**CHANGE ORDER: INCORPORATE SUSTAINABILITY**

During every engineering project there comes a time when you are almost done with the project and some type of change becomes necessary. For example, in the construction industry they call this a “Change Order.” We are going to assume that you are writing this paper for your job or conference, and after you have submitted the paper to your boss or to the final round of conference submissions, your boss or the conference Chairs tell you that the conference sponsoring organization, or the CEO, or the product’s “parent” organization, or the client, or the philanthropist or foundation putting up much of the money, or the city council, or the EPA, or the state DNR, or the investors, or the company lawyers are requiring significant information/discussion, in the paper, on “sustainability” and on how “sustainability” impacts your topic.

**YOUR “INCORPORATE SUSTAINABILITY” TASK:**

In addition to an overall revision of your paper, you are now required to integrate a discussion of sustainability into the paper. Include at least 600 words of discussion on how issues of sustainability are significant to your topic. You can use any significant definitions for sustainability; however, you do not want to rely on generalities and clichés about “environmental awareness” or “improved quality of life.” You will need to show how the definition of sustainability you are using in your paper brings about an even more valuable understanding of your topic than was communicated in your original Conference Paper.

If tensions between “environmental preservation” and “affordability” are associated with your topic, you will need to describe these tensions clearly and discuss why it is important for an engineer to fully understand them. If you are writing about “quality of life,” readers will need to have that concept defined in visible and concrete ways, and you will need to carefully detail the connection between those definitions and the technologies or products you are writing about. Be creative and far-reaching in your vision of sustainability and its relationship to your topic; provide clarity and impact for that creativity via appropriate data, strong specifics, and concrete details. See the “FAQ Revision/Sustainability” for further details of how to approach and complete the revision/add sustainability task.

**WHAT IS “SUSTAINABILITY?”**

**OVERALL DEFINITIONS/ISSUES**

"You cannot solve a problem by using the same thinking that created it." -Albert Einstein

Engineers seek to to alter the environment and shape it in ways that will serve the various needs of society. While our lives today can attest to the success of their endeavors, these endeavors have not been without cost. Oftentimes, the alteration of the environment--whether purposeful or unintentional--has led to undesirable consequences. In the past several decades, engineers acting ethically and in the public interest have become acutely aware of the consequences of their actions on the environment. This awareness and the growing public demand for attending to short and long term consequences of engineering innovations and actions have led to various legislative and regulatory actions attempting to minimize the adverse consequences of engineering and technology on our society and our environment. Unfortunately, many of these measures--such as the "no net loss" of wetlands policy and the industrial restrictions placed on various parts of the U.S. classified as air pollution "non-attainment" regions, can be seen as having a negative impact on growth, development, innovation, and global competition. A situation such as the wetlands use regulation poses a seeming contradiction between “sustainability” of a natural environment and “sustainability” of certain kinds of innovation and development.

In recent years, however, a realization has developed that both development and environmental protection are necessary and that either need not be sacrificed for the other. A growing movement recognizes that environmental protection can and must co-exist with development and must be planned for accordingly. Under the general umbrella of "sustainability," this movement encompasses various facets: “green engineering,” "sustainable development,” "environmentally conscious manufacturing,” and "green construction" are some of the terms that have recently entered the engineering lexicon and that describe the move towards "sustainability." However, each of these terms can mean different things to different people; thus, when discussing and making decisions about “sustainability,” responsible description and action requires clarity and
specificity. Whether constructing a new highway, designing a new product, or improving a manufacturing process, responsibly defining "sustainability" and acting on those definitions issues are at the forefront of challenges today's engineers face.

A responsible, ethical engineer will always be aware of issues of “sustainability” when developing a system, process, or product. With the addition of discussion on “sustainability” in your revised Conference Paper, you demonstrate your awareness of how particular definitions and aspects of sustainability must be considered within the context and outcomes of your topic. Through your discussion of “sustainability,” you enhance your readers’ understanding of how engineers involved in the developments, system, innovation, product, and/or outcomes of your topic must balance social, environmental, and economic needs and pressures. Sustainability becomes a study in benefits versus costs, and seldom are there easy, obvious solutions.

What exactly, is meant by "sustainability?" The 1987 Brundtland Report, prepared for the UN's World Commission on Environment and Development, defines it as "satisfying the needs of the present generation without compromising the ability of future generations to meet their own needs." The 1992 UN Rio Conference on Environment and Development offers a slightly modified version, describing "sustainability" as follows: "the right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations." Other organizations and individuals propose somewhat different definitions of sustainability. Through all the differing descriptions, however, a common thread remains: "sustainability seeks to minimize our footprint in nature, both now and in the future." Most issues revolving around sustainability, quite naturally, involve subjects traditionally thought of as environmental. These include conventional environmental engineering topics such as waste minimization, pollution prevention and control, and water/wastewater treatment. A second set of issues revolves around energy/resource conservation. It incorporates such items as recycling, alternative fuel sources, alternative fuel vehicles/mass transportation, and energy efficiency. A third group of subjects entails items thought of as environmental ecology. This subset comprises areas such as urban forestry, landscaping and biodiversity.

