WHEN IT COMES TO NEW BUILDINGS, SUSTAINABILITY PAYS

By Franklin Holtforster, P.Eng., and Ralf Nielsen

THE ENVIRONMENTAL, ECONOMIC and social benefits of sustainable buildings can no longer be denied. Being "green" is no longer a simple social statement–it is an imperative to success in today's economic landscape.

Sustainability is having far-reaching impacts on building standards, codes and specifications; it's a principle now common to municipal bylaws and zoning. (Most municipalities choose LEED as a green building standard.) For Canada's Building Owners and Managers Association (BOMA) International, a facility must be sustainable to qualify as Class A office space–by definition the "most prestigious buildings competing for premier office users with rents above average for the area."

Sustainability's reach and acceptance as the new standard of operations will only continue to grow as businesses recognize and reap the economic benefits of its inclusion.

WHY SUSTAINABILITY IS CRITICAL

Owners, developers, investors and building operators are well aware that costs are rising and revenue isn't. Energy, water, wastewater, insurance and maintenance costs are among the factors driving the cost increases. At the same time, the clock is ticking on climate change, cheap oil and clean water. As professionals in the industry, we know that excluding sustainability from the criteria for a building's success ignores:

- the life-cycle cost of heating, cooling, water and wastewater;
- the impact that indoor air quality and natural light can have on the wellness of occupants; and
- the opportunity to dramatically reduce the waste generated in the construction and operation of buildings.

THE PATH FORWARD

The benefits of sustainably designed buildings or facilities can generally be categorized as environmental, economic or social.

Environmental

The environmental benefits are multi-dimensional and can span the entire life cycle of a building or facility from the resource and raw material extraction stages through product manufacturing, construction, operation and decommissioning.

Sustainable building design seeks to reduce environmental impacts associated with greenhouse gas emissions, resource use, water use, air pollution, toxins and hazardous materials and wastes.

THE ARCHITECTURE, DESIGN AND ENGINEERING COMMUNITIES UNDERSTAND SUSTAINABLE DESIGN CAN MEAN LOWER ANNUAL COSTS FOR ENERGY, WATER, REPAIR AND OTHER EXPENSES RELATED TO MANAGING AND MAINTAINING A BUILDING OR FACILITY.

The benefits mostly accrue to society through clean air and water and healthy, productive soil.

Economic

The positive environmental impacts also often lead to lower operating costs. The architecture, design and engineering communities understand sustainable design can mean lower annual costs for energy, water, repair and other expenses related to managing and maintaining a building or facility.

These savings come mostly from more energy-efficient heating, cooling and ventilation systems. While they have a higher initial cost, the payback period for the incremental investment is often short, and the life-cycle cost is typically lower than that of more traditional buildings.

The building community also knows that using an integrated design approach can reduce initial costs by optimizing site orientation, using space-efficient design, eliminating unnecessary materials and components, avoiding structural and systems overdesign and by reducing construction waste.

Social

The social benefits of sustainable design are related to improvements in the quality of life, health and well-being, primarily for building occupants. A building environment can have both negative and positive impacts on quality of life. Negative impacts include illness, absenteeism, fatigue, discomfort, stress and distractions resulting from poor indoor air quality, thermal conditioning, lighting and specific aspects of interior space design (e.g. materials selection, furnishings and personnel densities).

Reducing these factors often improves health and well-being and should be considered just plain common sense and good design practice. As well, the softer side of sustainable design can include measures to create positive psychological and social experiences for occupants and the broader community.

PRODUCTIVITY AND RETENTION

This is an additional economic benefit realized through sustainability. While energy costs are in the realm of $2 to $3 a square foot, rent can be between $10 and $20 a square foot, and productivity $200 a square foot. We know that the primary cost of doing business is salaries. If the average private sector compensation is $50,000, a 1 per cent increase in productivity yields $500 for each employee in a year. Is there justification for a $500 investment in the quality of an employee's workspace? Productivity benefits have been demonstrated and are well documented (Carnegie Mellon University)–with some putting the estimated impact of better-performing buildings at more than 10 per cent (Leaman, 2001). Another study estimated an annual cost saving of $25,000 for 100 employees as the result of a one-time investment in better ventilation systems of $8,000 (Milton, 2002).

