal health	Reduce maternal mortality rate by 3/4 between 1990 and 2015	East and Southeast Asia, northern Africa, and Latin American on track to meet target; other developing regions behind
Combat HIV/AIDS, malaria, and other diseases	Have halted and begun to reverse spread of HIV/AIDS and incidence of malaria by 2015	No. of people with HIV/AIDS may have stabilized in sub-Saharan Africa; is rising in most other developing regions
Ensure environmental sustainability	Proportion of people lacking access to safe drinking water and basic sanitation to be halved between 1990 and 2015	East and Southeast Asia, northern Africa, and Latin America on track to meet sanitation target; other developing regions behind
Develop a global partnership for development	No quantitative target; a range of qualitative goals address mechanisms of assistance	If official development assistance is the index, progress is slight; debt and trade measures look better

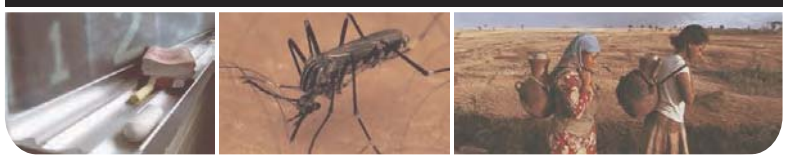

Table 2. MDGs, targets, and pace of progress (*10*, *11*).

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ments into account reveals that many of the world's river basins are already overexploited: Human withdrawals are leaving less water in rivers than needed to meet ecological requirements. Rising human water demands are also leading, at many locations around the world, to the extraction of groundwater from aquifers at rates exceeding natural recharge, leading to declining water tables, wells running dry, and increased drilling and pumping costs (*8*).

The current extent of human exploitation of Eath's land surface and vegetation is, similarly, far greater than is generally supposed. Crops, pastures, and grazing now take up about 40% of the planet's 133 million km^2 of ice-free land (*18*). Forests, which once covered 50 million km^2, have shrunk by about 10 million km^2 in the past 300 years (with half of that loss occurring in the past half century), and desert and near-desert lands have expanded by nearly 10 million km^2. Cities, towns, roads, and airports now cover about 2% of the land area—approaching 3 million km^2 (*18*–*20*).

Arguably a more informative measure of the scale of human intervention in terrestrial ecosystems than areas transformed is the fraction of the NPP of those ecosystems that human activities have eliminated or appropriated for human purposes; a pioneering study in the mid-1980s estimated that humans appropriate about 25% of terrestrial NPP and have eliminated nearly another 15% through land transformations (*21*). Subsequent studies using the more extensive remote-sensing information and geographic information systems (GIS) databases that have become available in the meantime have altered the details of the picture but reinforced the basic finding that, depending on the definitions employed, human activities are appropriating between 25 and 40% of terrestrial NPP (*22*).

Considering the increases in human demands for NPP that are in prospect both for the combination of food and feed and for biofuels, and considering the need to leave large areas of forest substantially intact for purposes of carbon sequestration and other ecosystem functions, these are not encouraging numbers. They become even less so when one considers the loss of biodiversity that has accompanied the level of appropriation of terrestrial NPP already reached.

The Millennium Ecosystem Assessment completed in 2005 developed estimates for contemporary and projected extinction rates compared to past rates suggested by the fossil record: 100 to 1000 times past extinction rates today, another 10 to 100 times higher in the future (*13*). And already in 2000 it was estimated that 18% of mammal species, 12% of bird species, and 8% of plant species worldwide were threatened with extinction (*23*); the projected increases in extinction rates, if they materialize, thus portend a biodiversity catastrophe.

The current state of understanding of ecosystem structure and function does not generally allow prediction of what forms and degrees of local or regional biodiversity decline will lead to severe impacts on basic ecosystem functions and the services associated with them. To confuse this ignorance with cause for complacency would be folly, however. The most elementary common sense (embodied in Aldo Leopold's famous dictum from *A Sand County Almanac* that "The first rule of intelligent tinkering is to save all the parts")—reinforced by a large part of the detailed ecological knowledge accumulated since—tells us that continuing biodiversity loss must eventually exact a large toll in ecosystem performance and resilience against shocks and stresses both natural and anthropogenic (*24*).

What is needed from S&T in relation to the intensifying competition for land, water, and biota? We need, for reasons both purely scientific and as a basis for sensible ecosystem management, a large increase in ecological research focused on the relations linking biodiversity and other aspects of ecosystem condition with ecosystem function and services; and we need a better understanding of what those services do and could deliver in support of human well-being, as well as better ways to quantify their value for incorporation into the market and nonmarket processes shaping the future of ecosystems (*25*).

We need more studies that combine projected land requirements for food and feed, fiber, biofuels, and infrastructure—rather than pretending that each use can be analyzed separately—and that attempt to reconcile the combined demands with the requirement for enough land covered by intact forests and other native ecosystems to provide the carbon sequestration and other ecosystem services society cannot do without (*26*). We need more effective use of the capabilities provided by satellite imagery and other remote sensing, and by GIS, both for conducting such studies and for conveying the results to publics and decision-makers in forms they will understand and use (*27*). And, not least, we need technologies for extracting food, fiber, and fuel from agricultural and forest ecosystems in ways less disruptive of the other services those systems provide than the technologies typically used today (*28*).

3 THE WORLD'S WATER

Stocks	Cubic kilometers
Water in the oceans (~35,000 parts per million salt)	1,400,000,000
Water locked up in ice	30,000,000
Groundwater	10,000,000
Water in lakes and rivers	100,000
Water in the atmosphere	10,000

Flows	Cubic kilometers per year
Precipitation on land	120,000
Evaporation from land	70,000
River runoff and groundwater recharge	50,000
Available river flow and recharge	12,000
Withdrawals for human use	5,000
of which Agriculture	3,500
Industry	1,000
Domestic	500
World desalting capacity	13

Flows per capita	Cubic meters per person per year
Available river flow and recharge/world population	1,800
Per capita withdrawals, global average	800
Nigeria	50
Israel	300
China	500
Mexico	800
Italy	1,000
United States	2,000
World desalting capacity/world population	2

Table 3. Where is the world's water and where is it going? Compiled and rounded from several sources (*17*). 1 km^3 = 10^9 m^3 = 10^{12} liters = 264 × 10^9 gallons. Available river flow and recharge = runoff + recharge – uncaptured storm runoff – remote areas. Withdrawals for human use are estimated for 2007. Per capita withdrawals are data for 2000.

The Oceans

The oceans cover 70% of the surface of the planet, contain 98% of the water, and contribute about half of the NPP. They are a gigantic bal-

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ance wheel in Earth's weather and climate. They are an immense reservoir of biodiversity; one even less cataloged and characterized than that of the terrestrial biota. And fisheries derived from them supply 20% or more of the per capita animal-derived protein consumed by 40% of the human population (*29*).

Although the oceans are perceived by many as being too gigantic and immutable to be much influenced by human activities, they have actually been, like the land, substantially altered by human influences. Human-caused warming of Earth's surface and atmosphere has penetrated the oceans to depths of hundreds of meters; and absorption by the ocean of part of the carbon dioxide (CO_2) added to the atmosphere by human activities has lowered the average pH of seawater by about 0.1 (*30*). Lead and mercury mobilized by humans move through marine food webs, concentrating at the higher levels, as do synthetic organic compounds such as DDT and PCBs. No part of the oceans is free of traces of oil spills or free of plastic trash.

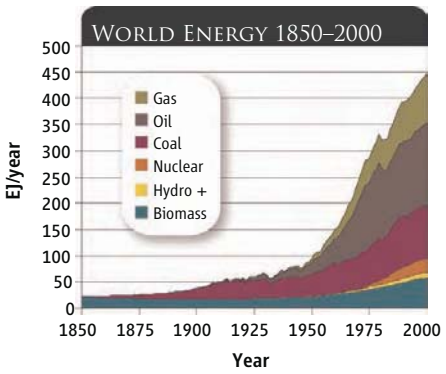

Fig. 1. World supply of primary energy 1850–2000 (*40*). Primary energy refers to energy forms found in nature (such as fuelwood, crude petroleum, and coal), as opposed to secondary forms (such as charcoal, gasoline, and electricity) produced from the primary ones using technology. "Hydro +" includes hydropower, geothermal, wind, and solar. Fossil fuels are counted at higher heating value and hydropower is counted as energy content, not fossil-fuel equivalent. 1 exajoule (EJ) = 10^{18} joules = 0.95 quadrillion Btu.

The most conspicuous of human impacts on the oceans to date has been the decline in the populations of many of the fish and shellfish we harvest for food. Marine fish catches reached a plateau in the mid-1990s and have been maintained there since only by dint of harvesting lower in the food web; continuing expansion of the total supply of protein from fish and shellfish has depended on rapid growth in aquaculture (*31*). The real magnitude of the human impact, however, is revealed only by looking region by region and species by species at the fish and shellfish stocks on which the catch had depended; it is a picture of devastating decline, brought about not only by unsustainable harvest of target species but also by the extensive bycatch and bottom-habitat destruction brought about by widely used if reprehensible fishing techniques (*32*).