SUSTAINABILITY ± “QUALITY OF LIFE “

“Life is an error-making and an error-correcting process, and nature in marking man's papers will grade him for wisdom as measured both by survival and by the quality of life of those who survive.” Jonas Salk

Although most sustainability issues deal with topics affecting the environment in some manner, one facet of sustainability is unique in that it generally has little to do with minimizing our footprint on nature, but deals with issues commonly referred to as "quality of life." Although sometimes not thought of as "sustainability" per se, "quality of life" concerns are often as important as (and in some cases, more important than) conventionally defined sustainability concerns.

What exactly is meant by "quality of life?" An admittedly imperfect definition is that “quality of life” encompasses issues that make human existence more enjoyable, more comfortable, safer, less burdensome. “Quality of life” can involve extending the lifespan in ways that provide for “quality” in an extended lifetime. “Sustainability” for most medical advances, for example, requires “quality of life” definitions and actions. Whether it is nano-medicine, nano-probes, new antibiotics, new surgical techniques or new and improved prosthetics, these areas all directly impact the quality of life.

CONSIDER THESE “SUSTAINABILITY” SCENARIOS

Assume you, as an engineer, participate in the “green” design of a building. Your design aims to reduce energy consumption by using materials and mechanics that reduce the outside air that enters the building, thereby reducing the need to heat cold outside air or cool warm outside air or remove humidity that comes from outside air. These design initiatives will reduce energy use but will also reduce the number of air exchanges in the building, which could lead to a “sick building syndrome.” As an environmentally conscious construction engineer, you must be aware of both aspects of “sustainability.” “Saving energy” while “good for the environment” in certain ways, can bring with it other high-impact consequences. A responsible, careful, ethical engineer will consider the multiple definitions and applications of “sustainability” in order to avoid the damage and costs of an oversimplification of “saving the environment.”

HOW DOES X IMPACT Y ?
There is considerable advocacy, today, for the development and use of alternative energy sources for generating electricity. Using coal to produce electricity involves potentially dangerous and damaging mining, as well as the production of greenhouse gases. Wind and hydroelectric power do not produce greenhouse gases, and less reliance on coal would mean less environmentally damaging mining and as well as reducing the illness and premature deaths associated with coal mining. Are wind and hydroelectric power, then, “sustainable” solutions for the safe and environmentally friendly generation of electricity?

Areas favorable to wind are also common migratory pathways for certain birds. When a bird meets a metal turbine, the turbine always wins. Similarly, dams required for hydroelectric power often prevent fish from migrating. Species can be dramatically reduced, or die out, which means not only the loss of that particular species, but the loss of its integral part in the bioecology of a region. Are wind and hydroelectric power, then, “sustainable?” How might (and must?) engineers thoughtfully address this question?

HOW MUCH?

Imagine that an automaker can produce a car that achieves 125 miles/gallon with minimal toxic emissions. For the automaker to turn a profit, the car must sell for a minimum of $100,000.00. Is this car “sustainable?” Should the automaker continue to invest (her money or the money of her shareholders) in the development of this car that contributes to the “sustainability” of cleaner air and less reliance on fossil fuels? Would a less fuel efficient design that more consumers could afford be “more sustainable?”

What is more important? No loss of woodland or more homes and industry? Is energy efficiency more important than indoor air quality - or vice versa? Is it more important to produce clean energy now or do the deaths of birds and fish take priority? What good is an environmentally safe computer or automobile if no one can afford it? The fact is that the population will continue to grow, and energy, food supplies, and habitats will need to keep pace to ensure a consistent and acceptable quality of life. The task for all future engineers will be to contribute to the definition of “quality of life,” and balance the quality of life against the environment against the cost to develop the best solution for us and generations that will follow us.

LIFE, ENGINEERING, AND ABET

Like all of your assignments this year, this one addresses real world issues, and addresses the ABET Engineering accreditation Criteria 3, that states students must show that they have “(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context” and “(j) a knowledge of contemporary issues.” See for yourself at: http://www.abet.org/engineering-criteria-2012-2013 .

In the fall semester, your writing assignments were about your positions on various topics and about how you came to have those positions. There was room for taking an overt stand on topics and issues. This semester you are combining “technical writing”—which often means fact-based descriptions of technologies, processes, and outcomes—with insight into social impact. Writing about sustainability provides you with another dimension for showing how the “technical” is not only scientifically but also socially complex. Have fun. Teach your readers important things.