People spend 90 per cent of their time indoors. We also know that indoor pollutant levels are higher than outdoors. Sustainable buildings can promote better health, comfort and well-being for occupants. This, in turn, reduces levels of illness and absenteeism and, in the case of work spaces, can better attract and retain employees. It has been estimated that the total cost of turnover for one employee in the United States is more than $25,000 (Fitz-Enz, 2000). But can we make a direct link between turnover and high performance, sustainable design and employee retention? Clearly, we need to provide better examples, or conduct more research to build this case.

VALUATION

Investors commonly use the capitalization (CAP) rate as a measure of an asset's performance. The CAP rate is the net operating income of a property divided by the assessed total asset value, and an indirect measure of how fast an investment will pay for itself. For example, real estate appraisals use net operating income to determine potential CAP rates.

If efficiency improvements are made to enhance the operating income or gain higher rents, the CAP rate will be higher (more desirable). One US study (Royal Institution of Chartered Surveyors, 2009) estimated that converting an average non-green office building to a green one resulted in a 16 per cent increase in market value. The same authors found that among their entire sample (9998 buildings; 893 either Energy Star- or LEED-certified), the premium gained in rent, adjusted for building occupancy levels, was more than 6 per cent.

Taking it a step further, their analysis also showed that a $1 saving in energy costs from increased thermal efficiency yields a return of roughly $18 in increased valuation for an Energy Star-certified building. As far as we are aware, no such studies have been conducted in Canada. But perhaps with the increased base of LEED, BOMA BESt and Green Up, data sets in Canada will produce similar findings.

Beyond net operating income, increasing asset value is another vehicle to drive up return on investment. For example, consider contaminated sites, where the growth and innovation in remediation techniques drive down their cost, benefiting savvy developers and investors who can apply these ahead of their competition to the benefit of the community, the environment and local government.

RISK

Building sustainable facilities has even more advantages for owners, operators and investors. Take worker health and safety–improved indoor environmental quality will lead, for example, to lower workers' compensation costs and lower absenteeism. Some insurance companies are making the connection between sustainable design and reduced risk, offering premium discounts for owners implementing particular energy-saving strategies, such as onsite renewable electricity generation that reduces the risk associated with regional blackouts or severe weather affecting a company's operations (i.e. reduction in premiums associated with catastrophic/emergency loss).

As well, the insurance industry is paying attention to our changing climate. According to a report by a coalition of investors, environmental groups and other public-interest organizations: "Insurers have begun to embrace a more sophisticated approach to climate change, increasingly recognizing the issue as one of 'enterprise risk management,' which cuts across the domains of underwriting, asset management, and corporate governance" (Ceres, 2009).

Some property insurance companies are undertaking such activities as changing their terms and conditions, promoting loss prevention, and promoting awareness of the pending problems of climate change. Such actions are intended to have companies assess their liability and risk associated with a changing climate and how it impacts their buildings and infrastructure, and perhaps choose such preventive measures as building envelope improvements, precipitation and water management, water-efficient landscaping, and structural improvements to accept greater snow loads.

The means already exist for property owners, developers and operators to understand the impact of climate change on their assets 20, 50 or 80 years into the future and put measures in place to adapt (Engineers Canada, 2008). Furthermore, the design and engineering community is well suited to lead into a new area of practice–climate change adaptation–as we come to terms with unprecedented changes that are already having an impact on buildings, infrastructure and facilities.

CARBON

Energy=carbon=money.

Unfortunately, placing a price on carbon can be fraught with complexity and misinformation. However, building owners, particularly those with larger portfolios, should at least be preparing themselves by understanding the applicable standards, such as ISO 14064 and BSI-PAS 2060 (World Resources Institute), tracking the provincial and national regulations, measuring and monitoring their energy and carbon emissions, and training their facility and portfolio on energy and carbon management. At most, owners should be developing an energy-management strategy and program that integrates carbon considerations into their long-term, capital-planning processes. Understanding possible planning and zoning restrictions, municipal bylaws and the selection of the best possible renewable energy technologies to suit the owner, location and building type could be part of such a strategy and program.

QUALITY

Forty years ago, when Philip Crosby wrote his ground-breaking book *Quality is Free*, things looked grim for North American car manufacturers. Crosby suggested a new approach. He argued that quality didn't increase costs; it decreased them. He concluded that "quality is free."

