SUSTAINABLE MANUFACTURING CURRICULUM

GREENING THE FUTURE BY EDUCATING TOMORROW'S WORKFORCE

MODULE 1
ENVIRONMENTAL SUSTAINABILITY

FACILITATORS GUIDE

EPA
United States
Environmental Protection
Agency

TABLE OF CONTENTS

LEARNING OBJECTIVES

By the end of this session, students will be able to:

- Identify the ways the environment has a direct personal impact.
- Define environmental justice and explain the concept of environmental justice when compared to equality.
- State each of the four global revolutions that affects our environment and summarize each revolution's impact(s).
- Define sustainability as it relates to manufacturing.
- Name the three pillars of sustainability and analyze the interdependence of a sustainability model.
- Correlate greening the supply chain to corporate success.
- Define a product's life cycle.
- Recognize what contributes to the full cost of manufactured goods.

APPROVED RESOURCE MATERIALS

Throughout the workshop, you will see references to approved materials not included in Appendix C which include:

Sustainability and the U.S. EPA.
http://www.nap.edu/catalog.php?record_id=13152

Life Cycle Assessment: Principles and Practice.
http://www.epa.gov/nrmrl/lcaccess/lca101.html

Life Cycle Management: A Business Guide to Sustainability.
http://www.unep.fr/shared/publications/pdf/DTIx0889xPA-LifeCycleManagement.pdf

Why Take a Life Cycle Approach?
http://www.unep.fr/shared/publications/pdf/DTIx0585xPA-WhyLifeCycleEN.pdf

The American Center for Life Cycle Analysis: http://www.lcacenter.org/

Cradle to Cradle: Remaking the Way We Make Things. By Michael Braungart and William McDonough

Full Cost Accounting: A Course Module on Incorporating Environmental and Social Costs Into Traditional Business Accounting Systems.
http://gdi.ce.cmu.edu/gd/education/FCA_Module_98.pdf

Glossary Terms

Anthropogenic impact—a change in the health of our environment or ecosystem biodiversity caused by the influence of humans.

Biodiversity—the variety of life in a certain area.

Bioaccumulation—the buildup of substances, such as pesticides, mercury, or other organic chemicals in an organism. It involves an organism retaining more of the substance than it can expel. Substances can enter the organism through respiration, food intake, skin contact, or other means.

Chlorofluorocarbons (CFCs)—compounds consisting of chlorine, fluorine, and carbon. They move up in our atmosphere and are broken down by strong ultraviolet (UV) light, where they release chlorine atoms that deplete our ozone layer. CFCs are used as refrigerants, solvents, propellants and foam blowing agents.

Down-cycled—a type of recycling that processes products into new materials or products of lesser quality and reduced functionality.

E-waste—discarded electronic devices. Some electronic scrap components, such as tube-style computer monitors, contain contaminants such as lead, cadmium, beryllium, or brominated flame retardants.

Emerging contaminants—chemicals in water that, in the past, were not previously detected at levels that may be significantly different than expected. These are typically found to pharmaceuticals and personal care products. The exposure risk to human health and the environment associated with their presence, frequency of occurrence, or source may not be known or completely understood, which can cause rising concerns.

Environmental justice—the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Eutrophication—an increase in plant biomass, by the addition of artificial or natural substances, such as nitrates and phosphates, through fertilizers or sewage. Increased plant density depletes healthy water sources of its oxygen, which causes a decline in fish and animal populations.

Glossary Terms

Life cycle analysis—a technique to evaluate environmental impacts associated with all the stages of a product's life or from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.

Outlay—a one-time payment to acquire a good or service.

Remediation—cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a polluted site.

Smog—a type of air pollution that resembles a combination of smoke and fog. The most common occurrence of smog is comprised of automobile emissions and industrial fumes that react in the atmosphere with sunlight to form secondary pollutants form photochemical fog. Smog can also be caused by emissions from coal combustion that includes a mixture of smoke, sulfur dioxide, and other components.

Supply chain—the functions inside and outside a company that enable it to make products and provide services to the customer. Typically refers to outside suppliers of goods and services.

Sustainability—the basic principle that everything we need for our survival and well-being depends, either directly or indirectly, on our natural environment.

Transport packaging—packaging used to protect or contain materials and products as they are moved from one point to another, within or between facilities, to customers, or to the marketplace.

MODULE-AT-A-GLANCE

Duration & *Elapsed Time*	Module 1 Topics	Assets
10 minutes *10 minutes*	Introduction	Facilitator Notes PowerPoint Slides Flipchart Handouts Activity 1
10 minutes *20 minutes*	Environmental Justice	Facilitator Notes PowerPoint Slides
15 minutes *35 minutes*	Environmental Revolutions	Facilitators Notes PowerPoint Slides Images Videos
20 minutes *55 minutes*	Sustainable Manufacturing	Facilitator Notes PowerPoint Slides Images Activity 2
15 minutes *1 hour, 10 minutes*	Environmental Awareness and Social Responsibility	Facilitator Notes PowerPoint Slides Images Videos Activity 3
15 minutes *1 hour, 25 minutes*	Greening the Supply Chain	Facilitator Notes PowerPoint Slides Handout Activities 4 and 5 Video
15 minutes *1 hour, 40 minutes*	Life Cycle Analysis	Facilitator Notes PowerPoint Slides Images
10 minutes *1 hour, 50 minutes*	Full Cost Accounting	Facilitators Notes PowerPoint Slides Activity 6

MODULE-AT-A-GLANCE (continued)

Duration	Module 1 Activities	Materials
10 min	Activity 1: Know, Want to Know, Learned (K-W-L) chart and Group Q and A's	Handout Questions-to-Ask
10 min	Activity 2: What NASCAR Can Teach Sustainability Professionals	Handout Questions-to-Ask
5 min	Activity 3: EPA's Pick 5 Campaign	Website
10 minutes	Activity 4: The Surprising Success of the Green Supply Chain	Handout
10 minutes	Activity 5: Case Study of the McDLT	Video Questions-to-Ask
20 minutes	Activity 6: Dust 2 Dust Energy Cost of New Vehicles	Research Report
TOTAL TIME: 2 HOURS, 55 MINUTES		

Step-by-Step Instructions

Facilitator Icon Key

Instructions to the Facilitator
This icon means there are specific instructions for the facilitator. This content should not be read aloud.

Background for the Facilitator
This icon indicates that there is background information the facilitator should be aware of when covering this topic. This information is for the facilitator only.

Facilitator Says
This icon means the facilitator should read the content nearly verbatim, interjecting his/her thoughts when appropriate.

Key Point
This icon indicates an important point that the facilitator should communicate to the audience in his/her own words.

Questions
This icon means the facilitator should allow time for the audience to ask questions or the facilitator should ask the audience questions.

Activity
This icon indicates an activity that the facilitator should explain. The activity can be either a group or individual activity.

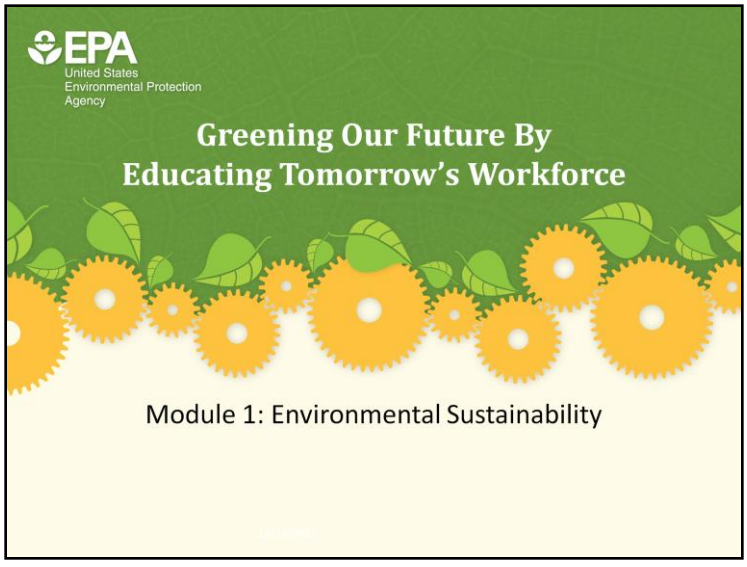
Assessment
This icon indicates the facilitator will conduct an assessment.

Multimedia
This icon indicates the facilitator will have students watch a video.

Computer
This icon indicates the facilitator will have students visit an online resource.

Handouts or Resource Materials
This icon indicates the facilitator will give students a handout or other resource material.

Transition
This icon indicates the facilitator will provide a transition from one topic to another.



Topic

Introduction
10 minutes

Learning Objective

Identify the ways the environment has a direct personal impact.

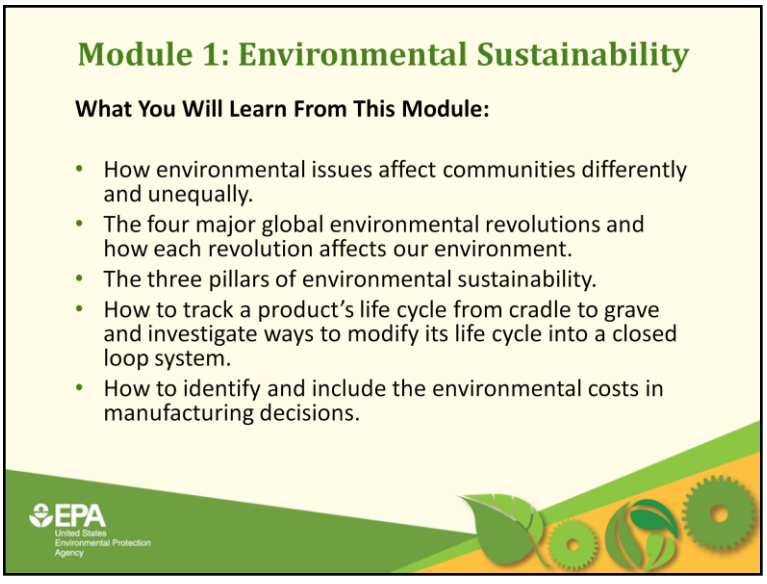
Notes for the Facilitator

As a class or in small groups, ask students to brainstorm what they already know about energy efficiency or carbon footprints and what they would like to know.

Pass out the *Know, Want to Know, Learned* (K-W-L) chart.

Have students begin a K-W-L chart. The K-W-L strategy allows students to take inventory of what they already know and what they want to know. This chart is to be completed by the end of the module.

Possible homework assignments: Add "How we can learn more" (H) to the K-W-L chart and ask students to select a related topic to research and present to the class.



Topic

Introduction
10 minutes

Learning Objective

Identify the ways the environment has a direct personal impact.

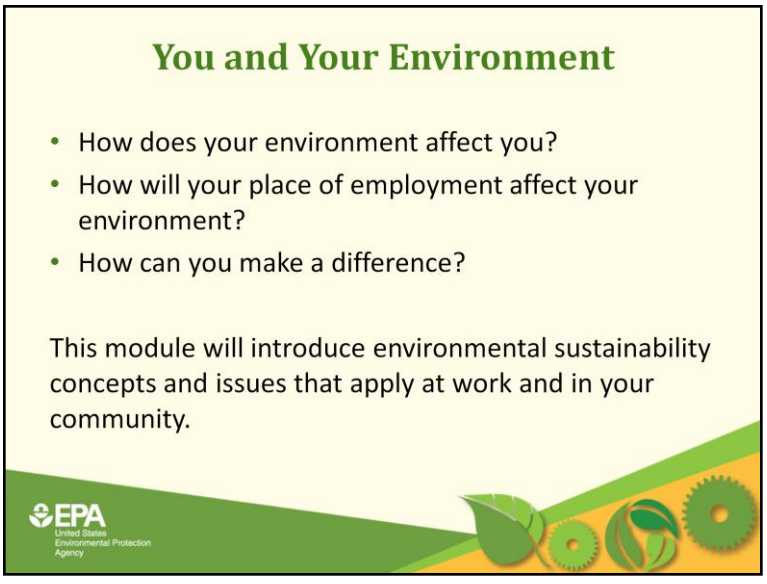
Notes for the Facilitator

Share the learning objectives with the students.

Another big part of our training philosophy is that you are responsible for your own learning. Now that you've seen the objectives, I'm going to ask you to please think about your expectations. Is there anything that's missing; anything you thought we would be going over or you wanted to go over that is not covered in the objectives?

Record all answers on a flipchart.

Thank you for your input on this topic. Some of these topics are the out of the scope of this course, but I'll see if I can find some resources for you or if we can fit it in if we have time.



Topic

Introduction
10 minutes

Learning Objective

Identify the ways the environment has a direct personal impact.

Notes for the Facilitator

Encourage a classroom conversation after this slide is posted. Ask students to brainstorm what they think of when given the terms "environmental issues," "sustainability," and "life cycle."

Possible homework assignment or variation for an in-class activity: Go to http://www.wordle.net/ and create a glossary term word cloud as a modern twist on a brainstorm.