Coral reefs, which have the highest density of biodiversity in the oceans, are also increasingly endangered. Originally the risks to reefs came mainly from subsistence fishing and sediment runoff from agriculture and land development on inhabited islands; to this was later added the stress on reef fish populations from rapidly expanding commercial fishing to supply the aquarium trade in North America and Europe and the live-fish restaurant trade in East and Southeast Asia, as well as physical damage to the reefs from the influx of cruise ships and the reef-walking tourists they carry (*33*).

Today, coral reefs are being affected throughout their range by two further factors that are independent of local population densities, tourist influxes, and commercial fishing fleets: increasing water temperatures, which can cause bleaching (ejection of the living coral organisms from the calcium carbonate structure) and disease; and declining pH, which hinders the ability of organisms to make the calcium carbonate. A recent survey concluded that 30% of the world's coral reefs are already severely damaged and that 60% could be lost by 2030 (*33*).

Another sign of trouble in the oceans is the rapid proliferation of harmful algal blooms and the oxygen-depleted "dead zones" that are often the ultimate result. This phenomenon is largely driven by overfertilization of coastal zones by river runoff laden with nutrients from sewage and agriculture. The number of regions affected and the scale of the impact in individual regions appear to have been growing recently, with a doubling time on the order of a decade (*29*, *34*).

Scientifically, technologically, and politically, human pressures on the oceans are even more challenging to deal with than the pressures on terrestrial ecosystems discussed above. Difficulties of observation and study in the oceans mean that the marine realm is less well explored and less well understood than terrestrial ecosystems. Technologically, the oceans are a more difficult operating environment than the land for almost any purpose. Politically, the problems of governance and management of ocean resources and the ocean environment are compounded by the circumstance that most of the world ocean is a commons, not the province of any nation.

Much of what is needed from S&T in relation to the challenge of sustainability for ocean systems and services, however, is similar to what is needed on the terrestrial side: more research on marine ecosystem structure, function, and service; more and better monitoring and reporting, in forms meaningful to and usable by decision-makers; and more integration of analyses relating to multiple interacting uses and stresses, so that limits on what is sustainable can be identified before they are exceeded. Also needed on the marine side is technological change in relation to what we already know is unsustainable: replacement of harvesting technologies that destroy habitat and decimate bycatch with more resource-friendly alternatives, and modification of agricultural and sewage-treatment practices on land in order to drastically reduce the dead zone–inducing impacts of nutrient-laden river runoff (*35*).

The Energy-Economy-Environment Dilemma

The essence of this dilemma resides in two robust propositions (*36*–*38*): First, reliable and affordable energy is essential for meeting basic human needs and fueling economic growth. Second, the harvesting, transport, processing, and conversion of energy using the resources and technologies relied upon today cause a large share of the most difficult and damaging environmental problems society faces.

Contemporary technologies of energy supply are responsible for most indoor and outdoor air pollution exposure, most acid precipitation, most radioactive wastes, much of the hydrocarbon and trace-metal pollution of soil and groundwater, nearly all of the oil added by humans to the oceans, and most of the human-caused emissions of greenhouse gases that are altering the global climate (*39*).

The study of these environmental impacts of energy has been a major preoccupation of mine for nearly four decades. I have concluded from this study that energy is the hardest part of the environment problem; environment is the hardest part of the energy problem; and resolving the energy-economy-environment dilemma is the hardest part of the challenge of sustainable well-being for industrial and developing countries alike.

Figure 1 shows the composition of world primary energy supply during the bulk of the fossil-fuel era to date, from 1850 to 2000 (*40*). Energy use increased 20-fold over this period—that number being the product of a somewhat

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greater than fivefold increase in world population and a somewhat less than fourfold increase in average energy use per person (*41*). Fossil-fuel use increased more than 150-fold, rising from 12% of the modest energy use of 1850 to 79% of 2000's much larger total. By 2005, fossil fuels were contributing 81% of the world primary energy supply, 82% in China, and 88% in the United States (*42*); even in the electricity sector (where nuclear, hydropower, wind, solar, and geothermal energies make their largest contributions), fossil fuels accounted for two-thirds of global generation (Table 4).

The huge increase in fossil-fuel use over the past century and a half played a large role in expanding the impact of humankind as a global biogeochemical force (*43*), not only through the associated emissions of CO_2, oxides of sulfur and nitrogen, trace metals, and more, but also through the mobilization of other materials, production of fertilizer, transport of water, and transformations of land that the availability of this energy made possible (*44*). At the end of the 20th century and the beginning of the 21st, the fossil-fuel–dominated energy supply system continued to impose immense environmental burdens at local, regional, and global scales, despite large investments and some success in reducing emissions to air and water per unit of energy supplied (*29*).

Fine particles appear to be the most toxic of the usual air pollutants resulting from the combustion of fossil and biomass fuels, and whether emitted directly or formed in the atmosphere from gaseous precursors, they have proven difficult to control (*45*). The concentrations of fine particulates in urban air in the United States, Western Europe, and Japan have mostly been falling in recent years, but in cities across the developing world the concentrations have risen to shockingly high levels—often several times the WHO guidelines (*29*). As noted above in connection with Table 1, population exposures to particulate matter from the combustion of fossil and biomass fuels indoors are even greater, with commensurate impacts on health.

A major regional impact of fossil-fuel combustion is wet and dry deposition of sulfur and nitrogen, much of it in acidic forms. Of the sulfur oxide and nitrogen oxide emissions that are the precursors of this fallout, the former are somewhat easier to control technologically. Global emissions of both are now increasing, however, as rapid expansion of poorly controlled sources in Asia, and to a lesser extent in Africa and Latin America, is now more than offsetting reductions in the industrialized countries (*29*).

Mid-range projections for energy growth over the next few decades show world use of energy reaching 1.5 and 2 to 2.5 times the 2005 level by 2030 and 2050, respectively; electricity generation in these "business-as-usual" cases nearly doubles by 2030 and triples by 2050 (*46*). Although these are daunting numbers from the standpoint of sustainability, the problem is not that the world is running out of energy. It isn't (*37*, *47*). But it is running out of cheap and easy oil and gas, and it is running out of environmental capacity to absorb, without intolerable consequences, the impacts of mobilizing these quantities of energy in the ways we have been accustomed to doing it (*48*).

Much discussion of the oil issue has been framed around the contentious question of "peak oil" (*49*): When will global production of conventional petroleum reach a peak and begin to decline, as U.S. domestic production did around 1970? The question derives its importance from the proposition that reaching this peak globally will presage large and long-lasting increases in the price of oil, plus a costly and demanding scramble for alternatives to fill the widening gap between the demand for liquid fuel and the supply of conventional petroleum.

Oil-supply pessimists argue that the peak of conventional oil production could occur any time now; oil-supply optimists say it probably won't happen until after 2030, perhaps not until after 2050. Similar arguments go on about conventional supplies of natural gas, the total recoverable resources of which are thought to be not greatly different, in terms of energy content, from those of crude petroleum.

In my judgment, it's difficult to tell at this juncture whether the optimists or the pessimists are closer to right about when the world will experience peak oil, but the answer is not very important as a determinant of what we need to be doing. After all, it's clear that heavy oil dependence carries substantial economic and political risks in a world where high proportions of the reserves and remaining recoverable resources lie in regions that are unstable and/or controlled by authoritarian governments that have sometimes been inclined to wield oil supply as a weapon. It's also clear that world oil use (which is dominated by the transport sector and, within it, by motor vehicles) is a huge producer of conventional air pollutants, as well as being about equal to coal burning as a contributor to the global buildup of the heat-trapping gas CO_2 (*29*, *42*). Given these liabilities, it makes sense to be looking urgently for ways to reduce oil dependence (while working to clean up continuing uses of oil), no matter when we think peak oil might occur under business as usual.

Indeed, the problem of how to reduce the dangers from urban and regional air pollution and from overdependence on oil in the face of rising worldwide demand for personal transportation is one of the two greatest challenges at the energy-economy-environment intersection. The other one is how to provide the affordable energy needed to create and sustain prosperity everywhere without wrecking the global climate with the CO_2 emitted by fossil-fuel burning.

Climate is the envelope within which nearly all other environmental conditions and processes important to human well-being must function (*50*). Climate strongly influences (so climate change directly affects) the availability of water; the productivity of farms, forests, and fisheries; the prevalence of oppressive heat and humidity; the geography of disease; the damages to be expected from storms, floods,

4 WORLD ENERGY SUPPLY IN 2005

		WORLD	USA	CHINA
Primary energy (exajoules)		514	106	80
of which	Oil	34%	40%	18%
	Natural gas	21%	24%	2%
	Coal	26%	25%	62%
	Nuclear energy	6%	8%	0.6%
	Hydropower	2%	1%	2%
	Biomass and other	11%	3%	15%
Primary energy (terawatt-hours)		17,300	4,000	2,400
of which	Coal	40%	50%	80%
	Oil and gas	26%	21%	3%
	Nuclear	16%	20%	2%
	Hydropower	16%	7%	15%
	Wind, geothermal, and solar	2%	2%	0.1%

Table 4. World energy supply in 2005. About a third of the primary energy is devoted to electricity generation. Net electricity = gross generation less the electricity used within the generating facility. In the "primary energy" column, hydropower is counted as energy content, not fossil-fuel equivalent. "Other" includes wind, geothermal, and solar energy (*42*).

