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TAMARA BEKEFI
DAEDALUS STRATEGIC ADVISING

MARC J. EPSTEIN
RICE UNIVERSITY

THE VALUE OF GREEN TIRES TO CORPORATE PROFITABILITY

RUBBER GOES GREEN

"Tire manufacturers are already beginning to compete on 'green' and manufacturing a high quality, safe, and cost-effective green tire using engineered ultra-fine recycled rubber powder is the next logical step in this trend."

ABOUT THE AUTHORS

Tamara Bekefi (tbekefi@daedalusadvising.com) is Principal of Daedalus Strategic Advising, a firm focused on sustainability and corporate social and political risk management. Until recently, Ms. Bekefi was the manager of business and international development research and a Research Fellow at Harvard University's Kennedy School of Government.

With expertise in corporate responsibility, corporate political and social risk measurement and management, and sustainable private sector development, Ms. Bekefi has worked with Fortune 500 companies, industry organizations and social investment firms. These include Starbucks Coffee Company, Campbell Soup Company, ExxonMobil, Phillips-Van Heusen, IPIECA (International Petroleum Industry Environmental Conservation Association), and KLD Research & Analytics.

Author of numerous papers, articles, reports, and management guidelines, Tamara has lectured at leading universities and corporate forums. She has a Masters degree in international business and political economy from the Fletcher School of Law and Diplomacy (Tufts University) and graduated with a BA, summa cum laude, from McGill University.

Marc J. Epstein (epstein@rice.edu) is Distinguished Research Professor of Management at Jones Graduate School of Management at Rice University in Houston, Texas. Prior to joining Rice, Dr. Epstein was a professor at Stanford Business School, Harvard Business School, and INSEAD (European Institute of Business Administration).

He has focused extensively on sustainability, environmental, and corporate social responsibility and the measurement of corporate social, environmental, and economic impacts for most of his career. In both academic research and managerial practice, Dr. Epstein is considered one of the global luminaries in the areas of corporate sustainability, governance, and accountability.

His 18 authored or co-authored books and over 100 professional articles include many award winners including Measuring Corporate Environmental Performance: Best Practices for Costing and Managing an Effective Environmental Strategy and Counting What Counts: Turning Corporate Accountability to Competitive Advantage. His most recent book, Making Sustainability Work: Best Practices in Managing and Measuring Corporate Social, Environmental, and Economic Impacts, was released in January, 2008.

Executive Summary

There is a growing market for green products that, according to experts, is not an ephemeral trend but is here to stay. Given the choice between eco and non-eco products, consumers buy "green" when the products on offer are of equal price and quality. The tire industry ought to capitalize on this trend by offering green tires, of equal quality and price to current products, formulated from Engineered Rubber Powders (ERP) derived from post industrial and consumer rubber. This new powder, resulting from technology borrowed from the pharmaceutical industry and refined for the specific demands of the tire industry, offers an opportunity to satisfy consumers while saving input and manufacturing costs. Auto manufacturers, governments, and fleet owners are all beginning to compete on environmental issues, and providing them with a green tire would aid them in meeting their environmental responsibility goals. In an age of sky-rocketing oil prices, engineered ultra-fine recycled rubber powder also offers tire manufacturers a high quality replacement substance to drive down the price of its main raw material

While the tire manufacturing industry continues to slowly move towards green products and environmental stewardship, individual tire companies have the choice to take a leadership role and gain first mover advantage, or to become followers and potentially forego market opportunities. Tire manufacturers are already beginning to compete on "green" and manufacturing a high quality, safe, and cost-effective green tire using engineered ultra-fine recycled rubber powder is the next logical step in this trend.

INTRODUCTION

Many industries are beginning to capitalize on new market opportunities resulting from an increased focus on "green" products—industrial carpet manufacturers like Interface, hybrid cars ranging from the Toyota Prius to the Ford Escape hybrid SUV, and big box stores like Wal-Mart are all embracing "green" as a new mechanism to attract customer interest and spending. However, the American tire industry has yet to capture the "green" tide, which holds the potential to propel business growth and profit and provide significant possibilities for new competitive advantage. Producing a green tire—here defined as a tire that includes 15% loading of Engineered Rubber Powders (ERP) derived from post industrial and consumer rubber—would:

- Lower input costs
- Lower the cost of production
- Allow the tire manufacturer to become the "supplier of choice" for the U.S. government
- Allow the tire manufacturer to become the "supplier of choice" for box brands, fleets, and many after market consumers
- Create a "closed-loop" generating savings for tire manufacturers and distributors
- Capture reputation value
- Respond to the growing trend in society for green products, and
- Potentially get carbon credits for using a material recycled from discarded tires.

Seismic changes in customers' attitudes towards environmental conservation in the past few years and a new technology to formulate ultra-fine recycled rubber powder have created an opportunity for tire manufacturers to produce a green tire to capture market share. Production of an eco-friendly tire is logical and necessary. As tire manufacturers' customers, including the after market, fleets, the government, and tire distributors, are all demanding environmentally friendly products, a green tire would meet consumer needs, be lucrative for tire manufacturers and be good for society. Production of an eco-friendly tire is now possible with recent innovations in generating ultra-fine (80-400 mesh) engineered rubber powder at commercial volumes and of consistent, repeatable quality tailored to manufacturer's specifications using a cryogenic-aided turbo shearing mill. Inclusion of this fine mesh powder at up to 15% loading creates technical, process and cost efficiencies that have not historically been available to the tire manufacturing industry. [For more technical data on ultra-fine engineered rubber powder, please see Appendix 1.]

The first company that manufactures and markets a green tire, in particular, has much to gain. Consider the story of Toyota's first mover success with the Prius gas-electric hybrid car.[1] Trying to envisage what might transform its industry and threaten its market share in the future, Toyota's leaders convened a team to create the first great car of the 21st century in 1993, nearly a decade before that century arrived. Toyota's leadership pushed the team beyond the technological limits it had previously worked within. As a

result of a series of technological breakthroughs, manufacturing innovations, and careful marketing, Toyota has sold more than 1 million hybrid cars—five times as many as its nearest competitor—since introducing them in 1997, and has tripled its U.S. monthly sales to 24,000.[2] In addition, its reputation as an environmental leader has driven sales of non-Prius cars significantly.

The market is now ripe for similar innovation in tire manufacturing. Some tire manufacturers are using Engineered Rubber Powders (ERP) but are not marketing it. The first tire manufacturer that markets its use of ERP will gain first mover advantage by meeting consumers' demand for more environmentally-friendly products and will pull ahead of the competition in a market that is moving in this direction in any case.

I. CONSUMERS ARE BUYING GREEN

Numerous academic and industry studies have shown that consumers are increasingly interested in green product. Given equal price and quality, consumers will now buy green products as opposed to non-environmentally friendly ones.[3] According to a May 2007 ImagePower® Green Brands Survey:[4]

- Green products are considered to be of superior quality
- Consumers perceive green as a direct and positive reflection of their social status, in addition to recognizing its broader value to society and the world.
- 80% of consumers believe it is important to buy from green companies.

This is a radical shift in the past year. "For today's consumers, being green is not a fad, but a seismic, long-term shift in self-definition and behavior."[5] These shifting attitudes are also being seen among corporate executives and in radical changes in supply chain management. These changes in corporate products and processes are practical and business driven. [For more on shifting consumer and corporate leadership attitudes towards environmental stewardship, please see Appendix 2]

Companies in a variety of sectors have successfully differentiated themselves from their competition using the environment as a vehicle. Home Depot, the world's largest buyer of construction material and America's second largest retailer, began offering Forest Stewardship Council certified sustainably harvested wood in addition to its traditional line. It first tested customer response to eco vs. non-eco products by placing two nearby bins of plywood of the same size, one with Forest Stewardship Council certification and labeling and the other without. When the cost was the same, the FSC-labeled wood outsold unlabelled plywood by more than two to one.[6] Home Depot found that, "given the option of a product that performs just as well, we are seeing the consumer would rather buy something that has less of an impact on the environment."[7] As a result of its initial success with "green" wood Home Depot has launched its "Eco Options" label for nearly 3,000 products ranging from energy efficient fluorescent light bulbs to natural insect killers. The company expects to expand the Eco Options line to 6,000 products by 2009.

II. GOVERNMENT IS LOOKING TO GREEN SOLUTIONS

The U.S. government has long been involved in spurring the market for recycled goods for two reasons:

a) ***Landfills cannot accommodate all of our waste***. The Federal government acknowledged, in 1976, that landfills were quickly overfilling and as a result passed the Solid Waste Disposal Act.[8]

b) ***The recycling industry is a market solution to a societal problem***. The Federal government realized that, according to the Environmental Protection Agency (EPA), "By converting waste into valuable raw materials, recycling creates jobs, builds more competitive manufacturing industries, and adds significantly to the U.S. economy."[9] In fact, according to a 2001 EPA-commissioned study, the recycling and reuse industry consists of approximately 56,000 establishments that employ over 1.1 million people, generate an annual payroll of nearly $37 billion, and gross over $236 billion in annual revenues, contributing roughly $12.9 billion in federal, state, and local tax revenues, with 80 percent going to federal and state government.[10]

As a result of these acknowledged benefits, the Federal government has acted as a catalyst to stimulate the recycling industry in a number of sectors. This has usually been done by using its own purchasing power to increase recycling demand through procurement policies or leveraging its authority in others ways.

