

JUNE 30, 2005

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Sustainable Development: An Engineering Perspective

Dear Dr. Ibeh,

I am pleased to announce that I am finished with my research studies on the above subject that I am doing for you. The main objectives for this report are to become familiar with the issues in engineering and sustainable development, which is an important issue in today's society. Sustainable development means that we must look forward to the future in our plans for the present so that we may protect our future generations. This study shows the problems that arise in the aerospace, automotive, and civil engineering fields. It also shows the need for Corporations to fix the way they do things and to realize that planning ethically and looking toward the future not only helps the environment but also helps their profits, which will provide longevity for the corporation and the environment.

I hope that this report will meet your standards and possibly give you further knowledge of this subject. If I can give you any further information that you would like to know that was not included in this report. If you have any questions call me at 713-628-8049 or email me at Maduf73@erau.edu

Sincerely,

Fitzgerald Madu

Sustainable Development: An Engineering Perspective

By
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FOR:

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I. Summary

- a. When we view "Sustainable Development" we should view it as a fence, not as a wall. As Engineers we need to be the ones who understand the limits of our current knowledge; to make use of the benefits of new discoveries for the rise of all society, and when they do not exist, to create them. In that lies the future of Engineering, not in building the first vehicle to break light speed, but the safety in place to replicate it over and over again without a problem.

II. Introduction

a.

Environmental Degradation is something that affects every factor of our way of life. The ways we drive, eat, consume goods (i.e. energy and supplies) contributes to this problem. In engineering Environmental Degradation is a giant factor. Millions of dollars are spent to investigate and reduce environmental impact of buildings and mobile structures, When you do not take these factors into account you contribute to the degradation of the Environment, not only hindering your own ability to survive but completely forsaking the future generations and the longevity of the Earth. The Ideal of Sustainable Development helps to insure that our future generations have the same resources and advantages we have if not more. Using proper engineering and design techniques along with proper disposal we can insure the future of the environment.

b. What is Environmental Degradation?

- i. Environmental Degradation refers to the diminishment of a local ecosystem as a whole due to human activity. Environmental degradation occurs when nature's resources, such as trees, habitat, earth, water, air, are being consumed faster than nature can replenish them. An unsustainable situation occurs when natural capital the sum total of nature's resources, is used up faster than it can be replenished. Sustainability requires that human activity, at a minimum, only uses nature's resources to the point where they can be replenished naturally.

c. What is Sustainable Development?

- i. Buildings, structures, and even vehicles that can be constructed without having a heavy impact on the environment. Buildings and vehicles designed with these ideals in mind helps to insure the protection of the interests of our future generations

d. History of Sustainable Development

- i. Sustainable development was first brought to the forefront by the **Brundtland Report**, also known as *Our Common Future*.

Published by the World Commission on Environment and Development in 1987(Brundtland Commission)

This report stated that “One of the factors which sustainable development must overcome is environmental degradation.” (“Our Common Future”, 1987).

e. Objective

- i. The objective of this ethical study is to show the need for sustainable development in engineering and to show that in the long run making ethical ecological decisions is worthwhile for any corporation.

f. Scope

- i. The Scope of this project includes the corporate and research& development aspect of design, implementation and disposal of industrial wastes. The reason corporations are brought into this study is that engineering is the perfect mix of fine design, technology, safety, implementation and cost management and effectiveness.

III. Literature Review

a. Three relevant projects and papers

- i. *Our Common Future* (Brundtland Commission)
 1. Brundtland was given the task to re-examine the environment and makes projections to the future and make proposals to alleviate environmental problems
 2. The Report by the Brundtland Commission brings forth the need for economy and ecology to work in a synergistic manner. Doing this will not only insure economic growth but also environmental longevity.
 3. The problem stated in this report is Environmental Degradation at such a high rate that the environment is not able to keep up. This problem may not be so evident in our generation but it surely will be in later generations.
 4. The Brundtland Report opened up the idea sustainable development for an environment going through globalization.
- ii. Beyond Reporting (WBCSD)
 1. Using corporate governance and environmental compliance and over-compliance can increase corporate value.
 2. The report by the WBCSD brings forth the idea that a company that puts time and effort into reducing its environmental impact increases the company’s profit and industry respect.