He showed that ignoring quality in the profit equation also ignores the cost of returns, rework, disaffected clients, loss of corporate reputation, increased operating costs, reduced sales, reduced profitability and reduced competitiveness. Investing in quality, said Crosby, paid back richly with dividends of lower cost, higher profit and increased competitiveness.

The same can be said for sustainable buildings. We can show that making these investments will also pay back with higher profit, increased competitiveness, reduced risk and enhanced asset value.

As a result, sustainable practices are increasingly being included in developing private and public sector policies–a trend that will continue into the future.

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Franklin Holtforster, P.Eng., is president and CEO, and Ralf Nielsen is director, sustainability, MHPM Project Leaders.

ENGINEERS: IT'S TIME TO WORK TOGETHER AND SAVE THE WORLD

By Joshua M. Pearce, PhD

WHEN I WAS AN undergraduate, groups of future engineers and I would meet every day in the tech room to work on our homework–problem sets so complicated and challenging that our professors encouraged us to work in teams or they would go unsolved. I like solving problems–the harder, the better. And I remember these "problem annihilation" sessions with a warm fondness. At the time, it really didn't matter what the problem was, as long as it was difficult. But with maturity comes a realization that the problems we spend our time on do matter. Now it's clear that engineers must begin spending significantly more time "saving the world" and less time solving the problems they are assigned to solve.

THE PROBLEMS

United Nations reports indicate about four billion people are mired in poverty, sustaining themselves on less than $2 a day. About a billion lack access to clean water sources (both safe drinking water and basic sanitation), and more than 30,000 children under the age of five die every day from easily preventable causes.

The future looks worse: ecological systems are in collapse all over the planet. Perhaps most sobering is that human-generated greenhouse gas emissions have destabilized the global climate. Now we find ourselves relatively blindly rushing toward an unknown, irreversible tipping point of runaway climate change. Our friends, the scientists, are quite emphatic that climate change represents an immediate threat to human welfare and the temperate climate for which life on Earth has evolved. Simply put: the waste of our civilization is threatening the capacity of the Earth to support life as we know it, and yet we cling to old ways of thinking and appear fixated on capturing the last of the dwindling fossil fuel stores when we know we should not be burning them.

Our society is clearly unsustainable, with serious problems, of which those listed above are only a few. Engineers are trained to solve problems, which might lead one to believe they should be doing that rather than doing what they are doing now. If engineers continue to engineer only what they are told to do, humanity is clearly in for a rough ride.

CENTRAL ROLE

A growing chorus is voicing similar thoughts. In *The Essential Engineer*, Henry Petroski argues that engineers should play a central role in helping societies cope with urgent environmental and sustainability problems. Similarly, Pascal Zachary for the Institute of Electrical and Electronics Engineers argues: "Saving the planet, in an era of multitudinous threats, is the new mantra. Sustainability is fervently preached as an ideal for technoscience and society both...Increasingly, professional engineers are considered among the chosen actors in the great drama of human civilization's preservation."

This idea that engineers need to save the world is not new. William Henry Smyth, an engineer from California, invented the word "technocracy" in 1919 to describe "the rule of the people made effective through the agency of their servants, the scientists and engineers." Two years later, in *The Engineers and the Price System*, economist Thorstein Veblen speculated that engineers might grow so disgusted with waste and wanton sabotage that they would overthrow their bosses and take charge. After all, he felt the administrators needed the engineers more than they needed the administrators. Technical specialists representing 1 per cent of the population might emerge as the "philosopher kings" of Veblen's republic.

This did not happen either and the evidence is all around us. Consider how commentators cheer big box stores that can be built in less than a month, or the modern-day race cars made affordable to almost everyone in Canada as amazing feats of engineering. However, through the lens of sustainability, uninsulated box store buildings with pathetic 25-year lifetimes and a fleet of automobiles with lower fuel efficiency than the Model T are humiliating examples of sustainable engineering clearly driven by something other than technical excellence. As tantalizing as Veblen's republic might be to some, engineers are generally conservative and cautious by nature and a great engineering uprising is unlikely to occur

TITHING, WHICH GOES BACK TO BIBLICAL TIMES, IS GIVING ONE-TENTH OF SOMETHING (USUALLY INCOME) AS A VOLUNTARY CONTRIBUTION TO SUPPORT A CHURCH. BUT BEFORE YOU REACH FOR YOUR CHEQUEBOOK, REALIZE IT WILL TAKE MORE THAN YOUR MONEY TO SOLVE THE LOOMING, INTERDEPENDENT GLOBAL CATASTROPHES.

anytime soon. A more modest approach grounded in experience seems more appropriate.