- *Paper*: In 1993 the White House issued an Executive Order requiring federal agencies and the military to buy recycled paper with at least 20% post-consumer content.[11]
- *Plastic and aluminum*: Eleven states have deposit laws, or "bottle bills", requiring refundable deposits on certain beverage containers.
- *Electronics*: The Electronic Waste Recycling Act of 2003 in the State of California resulted in the collection of 32,000 tons of consumer electronics.[12]
- *Recycled content materials*: In 2007, President Bush issued Presidential Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Federal Environmental, Energy, and Transportation Management" directing agencies to implement sustainable acquisition, including the purchase of recycled-content products whenever possible.

With increased concern about global warming and climate change, as well as dependence on foreign sources of oil becoming a national security issue, the U.S. Government now seems to be turning its attention towards the tire industry. The U.S. House of Representatives began consideration of the Tire Investment, Recovery and Extension Act (TIRE Act) in 2008, which would give a $3/tire tax credit to high volume tire purchasers who bought tires made of recycled rubber.[13]

Producer responsibility and product take-back

In Europe and Japan laws have already been passed making companies responsible for their products from "cradle to grave". These product take-back mandates dictate that companies are responsible for collecting their products when the consumer is done with them. These regulations are designed to keep bulky or toxic products and packaging out of the waste stream. In Europe, the European Union (EU) has passed the End-of-Life Vehicles Directive mandating that by 2015, 85% of a car's materials, by weight, to be recovered and reused. In many European countries governments have also mandated that tire manufacturers must collect the equivalent number of tires as they produce annually. In France alone, the cost of this legislation to tire manufacturers has reached close to $100 million per year.[14] In Japan, the government has mandated that 70% of automobile materials must be reused by 2015, while the Japanese auto industry has set a 95% target for the same time period. [15]

In contrast to these product take-back mandates, the U.S. Government has an opportunity to create a win-win situation for business and society by advancing the development of a rubber recycling industry. Encouraging wider use of highly engineered rubber powder would spur innovation and the profitable use of waste tires. Engineered rubber powder could be re-integrated into tires and a host of other substances ranging from car parts to building materials. So rather than the punitive "cradle to grave" approach now being enacted in Europe and Japan, a rubber recycling industry with highly engineered rubber powder as an end-product creates a "cradle to cradle" scenario where the waste product is re-integrated into new tires and other products in a manner that is lucrative for business and good for society.

III. TIRE COMPANIES ARE ALREADY BEGINNING TO COMPETE ON "GREEN"

The tire industry has already begun work to address environmental issues by developing lower roll-resistant tires.[16] Many companies have begun marketing a low roll resistance, high priced "green tire" containing silica coated with saline. However, this product contains little to no recycled content, so does not fully capitalize on the opportunity for a green tire. Several tire manufacturers have already announced their investments in technological solutions to address environmental issues. Yokohama has indicated that "green" is a cornerstone of its corporate market growth strategy. It has even explicitly mentioned scrap tire processing technology allowing the company to use recycled rubber in new tires beginning this year.[17] Michelin North America Inc. recently announced its plan to invest $6.8 million for fuel economy research and design, partly with Clemson University's International Center for Automotive Research, with an expected outcome of new materials, modeling tools and manufacturing processes for future tires.[18] France's Michelin SA is also touting its environmentally friendly tire with an advertising campaign that estimates its 570 million tires sold worldwide over the past 15 years have reduced fuel consumption by an estimated 2.38 billion gallons, resulting in a reduction of CO2 emissions of 25 million tons.[19] With competition on the environment among tire companies already beginning to take shape, the opportunity to capitalize on a tire loaded with up to 15% highly engineered, superior quality materials that have been reclaimed from the existing tire stockpile is enormous.

IV. TIRE MANUFACTURERS ARE FACING CHALLENGES THAT RUBBER MESH ADDRESSES

By producing and marketing a green tire using fine rubber mesh manufacturers could capture significant reputation value; however, the drivers for a green tire are entirely practical.

1. *Tire manufacturers' customers are demanding "green"*. Big box stores, tire retailers, the government, and the aftermarket are all demanding green products. Production of a green tire formulated from Engineered Rubber Powders (ERP) derived from post industrial and consumer rubber would address these demands.

2. *There is the real possibility that the supply of virgin rubber will not be able to meet demand in the coming years*. Motorization is projected to increase dramatically in the developing world—the Energy Information Administration estimates that the road vehicle population will grow from 170 million vehicles in 1996 to 454 million in 2020 in developing regions.[20] In China, for example, car ownership is increasing almost as quickly as GDP and by 2020 it is estimated that between 88.85 and 132.24 million privately owned cars will grace China's roads.[21] This increased demand for cars translates into a massive increase in demand for tires, particularly in China and India. As demand for tires grows, virgin rubber supplies may not be able to keep pace.

3. *Oil prices continue to rise and as a result synthetic rubber is becoming increasingly expensive*. Petroleum derivatives are the main inputs for synthetic rubber, tires' base component. With oil prices rising to over $100/barrel for the first time in history, tire manufacturers may want to seek savings by finding a high quality replacement substance to drive down the price of its main raw material. In fact, Michelin has instituted a new pricing system for its original equipment customers worldwide based on a scale indexed to changes in oil prices. The company reports that petroleum-based products account for about 60 percent of the cost of a passenger car or light truck tire. Creating a "closed loop" in which old tires are converted into Engineered Rubber Powders (ERP) for use in new tires, could represent significant savings to manufacturers.

4. *There is an ample supply of discarded rubber that can be reformulated and reused*. On average the U.S. produces 300 million waste tires annually, or one per member of the population. Approximately 51% of these are shredded to make tire derived fuel (TDF), 16% for civil engineering purposes like road construction, and 12% for playground and sports surfacing and other rubber products.[22] This leaves 63 million scrap tires annually, which are chopped up and thrown into monofills—essentially landfills for scrap tire waste. Engineered rubber powder represents the most beneficial use of this scrap material, both environmentally and economically. It can be used as a replacement material for petroleum-derived polymers in high performance materials like tires, and has ten times the value of crumb rubber and 30 times the value of tire derived fuel.

> With a recent lawsuit against the Environmental Protection Agency changing regulations governing industrial boilers using TDF and classifying this process as hazardous waste incineration, industry analysts predict that facilities which traditionally used TDF will become loath to do so because of additional administrative requirements.[23] The slowdown of TDF use would result in an even greater number of scrap tires going to monofills on an annual basis, thus creating an even greater glut of waste tires that can be used to make ultra-fine engineered rubber powder for use in green tires. Generating fine rubber powder for industrial use from waste tires would also solve the huge problem of tire piles that pose fire and health risks. Illegal tire dumping and tire piles are such big problems that 48 states passed laws of regulations specifically dealing with scrap tires.[24]

Production of a green tire by using ultra-fine rubber powder provides tire manufacturers with cost savings and the potential to capture markets on an environmental platform that has, to date, been left untapped.