Understanding the interconnectivity between you and your environment sets the stage for the remainder of this module. Make sure students understand how environmental issues have an impact on them personally.

Topic

Introduction
10 minutes

Learning Objective

Identify the ways the environment has a direct personal impact.

Notes for the Facilitator

This slide lists out types of anthropogenic environmental impacts. Anthropogenic impacts—meaning impacts caused by humans—not only affect our surroundings, but also self-inflict ourselves with a great deal of pain and suffering. While pollution directly affects our air, land, water, food, and wildlife resources, it also directly and indirectly affects our health and well-being.

Ask the class for examples of how these environmental impacts affect our health and safety.

Keep track of the answers and compare them to the ones provided on the next slide.

Topic

Introduction
10 minutes

Learning Objective

Identify the ways the environment has a direct personal impact.

Notes for the Facilitator

This slide lists the examples of how environmental impacts affect our health and well being. Anyone can be adversely affected by his or her environment, but employment in the manufacturing industry can raise the risks of some environmental exposures if proper protective health and safety measures are not in place.

Working in a manufacturing facility can increase exposure to hazardous pollutants. One example of exposure to hazardous pollutants in the workplace is the origin of the colloquial phrase "Mad as a Hatter." In the 18th and 19th centuries, mercury was used in the production of felt, which was commonly used in the manufacturing of hats. People who worked in these hat factories were exposed daily to trace amounts of the toxic metal, which bio-accumulated in their bodies over time and caused some workers to develop dementia.

Topic

Environmental Justice
10 minutes
(Elapsed Time: 20 minutes)

Learning Objective

Define environmental justice and explain the concept of environmental justice when compared to equality.

Notes for the Facilitator

Discussion questions: Do environmental pollutants affect all communities equally? Where would you typically see the images shown on this slide? Who would want to live or raise their family next to a landfill or power plant?

The impacts that environmental pollution has on one community/population versus another should not just be based on looking at the impacts of a comparison community. Environmental pollutants can impact some communities differently, because of other stressors that the community may be dealing with (e.g., joblessness, lack of access to health care and fresh produce, lack of recreational facilities/park space).

When environmental pollution affects one segment of a community or population at a greater intensity than another segment, this is called environmental inequality or injustice.

Possible Homework assignment: Ask students to find their own example on the Internet of environmental justice or injustice with a short two paragraph example of their choosing.

Point students to EPA's Environmental Justice website to start: http://www.epa.gov/environmentaljustice/

Topic

Environmental Justice
10 minutes
(Elapsed Time: 20 minutes)

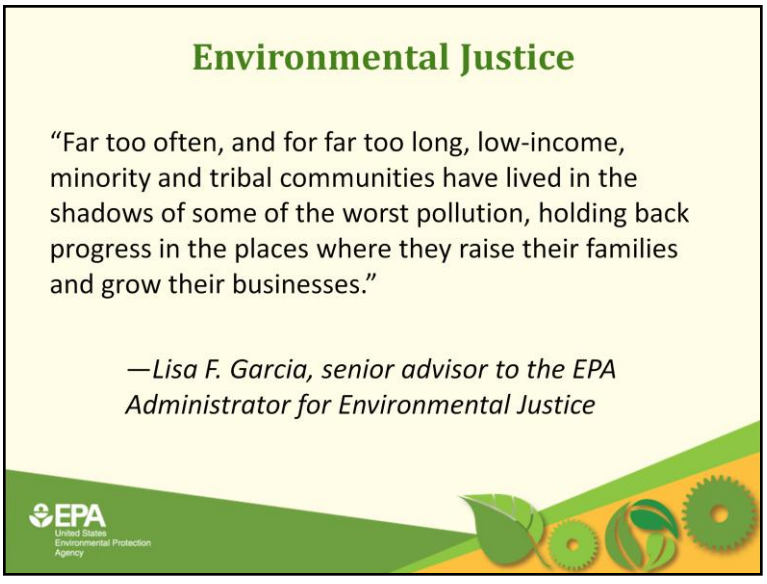
Learning Objective

Define environmental justice and explain the concept of environmental justice when compared to equality.

Notes for the Facilitator

Other factors that contribute to environmental injustice include:

- The price of land in environmental justice (EJ) communities is typically cheaper and easier for a buyer to acquire.
- Impoverished or minority communities are less organized to generate political pressure to stop planned environmental impacts in their area.
- Zoning laws and local ordinances oftentimes are not EJ community-friendly. For example, some areas may be rezoned to "industrial" even though the area is adjacent or in close proximity to a residential area.
- Environmental regulations do not require regulators to consider cumulative and multiple impacts. Therefore, individual facilities are permitted, but no consideration is made to the number of facilities that may already be surrounding a community.



Topic

Environmental Justice
10 minutes
(Elapsed Time: 20 minutes)

Learning Objective

Define environmental justice and explain the concept of environmental justice when compared to equality.

Notes for the Facilitator

EJ communities typically do not prosper economically due to the close proximity of polluting industries. These areas are usually not targeted for revitalization or economic development activities and remain less desirable than more affluent communities.

Topic

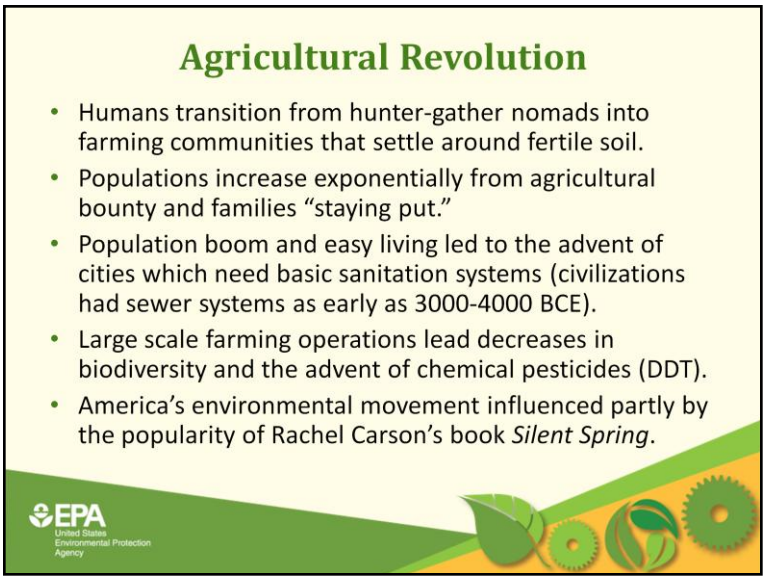
Environmental Revolutions
15 minutes
(Elapsed Time: 35 minutes)

Learning Objective

State each of the four global revolutions that affects our environment and summarize each revolution's impact(s).

Notes for the Facilitator

There are many major changes in human history that can be described as "revolutions" but the three revolutions discussed on this slide have caused significant environmental impacts. As our behaviors and actions change, our environment is impacted. We react to environmental impacts instinctively and protectively because our health and future well-being depend upon our environment. Reviewing past revolutions will strengthen the case why sustainable manufacturing is not only imperative, but will also be our next major environmental revolution.



Topic

Environmental Revolutions
15 minutes
(Elapsed Time: 35 minutes)

Learning Objective

State each of the four global revolutions that affects our environment and summarize each revolution's impact(s).

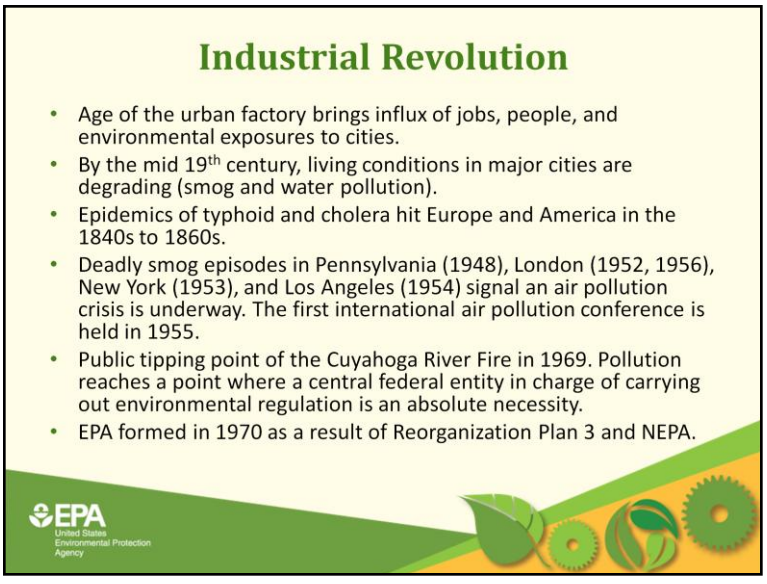
Notes for the Facilitator

Before humans could farm, we sustained ourselves through hunting and gathering, the first of many unsustainable human activities. Early humans would gather all the wild edibles and kill all the easiest-to-catch wildlife they could until they ran out. Then they would simply get up and move to a new place where hunting and gathering would be easier. It wasn't until we figured out how to grow crops that we settled down and formed communities as we know them today.

People "staying put" in one location for a long time resulted in the basic need to manage waste. Early civilizations conceived ways to deal with sanitation issues, which resulted in wastewater pollution.

Farming worked well as a means to provide food for the masses for centuries until the beginning of the 20th century. Large farms become so specialized in what they are growing that there is a loss in biodiversity. It creates the need for chemical pesticides, herbicides, and fungicides to continue growing crops at the same rate. Farms apply large quantities of new chemical formulations to continue farming in "business-as-usual" mindset without knowing or understanding the effects of these chemicals on other plants and animals.

During the peacetime that followed WWII, people started to recognize the way in which chemicals were affecting the environment. Rachel Carson, a former employee of the U.S. Fish and Wildlife Service, published the book *Silent Spring* in 1962. It brought the detrimental effects of chemical pesticides on the environment, particularly on birds and bird eggs, into the public eye. Carson wrote of the possibility of a spring in which no more birds could be heard chirping (a silent spring). The book's popularity led to the ban of DDT and a landmark event in the national environmental awareness movement.



Topic

Environmental Revolutions
15 minutes
(Elapsed Time: 35 minutes)

Learning Objective

State each of the four global revolutions that affects our environment and summarize each revolution's impact(s).

Notes for the Facilitator

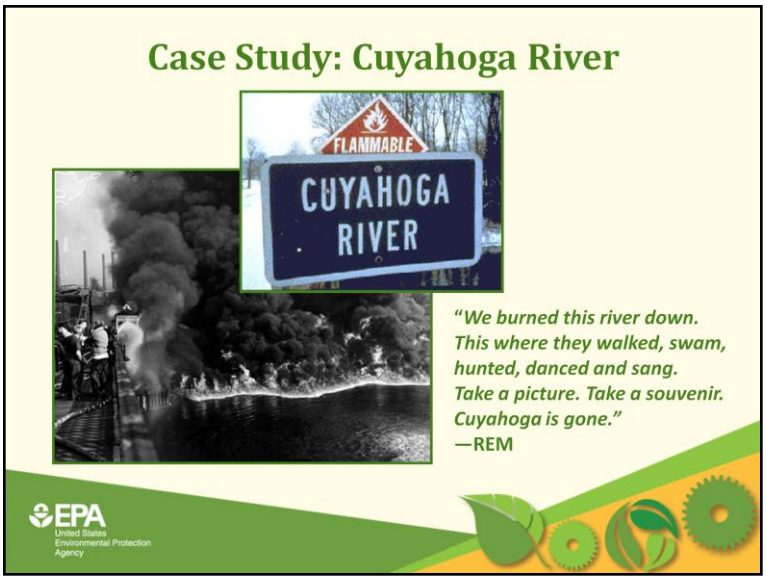
As industrial factories sprung up in or near major population centers , people flocked from rural communities in search of work. Cities grew rapidly and outpaced sanitary infrastructure.

The use of coal as primary fuel resulted in coal tar residue building up on structures and deaths from black lung.

Disease outbreaks decimated urban populations but no one understood why because urban population growth outpaces medical advances. No one comprehended how sanitation and water pollution play a role until John Snow, a London physician, traced a part of the city's cholera epidemic to a contaminated water pump in 1855.

Deadly smog outbreaks and Cuyahoga River Fire demonstrate industrial pollution can no longer be ignored.

Case study of Donora, Pennsylvania smog outbreak (listed in 4th bullet): Thick yellow smog caused by air pollution from U.S. Steel, Donora Zinc Works, and its American Steel & Wire rolled into Donora in the fall of 1948. It caused coughing and other signs of respiratory distress for many residents of the community in the Pittsburg suburb during the month of October. The smog continued until it rained on October 31, by which time 20 residents of Donora had died and approximately a third to one half of the town's population of 14,000 residents had been sickened.



Topic

Environmental Revolutions
15 minutes
(Elapsed Time: 35 minutes)

Learning Objective

State each of the four global revolutions that affects our environment and summarize each revolution's impact(s).

Notes for the Facilitator

The Cuyahoga River from Akron to Cleveland, Ohio was at one point one of the most polluted rivers in the world. It was devoid of fish and covered in a film of heavy black oil floating in slicks, sometimes several inches thick. Trash was commonly caught up in oil slicks ,forming a floating trash dump.