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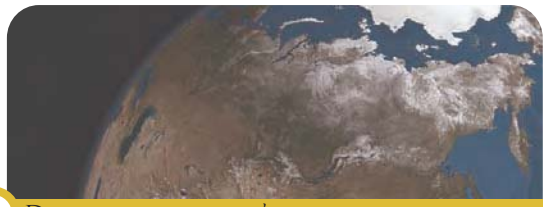
droughts, and wildfires; the property losses to be expected from sea-level rise; the investments of capital, technology, and energy devoted to ameliorating aspects of climate we don't like; and the distribution and abundance of species of all kinds (those we love and those we hate). A sufficient distortion in the climatic envelope, as recent human activities are well on the way to achieving, can be expected to have substantial impacts in most of these dimensions.

Indeed, after a rise in global average surface temperature of about 0.75° ± 0.20°C since 1880–1900 (*51*), changes in most of these categories, and significant damages in many, have already become apparent (*5*, *10*, *16*, *52*, *53*). Large impacts from seemingly modest changes in global average surface temperature underline the reality that this temperature is a sensitive proxy for the state of the world's climate, which consists of the patterns in space and time not only of temperature and humidity but of sun and clouds, rainfall and snowfall, winds and storm tracks, and more. (The sensitivity of the temperature proxy for the state of the climate is often illustrated by the observation that the difference in global average surface temperature between an ice age and a warm interglacial—drastically different climates—is only about 5°C.)

There is no longer any serious doubt that most of the climatic change that has been observed over the past few decades has been due to human rather than natural influences (*54*). As shown in Table 5, the largest of the positive human "forcings" (warming influences) has been the buildup of CO_2 in the atmosphere over the past two and a half centuries. (About two-thirds of this buildup has come from fossil-fuel burning and the other one-third from land-use change.) Other important contributors have been methane from energy supply, land-use change, and waste disposal; halocarbons from a variety of commercial and industrial applications; nitrous oxide from fertilizer and combustion; and soot from inefficient engines and biomass burning. Partially offsetting cooling effects have been caused by the reflecting and cloud-forming effects of human-produced particulate matter and by increased surface reflectivity due to deforestation and desertification.



5 DISRUPTING EARTH'S CLIMATE

Cause of forcing	Magnitude of forcing (W/m^2)
Change in atmospheric concentration of	
Carbon dioxide	+1.66 (±0.17)
Methane	+0.55 (±0.07)
Halocarbons	+0.34 (±0.03)
Nitrous oxide	+0.16 (±0.02)
Tropospheric ozone	+0.35 (–0.10,+0.30)
Stratospheric ozone	–0.05 (±0.10)
Soot	+0.3 (±0.2)
Reflecting particles	–0.8 (±0.4)
Cloud-forming effect of particles	–0.7 (–1.1,+0.4)
Change in reflectivity of surface (albedo) due to	
Land-use change	–0.2 (±0.2)
Soot on snow	+0.1 (±0.1)
Change in solar irradiance	+0.12 (–0.06,+0.18)

Table 5. IPCC estimates of principal human-produced and natural forcings since 1750. Forcings are essentially changes in Earth's energy balance, measured in watts per square meter of the planetary surface, with positive values denoting warming influences and negative values denoting cooling. The uncertainty range is given in parentheses. Large volcanic eruptions produce negative forcings of a few years' duration due to the particles they inject into the atmosphere, but they are not included in the table because no trend is evident in the size of this effect over time. Effects of the 11-year sunspot cycle are likewise not shown because they average out over time periods longer than that. Note that the IPCC's best estimate of the contribution of the net change in input from the Sun since 1750 is some 14 times smaller than that of the CO_2 (*30*).

Facing the menace of growing, human-caused disruption of global climate, civilization has only three options: mitigation (taking steps to reduce the pace and the magnitude of the climatic changes we are causing); adaptation (taking steps to reduce the adverse impacts of the changes that occur); and suffering from impacts not averted by either mitigation or adaptation. We are already doing some of each and will do more of all, but what the mix will be depends on choices that society will make going forward. Avoiding increases in suffering that could become catastrophic will require large increases in the efforts devoted to both mitigation and adaptation.

A 2007 report for the UN Commission on Sustainable Development, focused on what to do, emphasizing mitigation and adaptation equally, concluded that the chances of a "tipping point" into unmanageable degrees of climatic change increase steeply once the global average surface temperature exceeds 2° to 2.5°C above the pre-industrial level, and that mitigation strategies should therefore be designed to avoid increases larger than that (*52*). Having a better-than-even chance of doing this means stabilizing atmospheric concentrations of greenhouse gases and particles at the equivalent of no more than 450 to 500 parts per million by volume (ppmv) of CO_2 (*55*, *56*).

A mitigation strategy sufficient to achieve such stabilization will need to address methane, halocarbons, nitrous oxide, and soot as well as CO_2, but the largest and most difficult reductions from business-as-usual trajectories of future emissions are those needed for CO_2 itself. The difficulty in the case of CO_2 emissions from the energy system resides in the current 80% dependence of world energy supply on fossil fuels, the technical difficulty of avoiding release to the atmosphere of the immense quantities of CO_2 involved, and the long turnover time of the energy-system capital stock (meaning that the shares of the different energy sources are hard to change quickly) (*57*). In the case of the 15 to 25% of global CO_2 emissions still coming from deforestation (essentially all of it now in the tropics), the difficulty is that the causes of this deforestation are deeply embedded in the economics of food, timber, biofuel, trade, and development, and in the lack of valuation and marketization of the services of intact forests (*58*).

Stabilizing atmospheric CO_2 at 500 ppmv would be possible if global emissions from fossil-fuel combustion in 2050 could be cut in half from the mid-range business-as-usual figure of 14 billion metric tons of carbon in CO_2 per year. Numerous studies of how reductions of this general magnitude might be achieved have been undertaken (*59*), and, notwithstanding differences in emphasis, virtually all have shown that: (i) such reductions are possible but very demanding to achieve; (ii) there is no single silver-bullet approach that can do all or even most of the job; (iii) it is essential, in terms of both feasibility of the ultimate aim and cost of achieving it, to begin reductions sooner rather than later; (iv) the quickest and cheapest available reductions will be through improving the efficiency of energy end-use in residential and commercial buildings, manufacturing, and transport, but costlier measures to reduce emissions from the energy supply system will also need to be embraced; and (v) without major

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improvements in technology on both the demand side and the supply side—and a major expansion of international cooperation in the development and deployment of these technologies—the world is unlikely to achieve reductions as large as required.

The improved technologies we should be pursuing, for help not only with the energy-climate challenge but also with other aspects of the energy-economy-environment dilemma, are of many kinds: improved batteries for plug-in hybrid vehicles; cheaper photovoltaic cells; improved coal-gasification technologies to make electricity and hydrogen while capturing CO_2; new processes for producing hydrogen from water using solar energy; better means of hydrogen storage; cheaper, more durable, more efficient fuel cells; biofuel options that do not compete with food production or drive deforestation; advanced fission reactors with proliferation-resistant fuel cycles and increased robustness against malfunction and malfeasance; fusion; more attractive and efficient public transportation options; and a range of potential advances in materials science, biotechnology, nanotechnology, information technology, and process engineering that could drastically reduce the energy and resource requirements of manufacturing and food production (*60*).

Also urgently needed from S&T in the energy-climate domain are improved understanding of potential tipping points related to ice-sheet disintegration and carbon release from the heating of northern soils; a greatly expanded research, development, and demonstration effort to determine the best approaches for both geologic and enhanced biologic sequestration of CO_2; a serious program of research to determine whether there are "geoengineering" options (to create global cooling effects that counter the ongoing warming) that make practical sense; and wide-ranging integrated assessments of the options for adaptation (*61*).

Adequately addressing these and other needs in the science and engineering of the energy-environment interaction would probably require a 2- to 10-fold increase in the sum of public and private spending for energy research, development, and demonstration (ERD&D) (*62*). This sounds daunting, but the amounts involved are astonishingly small compared to what society spends for energy itself (*63*). There are signs that the private sector is ramping up its efforts in ERD&D in response to the challenge, but for reasons that have been abundantly documented (*64*), the public sector must also play a large role in the needed expansion. Sadly, until now there has been precious little sign of that happening, notwithstanding abundant rhetoric from political leaders about new technologies being the key to the solution (*65*).

Moving Toward Elimination of Nuclear Weapons

Throughout the Cold War, the world's nuclear arsenals (which reached tens of thousands of nuclear weapons on each side in the USA-USSR confrontation and hundreds each in the possession of the United Kingdom, France, China, and probably Israel) were recognized by nearly everyone as a threat to the existence of a sizable part of the human population and to the well-being of most of it, if any significant fraction of them were ever used. Following the peaceful end of the Cold War at the beginning of the 1990s, however, the salience of the threat from these nuclear weapons rapidly receded in the minds of most people. The most plausible political source of a nuclear conflagration had disappeared, and the only related set of worries that retained any widespread salience was a concern—initially much less compelling and immediate than the Cold War's nuclear threat had been—about the possible acquisition of nuclear weapons by rogue states and terrorists.