UNDERSTANDING THE BENEFITS WITHIN A CORPORATE SUSTAINABILITY MODEL

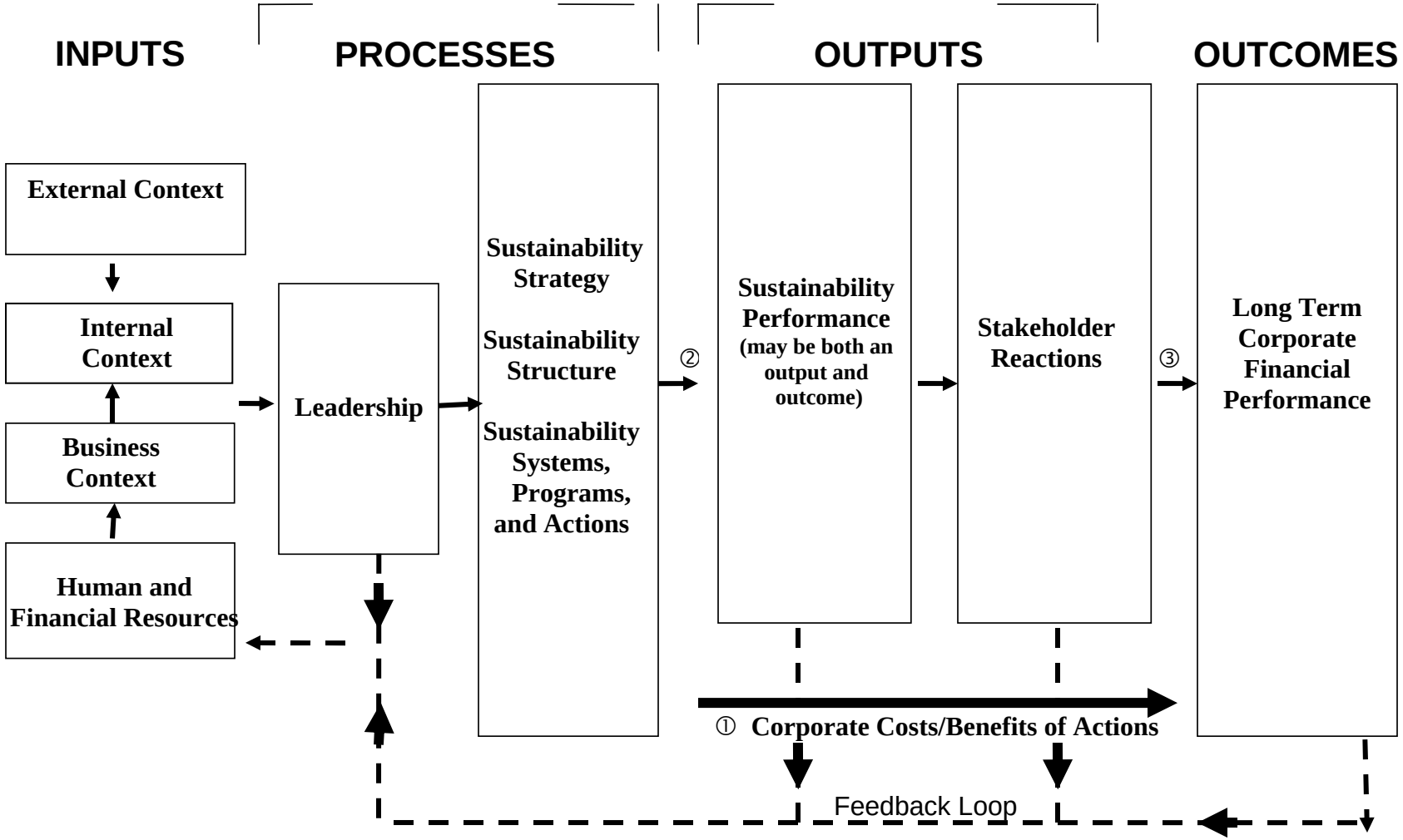
The benefits to tire manufacturers of producing and marketing a green tire can be examined and calculated within the context of the Corporate Sustainability model in Exhibit 1. Understanding the link between corporate environmental, social and financial performance will help tire company managers to see the impact of developing a green tire on return on investment (ROI) decisions.[25] The Corporate Sustainability Model describes the inputs, processes, outputs, and outcomes necessary to implement a successful sustainability strategy. The inputs include:

- The external context
- The internal context
- The business context
- Human and financial resources

In this analysis, we concentrate on the outputs and outcomes in the model. [For information on inputs and processes, particularly as they relate to tire manufacturers, please see Appendix 3.]

The output of these processes is sustainability performance—that is, the effect of corporate activity on the social, environmental, and economic fabric of society. In addition to having an effect on society, these activities often impact corporate financial performance (outcome, in the model). This typically occurs through various positive and negative stakeholder (such as customers, employees, regulators, and consumer activists) reactions such as additional purchases, consumer protests, employee loyalty or resistance, and government regulations.

Exhibit 1: Corporate Sustainability Model[26]



There are three major sets of impacts.

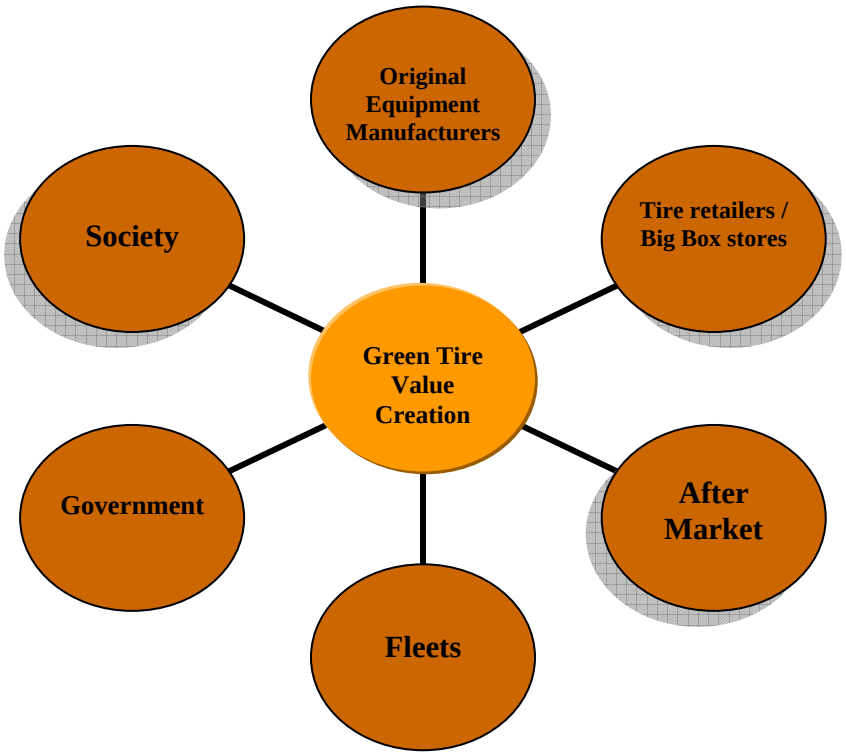
① **Corporate Financial Costs/Benefits of Actions**
② **Social Impact**
③ **Financial impact through sustainability performance**

OUTPUTS

Sustainability performance: Sustainability performance is the social, environmental, and economic performance of a company and relates to the objectives that are important to the internal and external stakeholders of the organization. In the tire industry this includes steps taken to reduce environmental impacts of tire production through both the production methodology and the product inputs.

Stakeholders' reactions: Stakeholder reactions are an important component of the framework as they may significantly affect short-term revenues and costs and long-term corporate performance on many levels. Because gaining advantage through stakeholders has been recognized as a driver of strategic success, companies must identify the key stakeholder groups that are the primary drivers of their strategy. Exhibit 2 provides an overview of tire manufacturers' stakeholders who would react to production of a green tire. In all cases, the reaction would range from neutral to overwhelmingly positive.

Exhibit 2: Tire company stakeholders benefiting from green tires



Original Equipment Manufacturers (Automotive companies): The car industry, faced with increasing pressure both from consumers and legislators, is beginning to compete on environmental responsibility. Providing OEMs with a green tire would help them meet their own customer demands and fulfill new regulatory requirements outlined by the Corporate Average Fuel Economy (CAFE) requirements. [More information on the green push among automotive manufacturers' competing and how green tires would help them reach CAFE requirements can be found in Appendix 4.]

Tire Retailers: Many tire retailers are seeking to "green" their brand images, and providing a green tire made from ERP would help them do so. Sears has a stated corporate commitment to environmental sustainability,[27] as do other tire retailers like Costco.[28] Given that many retailers also reclaim tires from their customers, providing a green tire made from this reclaimed waste helps them create a closed-loop and move towards their environmental stewardship and zero-waste goals. Big box stores can glean even more benefits given a green tire because they interact with tires at three levels: they use tires on their fleets, sell tires to their customers, and reclaim tires. [For more information on benefits to big box stores, please see Appendix 5.]

After market: Individual consumers (called the after market) are increasingly interested in purchasing green products if they are of equal price and quality as non-green products. Providing the after market with the option to buy a green tire would be appealing to two particular demographics:

1. Those with "green" attitudes and behaviors, which includes virtually the entire American public to one degree or another, according to a recent Penn, Schoen and Berland poll of 1504 adults.[29]
2. Those concerned with American energy security and dependence on foreign oil—which accounts for 73% of Americans.[30]

[For more information on the large demographics interested in each of these issues, please see Appendix 6.]

Fleet owners*:* Fleet owners like Federal Express, the United Parcel Service, and Wal-Mart are all seeking to capture economic savings and enhanced brand value through environmental stewardship. Each has set environmental goals, like Wal-Mart's aim to double truck fuel economy by 2015, which it is well on the way to accomplishing.[31] Fleet owners have explicitly stated their expectation that they will be provided with a "green" totally recyclable tire. [For more information on the demands and drivers for green tires among fleet owners, please see Appendix 7.]

Government*:* The U.S. Federal government has made it clear that it is interested in greening its overall operations. The General Services Administration (GSA)—which itself had over 200,000 vehicles in 2007 and is one of the largest non-tactical federal fleets in the U.S. government[32]—has outlined a number of new policies related to fleet management, fuel efficiency and recycling. [For more information on the government's new policies around environmental sustainability, please see Appendix 8.] The first tire

company to produce and market a green tire could capture huge market share because it would be the only supplier able to fulfill the mandate of these government requirements.