THE CHALLENGE

I offer you a challenge: for the next year, tithe for a sustainable world.

Tithing, which goes back to biblical times, is giving one-tenth of something (usually income) as a voluntary contribution to support a church. But before you reach for your chequebook, realize it will take more than your money to solve the looming, interdependent global catastrophes. Others can give money–what the world needs is your time in actually solving problems.

If we assume the average engineer works 40 hours a week–you need to find four additional hours in your week that you can donate to solving sustainability problems. This is less time than the average Canadian spends watching television each day. I realize this may be asking too much, so let us round down to one hour a week.

Engineers have much to contribute to the field of applied sustainability, which is defined as applying science and innovation to meet human needs while indefinitely preserving the life-support systems of the planet. This is something engineers are particularly well positioned to do. But with such tight time frames (one hour a week) goals must be set that are modest. You can't expect to redesign our entire transportation system and change national policy to run it with hydrogen generated by renewable energy sources. You can, however, make small micro-sustainability projects with growing impacts doing relatively easy engineering calculations that others in society are simply not equipped to do.

These micro-sustainability projects do not need to be large or overly complicated, but there are a lot of them to do.

Consider an example in the broad field of energy, which, for most organizations, may not be given much attention because energy costs make up a relatively small fraction of their operating budget. Does your office or businesses you visit have vending machines? Energy use in vending machines can be cut by about half by using a motion sensor that enables a standby mode. When motion is sensed (i.e. a potential customer approaches), the controller turns on the machine's light and compressor to be ready for a sale. The lights and compressor are then turned off after a predefined period of inactivity and the goods are maintained by a micro-controller in the system that powers up the machine every two hours to maintain standard operating temperatures. Adding this easy retrofit provides a five-year rate of return of 46 per cent while saving 387 kg of carbon dioxide a year.

THOUSANDS OF PROJECTS

The sheer volume of projects available to most organizations is astounding, and if the time is taken to do a proper engineering analysis and provide the return on investment to decision makers, projects will get done (Pearce, Carpenter and Denkenberger, 2009).

There are thousands of such projects that can effectively change policy and nudge society toward sustainability in all the engineering subfields. The most obvious targets are the so-called industrial back-burner problems–things every engineer knows should be done but are never a priority of management. If you implement small energy conservation measures (ECMs) in your community by improving policy and practice at work or in your municipality, you will have a gratifying, measurable and increasing impact. Global problems, however, are large and thus we need a way to magnify your efforts.

OPEN SOURCE

The most effective force multiplier available can be borrowed from the software industry–the concept of open source. Open source describes practices in production that promote access to an end product's source materials. It's simply a pragmatic methodology with the same benefits as working together on a homework assignment. It has been claimed the potential for open source appropriate technology to drive applied sustainability is enormous (Buitenhuis et al., 2010). The built-in, continuous peer review can result in better quality, higher reliability, and more flexibility than conventional design/patenting of technologies. The free nature of the knowledge also obviously provides lower costs, which is particularly important in the context of technology focused on relieving suffering and saving lives in the developing world.

For example, if you are interested in deploying the vending machine motion sensors, you can download free and open source templates we developed at Queen's and plug in your own particulars (www.appropedia.org/Category:Queens_Green_IT_ECMs).

Having access to the templates will save you time so you can do more with your hour. But for such templates to be useful and valid, the methodology must be transparent and rigorous, the technology realistic, and the sources of input information and assumptions trusted (Corbett et al., 2010). So, in developing open-source sustainability solutions to give effect to policy, it's imperative each calculation be easily traced back to an equation (accomplished with hyperlinks) that is also easily verified. In addition, all variables must be limited to realistic values and only reliable sources used for data inputs. This is time-consuming, but it allows your work the potential to go viral.