The river caught fire several times over a hundred year period from 1868 until 1969, the worst of which in 1852 cost residents more than $1 million in damage. Magazine covers depict photos of the 1969 fire, which increased public awareness and outcry. This helped spur the creation of the Clean Water Act, Great Lakes Water Quality Agreement, and the creation of the federal Environmental Protection Agency. As a result, large sources of pollution on the Cuyahoga have received significant attention and the health of the waterway is now much improved.

The story of the Cuyahoga River became part of American pop culture and was featured in numerous songs and films. The quote appearing on the screen is from REM's 1986 song, *Cuyahoga*. The song can be heard here: http://www.youtube.com/watch?v=nRUpkgykwfM

Topic

Environmental Revolutions
15 minutes
(Elapsed Time: 35 minutes)

Learning Objective

State each of the four global revolutions that affects our environment and summarize each revolution's impact(s).

Notes for the Facilitator

Early scientific research on the causes of smog showed a significant relationship between automobile exhaust. Motivated by smog's effects on human health, Eugene Houdry invented the catalytic converter, which greatly reduced the amount of carbon monoxide and unburned hydrocarbons in automobile exhausts. The catalytic converter was granted a U.S. Patent in 1956 and were introduced into production vehicles in 1973. Widespread adoption of his invention was delayed by the existence of lead in gasoline because it would spoil the converter by forming a coating on the catalyst's surface, effectively disabling it.

The personal computer was at first considered a tool only for academics and research institutes. From 1970s to the 1990s, the computer's use in industry transitions from convenience, to advantageous, to a market necessity. With frequent technological upgrades taking place in hardware, the computer industry begins generating a lot of waste–known as e-waste. The use of electronic products has changed the way and the speed in which we communicate and how we get information and entertainment.

According to the Consumer Electronics Association, Americans own approximately 24 electronic products per household. In 2009, discarded TVs, computers, printers, scanners, fax machines, mice, keyboards, and cell phones totaled more than 2 million metric tons.

Rare earth metals are vital to many of today's tech products. Mining, refining, and recycling of rare earth metals have serious environmental consequences if not properly managed.

The environmental impacts, combined with the geo-political concerns of where most rare earths are located, intensify the need for manufacturers to work toward a sustainable future.

Topic

Environmental Revolutions
15 minutes
(Elapsed Time: 35 minutes)

Learning Objective

State each of the four global revolutions that affects our environment and summarize each revolution's impact(s).

Notes for the Facilitator

Read the slide aloud to make the case that the Sustainable Revolution is inevitable based on our current levels of growth and resource use. Follow the slide by showing one or both of the following videos.

World Population: http://www.youtube.com/watch?v=9_9SutNmfFk
Hans Rosling's 200 Countries, 200 Years, 4 Minutes: http://www.youtube.com/watch?v=jbkSRLYSojo

Topic

Sustainable Manufacturing
20 minutes
(Elapsed Time: 55 minutes)

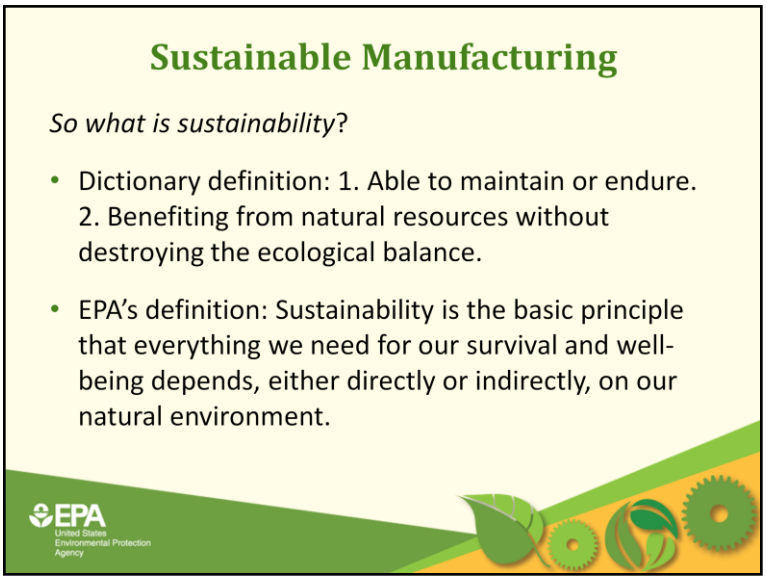
Learning Objective

Define sustainability as it relates to manufacturing.

Notes for the Facilitator

Pass out the article entitled *What NASCAR Can Teach Sustainability Professionals*.

Use this article to start the conversation of how, over time, the impact on the environment and our role in it changes.



Topic

Sustainable Manufacturing
20 minutes
(Elapsed Time: 55 minutes)

Learning Objective

Define sustainability as it relates to manufacturing.

Notes for the Facilitator

Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations.

Sustainability is based on the undeniable premise that everything we need for our survival and well-being comes from our environment.

- Thinking with a sustainable mindset is important to ensure that we have and will continue to have the water, materials, and resources to protect human health and our environment.
- Manufacturers also see potential in adopting sustainable initiatives because they can result in spending less money on wasting energy, water, raw materials, and time. The less money manufacturers need to spend on resources means they will have more money to spend on hiring new employees, adopting new innovations and expanding markets.

Sustainability and the U.S. EPA provides a detailed description of how EPA is establishing an operation policy framework that supports sustainable development. The report provides recommendations that both incorporate sustainability and go beyond the approach based on assessing and managing the risks posed by pollutants that largely shaped environmental policy in the past. The report recognizes the validity of the widely accepted sustainability paradigm, the "three pillars" approach, which means considering the environmental, social, and economic impacts of an action or decision. The report is available in its entirety from the National Academic Press.
http://www.nap.edu/catalog.php?record_id=13152

Topic

Sustainable Manufacturing
20 minutes
(Elapsed Time: 55 minutes)

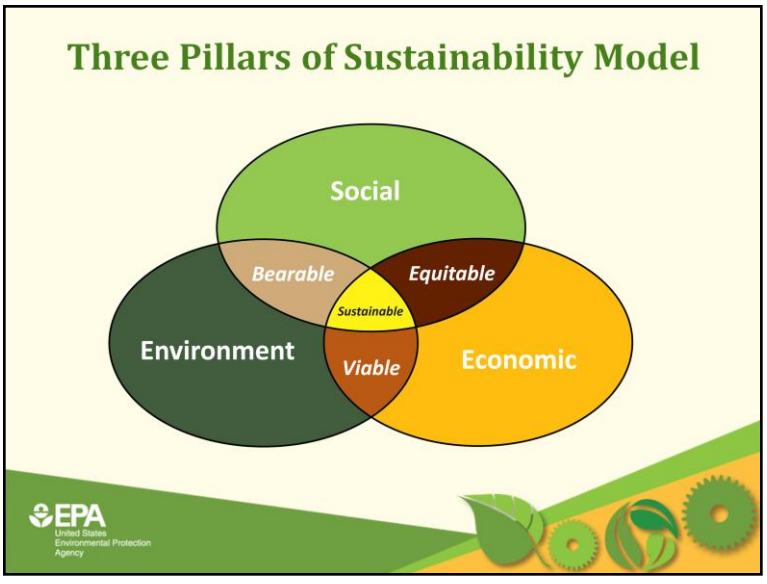
Learning Objective

Name the three pillars of sustainability and analyze the interdependence of a sustainability model.

Notes for the Facilitator

A simple way of understanding the concept of sustainable manufacturing is to picture a stool with three legs. The legs represent the three pillars of sustainability: environment, the economy, and our society.

When making manufacturing decisions, if any leg is more or less important (i.e., shorter or longer) than the others, the stool will be unstable (but perhaps still usable—at least for a while). If any leg is missing, the stool simply will fall over. But if all three legs are the same length (i.e., environmental, economic, and social considerations have been given equal weight), the result will be a well-balanced stool that will serve its purpose indefinitely.



Topic

Sustainable Manufacturing
20 minutes
(Elapsed Time: 55 minutes)

Learning Objective

Name the three pillars of sustainability and analyze the interdependence of a sustainability model.

Notes for the Facilitator

Another way to visualize the pillars of sustainability is by drawing three overlapping circles.

Where two of the three circles overlap, there is a tolerable state between both factors; where all three overlap, all factors are in a sustainable state.

Topic

Sustainable Manufacturing
20 minutes
(Elapsed Time: 55 minutes)

Learning Objective

Name the three pillars of sustainability and analyze the interdependence of a sustainability model.

Notes for the Facilitator

It's promising that some large corporations are now viewing the planet on equal footing as profit and its customers.

But is giving the environment an equal importance enough or does its protection garner higher importance than economic advantages?

The three legged stool model also places people outside the planet—is this approach correct?

What potential consequences could occur if our culture places a higher priority on economic growth than it does on environmental health? Remember the Cuyahoga River example?

Another view of sustainability is that humanity can have neither an economy nor social well-being without a healthy environment. In this case, the environment cannot be a leg of the sustainable development stool; it should be the floor or foundation upon which the stool, or any sustainable development model, must stand. This view is called the nested sustainability model.

Because change involves "vision" and a "shared societal goal," visuals such play an important role in helping understand complex systems such as sustainability.

Topic

Sustainable Manufacturing
20 minutes
(Elapsed Time: 55 minutes)

Learning Objective

Name the three pillars of sustainability and analyze the interdependence of a sustainability model.

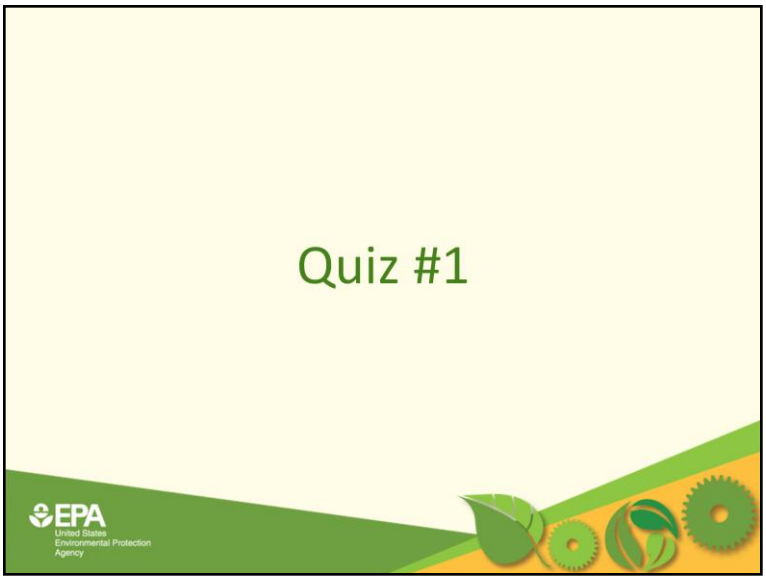
Notes for the Facilitator

Some experts feel that the "nested sustainability model" is a better visual representation of the interdependency of the pillars of sustainability. This model views the economy as a part of society and our society being a part of our environment as a whole. This model is intended to convey that all economic decisions have an effect on our society and environment, but that the environment encompasses all.

This website lists out other ways to visualize the interactions between the environment, the economy and society in sustainable development models. http://computingforsustainability.wordpress.com/2009/03/15/visualising-sustainability/

Using visuals available from the website above, print out various models of sustainability. Pass them out and have students get into groups and explain why the visual does or doesn't work to convey the concept of sustainability.

By having the students analyze the visuals, they will start to mentally construct (make mental models) of the interdependence such as the "three-legged" model. The goal is to shift their paradigm thinking of a one-to-one relationship to a complex/interdependent relationship. Keep the "onscreen text" PowerPoint up so students can ask these questions when looking at visuals of the model.



Topic

Learning Objective

Notes for the Facilitator

This quiz can serve as the end or the beginning a classroom session. The material covered in the rest of module 1 builds upon the material covered in this quiz. See Appendix B for sample quiz and answer key.

Topic

Environmental Awareness and Social Responsibility
15 minutes
(Elapsed Time: 1 hour, 10 minutes)

Learning Objective

Correlate greening the supply chain to corporate success.

Define a product's life cycle.

Recognize what contributes to the full cost of manufactured goods.

Notes for the Facilitator

This slide contains a video that serves an introduction to the next four topics. The video covers material on making environmentally responsible decisions, investigates the supply chain for bottled water companies, discusses at the life cycle of a plastic bottle, and highlights the full cost of purchasing decisions.

Watch this video in class: *The Story of Stuff*
http://www.youtube.com/watch?v=Se12y9hSOM0

Questions to ask following the video:

- Any ideas on why Cleveland was singled out for bottled water advertising? Recall the Cuyahoga River fires.
- Based on the information provided, is gasoline or bottled water more expensive? What would you do if you could turn on a tap to get gas at your house at 1/2000 the price? Would you still buy it at the gas station?
- What is the socially responsible and environmentally preferable thing to do after viewing this video? Are there economic trade-offs?
- How is the bottled water industry impacting the automobile industry? Competing resources. Point out the gas for 1,000,000 cars equivalency at 4:05 in the video.
- From this assessment, is the bottled water industry sustainable in the long run?