Society: Society at large is becoming increasingly concerned about the human impact on the environment and it is also looking to companies to address this issue. In a recent survey, 77% of people counted the environment as among the top four causes companies should address and 93% believe companies have a responsibility to help preserve the environment.[33] However, 94% of Americans drive[34] and most are aware of their tires' impact on fuel efficiency. So they are increasingly looking towards car manufacturers and related technologies to help lower their impact on the environment. [For more information on American driving rates and tire impacts on the environment, please see Appendix 9.]

OUTCOMES

Corporate financial performance: For most companies, the ultimate focus of sustainability strategies and programs must be short-term or long-term corporate financial performance. Corporations can translate sustainability into profitability. To effectively capture the impact on organizational performance, the outputs of the sustainability processes must be ultimately converted to monetary measures. Extensive research has shown that improved corporate sustainability performance impacts financial results through both enhanced revenues and lower costs.[35] Numerous studies have shown that consumers have a more favorable image of corporations that support causes that the consumers care about, and that many consumers report that they would switch brands based on social reputation. Revenues related to sustainability management initiatives can be positively impacted through reputational effects as well as through "green" marketing initiatives. Costs are also positively influenced by sustainable management initiatives. Process improvements may lower costs of energy and water usage and decrease costs of waste handling and recycling. These process improvements could all be applied to the tire manufacturing industry in the context of using ultra-fine engineered rubber powder to produce a green tire. Alcoa reduced its emissions 26% below 1990 levels in 2003 through energy efficiency improvements, and has captured over $16 million per year in energy savings.[36] Companies with stronger environmental performance also tend to have lower costs attributed to fines, penalties, and legal fees related to environmental activities. So, for many companies, excellence in sustainability performance is a desired final outcome—the sustainability actions taken to reduce the organization's "footprint" on society and the environment.

TIRE MANUFACTURER OUTCOMES OF PRODUCING A GREEN TIRE

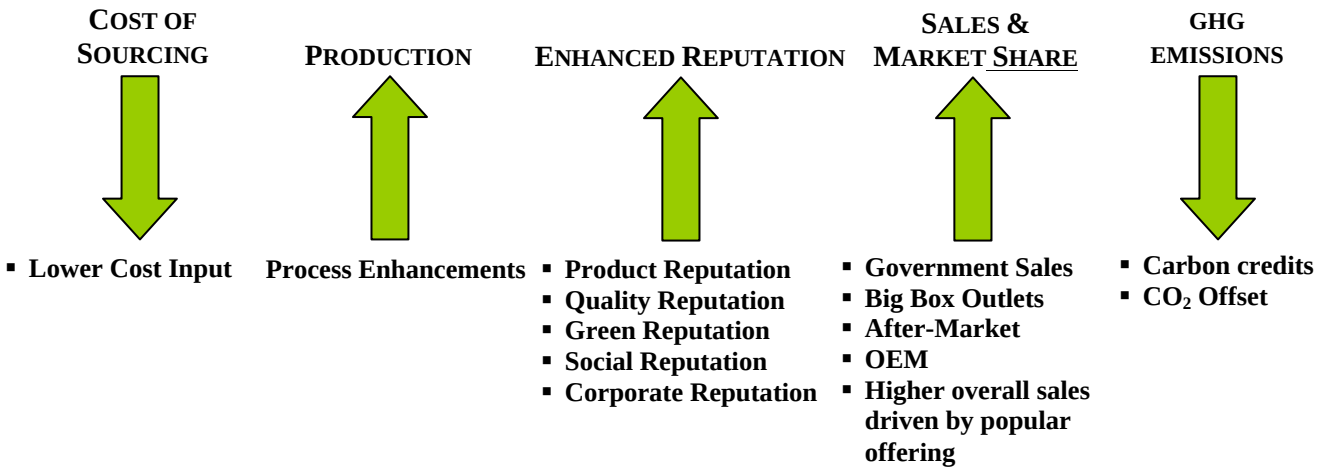
The market for green tires in the United States is large. End user consumers, box stores, fleet owners and the government are all expressing a commitment to environmental stewardship, and each of these sectors is using its purchasing power as confirmation. With no upfront investment costs or special equipment needed, simply changing purchasing patterns could help tire companies capture new customers and save costs at a time when raw materials prices are soaring.

Benefits to a tire company that manufactured a green tire include:

- Lowering input cost by including less expensive ultra-fine engineered rubber powder. Companies can save 30-50% by using rubber powder instead of virgin rubber;
- Lowering the cost of production through process enhancement gained from using fine rubber powder;
- Becoming the "supplier of choice" for the U.S. government, which is considering a new "green purchasing policies and affirmative procurement program" for all government contracting mechanisms and acquisition strategies to protect the environment and conserve natural resources and energy through contracting (72 Fed. Reg. 73,904);[37]
- Becoming the supplier of choice for box brands, fleets, and many after market consumers;
- Capturing reputation value; and
- Getting carbon credits for using a material recycled from discarded tires

These benefits are illustrated in Exhibit 3.

Exhibit 3: Business benefits of a green tire to tire manufacturers



Change of inputs in the tire industry is, understandably, slow because it is a technology-based safety product. The barriers to uptake of precision engineered fine rubber powder are largely based on the industry's negative historic experience with crumb rubber and some internal incentive issues within companies. [For more on barriers to update, please see Appendix 10.]

However, based on its own testing, the Ford Motor Company has found that, "Recycled-content tires perform equal to or better than conventional tires in all parameters including traction, durability, wear, rolling resistance, and handling. Plus, the tires meet or exceed all federal safety standards." The Nevada Automotive Test Center found similar results, stating that, "Incorporating recycled content of up to 10 to 15 percent in new tires is reported as technically feasible, without significantly impacting the performance of the tires."

Given the technical and safety data, producing and marketing a high quality green tire based on ultra-fine engineered rubber powder can lead to great gains for both companies and for society. With more than 80% of global executives expecting some form of climate change regulation to come to their companies' home country within five years,[38] launching a green tire ahead of a government mandate dictating what should happen to scrap tires would also be a proactive stance that could help to avoid burdensome regulation. Tire companies are already looking at the environment as a source of competitive advantage, and a green tire is the next logical step to saving input costs and satisfying customers. At a time when individual tire makers are concerned about the volatility of raw materials prices and energy costs, and the record weakness of the U.S. dollar are combining to create unprecedented challenges in 2008,[39] using ultra-fine engineered rubber powder to create a green tire is an innovation that should be hard to overlook.

APPENDIX 1: New material creates the opportunity for green tires

Historically, manufacturing a high quality green tire was virtually impossible. However, recent innovations in producing ultra-fine engineered rubber powder have opened up new vistas of opportunity. Lehigh Technologies has adapted pharmaceutical technology and applied it to rubber, using a cryogenic-aided turbo shearing mill to produce ultra-fine rubber powder (80-400 mesh) from used tires. According to a Clemson University study, "tire rubber powder prepared by the Lehigh process is unique and offers a value-added reactivity and functionalization. Breakthrough results from electron paramagnetic resonance spectroscopy (EPR) measurements indicate that the Lehigh process provides a significant increase in free radicals, which can bond to matrix resins or other application-specific substrates, extending the powder's usefulness beyond that of an added filler. With this study, tire manufacturers worldwide have a viable alternative ingredient that can be used to make "green" tires, while at the same time enhancing the performance of the tire."[40]

Inclusion of up to 10% ultra-fine engineered rubber powder in the production of new tires creates technical efficiencies, production efficiencies, and raw materials cost efficiencies. These are all significant at a time when the tire industry has run out of opportunities to drive down the costs of raw materials.

1. Technical Efficiencies

Integrating ultra-fine engineered rubber powder into new tires increases fuel efficiency in two ways; through reduced roll resistance of the tire and decreased air permeability, according to a Georgia Institute of Technology study.

a. Reduced roll resistance: Including 80 mesh or finer rubber powder at 15% loading reduces the Yerzley Tan Delta by 9% at 60ºC. The lower the tan delta value, the lower the roll resistance and the higher the fuel efficiency.
b. Reduced air permeability: Incorporating 140 mesh or finer rubber powder at 7.5% loading in the innerliner compound improved air retention by 19% per month. This both increases the life of the tire and provides better fuel efficiency.

2. Process Efficiency

Use of ultra-fine engineered rubber powder increases production capacity and mold release efficiency, saving both costs and time for companies.

3. Cost Efficiency

Historically, recycled rubber was expensive to produce. However, Lehigh has developed a cost efficient process, significantly different from prior attempts to mill rubber. Lehigh's process ensures consistent quality and supply, while also offering significant savings. Virgin rubber compounds needed for tread, sidewall, and inner tire liner currently cost 80-85 cents or more, depending on the formulation, Lehigh produces 80 mesh powder for $0.45/lb, providing significant savings.

While the technical and supply issues have been addressed by Lehigh Technology's innovative production and sourcing mechanisms, there have been some historical challenges that are creating roadblocks to tire companies adopting this technology and capitalizing on increasing consumer demand for green products.