The tendency toward complacency about dangers from nuclear weapons in the possession of the major powers was reinforced by considerable shrinkage in the U.S. and Russian arsenals—as weapons now deemed surplus were retired from active service and a process of dismantling was begun—and subsequently by conclusion of the Moscow Treaty of 2002, which appeared to promise further significant cuts. Meanwhile, the refocusing of residual concerns about nuclear weapons on issues of proliferation and terrorism proceeded apace, driven by the initial discovery of a nuclear weapon program in Iraq, the Indian and Pakistani nuclear tests of 1998, the revelation of A. Q. Khan's proliferation network, the unmasking of North Korea's nuclear weapon program, and the exercise of frighteningly organized and destructive (even if non-nuclear) terrorist capabilities on September 11, 2001.

To be concerned about nuclear proliferation and the possibility of nuclear terrorism certainly wasn't and isn't wrong (*66*). But to believe that the nuclear weapons still in the possession of the United States, Russia, and the other de jure nuclear weapon states (*67*) are not themselves still a major threat to the world is to underrate both the direct threat of their use that remains and the ways in which their existence influences the proliferation and terrorism threats.

Concerning the possibility that these major-power weapons might in fact be used, highly relevant facts (which polls show are largely unknown to the U.S. public) are as follows: (i) These arsenals still contain altogether about 20,000 nuclear weapons, of which the United States possesses about half; (ii) most of the U.S. and Russian nuclear weapons are not covered by the Moscow Treaty, which governs only a subcategory called "operationally deployed strategic nuclear weapons" (and which also lacks any provision or mechanism for verification); (iii) the United States and Russia each continue to maintain about 2000 strategic nuclear weapons on short-reaction-time alert, increasing the chance of use by mistake or malfunction; and (iv) the United States and Russia both reserve the "right" of first use of nuclear weapons, including in response to non-nuclear threats. While the chance of large-scale use of U.S. and Soviet/Russian nuclear weapons certainly diminished with the end of the Cold War, then, the danger has by no means completely disappeared (*68*, *69*).

The existing nuclear arsenals and the postures of their owners toward their potential uses and improvement are hardly unconnected, moreover, from the dangers of nuclear proliferation and nuclear terrorism. The evident intentions of the current nuclear weapon states to retain large arsenals indefinitely, to maintain high states of alert, to continue to threaten first use of nuclear weapons even against states that do not possess them, and to pursue development of new types of nuclear weapons for increased effectiveness or new purposes are manifestly incompatible with the bargain embodied in the Non-Proliferation Treaty and corrosive of the nonproliferation regime (*70*).

More specifically, with these stances the nuclear weapon states forfeit any moral authority to which they might aspire on questions of nuclear weapon possession, and they reduce the chances of gaining the cooperation of the world community on technology-transfer restrictions and sanctions directed against proliferators. They also directly encourage proliferation by reinforcing the view that nuclear weapons have great political and military value and by undermining confidence that nonpossession of nuclear weapons means a country need not fear being attacked with them.

Nuclear proliferation itself, when it occurs, tends to increase both the incentives and the opportunities for further proliferation, as well as expanding the opportunities for terrorist acquisition of nuclear weapons. The expansion of opportunities accompanying proliferation

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comes not merely because nuclear weapons, nuclear weapons expertise, and nuclear explosive materials have been put in additional hands in additional locations, from which they may spread further (as the Khan network so appallingly demonstrated), but especially because they have been placed into contexts where there has been no experience in controlling them. Constraints on the numbers, dispersion, and contemplated uses of nuclear weapons are important, therefore, both to reduce the probability of accidental, erroneous, unauthorized, or authorized use and to reduce the chances of nuclear weapons coming into the possession of additional proliferant states or terrorists.

Ultimately, however, the only alternative to continued proliferation is achievement of a universal prohibition on nuclear weapons, coupled with means to ensure confidence in compliance. If possession of nuclear weapons does not tend toward zero, it will tend instead toward universality; and though no one can predict the pace of this, it will mean, in the long run, that the probability of use of these weapons will tend toward unity (*71*). There are, moreover, powerful arguments that a prohibition of nuclear weapons is not only a practical and moral but a legal necessity, under international law (*72*). It is also telling that, over the years, more and more of the people who have had command over the U.S. nuclear arsenal and the policies governing its use have reached the conclusion that pursuing prohibition is the only sensible option (*73*).

While the contrary is often claimed, prohibition does not require "un-inventing" nuclear weapons (an impossibility). Societies separately and together have productively prohibited murder, slavery, and chemical and biological weapons without imagining that these have been un-invented. Nor is verification an insurmountable obstacle. Verification, with further innovations both technical and social, can be more effective than most suppose (*74*); and in any case, the dangers to the world from cheating are likely to be smaller than the dangers to be expected in a world from which nuclear weapons have not been banned (*75*).

As for timing, the buildup of the global nuclear weapon stockpile from a dozen in 1946 (all in the possession of the United States) to the peak of about 65,000 in 1986 took just four decades; another two decades later, the number had fallen by more than two-thirds (*76*). I see no reason the world shouldn't aim for getting to zero in another two decades; that is, by about 2025. Crucial early steps in that direction include declarations by the nuclear weapon states that they will never, in any circumstances, use nuclear weapons first or against countries that do not possess such weapons; dealerting of all nuclear forces; a series of progressively deeper cuts in total numbers of nuclear weapons (strategic and nonstrategic, deployed and nondeployed), with physical destruction of all of the weapons made surplus by these cuts and disposition of their nuclear explosive materials in ways that effectively preclude their reuse for weapons, and with internationally agreed means of verification; ratification and entry into force of the Comprehensive Nuclear Test Ban Treaty; and negotiation of a cutoff of production of nuclear explosive materials for weapons (*77*).

S&T can contribute to achieving such progress in several ways: through technical advances that make verifying weapon-reduction agreements easier (and thus make agreeing to them easier); through other technical advances that make nuclear energy technology less likely to be used for nuclear weaponry and/or more likely to be detected if this happens; through applications of science and engineering to the task of reducing the dangers of accidental, erroneous, or unauthorized use of nuclear weapons, as well to the task of obviating any need for nuclear explosive testing of weapons, for as long as these still exist; and through S&T-based integrated assessments clarifying dangers and pitfalls on the path to zero and how to avoid them.

Almost certainly, getting to a world of zero nuclear weapons will be as much a matter of political wisdom, political courage, and diminution in the motivations for armed conflict of any sort as a matter of S&T per se. But in the domain of diminishing motivations for conflict, the alleviation of the other shortfalls in sustainable well-being discussed here—to which, as I have tried to show, S&T have large contributions to make—will be indispensable (*78*).

What Else Is Needed?

Beyond the points made already here about the contributions needed from S&T with respect to the five specific challenges on which I have focused, I want to mention some cross-cutting desiderata. We need:

- A stronger, clearer focus by scientists and technologists on the largest threats to human well-being;
- Greater emphasis on analysis of threats and remedies by teams that are interdisciplinary, intersectoral, international, and intergenerational (as the problems are);
- Undergraduate education and graduate training better matched to these tasks;
- More attention to interactions among threats and to remedies that address multiple threats at once;
- Larger and more coordinated investments in advances in S&T that meet key needs at lower cost with smaller adverse side effects;
- Clearer and more compelling arguments to policy-makers about the threats and the remedies; and
- Increased public S&T literacy.

Most, if not all, of these aims would be advanced by wider acceptance, within the academic scientific and engineering communities and elsewhere, of the proposition that applied, interdisciplinary, and integrative work by individual scientists and technologists and by teams is not necessarily less rigorous, less demanding, or less worthy of recognition—and certainly not less valuable to society—than work that is narrower or "purer" (*79*).

The role of the AAAS in advancing these ideas has been and remains immensely important. It is the largest, most diverse, and most interdisciplinary of U.S. scientific societies, and it is also the most influential. Our flagship publication, *Science*, has the largest paid circulation among all the peer-reviewed science journals in the world and enjoys a well-earned reputation for discerning coverage of the intersection of S&T with public policy (as well as for cutting-edge reports on disciplinary research in multiple fields). The extraordinary intellectual smorgasbord of our annual meeting makes it the year's most important gathering for the growing segment of the S&T community interested in the interactions among S&T disciplines and in the influence of S&T on the human condition. It also draws, appropriately, by far the most and best media coverage of any scientific meeting (*80*).

As a visit to the AAAS Web site at www.aaas.org will reveal, there is much more. A remarkable array of interdisciplinary, intersectoral, practice- and policy-oriented centers, programs, and initiatives operate out of AAAS headquarters and engage the energies of members and the attention of publics and policy-makers all around the world. The AAAS R&D Budget and Policy Program provides the most comprehensive and continuously up-to-date coverage available anywhere on patterns, priorities, and policy underpinnings of U.S. government investments in S&T. Since 1973, the AAAS Science and Technology Policy Fellowship programs have been installing postdoctoral to mid-career scientists and engineers in key venues of the federal government where their insights can inform real-world policy-making

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while they learn how the policy process works and how it can be made to work better; there have been something in the range of 2000 of these AAAS S&T fellows, and this tremendous body of talent and experience now constitutes a major part of the national community of teaching and practice in science, technology, and public policy. And the extraordinary AAAS Project 2061 has become a major force in strengthening S&T education in our schools and communities.