Topic

Environmental Awareness and Social Responsibility
15 minutes
(Elapsed Time: 1 hour, 10 minutes)

Learning Objective

N/A

Notes for the Facilitator

Have students pick 5 at www.epa.gov/pick5 in class or for homework.

Students can either hand in the assignment or sign into Facebook and do it electronically
http://www.facebook.com/epapick5

The focus of this assignment is to tie individual responsibility and the ability we each have to contribute to responsible sustainable choices.

Topic

Environmental Awareness and Social Responsibility
15 minutes
(Elapsed Time: 1 hour, 10 minutes)

Learning Objective

Correlate greening the supply chain to corporate success.

Notes for the Facilitator

This slide presents findings from a recent survey that asked large manufacturers how sustainability will affect their purchasing decisions.

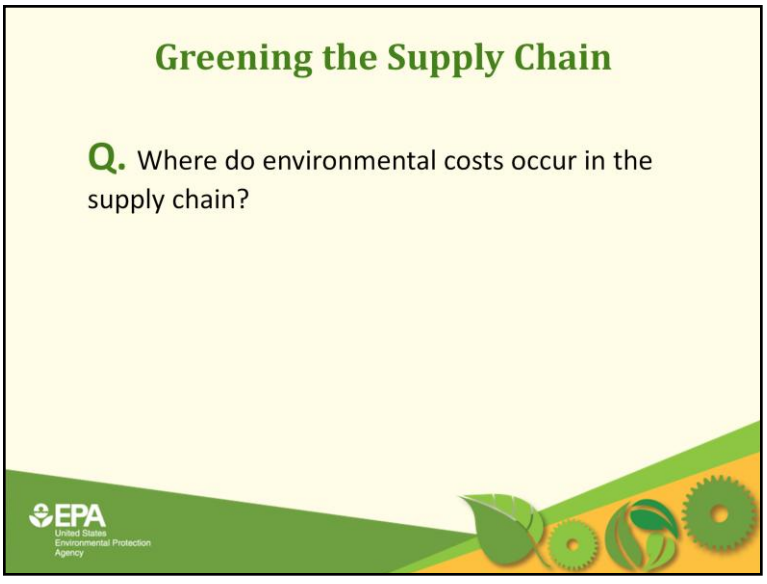
As OEMs place more importance on the environmental footprint of their supply chain, tier I and II suppliers will no longer be able to have a novel approach to sustainability because it will be a market imperative. In fact, recent surveys found that:

- Severn out of every ten companies across the manufacturing industry sector agree that transitioning toward sustainability is essential to staying competitive in today's marketplace.
- Investment in sustainable manufacturing is increasing despite the recent economic downturn, with about 70 percent of companies stating that their annual investments in sustainability are increasing.
- 75 percent of companies will reward suppliers with sound sustainability practices and will de-select suppliers based on failure to meet environmental criteria.
- 70 percent of companies state that sustainability is permanently on their agenda.
- One in two companies state that sustainability will lead to reduced costs and increased profitability.

Pass out the article entitled *Surprising Success of the Green Supply Chain*. Have students read the article.

Once students are finished reading the article, watch the related video entitled *Wal-Mart Measures Sustainability*: http://www.youtube.com/watch?v=lwjuJQ6Bl7U

Discuss students' reactions to articles, website and video. Have them share if they surprised by the corporate initiatives? Why or why not? Do the examples fit into the three-legged model?



Topic

Greening the Supply Chain
15 minutes
(Elapsed Time: 1 hour, 25 minutes)

Learning Objective

Correlate greening the supply chain to corporate success.

Notes for the Facilitator

Ask the question displayed on the slide and see how many environmental costs the class can name before advancing to the next slide.

What are the environmental costs that occur in the supply chain?

Topic

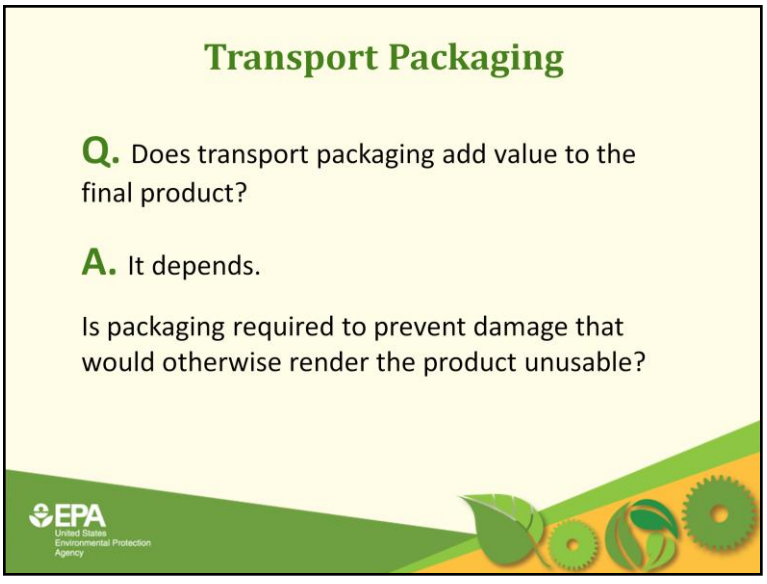
Greening the Supply Chain
15 minutes
(Elapsed Time: 1 hour, 25 minutes)

Learning Objective

Correlate greening the supply chain to corporate success.

Notes for the Facilitator

Reveal this slide once the activity on the previous slide is completed. This slide lists common places where environmental costs occur. Your class could list many more. Discuss examples that were not mentioned during the activity. Highlight instances where students feel strongly about one or two examples of where environmental costs occur.



Topic

Greening the Supply Chain
15 minutes
(Elapsed Time: 1 hour, 25 minutes)

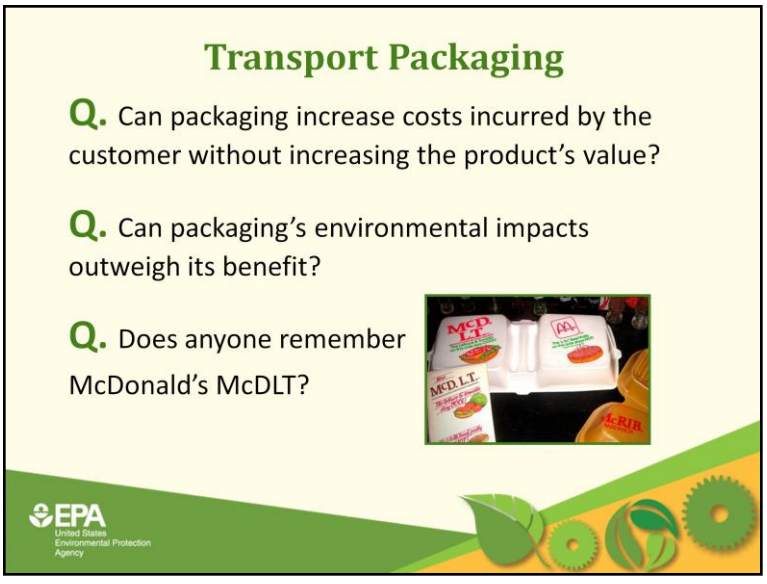
Learning Objective

Correlate greening the supply chain to corporate success.

Notes for the Facilitator

Read the slide aloud. Pose the question and use the provided answer to stimulate discussion. See if students can describe examples of when transport packaging is wasteful or unnecessary and also examples of when it is necessary to ensure value of the product.

Use the discussion as a transition to the next slide, which provides an example of where excessive transport packaging was the downfall of a product.



Topic

Greening the Supply Chain
15 minutes
(Elapsed Time: 1 hour, 25 minutes)

Learning Objective

Correlate greening the supply chain to corporate success.

Notes for the Facilitator

Read the questions displayed on the slide and foster a discussion that attempts to answer the first two questions. Move on to the third question once adequate answers are provided.

If the students are not familiar with the McDonald's sandwich McDLT, show this commercial before discussing the case study.
http://www.youtube.com/watch?v=A_IVEdui0Z4

Case study of the McDLT: The McDLT was a McDonald's sandwich that took transport packaging to excess. McDonald's introduced McDLT in the fall of 1984. It was a simple burger with lettuce and tomato, but came in a specially designed two-sided Styrofoam container. The consumer was then expected to finalize preparation of the sandwich by combining the hot and cool sides just prior to eating.

All was going well for the McDLT until a PR crisis squashed it. The country was becoming increasingly conscious about the environment, and the double-container caused double the damage. McDonald's pulled the ill-fated McDLT from its menu in 1990 due to concerns about Styrofoam.

After sharing this case study, initiate a discussion about the environmental and business implications of the transport packaging design. Have students break into groups and consider how everyday products are packaged. Use examples of how the product packaging has changed over time to be friendlier environmentally and for corporate profit.

Each group should come up with at least one example of environmentally friendly and not friendly packaging to share.

Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

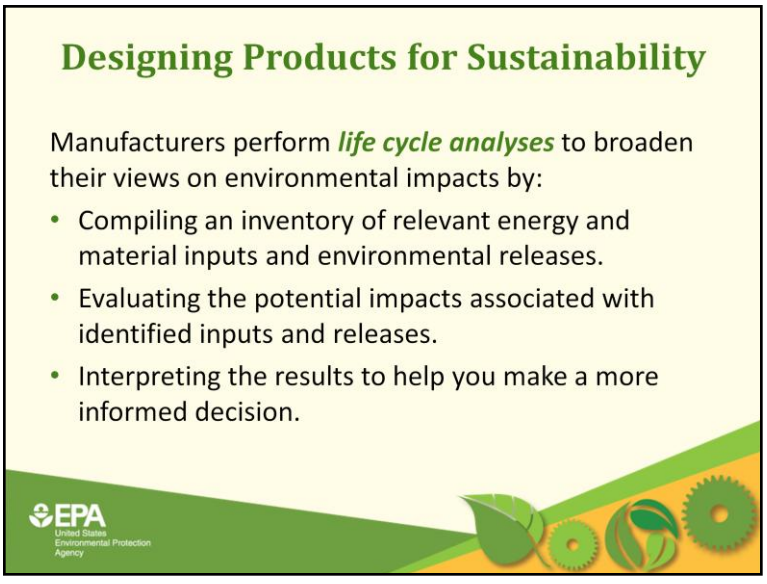
Learning Objective

Define a product's life cycle.

Notes for the Facilitator

Traditional product design was when raw materials were taken from the environment, made into products, and then were disposed as waste once the products reached the end of their useful life. In the past, companies didn't typically consider the waste that results after a product's useful life their responsibility. In simplified terms, traditional product design equated to "take, make, waste."

Sustainable product design is when companies consider a product's full life cycle in its design. The phrase "cradle to grave" is a way sustainability professionals talk about the boundaries of life cycle analyses , looking at environmental impacts from a product's design until its disposal.



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

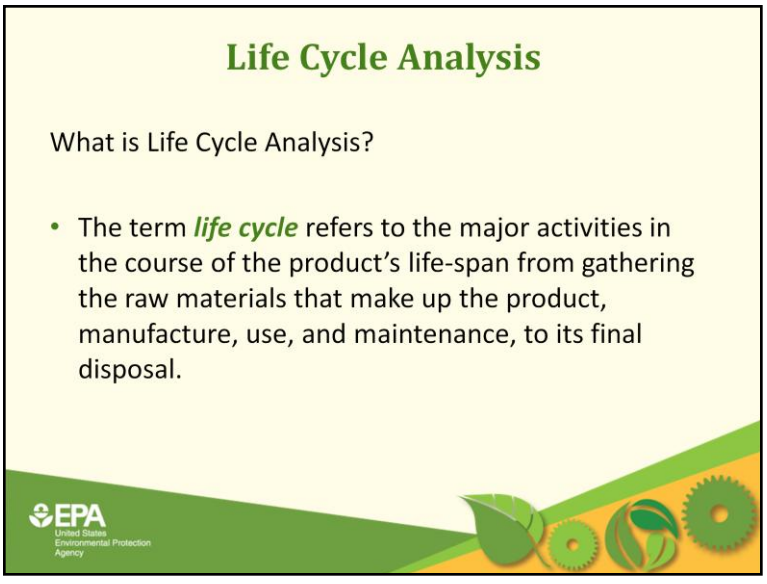
Learning Objective

Define a product's life cycle.

Notes for the Facilitator

Read the slide aloud.

Ask "what is a life cycle?" to provide a transition to the next slide, which answers the question.



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

Learning Objective

Define a product's life cycle.