Depending on your engineering specialty, there are many websites appropriate for open sourcing sustainability projects. Appropedia.org, in particular, can be useful to house information for any type of sustainability-related project and is the largest wiki dedicated to collaborative solutions in sustainability, poverty reduction and international development. Here, anyone can learn how to make and use appropriate technology free of patent concerns. At the same time, anyone can add to the collective open-source knowledge base by contributing ideas, observations, experimental data, deployment logs, etc. Many of the technologies and projects on Appropedia.org are well developed; however, the majority could be vastly improved by a careful critique by Ontario's engineering community. It's not difficult to begin–just navigate to a page you know something about, click edit and improve it.

MAJOR IMPACT

If we collectively picked a day to skip a single television show and worked on these little problems, it would make a major impact on the province's sustainability. If all 74,000 plus licence holders reading this commit one hour a week for a year, we will have almost 1900 working years of hard-core engineering on the table. If every Ontario engineer actually did this, there is little question the province would become the shining example of sustainability for the whole world. What are you doing for the next hour?

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Joshua M. Pearce, PhD, is an assistant professor, department of mechanical and materials engineering, and fellow, Institute for Energy and Environmental Policy, Queen's University.

THE CSCE GUIDELINES FOR SUSTAINABLE DEVELOPMENT

By Catherine N. Mulligan, PhD, ing.

TO MEET THE NEEDS of the world, and also meet the demands imposed by an ever-increasing world population, there will be increased needs for an adequate supply of goods and services to feed, shelter and clothe the population. The 27 principles articulated in the 1992 United Nations Conference on Environment and Development (UNCED), and published in a document commonly referred to as the Rio Declaration, show the need for protection and maintenance of environmental quality while meeting the needs of the global population. These ideas were reinforced at the 2002 World Summit on Sustainable Development (WSSD) held in Johannesburg.

At the heart of sustainable development is a healthy and sustainable environment. The ecosphere or the land environment contains all the elements that are vital for the sustenance and well-being of the human population. The essence of the ecosphere has been captured by Commoner (1971), who stated that the ecosphere, together with the Earth's mineral resources, is the source of all goods produced by human labour or wealth. It follows, then, that any degradation of the ecosphere will impact negatively on its capability to provide.

STRESSES AND MAINTENANCE OF LIFE

Currently, there are many stresses on the environment caused by human activities. The population is at 6.1 billion and is projected to be in the range of 9.3 billion by 2050, according to recent estimates by the United Nations. Consequences of increasing population will be increased urbanization, industrialization and exploitation of natural resources to meet the increased demands for food, shelter, clothing and energy.

Increased urbanization and industrialization pressures, infrastructure development, exploitation of natural resources, and use of intensive agricultural practices deplete agricultural lands and soil quality, which are of utmost importance in maintaining high-yield agricultural practices (Figure 1).

SUSTAINABLE DEVELOPMENT AND OUR RESPONSIBILITY

Sustainable development is the aim of environmental protection acts in many countries. Generally, these acts recognize that each person should enjoy a healthy environment and contribute to preserving and enhancing the environment. The activities of humans and their projects impact water (surface, groundwater, aquifers, receiving waters), air (air quality, emissions, transboundary transfers, greenhouse gases, climate) and land (land uses and quality) and ultimately impact the health of humans and other biotic receptors.

In 2002, the WSSD identified five priority areas that needed to be addressed for sustainable development to be universally applicable. The five priority areas make up the acronym of WEHAB. They are:

(a) water and sanitation;
(b) energy;
(c) health;
(d) agriculture; and
(e) biodiversity.