The invention of a process to generate highly engineered fine rubber powder for inclusion in new tires is providing a technological solution to solve material supply and demand problems.

APPENDIX 2: Consumer & corporate attitudes towards environmental stewardship have shifted

In 2006 less than one-third of consumers considered themselves green or expressed interest in green brands. In 2007, every consumer surveyed by Landor Associates self-identified as green to some extent.[41]

Many corporate executives are also recognizing the importance of environmental issues. Fully 60% of global executives surveyed by *The McKinsey Quarterly* regard climate change as strategically important, and a majority consider it important to product development, investment planning, and brand management.[42] Over 50 percent of companies surveyed in a recent EyeForProcurement poll have policies on greening their supply chain, and companies are nearly unanimous in their belief that green supply chains will only continue growing.[43]

There are a variety of reasons why companies are moving towards environmentally friendly products and processes. Most of these reasons are practical and business-driven, with the added benefit of improved reputation and increased customer loyalty. According to research, redesigning systems to be more efficient and environmentally friendly results in:

- Reduced operational costs and environmental expenses like waste handling and regulatory burdens,
- Reduced environmental and regulatory risks,
- Increased revenues as a result of environmentally superior products that meet customer's desires, and
- Increased intangible brand value from marketing the company's overall greenness.[44]

Clairol, a division of Bristol-Meyers Squibb, is one of many companies that recognized the power of green branding and succeeded as a result. The company reformulated its *Herbal Essence* brand of shampoo and conditioner as a natural line with recycled packaging, herbal and botanical formulas and support for conservation organizations. Within one year, Herbal Essences had become the number two hair brand in the US, and the company's marketing information refers to Herbal Essences as their "miracle." The line grew 60% in the first year of the re-launch, as did the company's overall business, on the strength of the Herbal Essence brand, leading to $169 million in sales in 1999.[45] Today, according to Clairol, somebody uses an Herbal Essences product every fifteen seconds in the U.S.[46]

APPENDIX 3: Inputs and processes as applied to tire manufacturers

INPUTS

External context: The local and global external context significantly affects the choices a corporation makes regarding the formulation and implementation of sustainability actions. Pressure is exerted by government regulations for corporations to follow minimum standards of sustainability performance like hazardous and other waste disposal regulations and pollution standards. The U.S. government is considering a strategy to encourage creation of a green tire that could benefit manufacturer's customers, thereby creating great demand. Among the pieces of legislation under consideration are:

- The Tire Investment, Recovery and Extension Act of 2008 (TIRE Act) was introduced to the House of Representatives by a bi-partisan group of members. The bill would provide a $3/tire tax incentive for purchasers of large volumes of tires made from recycled rubber.
- Office of Management and Budget, Office of Federal Procurement Policy: Proposed policy letter on the acquisition of green products and services. The proposed policy letter provides guidance on green purchasing policies and strategies. It requires agencies to identify opportunities and give preference to the acquisition of green products and services. While recycled-content and/or remanufactured products are explicitly mentioned, the discussion of unambiguously listing recycled content tires has been under discussion since Senator Joe Lieberman advocated, in 2001, that recycled content tires be added to the EPA's set of procurement instructions that guide government purchasing.[47]

In Europe, the European Union has passed the End-of-Life Vehicles Directive mandating that by 2015, 85% of a car's car's materials, by weight, to be recovered and reused.

***Internal context*:** This comprises corporate and business unit missions, strategies, structures, and systems; it is through the development and implementation of these that sustainability performance occurs.

Business context: Additional important considerations are the industry sector of the business, and the characteristics of customers and products. Companies that operate in high social and environmental impact industries, such as chemicals, oil, paper, and mining, may exhibit relatively poor performance in terms of sustainability elements such as consumption of natural resources, emissions, and health risk of their products or services compared to companies operating in other industries. Currently the tire industry has not been a focal point for environmental activists, but this could change. The National Resource Defense Council (NRDC) recently sued the EPA and won its case in federal court regarding the EPA's failure to properly regulate emissions from incineration of materials for alternative fuels, including scrap tires to make tire derived fuel (TDF).[48] The impact this will have on the TDF market is still unclear, but the case did draw attention to the issue of scrap tires and the glut of used tires that still go to waste.

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Leadership: It is important for corporate leaders to consider all of these inputs if they want to formulate effective sustainability strategies. Research[49] has shown that sustainability strategies are typically top-down, and that the most effective ones are when top management is clearly committed to the strategy. Signals of this commitment are given through how the strategy is communicated throughout the organization. Senior executives must be knowledgeable, support the organization, and effectively communicate the mission, vision, and strategy often to the other members of the organization. The commitment of the board of directors and management encourages employees to act in ways that are compliant and consistent with company strategy. We are already beginning to signs of such leadership in the tire industry. Yokohama Rubber Company's president, Tadanobu Nagumo, has indicated that "green" is a cornerstone of his company's strategy to improve operating income four-fold while doubling sales by 2017. At the 26th Annual Tire Society gathering in Akron, Ohio, Nagumo said the company's vision "is to assert world-class strengths in technologies for protecting the environment. This is the most important responsibility for those who are willing to expand in the global overseas marketplace."[50] Yokohama's "Eco-Motion" program will include ISO 14000 plant certification and launching of products, both tires and non-tires, that "exemplify environmental virtue."

Sustainability Strategy, Structure and Systems: Failing to examine strategies that address sustainability, and in this case, the environment, could lead to two related outcomes:

- Environmental impacts that have substantial future consequences involving increased costs, increased community concerns, increased legal claims, and damaged corporate reputation. While pressure is not yet being leveraged, tire companies could potentially take a proactive stance, side-step legislation and avoid damaging reputation issues by greening some of their products in advance of criticism.
- Decrease of current and future corporate profitability through decreased potential revenues related to sustainability issues. Companies may miss a golden opportunity to capture both savings and new markets ahead of the competition.

Without appropriate management structures and systems, corporations may not reap all the benefits associated with sustainability performance. The alignment of strategy, structure, and management systems is essential in both coordinating activities and motivating employees.

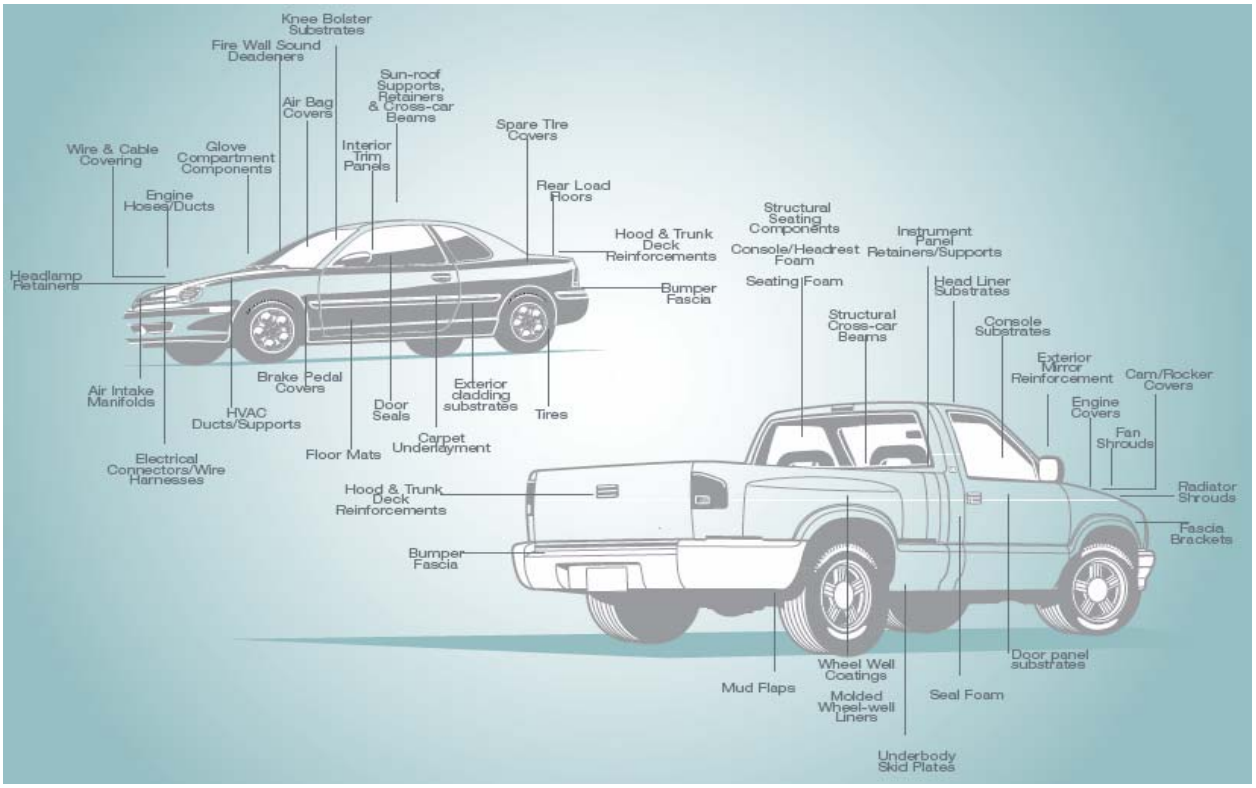
APPENDIX 4: Car manufacturers will benefit from green tires

Once just a niche market captured by the Toyota Prius, the auto industry is now looking at the environment as a source of market growth. At last year's Geneva motor show, the car industry seemed to be "going to absurd lengths to show its concern for the environment."[51] Ford Motor Company is introducing its "EcoBoost" technology, which aims to achieve a 20% increase in fuel economy and 15% reduction in carbon dioxide emissions in half-a-million vehicles annually in the next five years while Mercedes-Benz joins the ranks of car companies looking to green with its plans to add three fuel-efficient variants to its C-Class range under the BlueEFFICIENCY banner.