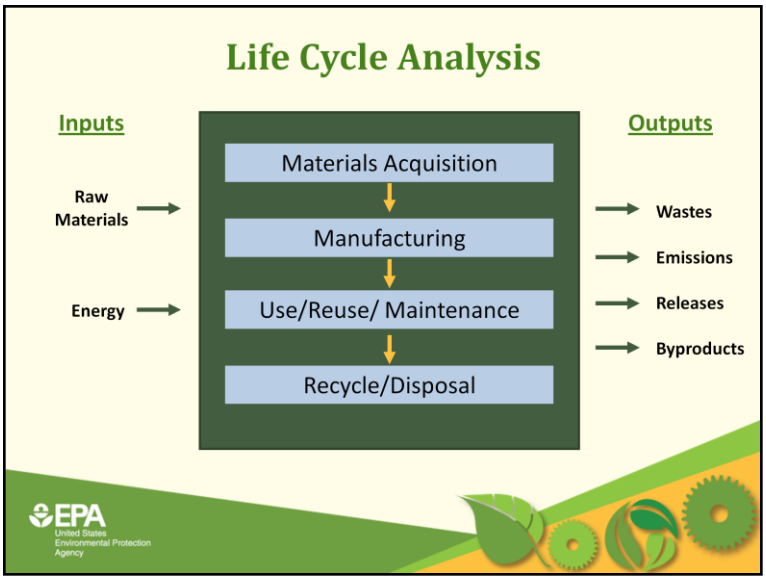
Notes for the Facilitator

The generalized goal of any life cycle analysis is to minimize a product's environmental impact and reduce its socio-economic burden. While a life cycle analysis can begin as a means to recognize the choices that carry environmental trade-offs, it can also identify product vulnerabilities, reduce raw material usage, and serve as a market differentiator.

An EPA guidance document entitled *Life Cycle Assessment: Principles and Practice* provides an introductory overview of Life Cycle Assessment (LCA) and describes the general uses and major components of LCA.
http://www.epa.gov/nrmrl/lcaccess/lca101.html

The United Nations Environment Programme also provides several publications on life cycle analysis, including *Life Cycle Management: A Business Guide to Sustainability*
http://www.unep.fr/shared/publications/pdf/DTIx0889xPA-LifeCycleManagement.pdf
and *Why Take a Life Cycle Approach?*
http://www.unep.fr/shared/publications/pdf/DTIx0585xPA-WhyLifeCycleEN.pdf

The American Center for Life Cycle Analysis provides additional learning materials, some sector-specific case studies ,and a general sustainability news feed.
http://www.lcacenter.org/



Topic

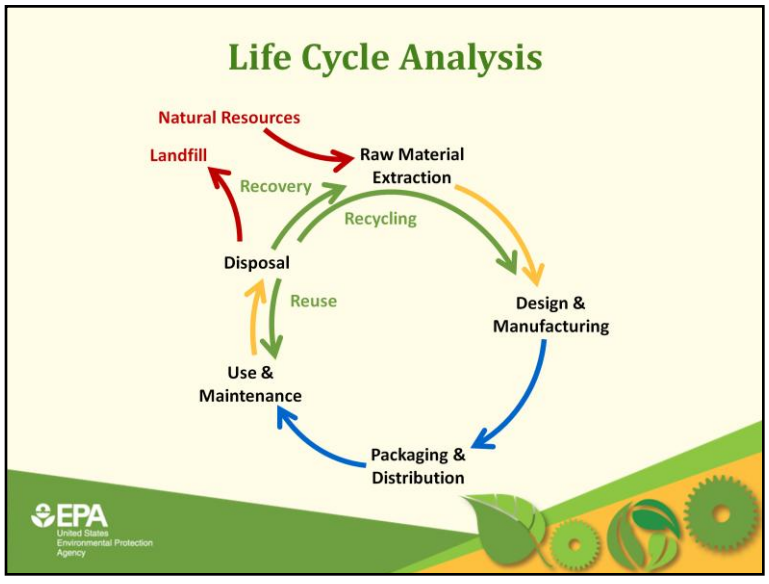
Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

Learning Objective

Define a product's life cycle.

Notes for the Facilitator

This slide graphically depicts a simple life cycle from materials acquisition to disposal, moving linearly from top to bottom (or cradle to grave) and lists out inputs and outputs. This graphic could be used as a guide for discussing a product's life cycle.



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

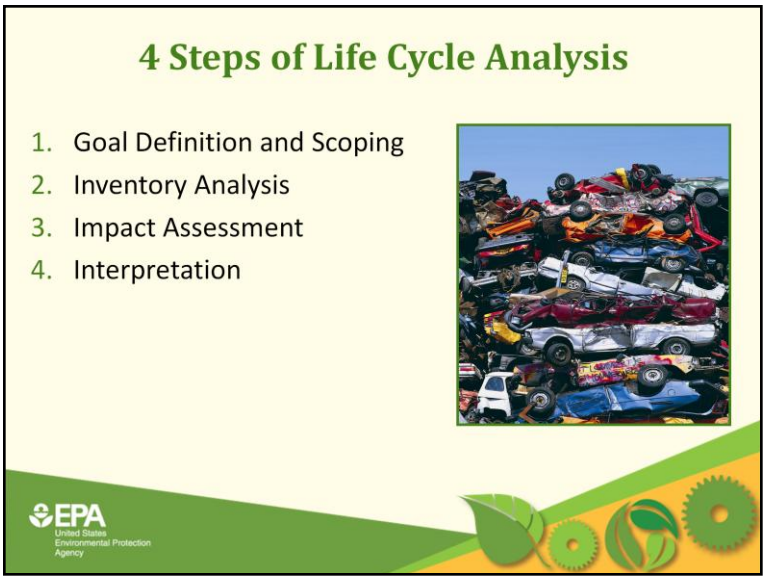
Learning Objective

Define a product's life cycle.

Notes for the Facilitator

This slide shows a circular life cycle with the addition of the 3 R's to show how it could be altered to reflect "cradle-to-cradle" design. Cradle-to-cradle design is a regenerative model that doesn't end with disposal, such as cradle-to-grave. Companies that approach product design with this model of thinking consider recyclability, reusability, and energy recovery as extensions of the product's useful life.

The phrase "cradle to cradle" is typically credited to Walter Stahel, a Swiss architect who was a pioneer in the field of sustainable design. The term was made popular by Michael Braungart and William McDonough's book, *Cradle to Cradle: Remaking the Way We Make Things.*



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

Learning Objective

Define a product's life cycle.

Notes for the Facilitator

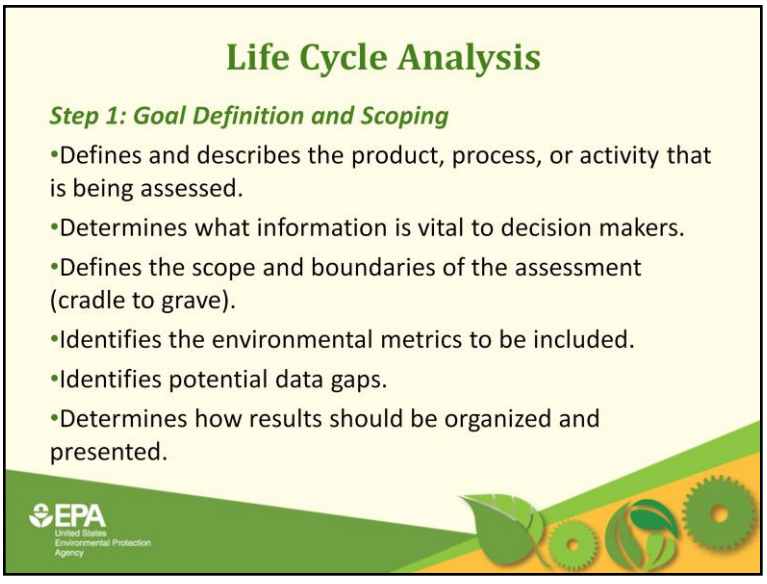
Each of the next 4 slides will expand upon the steps of performing a life cycle analysis. Walk through each one before moving on.

Goal Definition and Scoping—Define the product, process or activity to be assessed and establish the boundaries.

Inventory Analysis—Identify and quantify all inputs and outputs.

Impact Assessment—Assess the potential human and ecological effects of materials used and the potential environmental releases.

Interpretation—Evaluate the results to select the preferred product, process, or service with a clear understanding of its impacts.



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

Learning Objective

Define a product's life cycle.

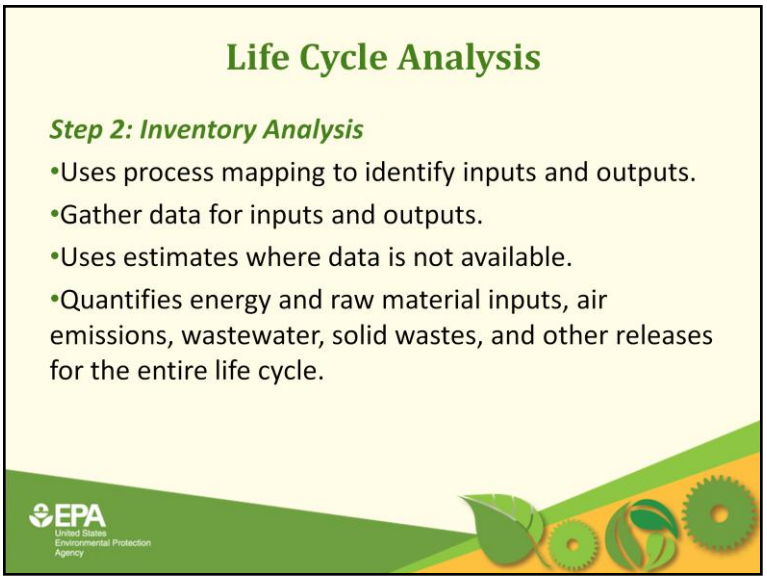
Notes for the Facilitator

Defining the goals and boundaries of a life cycle analysis (LCA) is important because clearly defined boundaries keep the analysis focused on the specified product and its usable life. Highlight this importance using the background information found below.

Conducting an LCA could serve many purposes. An LCA project could provide a broad overview of a company's environmental performance or it could be used to help guide the development of new products or activities toward reductions of raw material requirements, energy use, or air emissions. Defining the purpose of the LCA is an important step in developing a valuable analysis.

Clearly defining the scope or boundaries is important to developing a meaningful analysis. The most common scope for LCAs is referred to as cradle to grave, which describes a product's life cycle from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. Other scopes are possible, but cradle to grave is a broadly used term to look at the full life of a product and its components.

Other examples of potential boundaries for scoping LCA projects that assess energy consumption by automobiles could include "gas cap to tailpipe" or the "oil well to the wheels."



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

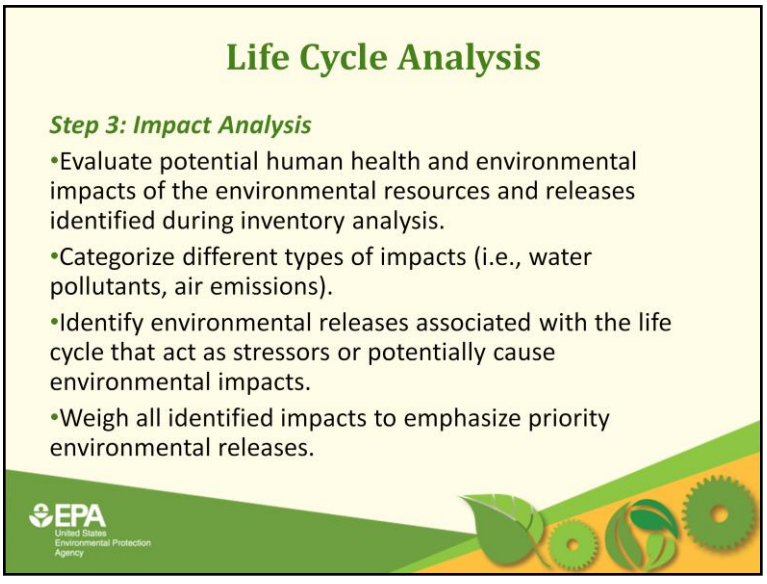
Learning Objective

Define a product's life cycle.

Notes for the Facilitator

This step in performing an LCA identifies and quantifies raw materials, energy, and water used in manufacturing and environmental releases (e.g., air emissions, solid waste disposal, waste water discharges) that result as byproducts from the manufacturing processes that go into making the product.

Process mapping is one effective way to identify inputs and outputs for each manufacturing process or product use, maintenance, or recycling.



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

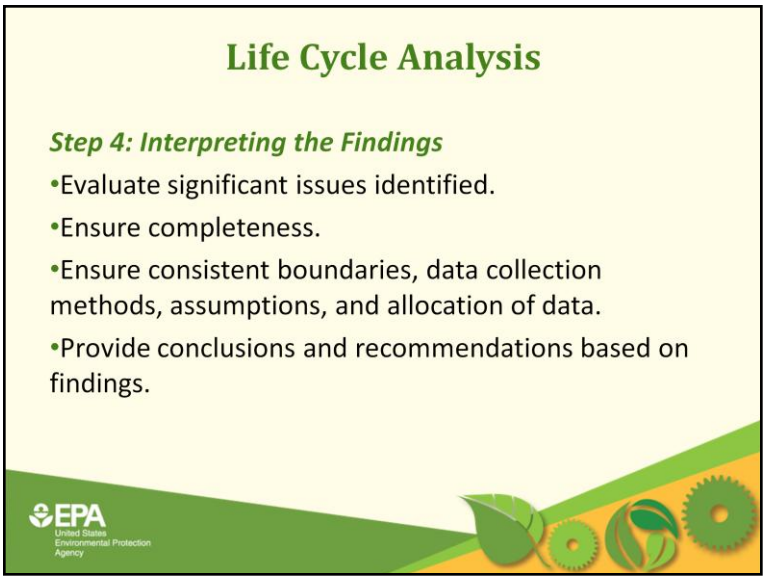
Learning Objective

Define a product's life cycle.