3. The problem being addressed is that many corporations are relying on the government to set regulations when they should be aiming higher than compliance.
- iii. United Nations Department of Economic & Social Affairs – Commission on Sustainable Development- Aviation and Sustainable Development(2001)
 1. The paper provides background information on aviation and a brief overview of environmental problems associated with aviation. It focuses on the two principal problems that governments have mandated ICAO (International Civil Aviation Organization) to address on a worldwide basis, namely aircraft noise and the impact of aircraft engine emissions. Finally, it examines economic tools to reduce aircraft noise.
 2. Using economics and engineering to design more effective aircraft engines capable of producing more power with less noise of emissions.
 3. The problems addressed are Commercial Aircraft Emissions and Aircraft noise Pollution.
 4. Recommendations made by this study have been adopted by many airlines in the United States and the World.
 - iv. The Corporation, Ethics, and the Environment(1990)
 1. Compilations of historical environmental case studies and solutions, more specifically the Martin Marietta study.
 2. Thinking ecologically and economically while holding your corporation accountable will boost profit and stockholder support in the long-run.

IV. Environmental Impact of Aerospace, Automotive and Building Design Industries

a. Environmental Degradation from building engineering and development

- i. Environmental degradation from engineering and development comes from many different factors. One of these is the use of energy, in 2002 Building Electrical consumption made up for 71 per cent of total Electrical Consumption (DOE). Also looking at chart 1.3.3 one can see that the most energy expenditures are in the cooling and heating sectors. A way to combat this is better designed buildings using more efficient windows and exterior materials. These materials would allow only the sunlight to come in and not the heat from the sun's rays. This same ideal can be used in winter too, but with a modification. In winter it would allow the sun's heat creating a greenhouse effect, keeping the building heated at a very low price.

- ii. These buildings may also contain countless health risks for their occupants, Asbestos, Fiberglass, Industrial Chemicals and waste are all hazards to the health of building occupants. Although using some of these in design may seem cheaper on paper for the bottom – line, they will end up costing the company more than it would have to implement healthier designs with air purification and better chemical storage and waste procedures. Paying for sick employees out of the company insurance plan would greatly decrease profit and also possibly leave the company liable from a variety of standpoints.
- iii. Another point is buildings with safer designs that fit in as much as possible with the environment. Buildings designed with safety in mind have to look forward a number of years to insure longevity. Designing the buildings with not just aesthetically pleasing looks but also important safety features, such as auto- emergency shut off valves for natural gas chemicals and even water to prevent waste in the event of a breach in the piping system. Proper storage of industrial and cleaning chemicals will help to prevent waste and also decrease healthcare cost by limiting occupant exposure.
- iv. Building to your surroundings is the idea where you use your limitless renewable resources, air, water, sunlight positively to lower your environmental impact. In places where the sun is abundant designers can use the sunlight to light buildings that cannot even be reached by sunlight using fiber optic technology and a reflector on the roof. The Steven Winter and Associates company has developed this passive lighting system where it uses fiber optics to light the building in the day and at night runs lights off of stored solar energy without the added heat to increase air conditioning costs.(Popsci.com) Innovations such as this will decrease environmental degradation and increase profitability.

b. Environmental degradation in Automotive Engineering

- i. Automobiles and other ground transport vehicles use, for the most part, fossil fuels. This contributes heavily to the CO₂ in the atmosphere. To combat this, vehicles must be designed to be over compliant so that they can meet growing emissions requirements, not just for the next two years but for the next 10-20 years. This method of design may be seen as unnecessary but it is beneficial. When a company puts the environment first stockholders and consumers take notice of it. This process may increase initial cost but it will most definitely pay off in the future. A typical consumer in this day will pay much more attention to the growing demand for oil and the need for more fuel efficient cars. Engineers must keep emissions at the top of their list when they design an automobile. Heavy Diesel Engineers are beginning to follow suite, diesel engines produce more pollution than gasoline engines. This

is an important issue to tackle since most ground cargo is transported by these diesel trucks. Many companies such as Mercedes Benz for instance are implementing electrical Cargo Trucks with strong electric motors can drastically reduce emissions and reduce our reliance on fossil fuels.