With the Corporate Average Fuel Economy (CAFE) requirements mandating an average car and light truck fuel economy of 35 miles per gallon by 2020 in the United States, automakers are rushing to produce a wide range of efficient vehicles. Tires represent up to 20% of the energy needed to operate a car,[52] and providing car manufacturers with an efficient, green tire could help them market their environmentally friendly vehicles as a more comprehensive package. In addition, if companies were able to get a CAFÉ offset that expired after three to five years (a three-five year sunset) for using green tires, this could further help them attain the guidelines set by the federal government.

In addition, ultrafine mesh powder can be integrated in many parts of the vehicle for added savings. This is illustrated in exhibit 4.1.

Exhibit 4.1: Car components that can integrate ultra-fine rubber powder



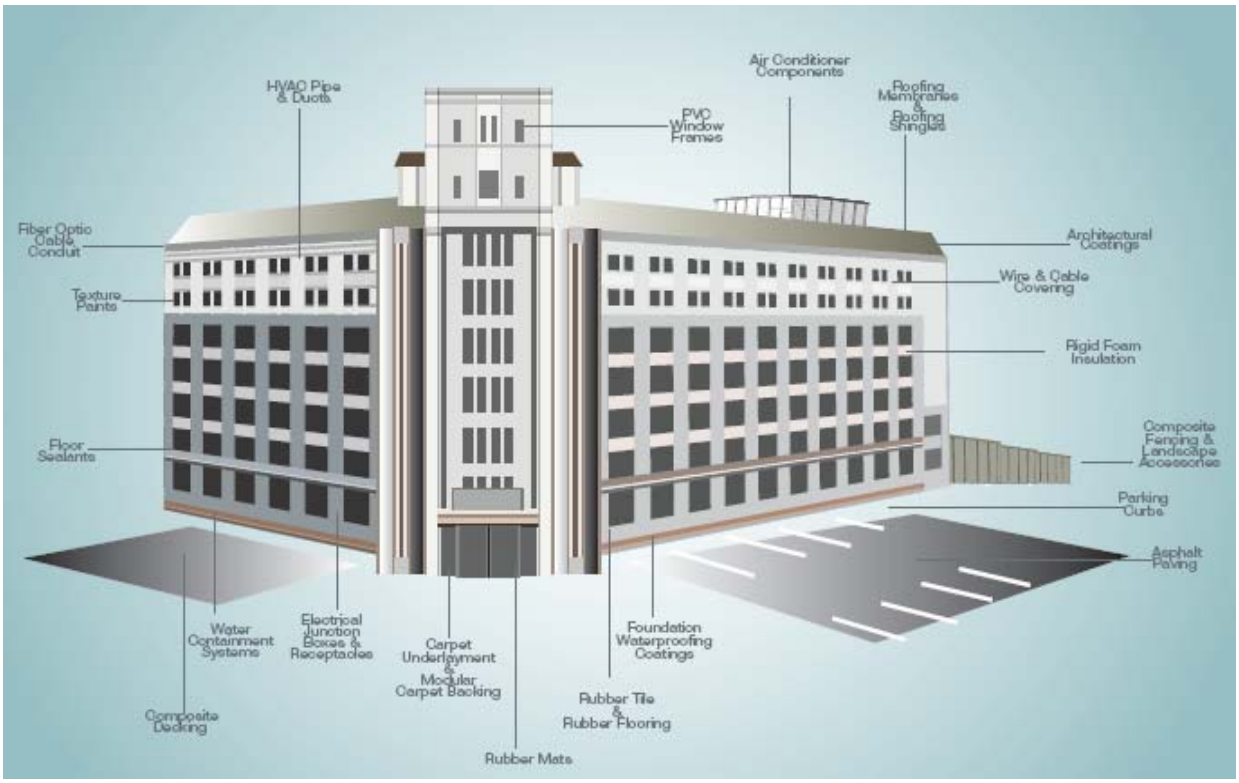
APPENDIX 5: Big box stores are tire retailers, fleet owners, and waste tire collectors and will benefit from green tires

Big box stores like Wal-Mart and Costco have three roles when it comes to tires. They are retailers, they are fleet owners, and they are responsible for collecting waste tires. These stores have openly declared their aim to have a positive impact on the environment. Wal-Mart has developed a comprehensive strategy to be a "good steward of the environment" and "ultimately use only renewable energy sources and produce zero waste."[53] These big box stores stand to gain significantly from offering a green tire in four ways:

1. **Lower waste tire collection costs**: Efficient reclamation process that would save waste tire hauling fees when big box stores work with fine powder manufacturers to establish waste tire collection centers in an efficient manner.
2. **Lower fleet costs**: Buying green tires for their fleets, big box stores would save in several ways. The green tire would provide energy efficiencies outlined above, saving the company on fuel costs. The box store could dispose of their fleet tires as outlined in (1), saving disposal fees. And, if the TIRE Act of 2008 were passed, there would be a significant tax incentive for box stores running their own fleets of trucks.
3. **Improved brand value from environmental stewardship**: A tire made of highly engineered recycled fine rubber powder would allow these companies to advertise a total recycling, or closed-loop, system in which the worn tires they take back were collected in an efficient way, processed using the latest technology and re-integrated into a new tire of equal, and sometimes even better, quality of equal price and providing equal safety statistics.

   The closed loop concept can also be taken a step further for Big Box stores. The Engineered Rubber Powder generated from scrap tires can also be used in a wide array of a store's infrastructure including shelving, parts of the buildings themselves (illustrated in Exhibit 5.1), external mulch and rubber mats. ERP can also be used in the plastic products offered for sale in the store like lawn and garden products. So, a minor and cost-effective change in the collection and use of scrap tires could represent a huge leap forward for Big Box stores' zero waste goals.

Exhibit 5.1: Building components that can integrate ultra-fine rubber powder



4. **Provide more choice for consumers**: A green tire offering of equal price and quality would provide more choice, one of the tenets of big box stores, to their customers.

APPENDIX 6: Many Americans are either concerned about the environment or with energy security, and some are concerned with both

While there is a particular demographic that is most interested in environmental conservation—termed "bright greens"—a recent Penn, Schoen and Berland poll of 1504 adults found that virtually everybody exhibits green attitudes and behavior to one degree or another. "Bright greens," however, tend to be in their mid-30's, female, live in urban and suburban settings, and have an average income of $50,000. This segment accounts for 34% of the survey pool.[54] It also happens that women influence up to 85% of all auto purchases and between 50-60% of all vehicle purchases in the U.S. are made by women. By some accounts women buy 65% of all new tires annually.[55]

The demographic which is least interested in the environmental issues, "dull greens," are primarily men, 50 years or older, a quarter of whom are retired. This group—that accounts for 11% of the survey pool—represents what was the traditional middle-class family with a combined household income of significantly above $50,000, has two or more children, and a stable marriage. This is also a demographic that has traditionally been seen as tire consumers and is concerned with American energy security and the country's dependence on vast amounts if imported fossil fuels. The "dull green" demographic would be attracted to green tires not for their environmental benefits but for their national security benefits. An energy security platform could be another angle to market green tires since research has shown that 69% of Americans (seven out of 10) think the U.S. government should set a real target date (2015) for ending the country's reliance on Middle Eastern and other foreign oil supplies. Support for this idea cuts across political party affiliations to include 66% of conservatives, 72% of moderates and 72% of liberals. This same poll found that 71% of Americans believed it was patriotic to drive a fuel efficient car.[56]

It is also conceivable that after market consumers could be rewarded for purchasing green tires, much like consumers of hybrids. Hybrid buyers get an income tax deduction in the U.S. and an increasing number of toll agencies around the world are offering discounts to alternative fuel car drivers.[57] These same discounts could be applied to drivers of all cars with green tires.

APPENDIX 7: Fleets looking towards tires as a solution to environmental and market challenges

With the price of diesel fuel up more than 50% over last year, fleets are looking for innovative ways to find savings and lower their fuel consumption[58] though there are very few "new tricks" to accomplish this. Green tires, which could be provided at the same or lower cost could be a transformative new technology to assist fleet owners. In addition, with legislation pending that would give fleets using green tires a tax credit, fleet owners could capture further economic benefits.