Notes for the Facilitator

The impact analysis is what sets LCA apart from other product assessment techniques, such as process or value stream mapping. Once an inventory is completed, a company looks holistically at the environmental impacts associated with each of the inputs and outputs. Understanding where environmental impacts potentially occur in a product's life cycle allow companies to make sustainable design decisions.

EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) provides an online environmental impact assessment tool that can assist in categorizing and weighing environmental impacts. More information about the TRACI tool is available here: http://www.epa.gov/nrmrl/std/sab/traci/index.html



Topic

Life Cycle Analysis
15 minutes
(Elapsed Time: 1 hour, 40 minutes)

Learning Objective

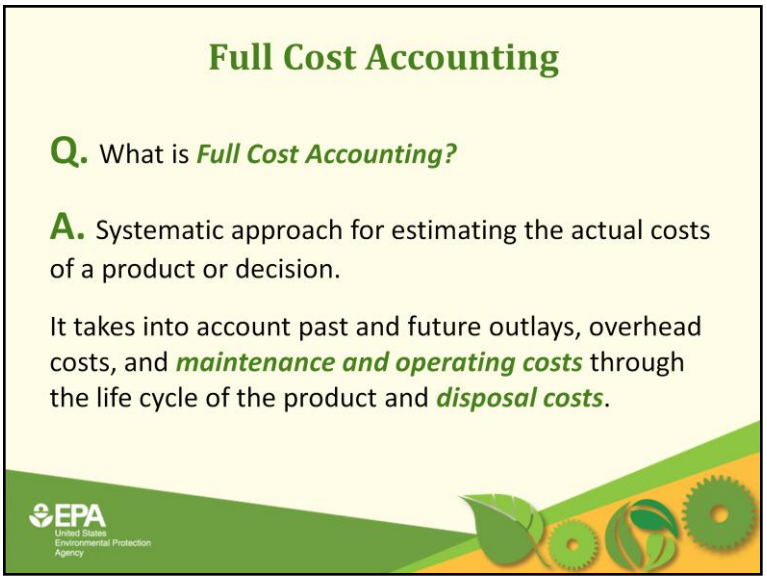
Define a product's life cycle.

Notes for the Facilitator

Interpreting the results of an LCA is not as simple as choosing one alternative over another. Conducting life cycle analyses requires making assumptions, calculating estimates, and making decisions based on tradeoffs, considering the opinions of customers and other stakeholders.

The results of an LCA are just one tool decision-makers can use when evaluating new or alternative product designs. They provide information on human health and environmental impacts that are not always considered when selecting a product or process. This valuable information provides a way to account for the full impacts of decisions, especially those that occur outside of the site that are directly influenced by the selection of a product or process.

This slide can be used to transition into the topic of full cost accounting, which is another tool decision-makers can use to evaluate products and environmental impacts.



Topic

Full Cost Accounting
15 minutes
(Elapsed Time: 1 hour, 55 minutes)

Learning Objective

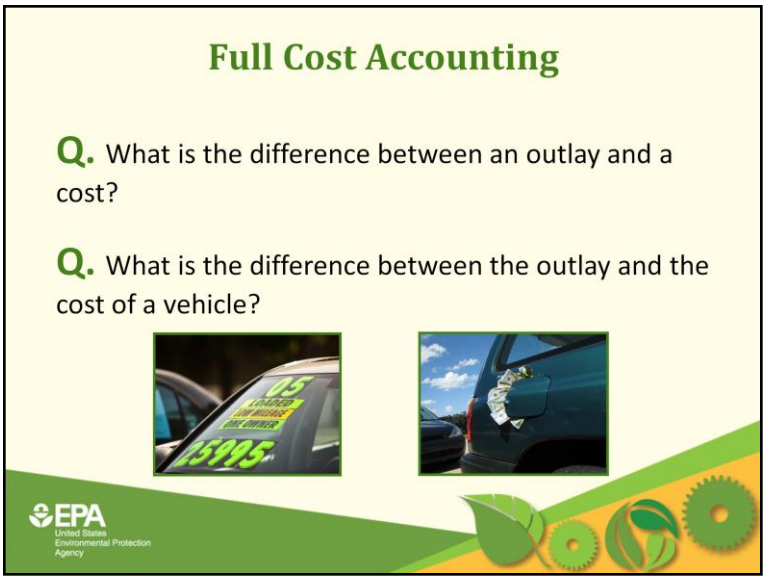
Recognize what contributes to the full cost of manufactured goods.

Notes for the Facilitator

Most environmental impacts are the result of product design and engineering decisions. For example, a product that contains toxic materials has the potential to have an environmental impact and can include a high environmental cost for end-of-life recycling or disposal. However, environmental costs are typically not apparent to the product designer.

Both life cycle analysis and full cost accounting are tools that decision-makers can better understand environmental outcomes associated with their products. While life cycle analysis looks at impacts, full cost accounting looks at environmental costs. Let's look closer at full cost accounting as a means to estimate environmental costs.

This approved resource covers the topic of full cost accounting in greater detail. *Full Cost Accounting: A Course Module on Incorporating Environmental and Social Costs Into Traditional Business Accounting Systems*. Developed by Carnegie Mellon University. http://gdi.ce.cmu.edu/gd/education/FCA_Module_98.pdf



Topic

Full Cost Accounting
15 minutes
(Elapsed Time: 1 hour, 55 minutes)

Learning Objective

Recognize what contributes to the full cost of manufactured goods.

Notes for the Facilitator

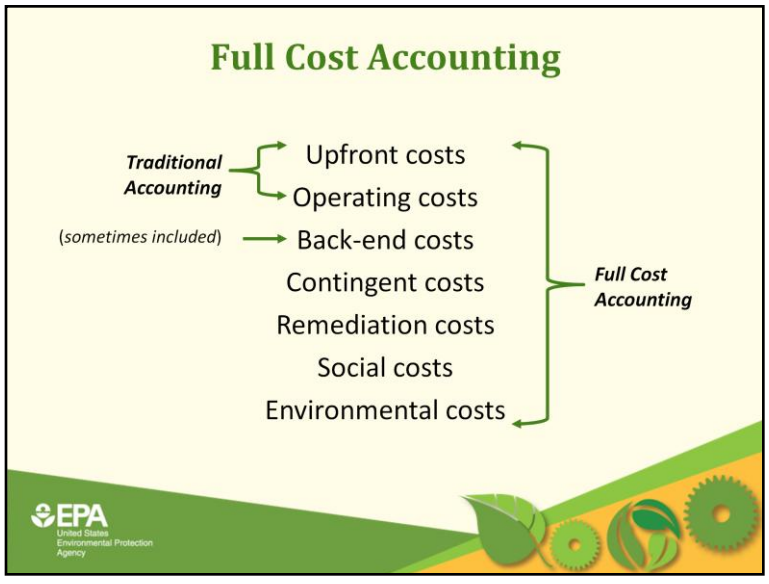
Read the questions displayed on the slide and ask for volunteers to provide answers. Compare their answers to the information below.

In manufacturing terms, traditional accounting concerns itself with cash flow and recouping upfront costs or "outlays" for raw materials and production operating costs, transportation costs, and overhead.

It is important to understand the difference between outlays versus costs. An outlay is made when a vehicle is purchased, but the cost of the vehicle is incurred over its active life. After the purchase is made, the vehicle still holds value and a portion of the outlay could be recouped through resale. The cost of the vehicle is only incurred because every year of its use contributes to the depreciation of the vehicle's value. Traditional cost only looks at this aspect of the vehicle's cost.

Full cost accounting would include the lifetime costs of gasoline (energy), upkeep, taxes, annual fees, insurance, replacement, and disposal of maintenance items (such as used oil, oil filters, tires, brake pads, wiper blades), and end of life disposal.

An outlay is a one-time payment to acquire a good or service. For example, payroll is an outlay because it is in exchange for labor which holds value.



Topic

Full Cost Accounting
15 minutes
(Elapsed Time: 1 hour, 55 minutes)

Learning Objective

Recognize what contributes to the full cost of manufactured goods.

Notes for the Facilitator

This slide graphically depicts the difference between traditional accounting and full cost accounting. Use the information below to explain the terms that appear on the slide.

Upfront costs include initial investments and expenses necessary to produce goods or services.

Operating costs are the expenses of doing business on a daily basis, including operations and maintenance, capital costs, debt service, and any unexpected costs.

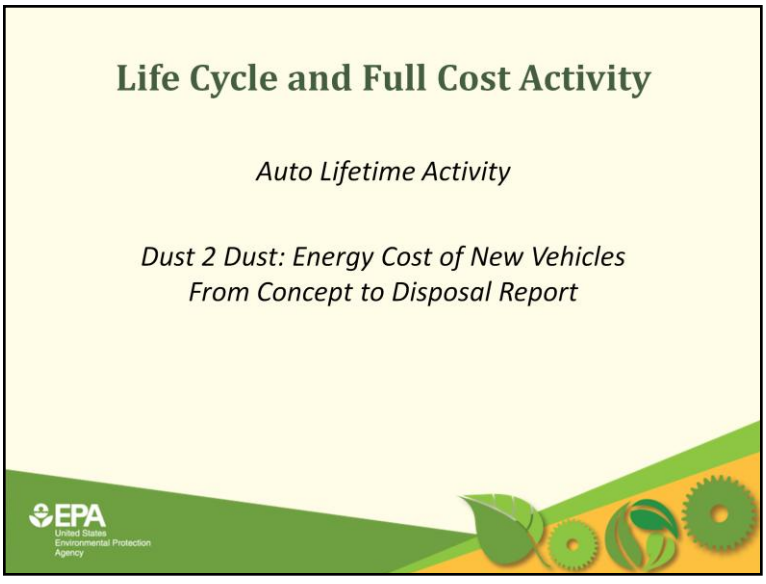
Back-end costs include expenditures to properly wrap up operations and take proper care of capital equipment, property, and materials at the end of their useful lives. Costs include site closure and building/equipment decommissioning.

Contingent costs are costs that might or might not be incurred at some point in the future. These costs can include liability findings through legal processes.

Remediation costs at inactive manufacturing sites include investigation, containment, and cleanup of known releases causing contamination of ground water, soil, or surface water.

Environmental costs are the costs of environmental degradation that cannot be easily measured or remedied, are difficult to value, and are not subject to legal liability. To truly capture all of the important life-cycle cost elements, some people advocate assessing the upstream and downstream environmental costs of resource use, pollution, and waste generated by providing goods and services.

Social costs are adverse impacts on human beings, their property, and welfare that cannot be compensated through the legal system. Social costs might include the impacts of manufacturing that have adverse effects on property values, community image, and aesthetics, as well as the increase of noise, odor, and traffic, which all contribute to social costs.



Topic

Full Cost Accounting
15 minutes
(Elapsed Time: 1 hour, 55 minutes)

Learning Objective

Define a product's life cycle.

Recognize what contributes to the full cost of manufactured goods.

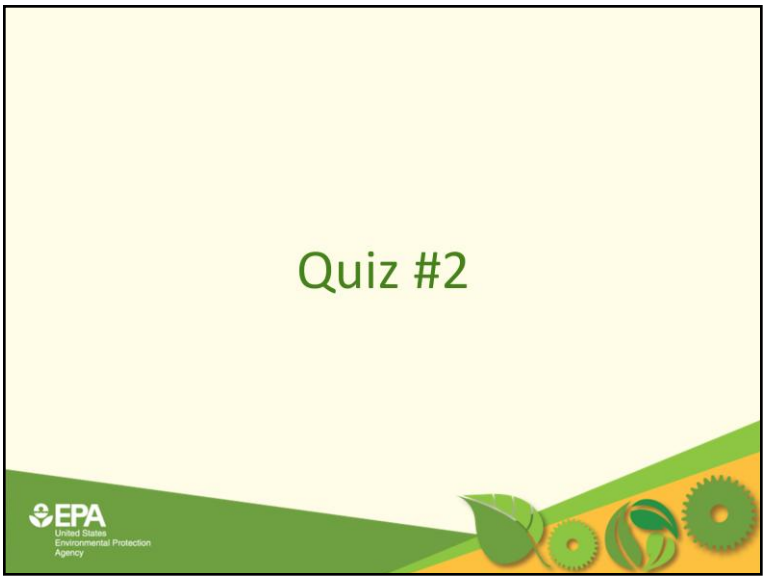
Notes for the Facilitator

For this activity, divide the class into groups of four students. Each group will be asked to investigate two vehicle models in four industry segments (economy, hybrid, SUV, and luxury). Each of the students in the group will also include one other vehicle for comparison. If a student owns a vehicle included in the comprehensive list, they should include it in the group's list. If a student doesn't own a vehicle, or their vehicle is not included in the data provided, he or she can include a vehicle owned by a family member or one that he or she dreams of purchasing.