ROLE OF CIVIL ENGINEERING

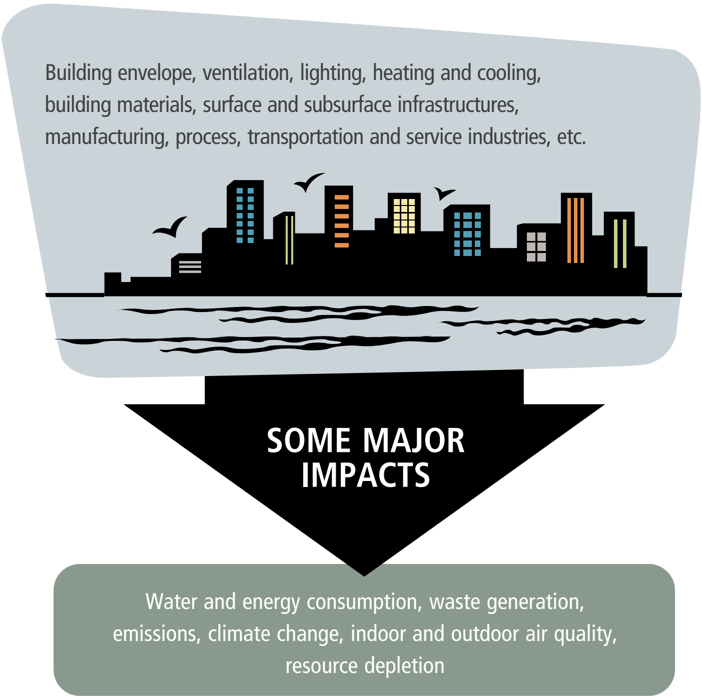
Civil engineering has a vital role to play now and in the future. Engineers must show leadership in environmental protection and restoration and promote development through sustainable practices (Figure 2). They contribute through planning, designing and managing projects and finding solutions to environmental challenges in a rapidly urbanizing and complex society.

Following the Brundtland Commission report known as *Our Common Future* by the World Commission on Environment and Development, many engineering organizations worldwide responded to the challenge.

The responsibilities of civil engineers were captured in 1993 in the Canadian Society for Civil Engineering's (CSCE) *Guidelines for Civil Engineering Practice, Our Commitment to a Sustainable Future*, a first attempt by the society's Committee on Sustainable Development to establish sustainability concepts within civil engineering practice and assist today's civil engineering community to practise in the most sustainable manner possible. The guidelines were updated in 2006 and approved in 2007.

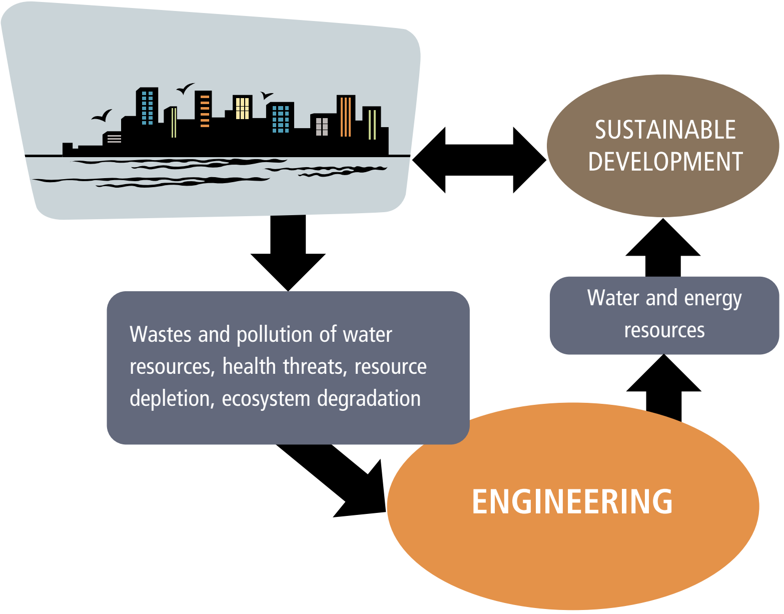
Following are the updates to the CSCE guidelines on sustainable development and comparisons to other guidelines by other societies.

Figure 1: Impact of urbanization on the environment



(adapted from Yong et al., 2006)

Figure 2: Reduction of impact on the environment by engineers



(adapted from Yong et al., 2006)

CSCE GUIDELINES

The CSCE guidelines include principles of sustainable development in civil engineering practice as follows:

1. Civil engineers need to develop and promote a sustainability ethic;
2. Civil engineers need to recognize the interdisciplinary nature of engineering;
3. Civil engineers should practise engineering in accord with an ethic that leads to sustainable development;
4. Civil engineers should act with integrity, objectivity and ethically, remembering their responsibility to the community; and
5. Civil engineers should pursue and encourage a sustainability ethic in their professional development.

UPDATES

For decision-making purposes, clear, well-defined guidelines are required. Since 1993, new issues have emerged, which include preservation and enhancement of the environment, air pollution and climate change. In addition, some issues were not discussed in 1993, including social and economic factors, and the role of the civil engineer in working toward sustainable development. So, in 2005, the Task Force on the Review and Comparative Analysis of the CSCE Guidelines on Sustainable Development was formed to update the guidelines by reviewing numerous guidelines, particularly regarding social, economic and environmental factors (Ford et al., 2006).