What More Can Individuals Do?

Individual scientists and technologists concerned with the roles of S&T in the pursuit of sustainable well-being have available to them an array of avenues and opportunities for effective thought and action. Perhaps the most obvious of these, given what I have just said about the AAAS, is to increase one's support for, participation in, and use of the relevant activities and resources of this organization. The similar activities of other science- and engineering-oriented professional societies, academies, and nongovernmental organizations (NGOs) likewise need and deserve increased participation and support.

More specifically, I would urge every scientist and engineer with an interest in the intersection of S&T with sustainable well-being (in all the senses I have explored here and more) to read more and think more about relevant fields outside your normal area of specialization, as well as about the interconnections of your specialty to these other domains and to the practical problems of improving the human condition; to improve the aspects of your communication skills that are germane to conveying your understandings about these interconnections to members of the public and to policymakers; to actively seek out additional and more effective avenues for doing so (including but not limited to increased participation in the relevant activities of the AAAS and other NGOs); and indeed to "tithe" 10% of your professional time and effort to working in these and other ways to increase the benefits of S&T for the human condition and to decrease the liabilities (*81*).

If so much as a substantial fraction of the world's scientists and engineers resolved to do this much, the acceleration of progress toward sustainable well-being for all of Earth's inhabitants would surprise us all.

References and Notes

1. See especially the classic treatise on sustainable development by the World Commission on Environment and Development, G. H. Brundtland, chair, *Our Common Future* (Oxford Univ. Press, 1987), and the more comprehensive and analytical update by the National Research Council Board on Sustainable Development, *Our Common Journey: A Transition Toward Sustainability* (National Academy Press, Washington, DC, 1999).
2. A number of the formulations in this section are adapted from J. P. Holdren, G. C. Daily, P. R. Ehrlich, in *Defining and Measuring Sustainability The Biogeophysical Foundations,* M. Munasinghe, W. Shearer, Eds. (World Bank, Washington, DC, 1995), pp. 3–17.
3. The quoted formulation is from Robert Kates.
4. This was the key insight in Paul Ehrlich's *The Population Bomb* (Ballantine, New York, 1968), as well as one of those in Harrison Brown's prescient earlier book, *The Challenge of Man's Future* (Viking, New York, 1954). The elementary but discomfiting truth of it may account for the vast amount of ink, paper, and angry energy that has been expended trying in vain to refute it.
5. WHO, *The World Health Report 2002* (WHO, Geneva, 2002); see also K. R. Smith, M. Ezatti, *Annu. Rev. Environ. Resour.* **30**, 291 (2005).
6. UN Development Programme (UNDP), *The Human Development Report 2005: International Cooperation at a Crossroads* (UNDP, New York, 2005).
7. An unsurprising conclusion from Table 1 is that poverty is a bigger cause of loss of life in today's world than high consumption is. More surprising to some, although known to specialists since the early 1980s, is that indoor air pollution from the use of solid fuels in primitive stoves for cooking, boiling water, and space heating in developing countries is a far bigger killer than the outdoor air pollution in all of the world's cities. See K. R. Smith, A. L. Aggarwal, R. M. Dave, *Atmos. Environ.* **17**, 2343 (1983). Also surprising to many is WHO's finding that, already in 2000, climate change was approaching urban air pollution as a contributor to global mortality, principally through the effects of increases in heat waves, floods, droughts, and the incidence of certain tropical diseases. For a discussion of the WHO estimate, arguing that it is conservative, see J. A. Patz *et al., Nature* **438**, 310 (2005).
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12. See U.S. Dept. of Commerce, *2007 Statistical Abstract of the United States* (U.S. Government Printing Office, Washington DC, 2007). The United States compounds its distinction as the meanest of wealthy countries in aid-giving by claiming the record for the fraction of its aid that is "tied": that is, the money must be used to purchase goods and services from the donor (*6*).
13. Millennium Ecosystem Assessment (MEA), *Ecosystems and Human Well-being: Biodiversity Synthesis* (World Resources Institute, Washington, DC, 2005).
14. G. C. Daily, Ed., *Nature's Services: Societal Dependence on Natural Ecosystems* (Island Press, Washington, DC, 1997).
15. Growing concern about global climate change, which is driven largely by the buildup of CO_2 and other greenhouse gases in the atmosphere, has helped drive increased demand for biofuels because of the impression that they are CO_2-neutral. This is indeed the case if the biomass being used for energy is replaced by new growth as rapidly as it is burned, and if no fossil fuels are used for growing the energy crop, harvesting it, transporting it, and converting it into the desired fuel form. Most often the latter condition is not met in the real world, as it most emphatically is not in the case of corn ethanol, which is by far the most rapidly expanding biofuel enterprise in the United States. But a biofuel operation that is short of CO_2-neutral may still offer some greenhouse gas–abatement benefit compared to direct burning of fossil fuel. See, e.g., A. E. Farrell *et al*., *Science* **311**, 506 (2006), and J. Hill, E. Nelson, D. Tilman, S. Polasky, D. Tiffany, *Proc. Natl. Acad. Sci. U.S.A.* **103**, 11206 (2006).
16. Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: Impacts, Adaptation, and Vulnerability* (Contribution of Working Group II to the Fourth Assessment Report of the IPCC, Cambridge Univ. Press, Cambridge, 2007).
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52. P. Raven *et al*., *Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable* (UN Foundation, Washington, DC, 2007).
53. UNDP, *Human Development Report 2007-2008: Fighting Climate Change* (UNDP, Washington, DC, 2007).
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55. For convenience, the IPCC and other analysts often represent the net effect of all of the human influences on Earth's energy balance as the increased concentration of CO_2 alone that would be needed to achieve the same effect, starting from a reference point of 278 ppmv of CO_2 in 1750. In 2005, when the actual CO_2 concentration was 379 ppmv, the additional warming influences of the non-CO_2 greenhouse gases and soot were the equivalent of another 100 ppmv of CO_2, and the cooling effects of human-produced reflecting and cloud-forming particles and surface reflectivity changes were (coincidentally) equivalent to subtracting about the same amount of CO_2. Thus, the net effect was about what would have been produced by the actual CO_2 increase alone (see Table 5).
56. The relationship between climate forcing (represented as the CO_2 concentration increase that would give the same effect as all of the human influences combined) and the corresponding change in global average surface temperature must be expressed in probabilistic terms because of uncertainty about the value of climate "sensitivity," which is commonly defined as the temperature change that would result from forcing corresponding to a doubling of the 1750 CO_2 concentration. See especially S. Schneider, M. Mastrandrea, *Proc. Natl. Acad, Sci. U.S.A.* **102**, 15728 (2005) as well as (*30*).
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62. See, e.g., President's Committee of Advisors on Science and Technology, *Federal Energy Research and Development for the Challenges of the 21st Century* (Executive Office of the President of the United States, Washington, DC, 2007); World Energy Council (WEC), *Energy Technologies for the 21st Century* (WEC, London, 2001); National Commission on Energy Policy (NCEP), *Breaking the Energy Stalemate* (NCEP, Washington, DC, 2004); and G. F. Nemet, D. M. Kammen, *Energy Policy* **35**, 746 (2007).
63. Expenditures of firms and individuals for energy are generally in the range of 5 to 10% of gross domestic product—in round numbers, perhaps a trillion dollars per year currently in the United States and five times that globally. Estimates of expenditures by governments on ERD&D depend on assumptions about exactly what should be included, but by any reasonable definition are currently not more than $12 billion to $15 billion per year worldwide. Private-sector investments in ERD&D are much more difficult to estimate; but, if following the general pattern in the United States they are assumed to be twice government investments, then the public/private total for the world is in the range of $35 billion to $50 billion per year, which is equal to at most 1% of what is spent on energy itself. By contrast, many other high-technology sectors spend 8 to 15% percent of revenues on R&D [see (*62*)].
64. See, e.g., K. S. Gallagher, J. P. Holdren, A. D. Sagar, *Annu. Rev. Environ. Resources* **31**, 193 (2006); President's Committee of Advisors on Science and Technology, *Powerful Partnerships: The Federal Role in International Cooperation on Energy-Technology Innovation* (Executive Office of the President of the United States, Washington, DC, 1999); and (*62*).
65. K. S. Gallagher, A. D. Sagar, D. Segal, P. de Sa, J. P. Holdren, *DOE Budget Authority for Energy Research, Development, and Demonstration Database* (Energy Technology Innovation Project, Cambridge, MA, 2006).
66. National Academy of Sciences, Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium* (National Academy Press, Washington, DC, 1994); G. Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe* (Henry Holt, New York, 2004); M. Bunn, *Securing the Bomb 2007* (Project on Managing the Atom, Cambridge, MA, and Nuclear Threat Initiative, Washington, DC, 2007).
67. The term "de jure nuclear weapon states" refers to those certified as legitimate albeit temporary possessors of such weapons by the Non-Proliferation Treaty (signed in 1968 and entering into force in 1970), in exchange for their agreement to make progress toward nuclear disarmament (Article VI) and to assist non–nuclear weapon states in acquiring the benefits of peaceful useful energy (Article IV). They are the United States, the Soviet Union (now Russia), the United Kingdom, France, and China.
68. National Academy of Sciences, Committee on International Security and Arms Control, *The Future of U.S. Nuclear Weapons Policy* (National Academy Press, Washington, DC, 1997).
69. John P. Holdren, "Beyond the Moscow Treaty," testimony before the Foreign Relations Committee, U.S. Senate, 12 September 2002 (www.belfercenter.org/files/holdren_testimony_9_12_02.pdf).
70. See, e.g., Canberra Commission on the Elimination of Nuclear Weapons, *Report of the Canberra Commission* (Department of Foreign Affairs, Commonwealth of Australia, Canberra, 1996) and (*68*).
71. This was recognized already in the prescient book that Harrison Brown, then a young chemist working in the Manhattan Project, started writing even before the Hiroshima and Nagasaki bombs were exploded: *Must Destruction Be Our Destiny?* (Simon & Schuster, New York, 1946). The Polish/British Manhattan Project scientist Joseph Rotblat also reached this conclusion before World War II ended, left the project as a result, and spent the rest of his 97 years working for the elimination of nuclear weapons (including through the Pugwash Conferences on Science and World Affairs, which he helped organize and lead and with which he shared the 1995 Nobel Peace Prize). See J. Rotblat, *Scientists in the Quest for Peace: A History of the Pugwash Conferences* (MIT Press, Cambridge, MA, 1972); J. Rotblat, in *Les Prix Nobel 1995* (Nobel Foundation, Stockholm, 1996); and J. P. Holdren, *Science* **310**, 633 (2005).
72. International Court of Justice, *Int. Legal Materials* **35**, 830 (1996).
73. G. L. Butler, "Abolition of Nuclear Weapons," speech at the National Press Club, 4 December 1996 (www.wagingpeace.org/articles/1996/12/04_butler_abolition-speech.htm); A. Goodpaster, chair, *An American Legacy: Building a Nuclear-Weapon-Free World* (Stimson Center, Washington, DC, 1997); G. Schultz, H. Kissinger, W. Perry, S. Nunn, *Wall Street Journal*, 6 January 2007, Op-Ed page. General Butler was the commander of all U.S. strategic nuclear forces; General Goodpaster was Supreme Allied Commander in Europe; Schultz, Kissinger, and Perry all served as U.S. secretary of defense.
74. Committee on International Security and Arms Control, National Academy of Sciences, *Monitoring Nuclear Weapons and Nuclear-Explosive Materials* (National Academy Press, Washington, DC, 2005).
75. J. P. Holdren, in M. Bruce, T. Milne, Eds., *Ending War: The Force of Reason: Essays in Honour of Joseph Rotblat* (St. Martin's Press, New York, 1999), chap. 4.
76. Natural Resources Defense Council, *Table of Global Nuclear Stockpiles, 1945–2002*, November 2002 (www.nrdc.org/nuclear/nudb/datab19.asp).
77. See, e.g., (*68–70*, *73*) and National Academy of Sciences, Committee on Technical Issues Related to Ratification of the Comprehensive Nuclear Test Ban Treaty, *Technical Issues Related to Ratification of the Comprehensive Nuclear Test Ban Treaty* (National Academy Press, Washington, DC, 2002).
78. See also J. P. Holdren, "Arms Limitation and Peace Building in the Post–Cold-War World" (Nobel Peace Prize acceptance lecture on behalf of the Pugwash Conferences on Science and World Affairs), *Les Prix Nobel 1995* (Nobel Foundation, Stockholm, Sweden, 1996).
79. A multidecade trend in the right direction is evident in the establishment and success of increasing numbers of interdisciplinary graduate degree programs focused on various dimensions of the science-technology-society intersection in universities of the first rank in the United States and around the world, as well as in the increasing number of prestigious prizes focused on such work and the increasing recognition of its importance by academies of science and engineering through the election of members whose careers have been largely in this domain.
80. This and the subsequent paragraph have been adapted from my candidate statement in the 2004 election for president-elect of the AAAS.
81. Although I have been advocating this tithe for decades, the idea is certainly not original with me. I note here that a similar idea was a major theme in J. Lubchenco's AAAS presidential address in 1997 [*Science* **279**, 491 (1998)].
82. I owe thanks for insight and inspiration to several late mentors (among them Harrison Brown, Roger Revelle, Gilbert White, Jerome Wiesner, Harvey Brooks, and Joseph Rotblat); to other mentors still very much alive (among them Paul Ehrlich, George Woodwell, Richard Garwin, Murray Gell-Mann, and Lewis Branscomb); to previous presidents of the AAAS who have shared my preoccupation with the links between S&T and sustainable well-being (among them Peter Raven, Jane Lubchenco, Shirley Ann Jackson, and Gil Omenn); to my wife (the biologist Cheryl E. Holdren); and to colleagues, students, and friends—too numerous to list here—at all of the institutions where I've worked or visited. I thank the editors of *Science* for their patience and assistance with this essay, and the AAAS staff—above all Alan Leshner and Gretchen Seiler—for their exceptional support throughout my term in the Association's leadership. My work on the topics discussed here has been supported by the John D. and Catherine T. MacArthur Foundation, the William and Flora Hewlett Foundation, the David and Lucile Packard Foundation, the Heinz Family Philanthropies, the Energy Foundation, the Winslow Foundation, the Henry Luce Foundation, and many individual donors to the Woods Hole Research Center. I am most grateful to all of them.