c. Environmental Impact of the Aerospace Industry

i. Although it may seem that the aerospace industry is one of the more harmless of the environmental degraders it is simply not true. The aerospace industry has many sustainability issues stemming from aircraft emissions, fuel consumption, material waste and countless others. When an aircraft or spacecraft for that matter is designed the engineers must take into account the impact that the craft will make on the environment. While ability to perform is a top factor, fuel consumption of aircraft is in the most important factor when thinking environmentally. According to the United Nations Department of Economic & Social Affairs – Commission on Sustainable Development- Aviation and Sustainable Development report of 2001

1. *Radiative Forcing*. The climate impacts of the gases and particles emitted and formed as a result of aviation can be compared to each other and to climate effects from other sectors by using the concept of radiative forcing. This is a measure of the importance of a potential climate change mechanism and expresses the perturbation or change to the energy balance of the Earth-atmosphere system in watts per square meter (Wm^{-2}). Positive values of radiative forcing imply a net warming, while negative values imply cooling. The major contributors from aircraft emissions to the radiative forcing are carbon dioxide, ozone, methane (negative effect) and contrails, with minor contributions from water vapor, sulfate aerosols (negative effect) and soot. The contribution from cirrus clouds is projected to be positive and could be quite significant, but our current lack of scientific understanding precludes a quantitative assessment of its contribution. While the contributions from carbon dioxide, ozone, methane (opposite sign) and contrails are comparable in magnitude, the uncertainties associated with ozone, methane and contrails are much larger than those associated with carbon dioxide. ***Current impact of aircraft emissions on climate. The best estimate of the radiative forcing by aircraft is 0.05 Wm^{-2} (0.01 to 0.1 Wm^{-2}) for the year 1992, or about 3.5 per cent of the total radiative forcing by all human activities. These estimates of forcing combine the effects of changes in all***

greenhouse gas concentrations, aerosols and line-shaped contrails, but do not include possible changes in cirrus.

- ii. Another point in the aerospace engineering field is the use of hazardous materials. The more advanced we get the less material we use, but the process in which we extract this extra material is become more and more hazardous. The materials used such as carbon fiber and glass fiber can be seriously hazardous to ones health. Disposal of waste is also an immense issue. Corporations should make ethically sound decisions when material disposal comes into account. Looking just at what the next quarter will reveal financially will not help the corporation succeed. An example of environmental over-compliance can be seen in the case study of Martin Marietta's Ocala water waste. After an investment of 10 million dollars they received a return of 30 million in savings over the next four years. This should be proof alone that "thinking green" is not only healthy to our environment but also to your pocketbook. By making liquid waste inert solids and implementing a zero discharge system with a closed loop water system, Martin Marietta was able to save 30 million dollars over 4 years from an initial 10 million dollar investment.
- iii. A way to tackle fuel consumption is to design airplanes with more aerodynamic features that allow for less drag which will drastically decrease the amount of power an aircraft will have to use to fly which in turn will decrease fuel consumption and hydrocarbon emissions. There are many groups working towards solar powered craft that require no fossil fuels at all. The team behind the design of the *Solar Impulse*. The goal of the craft is to circumnavigate the globe. Although it may take up to six days to make this trip under solar power the idea that a plane could stay aloft for six days with out the need for fuel is even more appealing. Ideas such as this will open the door to the future of flying using renewable resources.

V. Conclusions

Sustainable development is the best way to look at the future. We may prosper at the present but our future generations will only have a wasteland. As technology advances so will pollution, New materials being developed everyday such as fine ceramics, rare metals and composites and plastics allow for a reduce in use of resources. These industries must keep in mind that their production obligates them to preserve the environment so that it can be sustained for the future. Requirements like these require more than money, speeches and books, they require action and sincerity.