Prior to breaking the class into groups, briefly discuss as a class the types of cost components that would go into the full energy cost of an automobile over its useful lifetime. These cost components include:

- Design and development
- Manufacturing
- Fuel
- General repair and maintenance
- Accident repair
- Dealership expenses
- Recycling and disposal

Handouts 1 and 2 for this activity are located in Appendix C. Using the data tables provided in the *Dust to Dust: Energy Cost of New Vehicles From Concept to Disposal* report, students will answer questions on both handouts. Pass out Handout 1 with the data table starting on 39 first. Once all groups have completed the first handout, pass out the remaining materials so they can complete the activity.



Topic

Learning Objective

Notes for the Facilitator

This quiz can serve as the end or the beginning a classroom session. See Appendix B for sample quiz and answer key.

APPENDIX A: Video Resource List

Cuyahoga by R.E.M: http://www.youtube.com/watch?v=nRUpkgykwfM

World Population: http://www.youtube.com/watch?v=9_9SutNmfFk

Hans Rosling's 200 Countries, 200 Years, 4 Minutes: http://www.youtube.com/watch?v=jbkSRLYSojo

The Story of Bottled Water: http://www.youtube.com/watch?v=Se12y9hSOM0

Wal-Mart Measures Sustainability: http://www.youtube.com/watch?v=lwjuJQ6Bl7U

McDonald's Commercial 1985 - McDLT with Jason Alexander: http://www.youtube.com/watch?v=A_IVEdui0Z4

APPENDIX B: Module Quizzes

Environmental Sustainability
Quiz #1

1. Discuss how an environmental issue impacts you or your community.

_____

_____

_____

_____

_____

2. Identify three factors contributing to environmental injustice.

A) _____

B) _____

C) _____

3. Match the environmental revolution (left column) with one of its environmental impacts (right column) as discussed in class. Identify the correct impact by placing its letter next to the name of the revolution:

Environmental Revolution	***Environmental Impact***
___ Agricultural	A) Eradication of bumble bees
___ Industrial	B) Increased air pollution from burning coal
___ Technological	C) Resource scarcity
___ Sustainable	D) Floating trash dump
	E) Biodiversity loss from pesticides
	F) Radioactive wastewater from mining rare earth metals

4. Describe the term that best describes the relationship between the three pillars of sustainability:

A) Linear

B) Complex

C) Simple

D) One-to-one

5. Statement: True or False

___ Societal concerns need to be met before we can solve environmental problems.

Environmental Sustainability
Quiz #2

1. What percentage of companies state they will reward suppliers with sound sustainability practices?

A) 40% B) 90% C) 75% D) 60% E) 10%

2. Consider the McDLT case study discussed in class. Relate at least one way your findings about the environmental and business implications of the transport packaging design can be applied to the automotive manufacturing industry.

_____

_____

_____

_____

_____

_____

_____

3. What is the correct order of the life cycle analysis steps? Place the number 1-4 in the correct order with 1 as the first step.

___ Interpretation

___ Inventory Analysis

___ Goal Definition and Scoping

___ Impact Assessment

4. Explain the primary difference between "cradle-to-grave" and "cradle-to-cradle" design

_____

_____

_____

_____

5. Select the best answer below.

Full cost accounting is an estimate of:

A) Outlay minus environmental costs.

B) Actual costs in the future.

C) All operating costs.

D) Actual costs in the past and the future.

Environmental Sustainability
Quiz #1
(Answer Key)

1. Discuss how an environmental issue impacts you or your community.

_____

_____

_____

_____

_____

2. Identify three factors contributing to environmental injustice.

A) *Lack of environmental awareness*

B) *Lack of political influence*

C) *Lack of economic resources*

3. Match the environmental revolution (left column) with one of its environmental impacts (right column) as discussed in class. Identify the correct impact by placing its letter next to the name of the revolution:

Environmental Revolution	***Environmental Impact***
E Agricultural	A) Eradication of bumble bees
B Industrial	B) Increased air pollution from burning coal
F Technological	C) Resource scarcity
C Sustainable	D) Floating trash dump
	E) Biodiversity loss from pesticides
	F) Radioactive wastewater from mining rare earth metals

4. Describe the term that best describes the relationship between the three pillars of sustainability:

B) Complex

5. Statement: True or False

FALSE Societal concerns need to be met before we can solve environmental problems.

Environmental Sustainability
Quiz #2
(Answer Key)

1. What percentage of companies state they will reward suppliers with sound sustainability practices?

C) 75%

2. Consider the McDLT case study discussed in class. Relate at least one way your findings about the environmental and business implications of the transport packaging design can be applied to the automotive manufacturing industry.

_____

_____

_____

_____

_____

_____

_____

3. What is the correct order of the life cycle analysis steps? Place the number 1-4 in the correct order with 1 as the first step.

4 Interpretation

2 Inventory Analysis

1 Goal Definition and Scoping

3 Impact Assessment

4. Explain the primary difference between "cradle-to-grave" and "cradle-to-cradle" design

_____

_____

_____

_____

5. Select the best answer below.

Full cost accounting is an estimate of:

D) Actual costs in the past and the future.

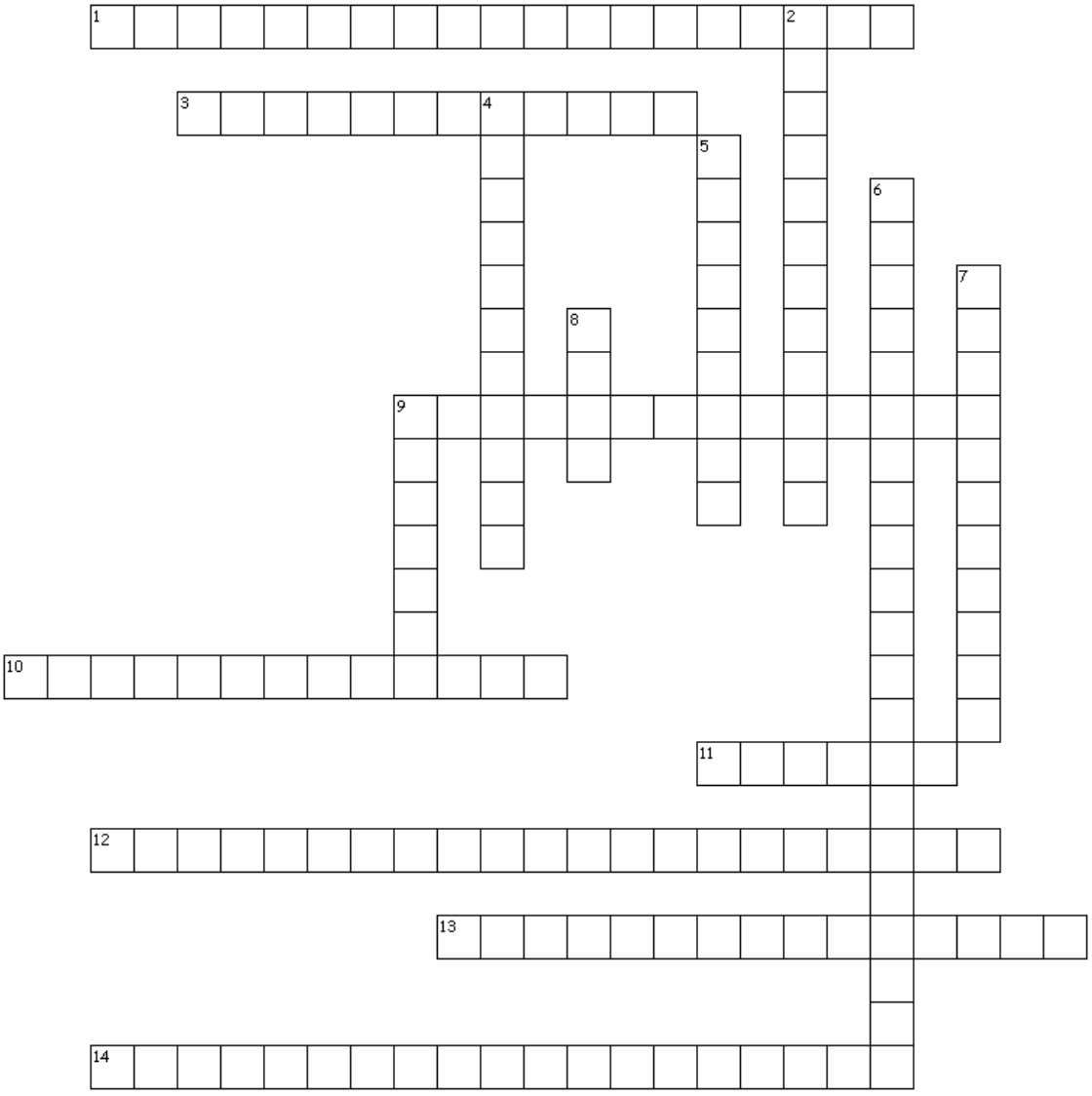
APPENDIX C: Facilitator Materials

SCHOLASTIC

KWL Chart

What do I know?	What do I want to find out?	What did I learn?

Environmental Terms Crossword – Environmental Sustainability



Across

1. A technique to evaluate environmental impacts associated with all the stages of a product's life. [Three words]
3. The variety of life in a certain area.
9. An increase in plant biomass, by the addition of artificial or natural substances through fertilizers or sewage.
10. Caused by the influence of humans.
11. A one-time payment to acquire a good or service.
12. The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. [Two words]
13. Buildup of substances in an organism.
14. Compounds consisting of chlorine, fluorine, and carbon.

Down

2. The functions inside and outside a company that enable it to make products and provide services to the customer.
4. Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a polluted site.
5. Used to protect or contain materials and products as they are moved from one point to another, within or between facilities, to customers, or to the marketplace.
6. Chemicals in water that, in the past, were not previously detected at levels that may be significantly different than expected. [Two words]
7. A type of recycling that process products into new materials or products of lesser quality and reduced functionality.
8. A type of air pollution that resembles a combination of smoke and fog.
9. Discarded electronic devices.

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What NASCAR Can Teach Sustainability Professionals

By *Leslie Guevarra*
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For many sustainability executives, their toughest challenge is to engage employees and persuade them to buy into their company's commitment. Mike Lynch's message is no different, but his toughest audience isn't his organization, industry or its fans. Often, it's his peers.

Recently, the managing director of NASCAR Green Innovation stood before a roomful of sustainability professionals gathered for a meeting of the GreenBiz Executive Network.

Just before he began his presentation, a hand came up in the audience and a voice said, "Before you start, just let me make sure you understand, this whole thing is an oxymoron from our standpoint," Lynch recalled.

"What was great about it," he said, remembering the moment, "was that it was the first time the interaction was so explicit. When I go into a room like that with a bunch of sustainability people, I assume that's the attitude. Because with anybody who is new to the idea [of NASCAR's green efforts], it's usually, 'You're the green guy from *where*?' "

It's not an unreasonable question. NASCAR is a 63-year-old, family-run, privately held company that's the governing body for America's No.1 spectator sport -- a showcase for fast cars zooming around racetracks. NASCAR doesn't own the tracks, drivers, cars or teams. And it's not pushing its green initiatives with regulations or in contracts. Exactly how is it going -- and doing -- green?

From long practice, Lynch has answers ready. A 20-plus-year veteran in strategic business planning with experience in environmental and health technology, Lynch joined the National Association for Stock Car Auto Racing in 2008 to help define its green strategy and carry the message to the organization's scores of business partners.

Since then, NASCAR has built the largest recycling program in sports. This year it's on target to divert more than 1,000 tons of material from events -- including cardboard and more than 12 million beverage containers – from landfill.

NASCAR's success with recycling -- as with all of its sustainability initiatives -- wouldn't be possible without its strategic partnerships. Coca-Cola Recycling is a key partner on recycling, as are Coors Light and Freightliner. The heavy-duty truck manufacturer provides a clean-idle diesel rig that brings Coca-Cola's Portable Processing Center, which can handle 1,100 containers a minute, to race venues.

NASCAR also has robust recycling programs for specialty materials. Official tire sponsor Goodyear recycles about 121,000 tires from NASCAR's top three national race series each year. Environmental services company Safety-Kleen collects and re-refines 180,000 gallons of oil used during races annually. Exide Technologies provides car battery recycling services. Sprint, the sponsor of the NASCAR's No. 1 national race series, offers race attendees postage-paid envelopes for the company's brand-agnostic cell phone recycling service.