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ERRATUM

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Association Affairs: "Science and technology for sustainable well-being" by John P. Holdren (25 January, p. 424). In Table 4, the heading reading "Primary energy (terawatt-hours)" should have read "Net electricity (terawatt-hours)." In ref. 73, the positions held by G. Schultz, H. Kissinger, W. Perry, and S. Nunn were incorrectly described. The text should have read "Schultz and Kissinger served as U.S. secretary of state, Perry was secretary of defense, and Nunn was chair of the Senate Armed Services Committee."

An Innovation Economics Agenda for the Next Administration

BY ROBERT D. ATKINSON | SEPTEMBER 2008

By putting innovation at the center of our nation's economic policies, we can ensure robust economic growth and rising standards of living for all Americans.

In today's economy, innovation – the development and adoption of new products and services, more efficient production processes, and new business models – is the most important factor driving increases in American standards of living. By putting innovation at the center of our nation's economic policies, we can ensure robust economic growth and rising standards of living for all Americans.

To ensure U.S. economic prosperity, the federal government cannot consign its role, as many neo-Keynesian economists advocate, to simply redistributing resources to the needy (or even the middle class). Economic policy must emphasize growth. This is not to say that government policies to ensure that growth is more fairly distributed are not needed, but without robust economic growth, it will be difficult to raise the standard of living for average Americans. In contrast to what many have recently asserted, productivity growth does still benefit average American workers.[1]

To foster prosperity, we also cannot, as many neoclassical economists do, simply hope that markets will get it right. Markets do play important roles in generating economic prosperity, but markets acting in response to price signals alone will not maximize U.S. economic growth. That requires proactive and strategic public policies to spur innovation.[2]

As a new Administration takes office in 2009, it is time for both Congress and the Executive Branch to take concrete steps to ensure that the economy is on a robust growth path over the next decade. To do this, they should adopt and implement eight key recommendations outlined below:

1. **Significantly Expand the Federal Research and Development Tax Credit**
2. **Create a National Innovation Foundation**
3. **Allow Foreign Students Receiving a Graduate Degree to Receive a Green Card**
4. **Reform the Patent System to Drive Innovation**
5. **Let Companies Expense New Investments in Information Technology in the First Year**
6. **Establish a Federal Chief Information Officer**
7. **Implement a National Broadband Strategy**
8. **Implement an Innovation-Based National Trade Policy**

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1. SIGNIFICANTLY EXPAND THE FEDERAL RESEARCH AND DEVELOPMENT TAX CREDIT

Virtually all scholarly studies of the research and development (R&D) tax credit find that it is a cost-effective tool to spur private sector R&D.[3] When President Clinton took office, the R&D tax credit in the United States was the most generous in the world. By 2004, in large part because other nations had put in place much more generous R&D tax incentives, the U.S. tax credit was only the 17th most generous.

It's time to not only make the federal R&D tax credit permanent, but also to significantly expand it to ensure that the United States can compete in the global innovation economy. Doing so would not only spur more R&D investments here at home, leading to faster economic growth and more quality-of-life enhancing innovations, but would also make the United States a more competitive location for internationally-mobile R&D.

To expand the federal R&D tax credit, Congress should do the following:

- **Double the 20 percent federal R&D tax credit to 40 percent.** The regular R&D tax credit allows companies to take a credit of 20 percent of increases in qualified R&D expenditures over a defined base period. The rate should be doubled to 40 percent.[4]

- **Expand the Alternative Simplified Credit by enacting a graduated three-tiered credit.** Under the Alternative Simplified Credit (ASC) established by Congress in 2006, firms can take a credit of 12 percent of qualified R&D expenditures above 50 percent of the average of their expenditures over the prior three years. Congress should expand the ASC to allow firms to receive (1) a credit of 20 percent of the amount of expenses greater than 75 percent and equal to or below 100 percent of the firm's average qualified research expenses; and (2) a credit of 40 percent for expenditures above 100 percent of the base. Establishing such a three-tiered credit would give firms a strong incentive to increase R&D in the United States.