VI. Recommendations

Corporations should use the ideals uncovered by Sustainable Development research to lead the market and look forward to the future, not just the bottom line to insure the success and longevity of future generations. Engineers should lead the way in this endeavor to create better more efficient methods of design and implementation, and the corporations they work for should allow them to “think green” and look forward to the future and longevity of our planet.

VII. References

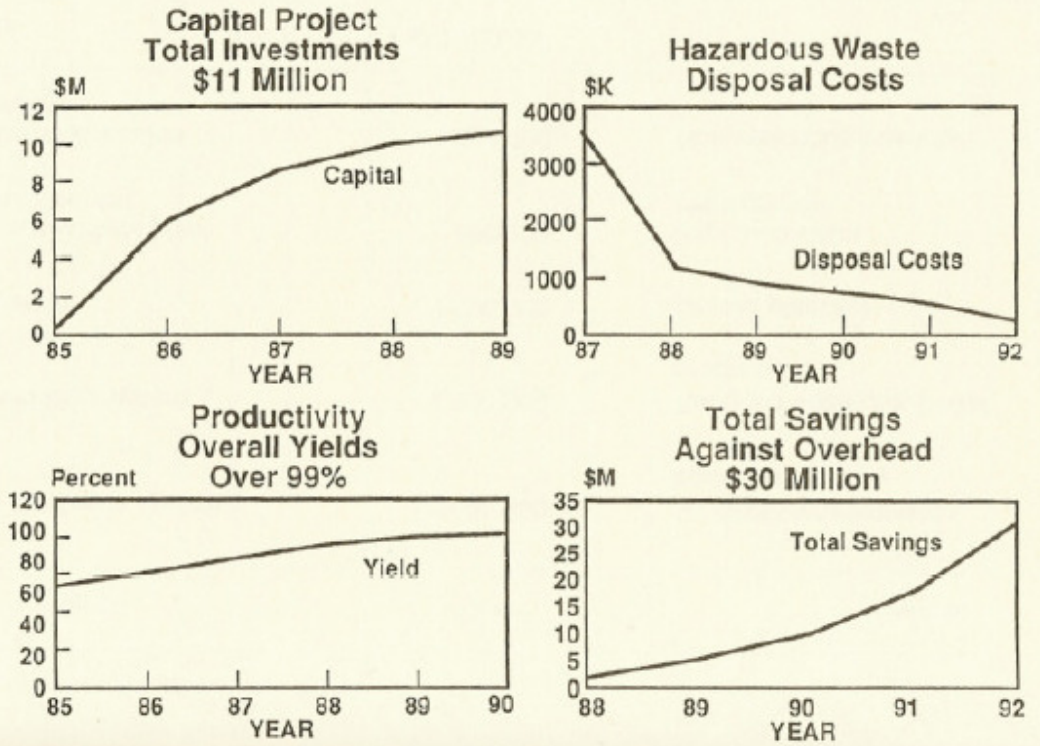
- a. http://buildingsdatabook.eren.doe.gov/default.asp?id=view_book&c=1
- b. <http://www.wbcsd.org/>
- c. http://www.un.org/esa/sustdev/csd/csd9_bp9.pdf
- d. Popular Science -
<http://www.popsci.com/popsci/aviation/article/0,20967,703053,00.html>

<http://www.popsci.com/popsci/hometech/article/0,20967,203677,00.html>
- e. The Corporation, Ethics and The Environment
Copyright 1990
- f. Our Common Future (Brundtland Report)
Copyright 1987

VIII. APPENDIX

a. Martin
Marietta

Figure 8.1
Investments and Savings



b. Martin
Marietta

Table 8.1
Florida Operations Waste Minimization Projects

Project	Cost	Benefit
Zero discharge system	\$5,500,000	No industrial wastewater better productivity
Closed-loop system	2,300,000	Reduced water use, better productivity
Incinerator	1,600,000	On-site disposal
Waste treatment plant improvements	300,000	Improved waste management
Waste minimization research	1,000,000	Nonhazardous cleaners
Total	\$10,700,000	