And at the start of the racing season in February, NASCAR launched a multiyear biofuels program that brought Sunoco's

NASCAR teamed with Growth Energy and the National Corn Growers Association for the green fuel initiative. Photo courtesy of NASCAR

Green E15, a blended fuel made with 15 percent ethanol from corn grown in the U.S., to the organization's three major race series – the Sprint Cup, Nationwide and Camping World Truck.

All the cars in 95 races scheduled this year are using the fuel. By season's end, just before Thanksgiving, they will have logged more than 1 million miles with the fuel that results in 20 percent less greenhouse gas emissions than unleaded gas. And drivers and their teams say Sunoco's Green E15 provides a 6 percent to 8 percent increase in horsepower.

That's just part of NASCAR's list of green activities. But the list alone doesn't spell out why sustainability professionals should care about NASCAR's green efforts. Talks with Lynch and other experts in racing, sports and the environment helped bring the big picture into focus from the green perspective.

NASCAR's work to reduce its environmental impact provides unique lessons for companies, especially those that face the same challenge that NASCAR does in its efforts to create change: Namely, problems in credibly conveying green initiatives, and a business model that relies heavily on stakeholder relationships instead of direct lines of authority.

The sport also holds huge potential for popularizing green values and behavior. As the top spectator sport in the U.S. and the No. 2-rated regular season sport on TV, an estimated 75 million people follow NASCAR.

It is an intensely brand-loyal sport. Allegiance to drivers, their teams and companies sponsoring them is "often handed down generation to generation," said Allen Hershkowitz, a senior scientist at the Natural Resources Defense Council who has worked with the entertainment industry and major league sports on environmental initiatives aimed at mass audiences, as well as the vast supply chains for the influential industries.

Next page: How NASCAR's brand loyalty is a corporate sustainability "sweet spot"

Fan loyalty, combined with the ability of sports and entertainment to sway public opinion and habits, can create an immense force for the environmental movement, Hershkowitz said. Star athletes and other celebrities are role models, and clips of them tossing bottles into recycling bins and urging others to do so send a powerful message: Green behavior can be cool and sexy, but most importantly, it's normal.

"If you want to change the world, you don't emphasize how different you are from everybody else," said Hershkowitz.

Brand loyalty is the reason why so many Fortune 500 companies, including several that have their own sustainability programs, sponsor NASCAR, race car drivers and teams. Take a look around the tracks at the logos in the stands, on cars and the drivers' uniforms, suggested Brent Dewar, who led Global Chevrolet at General Motors and is now a senior advisor at the consulting firm GreenOrder. "It's a reflection of America," he said.

That's the sweet spot for corporate sustainability pros.

"We're interested in influencing the supply chain for all those industries," Hershkowitz said, speaking of sports in general and entertainment. Hershkowitz emphasized he and the NRDC have not worked specifically with NASCAR. But he has worked with Roush Fenway Racing (the team that includes NASCAR star Carl Edwards) as part of NRDC's consulting in major league sports.

Both Hershkowitz and Dewar observed that NASCAR usually doesn't get credit for its efforts to ease its environmental impact. "People don't think about that when they think of NASCAR," Hershkowitz said. "Even though NASCAR is gigantic, it's harder to message. NASCAR is a tough lift."

NASCAR and its leaders are acutely aware of its image beyond its fans and the motor sports industry. That awareness informs every

element of how NASCAR does green and why it chose to focus its initiatives on waste, emissions and energy.

Here are four key points in NASCAR's strategy:

1. Literally Walk the Walk Before You Do Anything Else

When NASCAR CEO Brian France brought Lynch aboard, the sustainability expert's first move was "to walk every inch of every venue," absorb how NASCAR operates, connect with its many layers of business partners – venues, sponsors, teams and more -- and then build a game plan. It was "almost like a cultural immersion," he said. "You have to be part of it in order to start to understand the nuances and how these gears all fit together." A former member of the Boston Consulting Group, he initially thought, "How hard could it be?"

"It really did take me six months to kind of work my way through it," he said, and even now he keeps in mind that in NASCAR years he is a novice despite his more than two decades as an expert consultant.

Takeaway for Sustainability Pros: On-the-ground, first-hand information is essential.

2. Do First, Talk Later

NASCAR devised its initiatives based on industry knowledge, deep research into its market and identifying key operation areas where it could make a difference. (In NASCAR's eyes, its waste, emissions and energy initiatives share have equal priority, Lynch said.) The organization has a precise idea of where it's going, where it started and how much it needs to do to move the needle. But don't expect to hear much about that for now.

American Motor Sports' Green History

In U.S. motor sports, the IndyCar and American Le Mans series also pursue environmental initiatives. American Le Mans has the most mature programs. It was approached by the U.S. Department of Energy and Environmental Protection Agency about five years ago in an effort to drive innovation in fuel efficiency.

American Le Mans has since adopted the EPA's Green Racing Protocols and conducts two contests during the season that recognize best performance and fuel efficiency with the lightest tread on the environment. Manufacturers are eligible to win the Green Challenge Championship, created by the DOE, EPA and SAE International, a global group of automotive and aerospace engineers. Race teams compete for the Michelin Green X Challenge awards.

Next page: Why powerful partnerships are the key to NASCAR's successes

"We only talk about and focus attention on initiatives once they're up on their feet and moving along," Lynch said after fielding several questions from me about targets, goals, impacts and stats. "And we only talk about results as opposed to targets or projections."

In large part that's because NASCAR is highly respectful of -- and sensitive to -- its fans, business partners and other stakeholders. "Don't tell me about how fast you're gonna go. Don't tell me how you think you're gonna win. Don't make predictions. Don't tell me about the future with your crystal ball," Lynch said. "That's all interesting. [But] how'd you do? What'd you do? Are you gonna try that hard next time and try to do it again, or even do better? That's what folks in this environment want to hear."

For example, NASCAR spent a lot of time laying the groundwork to make an ethanol blend its fuel of choice. It didn't talk extensively about the program until all its stakeholders were on board and extensive testing indicated that the switch would not only reduce emissions but had a racing benefit as well: more horsepower.

That approach is very much in line with the racing ethos: It's how you finish that counts – a philosophy that applies to sports in general. It's not that sports organizations and key groups that work with them don't have a lot numbers; they do, according to Hershkowitz. It's a matter of how useful that information would be right now to sports' key audience and stakeholders.

Takeaway: Serve your core audience first. Do it in a way that appeals and makes sense to them. Transparency can come later, but don't wait too long.

3. Test with a Time Limit and Double Down (or More) on Stuff that Works

Generally, every proposed tactic for NASCAR's green initiatives is tested on a three-strikes basis, said Lynch. When efforts fail, NASCAR moves on -- so completely that Lynch doesn't talk about them publicly. Measures that pass muster are rolled out incrementally among operations areas.

That's the path NASCAR took with its recycling efforts. All 28 venues for NASCAR's three major race series now participate in event recycling and the volume of recycled material expected this year is five times greater than the amount diverted in 2010.

The organization's clean-air tree-planting program is taking a similar route. NASCAR plants 10 trees for each green flag drop with an aim of offsetting 100 percent of the carbon produced on track during races. Begun in 2009 at 11 tracks, the program led to the planting of more than 1,000 trees last year. Twenty tracks are now participating in the program. While the tally isn't in for 2011, NASCAR is looking to double the number of plantings this year and says its tree-planting program already is the largest in professional sports.

Takeaway: Be firm about pulling the plug on things that don't work. Go big with things that do.

4. Leverage the Power of Relationships

Kyle Busch Motorsports new corporate headquarters is built to LEED standards and awaits certification. Photo courtesy Kyle Busch Motorsports.

This is the key to how NASCAR's business model and its green initiatives work. Without regulations or requirements serving as a whip for the eco efforts, NASCAR relies on collaboration among its business partners to bring about change.

That may seem blissfully idealistic on first blush, but understanding how NASCAR grew from a relatively small regional sport to a mega-industry, and how it built strong ties among all its players, helps.

"I think NASCAR Nation sees itself and the members of it see themselves as members of a family. When you take that concept, you don't need a long list of checklist requirements," Lynch said. "If you have a track record as an organization and as a sport of having always done your homework, and when you say, 'We think we should go this way,' folks know that you've actually spent the time and really done the work up front to have that be based on something real."

That's where the trust and respect factors among fans and stakeholders come into play.

Takeaway: Strong relationships can trump structure.

Infineon Raceway has 3,000 sheep to tend the grass and five new solar arrays. Photo courtesy Infineon Raceway and Panasonic.

The competitive nature of sports and the star-power of top performers are important, too. It's why the Pocono Raceway, with a 3-megawatt solar farm installed last year, now has the largest renewable energy installation of any sports venue, why Infineon Raceway has solar power *and* thousands of sheep, why a custom paint scheme bearing Richard "The King" Petty's signature decorates the rig pulling Coca-Cola's portable processor for recycling, and why Kyle Busch Motorsports built its new headquarters to LEED standards.

The headquarters hosted the GBEN meeting where Lynch detailed NASCAR's strategy in a private session. At the close of his talk, the GBEN member who had voiced the group's collective doubts to the guest speaker turned to GreenBiz Executive Editor Joel Makower mouthed the word, "Wow."

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The surprising success of the green supply chain

PHOTO: CHRIS HONDROS/GETTY IMAGES

By John F. Wasik, contributor September 9, 2010: 11:14 AM ET

FORTUNE -- One year after Wal-Mart launched an ambitious plan to help its suppliers track their energy and materials use and carbon emissions, the effort has officially become a trend among corporate multinationals.

But don't assume that these companies are forcing change purely out of their love of the environment. A slow- or no-growth economy is another driver, since lower energy and resource costs translate into higher profits. They're going green, but mainly because they're seeing green.

Pacific Gas & Electric (**PCG**, **Fortune 500**), the California-based utility, is one of the most recent entries among a handful of large companies starting programs to green its supply chain. PG&E recently bestowed its first "Green Supplier of the Year" award to Southwire Company, a wire manufacturer headquartered in Carollton, Georgia.

Southwire won the award for converting almost one-third of its fleet to hybrid vehicles, reducing its landfill waste by 27% and eliminating almost all lead additives from its products. PG&E is also involved in an industry alliance to create more partnerships to green its supply chain.

Following in the footsteps of Procter & Gamble (**PG**, **Fortune 500**), IBM (**IBM**, **Fortune 500**) and Wal-Mart (**WMT**, **Fortune 500**), PG&E is taking a more comprehensive approach that leaps beyond carbon footprinting -- the amount of carbon dioxide released through all of its operations -- into life-cycle analysis. The General Services Administration, the federal government's giant purchasing manager, has also recently asked its 600,000 suppliers to start providing greenhouse gas emission tallies.

Forcing suppliers to change

Life-cycle analysis features a "cradle-to-grave" examination of how products and services impact the environment. Say you're P&G and you want to know how much your shampoo fares in a green evaluation. You'd then hire analysts to show how much raw materials were used, whether they resulted in pollution (and how much), energy and transportation inputs, and whether the product or its packaging ends up in a landfill.

Companies that adopt the life-cycle approach recruit their suppliers and other partners. P&G, for example, is using a scorecard for more than 400 key suppliers. The consumer products giant is employing its suppliers to help it reach its goal of a 20% cut in carbon emissions, energy and water use by 2012.

When it applies to supply-chain management, the savings from life-cycle analysis can be dramatic. Part of Wal-Mart's sustainability program, for example, calls for suppliers to "reduce packaging by 5% by 2013." Smaller packages mean more units per cargo carrier, which means fewer cargo carriers. The company estimates it will save 667,000 metric tons of carbon dioxide from being released and 66.7 million gallons of diesel fuel.

Wal-Mart measures sustainability

Like most companies with a global supply chain, Wal-Mart has a huge incentive to lower costs. Given its demanding approach with suppliers, it may just reach its goal and boost its $14.3 billion profit, which was up only 7% last year from 2008.

Savings down the supply chain are almost always good for the environment. Pulp and paper manufacturer Georgia-Pacific (**GP**), started a "packaging systems optimization program" that emphasizes efficiency and sustainability. It worked with Honest Tea to design 24-drink multi-packs that were 41% lighter than previous packaging, which saved money on shipping and fuel costs.

With sustainability and cost savings as tandem goals, many companies have aggressive targets in place. Although Kraft Foods (**KFT**, **Fortune 500**), said it has reduced the net amount of waste it's produced by 30% in the last half decade, its ultimate goal is to dump no waste in landfills. It's partnering with Sonoco (**SON**), the global packaging company, to achieve that objective.

Multinationals are not alone in feeling the pressure to assess their total environmental footprints. Every major company doing carbon and life-cycle analysis will need to examine all facets of its business in the post-BP, carbon-savvy climate. Global consumers and non-government organizations are starting to demand that multi-nationals go the extra mile.

Although the Senate took its summer recess without passing an energy or climate change bill -- and it is unlikely to pass the House bill when it returns after Labor Day -- companies will continue to seed green supply programs on their own. Pressured by a need to cut costs in a slack economy and conform with tougher European standards, corporate environmentalism is still catching on -- even if Washington can't seem to provide fertilizer for this growing movement. ■