- **Create a flat 40 percent tax credit for company expenditures on collaborative research at universities, federal laboratories, or Department of Justice-approved research consortia.** Collaborative research is critical to innovation, but firms invest less in it than is optimal because many of the benefits of such research spill over to other firms. Firms investing in extramural collaborative R&D should receive a flat tax credit of 40 percent on all such expenditures.

- **Transform the R&D tax credit into a "Knowledge Credit" by allowing workforce training expenses to also qualify for the credit.** Allowing firms to include workforce training expenditures in the calculations of qualified expenditures under the federal R&D credit would spur firms to invest more in the skills of the American workforce. At present, companies can expense investments in workforce development for tax purposes, but they cannot take a more generous tax credit on the investments. This is one reason why, with greater workforce turnover and more competitive markets, corporate expenditures on workforce training as a share of U.S. gross domestic product (GDP) have fallen by almost half in the last 15 years.[5] Transforming the R&D credit into a "Knowledge Credit" would help rectify this situation.

2. CREATE A NATIONAL INNOVATION FOUNDATION

Congress took an important step in the direction of supporting science and technology with the passage of the 2007 America Competes Act. But the challenge of maintaining U.S. competitiveness in science and technology is neither modest nor fleeting. We need to do more if we are to maintain our competitive position in the global innovation economy. Besides fully funding the America Competes Act, Congress should establish a National Innovation Foundation with a core mission of boosting technological innovation in the United States.[6]

A National Innovation Foundation would be a nimble, lean, and collaborative entity devoted to supporting firms and other organizations in their innovative activities.[7] It would catalyze industry-university research partnerships through national sector research grants, expand regional innovation-promotion through state-level grants to fund activities like technology commercialization and entrepreneurial support, and encourage technology adoption by assisting small and mid-sized firms in implementing best-practice processes and organizational forms that they do not currently use.

3. ALLOW FOREIGN STUDENTS RECEIVING A GRADUATE DEGREE IN MATH, SCIENCE, OR ENGINEERING TO QUALIFY FOR PERMANENT RESIDENT STATUS (I.E., RECEIVE A GREEN CARD)

Scientists and engineers are a key driver of innovation. This is why many nations are actively competing to lure this top-level talent to their borders.[8] Yet the number of Americans obtaining graduate science and engineering degrees has not kept up with demand. Indeed, almost one half of Ph.D. graduates of U.S. engineering, computer science, physical science, and life science programs are now from other nations. If we want the United States to continue to be the global innovation leader, we should make it easier for these talented individuals who receive a graduate degree in science, technology, engineering, and mathematics (STEM) fields to stay in the United States after graduation by making them eligible for a green card.[9]

4. REFORM THE PATENT SYSTEM TO DRIVE INNOVATION

Reforms to the U.S. patent system are urgently needed. A well-functioning patent system is key to driving innovation. But the U.S. patent system suffers from three key problems. First, the U.S. patent system is rife with delay. With over 700,000 pending patent applications in the U.S. Patent and Trademark Office (PTO), it can take four years to get a patent. Second, in part because the PTO has insufficient resources, patent examiners have been granting questionable patents that are overly broad and overlap with existing patents. Finally, there has been a dramatic increase in patent litigation and awards, which impose a significant tax on the U.S. innovation system. Patent reform legislation to address these issues has been introduced in Congress and should be passed.[10]

5. LET COMPANIES EXPENSE NEW INVESTMENTS IN INFORMATION TECHNOLOGY IN THE FIRST YEAR

Innovation itself is important, but it is largely through investment that innovations are diffused throughout the economy. Scholarly research has conclusively shown that investment in information technology (IT) powers growth.[11] In fact, IT seems to be "super capital" that has a much larger impact on productivity than other capital.

Greater investment in newer generations of IT spurs faster productivity growth. To encourage investment in IT in the United States, Congress should let companies expense IT investments in the first year. Currently, companies must depreciate IT equipment and software investments over a number of years. Allowing companies to write off all the costs for tax purposes in the first year would raise the rate of return of new equipment, spurring companies to invest more and to more rapidly turn over older, less productive equipment. By lowering the cost of equipment and software, investment incentives encourage more investment by helping these investments turn the corner of profitability earlier than such investments otherwise would. In addition, the expensing of IT investments would make companies in the United States more competitive with companies in other nations, especially nations that use firm-specific incentives to attract globally mobile establishments.[12]

6. ESTABLISH A FEDERAL CHIEF INFORMATION OFFICER

The lion's share of productivity gains for the foreseeable future will likely continue to come from the trend of digital transformation – leading all organizations and individuals to use digital technologies. Although the private sector will drive much of the digital transformation, several market failures are slowing the transformation process – and the federal government could take a number of steps to help speed the process.[13]

Without top-level leadership, however, it is difficult for the federal government to take the steps that are needed to help spur digital transformation of the U.S. economy and government. Currently, no one in the federal government is responsible for leading e-transformation. Although 54 federal agencies have chief information officers (CIOs) of their own, the federal government as a whole does not.

It's time to create a position of a federal CIO that reports directly to the President. The federal CIO should task all government agencies with examining how their procurement, regulatory, and other actions can speed the digitization of sectors they influence (e.g., health, education, transportation, banking and securities, law enforcement, and housing).[14] The CIO should also take the lead in shaping e-government for the entire federal government, help share the Administration's policy regarding the Internet, oversee issues of computer and network security for the government, and work with state and local governments to promote e-government.

7. CRAFT AND IMPLEMENT A NATIONAL BROADBAND STRATEGY

America lags behind other nations in broadband adoption, recently falling to 15th among Organization for Economic Cooperation Development (OECD) nations. To spur ubiquitous high-speed broadband deployment and adoption, Congress and the next Administration should do all of the following:

- **Enact more favorable tax policies to encourage investment in broadband networks, such as first year expensing and exempting broadband services from federal, state, and local taxation.**
- **Continue to make more spectrum, including unlicensed spectrum, available for next-generation wireless data networks.**
- **Reform the federal Universal Service Fund (USF) program to extend support to broadband for all carriers, and consider providing the funding through a reverse auction mechanism.**
- **Establish a national program to co-fund state-level broadband support programs, such as E-North Carolina and ConnectKentucky.**
- **Fund initiatives around the nation to encourage broadband usage and digital literacy.**[15]

8. CRAFT AND IMPLEMENT AN INNOVATION-BASED NATIONAL TRADE POLICY

U.S. trade policy should help spur innovation. To ensure that it does, Congress and the next Administration should craft and implement an innovation-based U.S. trade policy that has two major features.

First, given the limitations of bilateral free trade agreements and the difficulties in moving forward with broad multilateral agreements, the next Administration should actively explore other mechanisms to open markets around the world. This should include a renewed focus on sectoral agreements. The United States and the European Union, for example, tabled a proposal in the Doha Round context to forge a multilateral environmental goods and services agreement. With or without Doha, this should be pursued, especially given the critical importance of promoting green trade. In addition, the next Administration should begin efforts to forge a services industry sectoral agreement. However, to be WTO consistent, these would need to include substantially all the services sectors (including telecom, banking and health care).

Second, to combat other nations' systematic and unfair "mercantilist" trade policies directed at eroding technology leadership of nations like the United States, U.S. policy should focus more on assertively confronting practices used by other countries such as theft of intellectual property, discriminatory tax systems, and protectionist standards – to unfairly gain global market share. Many nations systematically seek to gain advantage in the innovation economy by violating either the letter or the spirit of the World Trade Organization (WTO).[16] It is critical that U.S. trade policy place as much emphasis on fighting other nations' mercantilist policies aimed at eroding U.S. technology leadership as it does opening up new markets.

To ensure that U.S. trade policy supports innovation while combating technology mercantilism, Congress and the next Administration should take the following steps:

- **Create within the U.S. Trade Representative's Office (USTR) an ambassador-level U.S. trade enforcement chief and a Trade Enforcement Working Group and add $20 million for trade enforcement to the USTR budget.** One reason why USTR has not done more to enforce existing trade agreements is because doing so is quite costly and labor intensive. Expanding USTR's trade enforcement budget and creating these new positions would provide USTR with needed resources and send a clear signal that a key part of USTR's job is to aggressively bring actions against other nations that are engaged in technology mercantilism.[17]
- **Allow companies to take a 25 percent tax credit for expenditures related to bringing WTO cases.** Companies that help the USTR bring cases are acting on behalf of the U.S. government and U.S. workers. But bringing WTO cases is costly for the government and the affected industry; and because trade enforcement is a collective good, companies have an incentive to free ride and take advantage of cases filed by the government and prepared by other companies. As a nation, therefore, the United States underinvests in trade enforcement. To help remedy

this situation, companies should be allowed to take a tax credit for expenses related to trade enforcement.

CONCLUSION

If the United States is to regain robust, broadly shared growth and maintain its international economic competitiveness, it's time for bold policy action to spur innovation. We need smart public-private partnerships that recognize that while the private sector is the key performer of innovation, the public sector can and should play a vital supportive role. These recommendations are intended as first steps towards building the innovation-based public-private partnerships needed to drive economic growth and prosperity.