Given the current challenges, fleet users are looking to tires as a source of innovation. The American Trucking Association's Technology & Maintenance Council released its "Future Truck Position Paper" detailing future performance requirements of tires, based on fleet/equipment user descriptions of their needs. In addition to technical requirement, "Future tires must be designed and used with environment quality in mind. Future tires—at the end of their useful lives—should be totally and safely recyclable. Tire construction materials should be non-toxic. And, as long as tires are held before disposal/recycling, the innerliner should include some material to make the tire interior inhospitable to insects and other small, undesirable wildlife."[59]

APPENDIX 8: U.S. Government starting to regulate and mandate environmentally friendly policies

Executive Order 13101: Greening the government through waste prevention, recycling, and federal acquisition states that: "the head of each executive agency shall…work to increase and expand markets for recovered materials through greater Federal Government preference and demand for such products. It is the national policy to prefer pollution prevention, whenever feasible. Pollution that cannot be prevented should be recycled."[60] In addition, the government is already looking at vehicles and their impact on the environment, mandating that, according to Executive Order 13149, Federal Agencies must reduce the use of petroleum fuels in vehicles by 20% and assure that 75% of new light vehicle acquisitions are alternative fueled vehicles (AFVs), and that the majority of the fuels used by the AFVs are alternative fuels.[61]

The army, too, is looking for ways to "green" its operations, which includes testing alternative fuel vehicles[62] and investigating new technologies through the Army Environmental Policy Institute.

With dual concerns about over-dependence on foreign-supplied fossil fuels and its own impact on the environment, the U.S. Government represents a high volume customer that would be interested in a green tire made of precision engineered ultra-fine rubber powder. Furthermore, the government is currently considering a new "green purchasing policies and affirmative procurement program" for all government contracting mechanisms and acquisition strategies to protect the environment and conserve natural resources and energy through contracting (72 Fed. Reg. 73,904).[63]

APPENDIX 9: American car driving habits and tire impact on the environment

Americans represent 5% of the world's population and drive almost a third of its cars. This, in turn, accounts for nearly half the carbon dioxide pumped out of exhaust pipes into the atmosphere each year, according to an Environmental Defense Fund report.[64] In a country where 220 million adults average an hour and a half a day in their cars and 90% of Americans drive to reach their destinations,[65] dual concern for the environment and dependence on motor vehicles begs a solution that enables continued heavy car usage coupled with environmental conservation. In addition to fuel consumption, tires represent a major source of environmental impact.

- The tire industry is the largest consumer of rubber in the U.S., using over 6 billion pounds of rubber annually to produce more than 250 million tires.
- On average, almost ten gallons of oil are used in the production of one automobile tire. By using ultra-fine rubber powder at ten percent loadings, tire companies can save the equivalent of approximately one gallon of oil for every tire produced.
- If every tire produced globally incorporated ten percent loadings of rubber powder, the world would save more than half a billion gallons of oil annually.
- In addition to reducing fossil fuel dependency, engineered rubber powder helps protect the environment from the air and water pollution associated with land-filled tires and the air pollution associated with the burning of scrap tires.
- A commitment to recycled rubber in the U.S. would have significant economic benefits, including: utilizing 83 million scrap tires (recycling 25% of the current total) and creating close to 4,000 new jobs.[66]

Green tires that incorporate ultra-fine engineered rubber powder are a low overhead, high yield, technologically available, safe innovation that can meet the American public's desire to be green but stay on the roads.

APPENDIX 10: Historic Challenges and Criticism

a. *Historic technical limitations of crumb rubber*: When the tire manufacturing industry initially examined the feasibility of re-integrating scrap rubber into the tire manufacturing process, the existing technology only allowed for the production of crumb rubber of a large size (80 mesh and larger). This crumb rubber had inferior physical and mechanical properties as compared to virgin and synthetic rubber. Despite the fact that this material was of lower quality than that which is now available, in 1999 Bridgestone/Firestone Research found that up to 20% loading could be used in tread compound with "quite good" retention of physical properties and "in many instances physical properties were actually improved." Lehigh Technologies has now pioneered a new technology with which it can consistently produce up to 400 mesh powder, with superior mechanical and physical properties, effectively addressing the historic technical issue with crumb rubber.

b. *Unreliable suppliers*: In the 1990s producers of crumb rubber were recycling facilities that provided unreliable quality and quantity of material. Often these recyclers would go out of business or be unable to provide enough materials for tire manufacturers, so were not dependable suppliers. In addition, there was no quality control or common standard for crumb rubber, creating even more variability in supply. Contrary to these waste management businesses, Lehigh Technologies is a chemical company that produces 100 million pounds of ultra-fine engineered rubber powder of consistent quality from scrap rubber. The company is slated to open additional facilities in 2009, each bringing and additional 100+ million fine rubber powders to the marketplace. This significantly changes the supply landscape for tire companies seeking high quality ultra-fine engineered rubber powder.

c. *End of life concerns:* Some in the tire industry have expressed reservations about using and capitalizing on the availability of ultra-fine engineered rubber powder because it would lead to companies being responsible for reclamation of the vast stock of waste tires currently in existence. This is unlikely simply because there are already uses for waste tires, including tire-derived fuel and rubber crumb for playgrounds, and the tire industry has yet to be penalized for the existence of supply for these products, or expected to be responsible for reclamation costs of rubber currently being recycled.

d. *Product liability:* Since the mid-1990s, when Firestone recalled seven million tires due to safety issues and the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act was passed, the American tire industry has been, understandably, cautious when it comes to product innovation.

e. *Corporate incentive structure spurring innovation:* While many tire companies would likely be interested in a cost effective raw material that would result in a green tire, there are few incentives within the hierarchy of American tire

companies to spur exploration of this option. Corporate CEOs are, justifiably, reluctant to dictate to their technical staffs what materials to use. The technical staff, on the other hand, is reluctant to pursue materials innovation for two reasons. Either they are seasoned engineers encumbered by their historic experience with crumb rubber, which 15 years ago was not technically developed enough to be useful and was economically prohibitive. Or they are at the early stage of their careers and reluctant to innovate with no incentive to do so.[67] Helping to incentivize the right people in tire companies to innovate for the sake of customer satisfaction and gaining market share is critical.

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[1] Adrian J. Slywotzky, *The Upside: The Seven Strategies for Turning Big Threats into Growth Breakthroughs*, New York: Random House. 2007, pp. 19-32.

[2] Chris Cooper and Naoko Fujimura, "Toyota says worldwide hybrid car sales top 1 million," *Bloomberg.com* June 7, 2007. <http://www.bloomberg.com/apps/news?pid=20601101&sid=atAqPjvDSm4k&refer=japan>

[3] Greenbiz.com survey; Cone Inc. Consumer Environmental Survey.

[4] Survey conducted by WPP's Landor Associates, Penn, Schoen & Berland (PSB) Associates and Cohn & Wolfe (C&W). Results based on 803 interviews conducted on the Internet among U.S. general population from September 7 - 9, 2007. Respondents were screened to meet the following criteria: Age 18 or over. Gender, age, and region were weighted based on US census information.

[5] Russ Meyer, Chief Strategy Officer, Landor Associates.

[6] Kleanhous, Anthony and Jules Peck. "Let them eat cake: Satisfying new customer appetite for responsible brands." May 2006. World Wildlife Fund. <http://www.wwf.org.uk/filelibrary/pdf/let_them_eat_cake_full.pdf>

[7] According to Ron Jarvis, vice president for environmental innovation. "Home Depot to go green," *International Herald Tribune*
< http://www.iht.com/articles/2007/04/17/business/retail.php>

[8] Resource Conservation and recovery act of 1976 (Solid waste disposal act) <http://ipl.unm.edu/cwl/fedbook/rcra.html>

[9] EPA. *Recycling is working in the United States.* <http://www.epa.gov/epaoswer/non-hw/recycle/rei-fs.pdf >

[10] R. W. Beck, Inc. "U.S. Recycling Economic Information Study," Prepared for The National Recycling Coalition, July 2001. <http://www.epa.gov/jtr/econ/rei-rw/pdf/exe-sum.pdf>

[11] The state of the recycled paper world. <http://www.conservatree.com/paper/PaperTypes/StateRecyWorld.shtml>

[12] American Chemistry Council. <http://www.americanchemistry.com/plastics/doc.asp?CID=1581&DID=6011>

[13] *The Environmental Leader* <http://www.environmentalleader.com/2007/12/11/green-pressure-on-tire-makers-builds/>

[14] Data from Aliapur, an industry-founded tire collection and re-processing organization <www.aliapur.fr>

[15] Japan increases car recycling rates. Recyclingbizz.com
<http://www.recyclingbizz.com/nonferrous/LA769830.html>

[16] Author discussion with Samir Gibara, Retired Chairman and CEO, The Goodyear Tire & Rubber Company.