COMPARATIVE ANALYSIS OF GUIDELINES

A comparison matrix (Perks et al., 2006) was developed to compare guidelines and policies of national-level civil engineering organizations and other engineering organizations, international and national specialized organizations and development agencies.

Many of the guidelines reviewed include the need to preserve and enhance the environment and provide for future generations. Clearly, sustainable development is accepted as an integral and essential aspect of engineering practice.

However, the guidelines lacked climate change commentary, operational support for sustainable development and indicator development. Depleting oil and gas reserves, sustainable transportation, environmental restoration following construction, ecosystem restoration, ethics and equity, and infrastructure operation and maintenance are other aspects that needed to be incorporated.

The guidelines of the World Federation of Engineering Organizations (WFEO) are particularly noteworthy. They emphasize that the role of engineers in sustainable development is to plan and build projects that preserve natural resources while supporting human and natural environments. The Shanghai Declaration on Engineering and the Sustainable Future (WFEO, 2004) emphasizes commitment and responsibility, in addition to ethics and a code of conduct, the interdisciplinary nature of engineering, education and capacity building, women and gender issues, and international co-operation.

ENTRUSTED TO OUR CARE

The CSCE guidelines were approved in 2007 to include the CSCE *Guideline for Civil Engineering Practice*–"Entrusted to Our Care" (CSCE, 2007). The aim of this effort is to promote sustainable concepts to its civil engineering members, to other professionals, the government and public. Based on the analysis, the chosen priority areas were:

1. Natural environment: A civil engineer must protect and enhance the environment, minimize the environmental impact of civil work, reduce waste and be efficient in energy use;
2. Financial and economic sustainability: The financial and economic sustainability in the provision of infrastructure must be ensured by employing a life-cycle approach;
3. Green construction: Construction that achieves the lowest possible consumption of raw materials and energy, and generation of waste, both during and after construction and use. Best practices and performance-based standards and guidelines should be used;
4. Human resources: Continuing education and professional development of human resources are integral to sustainable development so that civil engineers are informed on environmental

trends and issues and are able to educate the public and each other. Educational programs need to be strengthened;

5. Social, regulatory, and health concerns: Basic human services and poverty reduction through transparency and accountability are highly important in civil engineering projects. This can be accomplished by voluntary compliance through performance-based standards and guidelines;
6. Ethics: The public welfare and, inherently, the protection of the environment are the prime responsibility of a civil engineer in the planning, design, construction and operation of public infrastructure. A civil engineer, therefore, should adopt sustainable development practices and encourage others to do so;
7. Participation: The interdisciplinary nature of the issues mean there is the need for participation by other professionals, public agencies, civil societies and the general public in project development. Civil engineers must act as leaders in sustainable development; and
8. Implementation: Due to the importance of operations and maintenance in civil infrastructure projects, monitoring, reporting, evaluation and review of civil projects and programs are vital.

VITAL PROFESSION

Civil engineering will become an increasingly vital profession–a profession that impacts health and security, basic human services (water, wastewater, energy, transportation), and environmental protection and enhancement for the burgeoning global population that will increase markedly in numbers and demands. Therefore, civil engineers must strive to incorporate sustainability in all aspects of their work if humankind is to adapt and survive into the next millennium. They must also educate others to do the same.

Because the role and benefits of sustainable civil engineering activities affect food production, health and security, human services and environmental protection, they must be communicated effectively to civil engineering practitioners, the public, other stakeholders, regulatory agencies, infrastructure owners and developers and politicians, so the serious, urgent and growing problems faced by the world's growing population can be effectively addressed. We have the moral and ethical obligation to develop and implement design, construction and management techniques that do not have an impact on the environment. We need to provide students with the knowledge, training and capability to make development sustainable. If not, we will compromise the future for our children and their children.

It is hoped the CSCE *Guidelines for Sustainable Development* will become an integral means for moving toward sustainable development. Σ

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Catherine N. Mulligan, PhD, ing., is a professor, department of building, civil and environmental engineering, and associate dean, research and graduate studies, faculty of engineering and computer science, Concordia University, Montreal.