ENDNOTES

1. Stephen Rose, "Does Productivity Growth Still Benefit Working Americans?: Unraveling the Income Growth Mystery to Determine How Much Median Incomes Trail Productivity Growth," Information Technology and Innovation Foundation, Washington, D.C., June 2007 <www.itif.org/files/ DoesProductivityGrowthStillBenefitWorkingAmericans.pdf> (accessed September 14, 2008).

2. Robert D. Atkinson and David B. Audretsch, "Economic Doctrines and Policy Differences: Why Washington Can't Agree on Economic Policies," Information Technology and Innovation Foundation, Washington, D.C., September 12, 2008 <www.itif.org/index.php?id=177> (accessed September 14, 2008).

3. Robert D. Atkinson, "The Research and Experimentation Tax Credit: A Critical Policy Tool for Boosting Research and Enhancing U.S. Economic Competitiveness," Information Technology and Innovation Foundation, Washington, D.C., September 5, 2006 <www.itif.org/index.php?id=67> (accessed September 14, 2008).

4. For more detail on these recommendations, see Robert D. Atkinson, "Expanding the Research and Development Tax Credit to Drive Innovation, Competitiveness and Prosperity," Information Technology and Innovation Foundation, Washington, D.C., April 2, 2007 <www.itif.org/index.php?id=58>(accessed September 14, 2008).

5. In 1988, training expenditures by organizations in the United States were about 0.82 percent of GDP. See Robert D. Atkinson, *The New Economy Index* (Washington, D.C.: Progressive Policy Institute, 1998). By 2007, training expenditures had declined to 0.42 percent of GDP. See The New Economy Index and industry report data from Training Magazine's 2001-2007 Industry Reports <www.trainingmag.com/msg/ content_display/publications/e3ib4fbcf3a3d03c749c530aa54043278f5> (accessed September 14, 2008).

6. The National Innovation and Job Creation Act (S. 3078), introduced by Senators Clinton (D-NY) and Collins (R-ME) would create a National Innovation Council modeled after the National Innovation Foundation. See S. 3078: National Innovation and Job Creation Act <thomas.loc.gov/cgi-bin/query/z?c110:S.3078:> (accessed September 14, 2008).

7. Robert D. Atkinson and Howard Wial, "Boosting Productivity, Innovation, and Growth Through a National Innovation Foundation," Information Technology and Innovation Foundation, Washington, D.C., April 2008 <www.itif.org/files/NIF.pdf> (accessed September 14, 2008).

8. David M. Hart, "Global Flows of Talent: Benchmarking the United States," Information Technology and Innovation Foundation, Washington, D.C., November 17, 2006 <www.itif.org/index.php?id=66>.

9. See H.R. 6093, introduced by Congresswoman Zoe Lofgren (D-CA) which exempts from the employment-based (EB) caps any alien who has earned a master's or higher degree from a United States institution of higher education in a STEM field and who has an offer of employment from a United States employer in a field related to such degree.

10. In the House, H.R. 1098 passed this year. In the Senate, the Judiciary Committee passed S. 1145, but it was not voted on by the full Senate.

11. Robert D. Atkinson and Andrew S. McKay, *Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution* (Washington, D.C.: Information Technology and Innovation Foundation, March 2007) <www.itif.org/files/digital_prosperity.pdf>.

12. For example, semiconductor factories in Japan can depreciate 88 percent of their cost in the first year, compared to just 20 percent in the United States.

13. These include opposition by vested interests, lack of standards, chicken or egg issues, and system interdependencies, as we see in the slow pace of health IT adoption. See Daniel Castro, "Improving Health Care: Why a Dose of IT May Be Just What the Doctor Ordered," Information Technology and Innovation Foundation, Washington, D.C., October 2007 <www.itif.org/files/HealthIT.pdf> (accessed September 14, 2008).

14. Robert. D. Atkinson, "What's Next," Public CIO, February 23, 2005 <www.govtech.com/pcio/ more.php?code=GT_WRITER_ROBERT_D__ATKINSON&format=tag_articles_simple> (accessed September 14, 2008).

15. For more detail on these proposals see, Robert D. Atkinson, "Framing a National Broadband Policy," CommLaw Conspectus 16 (2007): 145 <commlaw.cua.edu//articles/v16/16.1/Atkinson.pdf> (accessed September 14, 2008).

16. Julie A. Hedlund and Robert D. Atkinson, "The Rise of the New Mercantilists: Unfair Trade Practices in the Innovation Economy," Information Technology and Innovation Foundation, Washington, D.C., June 2007 <www.itif.org/files/ITMercantilism.pdf> (accessed September 14, 2008).

17. Robert D. Atkinson, "Combating Unfair Trade Practices in the Innovation Economy," testimony before the Senate Committee on Finance, U.S. Congress, Washington, D.C., May 22, 2008 <www.itif.org/files/atkinsonfinancecommitteetestimony.pdf > (accessed September 14, 2008).

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Dr. Robert D. Atkinson is President of the Information Technology and Innovation Foundation, a Washington, DC-based technology policy think tank. He is also author of the *The Past and Future of America's Economy: Long Waves of Innovation that Power Cycles of Growth* (Edward Elgar, 2005).

ABOUT THE INFORMATION TECHNOLOGY AND INNOVATION FOUNDATION

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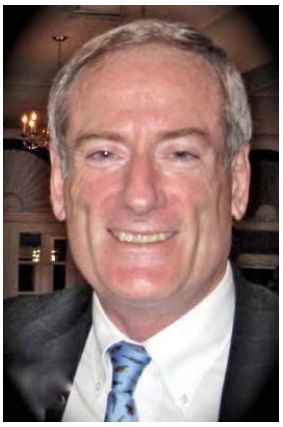

Robert Spurrier Boege ("Bur—ga") has served as Executive Director of ASTRA, the Alliance for Science & Technology Research in America since January of 2001. ASTRA is a collaboration of more than 120 companies, academic institutions, professional and trade associations focused on increasing federal research support for the physical sciences, mathematics & computational sciences, and engineering.

ASTRA was founded in 2000. The "Friends of ASTRA" world- wide number about 32,000 scientists, engineers and technologists. ASTRA is primarily a Web-based network of institutions and individuals linking through two key Web Sites: **www.usinnovation.org** and **www.aboutastra.org**. Mr. Boege edits *ASTRA Briefs* and *Tipping Points* for ASTRA and oversees ASTRA's two Web sites as part of his ASTRA duties.

Mr. Boege has served in various positions within the government, nonprofit sector and industry. He has published extensively in the areas of nonprofit taxation and antitrust law. Boege created the publication *Association Law & Policy* and served as its editor for 11 years. Following positions with the Congressional Research Service's American Law Division and Sperry Corporation's Washington Office,

Mr. Boege became the chief lobbyist for the American Society of Association Executives (ASAE) and began that organization's government affairs outreach program in 1982.

He was in charge of business liaison for the 1984 Presidential Campaign for President Reagan and then the Presidential Inaugural Committee in 1985. Mr. Boege was subsequently appointed Associate Director of the White House Conference on Small Business in 1985-86, then held a series of positions in the U.S. Small Business Administration and the U.S. Department of Energy.

From 1999-2000 he served in the Technology Administration at the U.S. Department of Commerce, where he specialized in issues related to the "new" economy, workforce development and technology policy.

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A native of Davenport, Iowa, Boege's home town is Park Forest, Illinois. Boege is now a resident of Martinsburg, West Virginia where he is active in civic affairs and historic preservation activities.

Visiting Speaker: Susan B. Butts, Ph.D.

Dr. Susan Butts is Senior Director of External Science and Technology Programs at The Dow Chemical Company. In this capacity she is responsible for Dow's contract research activities with US and European government agencies and sponsored research programs at over 100 universities, institutes, and national laboratories worldwide. She has also held the role of Global Staffing Leader in which she managed recruiting and hiring activities for the R&D function. She currently works from Dow's Washington, DC office and represents the company on many issues relating to science & technology policy.

Dr. Butts is active in a number of organizations that address issues pertaining to relationships between industry, universities, and government research laboratories. She was a co-founder and member of the Steering Team for the University-Industry Partnership Project, an effort sponsored by the Government-University-Industry Research Roundtable (GUIRR) of the National Academies, NCURA and IRI with the goal of lowering the barriers to industry sponsored research at universities. This project led to the creation of a new organization, the University-Industry Demonstration Partnership (UIDP), which operates within GUIRR. Dr. Butts is currently the President of the UIDP. She also serves on the governing boards for the Council for Chemical Research (CCR) and the Alliance for Science and Technology Research in America (ASTRA). She is the Dow representative to the American Chemical Society's Committee on Corporation Associates, and the Industrial Research Institute (IRI). She is also a member of the National Council of University Research Administrators (NCURA), the Association of University Technology Managers, the American Association for the Advancement of Science, and Sigma Xi.

Dr. Butts holds the degrees of B.S. in Chemistry from the University of Michigan and Ph.D. in chemistry from Northwestern University. Before joining the External Technology group Dr. Butts held several other positions at Dow including Senior Resource Leader for Atomic Spectroscopy and Inorganic Analysis within the Analytical Sciences Laboratory, Manager of Ph.D. Hiring and Placement, Safety and Regulatory Affairs Manager for Central Research, and Principal Investigator on various catalysis research projects in Central Research.

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