[17] Bruce Davis. "Yokohama goes green in a big way." *Rubber and Plastics News*. October 2007.

[18] Michelin Tire Company. *Press Release*. "Michelin Invests $6.8 Million In R&D To Further Improve Tire Fuel Economy"http://www.michelinmedia.com/pressSingle/value=MCH2008020433509/kw=

[19] Michelin Green Tires. <http://www.michelin-green-meter.com/main.php?cLang=en>

[20]Energy Information Administration International Energy Outlook <http://tonto.eia.doe.gov/FTPROOT/international/edexfiles/1>

[21] Zhongyuan, S. "Outlook for China's Motorization and Energy Consumption," IEEJ, 2002.

[22] Rubber Manufacturers Association. *Scrap Tire Markets in the United States*. November 2006. <https://www.rma.org/publications/scrap_tires/index.cfm?PublicationID=11453>

[23] Miles Moore. "Ruling could hit rubber recycling industry hard." *Rubber and Plastics News.*

[24] Rubber Manufacturers Association. "What can be done to limit scrap tire dumping?" <http://www.rma.org/scrap_tires/scrap_tires_and_the_environment/tiredumping.cfm>

[25] This section is based on : Marc J. Epstein. *Making Sustainability Work: Best Practices in Managing and Measuring Corporate Social, Environmental and Economic Impacts*. United States: Berrett-Koehler Publishers; United Kingdom: Greenleaf Publishing. 2008.

[26] Marc J. Epstein. *Making Sustainability Work: Best Practices in Managing and Measuring Corporate Social, Environmental and Economic Impacts*. United States: Berrett-Koehler Publishers; United Kingdom: Greenleaf Publishing. 2008

[27] Sears Sustainability. <http://www.searsholdings.com/about/sustainability/index.htm>

[28] *The Packer*. "Costco makes the environment a priority." <http://thepacker.com/icms/_dtaa2/content/2008-133556-494.asp?stype=topnews>

[29] *Auto Insider*. "GM woos female drivers." <http://www.detnews.com/2005/autosinsider/0509/18/B01-318118.htm>

[30] American Environics and the Nathan Cummings Foundation. Energy Attitudes. Summer 2007. p. 9 <http://www.americanenvironics.com/PDF/EnergyAttitudesSummer2007.pdf>

[31] MSNBC. "Wal-Mart on track to cut truck fuel use by 25%: Annual savings in carbon dioxide equal to taking 67,744 cars off the road." <http://www.msnbc.msn.com/id/19810648/>

[32] GSA. "GSA fleet: Leading the way." <http://www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=8211&channelPage=%252Fep%252Fchannel%252FgsaOverview.jsp&channelId=-13036>

[33] Cone, Inc. Cone 2007 Cone Cause Evolution & Environmental Survey

[34] Author discussion with Hal Quinley, Director of Public Relations Research, Yankelovich.

[35] Marc J. Epstein. Measuring Corporate Environmental Performance: Measuring Corporate Environmental Performance. Burr Ridge, Illinois Institute for Management Accounting and Irwin Professional Publishing. 1996.

[36] Levy and Nezamutinova (2006) "Climate Change."

[37] Bureau of National Affairs. *Chemical Regulations Report*. "Government Proposes Policy Letter On Acquiring 'Green' Products, Services" Volume: 32 Number: 2. January 14, 2008. <http://ehscenter.bna.com/pic2/ehs.nsf/id/BNAP-7AUGJN?OpenDocument>

[38] McKinsey & Co. "How companies think about climate change: A McKinsey Global Survey" <http://www.mckinseyquarterly.com/How_companies_think_about_climate_change_A_McKinsey_Global_Survey_2099>

[39] Bruce Davis. *Rubber News*. 2008 Forecast. <http://rubberandplastics.texterity.com/rubberandplastics/20080114/?pg=11>

[40] Dennis Smith, Madan Banda. Department of Chemistry. Clemson University.

[41] Brands in the Balance, Russ Meyer *The Hub* July/August 2007. <http://hubmagazine.com/archives/the_hub/2007/jul_aug/the_hub19_landor.pdf>

[42] How companies think about climate change: A McKinsey Global Survey <http://www.mckinseyquarterly.com/Energy_Resources_Materials/Environment/How_companies_think_about_climate_change_A_McKinsey_Global_Survey_2099_abstract#registerNow>

[43] The survey asked 188 procurement professionals -- primarily in the United States, Europe and Asia -- about their companies' practices, policies and plans for reducing the environmental impact of the materials used in their work. The two most heavily represented sectors in the survey were the transportation/logistics fields and the high-tech industry. *Green Purchasing*, July 2007 <http://www.eyeforprocurement.com/green>

[44] Daniel Esty and Andrew S. Winston. *Green to Gold: How smart companies use environmental strategy to innovate, create value, and build competitive advantage.* New Haven: Yale University Press, 2006. p. 103-104.

[45] Christine Bittar. Green Noise, *Brandweek*, Feb 22, 1999. <http://findarticles.com/p/articles/mi_m0BDW/is_8_40/ai_53960387>
[46] Brandchannel <http://www.brandchannel.com/features_effect.asp?pf_id=67>
[47] Press Release. <www.lieberman.gov>
[48] Miles Moore. *Rubber and Plastics News*. "Ruling could hit rubber recycling industry hard." October 1, 2007.
[49] Wisner et al. (2006) "Organizational Antecedents and Consequences of Environmental Performance."
[50] Bruce Davis. "Yokohama goes green in a big way." *Rubber and Plastics News*. October 2007. <http://rubberandplastics.texterity.com/rubberandplastics/20071001/?pg=3>
[51] *The Economist*. "The Any colour you like, as long as it's green." Mar 9, 2007
[52] Michelin Tire Company. *Press Release*. "Michelin Invests $6.8 Million In R&D To Further Improve Tire Fuel Economy"http://www.michelinmedia.com/pressSingle/value=MCH2008020433509/kw=
[53] MSNBC.com. "Is Wal-Mart going green?" <http://www.msnbc.msn.com/id/9815727/>
[54] Penn, Schoen and Berland Associates, Inc. "Green Brands 2.0." Survey conducted 1504 interviews on the internet among US general population between April 6 and April 8, 2007.
[55] *Auto Insider*. "GM woos female drivers." <http://www.detnews.com/2005/autosinsider/0509/18/B01-318118.htm>
[56] Opinion Research Corporation. "Red White and Green." *Reported by CBS*. Results based on telephone interviews of 2055 adults, 18 and older, September 21-25, 2006. <http://redwhiteandgreen.org/101106%20CSI%20Red%20White%20and%20Green%20survey%20findings%20FINAL.pdf>
[57] Ken Belson. "Toll Discounts for going green." *New York Times*. January 27, 2008.
[58] Fern Abrams (American Trucking Associations). *Fleet Owner Magazine*. "Fuel for thought." <http://www.greentruck.com/news/fo0500.html>
[59] American Trucking Association, Technology & Maintenance Council-- Future Tire Reliability/Productivity Task Force. "Expectations for Future Tires." Future Truck Program Position Paper: 2004-4. March 2005. <http://www.truckline.com/NR/rdonlyres/F6252030-BD51-4393-B787-AE1223AAD618/0/FT_TIRES.pdf>
[60] Executive Order 13101 - greening the government through waste prevention, recycling, and federal acquisition. Section 101. <http://findarticles.com/p/articles/mi_m2889/is_n38_v34/ai_21232229>
[61] GSA. *Alternative Fuel Vehicles*. <http://www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=8211&channelPage=%2Fep%2Fchannel%2FgsaOverview.jsp&channelId=-13037>
[62] Captain Jessica Prindiville. "Environmental Transformations: What a company commander needs to know" *CML Army Chemical Review*. Feb, 2002 <http://findarticles.com/p/articles/mi_m0IUN/is_2002_Feb/ai_84668288>
<http://findarticles.com/p/articles/mi_m0IUN/is_2002_Feb/ai_84668288>
[63] Bureau of National Affairs. *Chemical Regulations Report*. "Government Proposes Policy Letter On Acquiring 'Green' Products, Services" Volume: 32 Number: 2. January 14, 2008. <http://ehscenter.bna.com/pic2/ehs.nsf/id/BNAP-7AUGJN?OpenDocument>
[64] Julian Borger. "Half of global car exhaust produced by US vehicles." *The Guardian*. June 29, 2006. <http://www.guardian.co.uk/environment/2006/jun/29/travelandtransport.usnews>
[65] Gary Langer. "Poll: Traffic in the United States: A Look Under the Hood of a Nation on Wheels."ABC News. <http://abcnews.go.com/Technology/Traffic/story?id=485098>
[66] The TIRE Act of 2008. <http://www.gak.de/index.php?id=307&backPID=306&tt_news=4606>
[67] Interview with Edward W. Kissel. Former Executive Vice President/Division President General Tire, Inc. and Goodyear Tire Company veteran.