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Transforming sustainable development

By Willem H. Vanderburg, P.Eng.

Sustainability should compel engineering and other professions to re-think the very parameters of wealth creation, says this engineering educator, who sees the steady division of labour and intellect creating obstacles to a more sophisticated understanding of economic growth. But who should take the lead in promoting a new vision for business, wealth and the management of technology?

Until industrialization was well advanced, humanity could take for granted that the way of life of its communities and societies included technologies that were appropriate and sustainable. These concepts had to be invented so that we could talk about what had been lost. Recreating sustainable technologies and way of life in contemporary forms is a challenge to societies in general, and the engineering profession in particular. Unfortunately, we've been so busy talking about sustainable development that we've missed its vast economic potential. That this is the case will become apparent when we focus on net wealth production as opposed to gross wealth production, thereby revealing a deep structural problem, a primary symptom of which is the extreme intellectual and professional division of labour.

Contemporary societies evolve their way of life through countless decisions made by people so highly specialized they cannot know the consequences of their actions, except for the desired results that fall within their areas of expertise. It ought to be no surprise that decision making in a specialized context has a poor "signal-to-noise" ratio of desired to undesired effects. It also institutionalizes an end-of-pipe approach for dealing with undesired consequences which, once created, are dealt with by specialists in whose domain of competence they fall.

Imagine what would happen to hockey if we wanted the players to specialize by wearing blinkers to visually concentrate their attention. Cooperation and teamwork would become much more difficult, and hockey wouldn't be the same. Next, imagine what would happen to traffic if drivers concentrated on the "immediate world" of their cars by focusing on their dashboard instruments and only occasionally glancing out their windows. Chaos would reign.

Similarly, we are gradually becoming aware that evolving ways of life by means of highly specialized knowing and doing creates chaos everywhere. The signal-to-noise ratio of economic growth (the ratio of the total output of desired goods and services to the costs incurred in the production of wealth) has declined to the point that some economists estimate that net wealth production has been diminishing for several decades.[1]

Contributing factors can be found everywhere. The American Academy of Engineering estimates that less than 10 per cent of all matter borrowed from the biosphere ends up in desired goods and services. The spectacular increases in the productivity of labour have been undermined by the "production" of physical and mental illness in workplaces to the point that, prior to employers having to cut back on health benefits, Blue Cross was the largest supplier to one of the world's largest corporations. Socio-epidemiology confirms that work is one of the primary sources of ill health.[2] In sum, the environmental crisis, the greatly weakened social safety net, and the health care crisis are all symptoms of undesired consequences undermining and, in some cases, overwhelming desired ones. It also shows that dealing with them in an end-of-pipe fashion is bankrupting us. Our much-talked-about health care crisis should be attributed to the rate at which we "produce" illness outstripping our ability to pay for end-of-pipe disease care.

All this gives a whole new meaning to keeping the public interest as paramount. Assuming that this is satisfied when each technological element produces the desired effects, with only small and acceptable negative effects, is the methodological equivalent of assuming that the effect water has on paper can be derived from the separate effects of hydrogen and oxygen. The overall effect technology has on human life, society and the biosphere cannot be understood in terms of the sum of the effects of its constituent elements.

Individual specialist limitations

How do we all participate in a highly developed intellectual and professional division of labour? It has now become evident that highly specialized knowing is knowing of an unusual kind. Scientific knowing doesn't seek to understand things in their full world context, but in the limited intellectual context of a discipline or professional specialty and in the simplified context of a laboratory designed to study a few variables, preferably one at a time. Liberated from the need to pay attention to a broad context, this kind of knowing became so efficient that its exponential growth was assured. Recently, we've become aware that this exponential growth is indissociably linked to an exponential growth of ignorance about how everything we know fits into, depends on, and evolves with everything else. This interrelated knowledge is exactly the kind of knowledge we need to create an appropriate and sustainable technology.

In the same vein, highly specialized doing doesn't deal with a "chunk" of the world but

with its "technical shadow." The practitioners of particular disciplines or professional specialties know the "world" beyond only in terms of the requisite "inputs" received from it and the desired "outputs" to be returned to it. What remains of the world becomes only a family of aspects of the process of converting the requisite inputs into desired outputs identified with the specialty of the practitioner. We have no experts on factories, offices, universities or hospitals. For example, doctors, nurses, lab technicians, support staff, nutritionists, administrators, social workers, clergy, relatives and friends all know very differently the process of transforming the input of sick people into the output of people on the mend. An abstraction occurs when specialists need to decide between alternate courses of action. Design or decision alternatives cannot be adjudicated in terms of their meaning and value for human life, society and the biosphere. This would require that specialists put their domains of expertise in the context of all others to create a context-rich understanding of what they are doing. Lacking this knowledge, they can only derive as much output as possible from the requisite inputs, as measured by efficiency, productivity, profitability and other such input/output ratios.

It ought to come as no surprise, therefore, that such an evolution of a contemporary way of life would undermine the integrity of what is transformed as a result of the highly specialized design and decision making, weaken its compatibility with its surroundings and, in the case of living entities, reduce their ability to evolve on the basis of self-regulating processes.

The "technical shadows" that disciplines and specialties derive from our world don't contain the right mix of information, because the knowledge of other disciplines and specialties is ignored at our peril. However, specialists have little choice but to intervene in the world by means of technical shadows as a consequence of our highly developed intellectual and professional division of labour.

Collaborating within the "system"

The above constraints influence our ability to work together. First, it becomes next to impossible to arrive at a consensus as to what are the symptoms and what constitutes the root issue confronting a team of experts. Each member of the team tends to form his or her mental image of a situation by using his or her area of specialization as the foreground, and the remaining details as the background. Any alternative approach would require knowledge of many other specialties. Technical shadows cannot simply be superimposed on each other to form a more complete picture of the situation.

Second, the diagnosis of a particular problem arrived at by different specialists cannot be adjudicated by which one best represents the problem. That would be like trying to determine the original landscape from paintings by three artists sitting side by side but selecting different elements as a foreground and others as a background according to their interests.

Third, collaboration between specialists on a team doesn't readily result in an overall and comprehensive prescription as to what to do about a problem. We have all experienced this as members of teams dealing with complex issues. In the 1960s and '70s, it was believed that systems thinking could overcome these difficulties. With much hindsight, however, it's now clear that systems thinking is just another specialty with its own unique technical shadows. Not surprisingly, apart from relatively narrow issues (corresponding to only a few cognate disciplines or specialties), we have made little headway with the broad issues confronting all professions, including engineering.

Economic opportunity

The above thumbnail sketch of our contemporary situation has been studied in detail and quantitatively verified for the engineering and management of modern technology. The creation of technical shadows externalizes all local details, leaving only what is objective and universal. Such approaches are well adapted to global systems of production and distribution, but block the potential advantages of more synergistic relationships with local economic, social, cultural and environmental conditions. In other words, current methods and approaches in engineering and management support transnational corporations and institutions. In contrast, more context-rich knowing and doing would support small- and medium-sized businesses, based on strategies designed to take advantage of synergies between these businesses and local socio-cultural and ecological niches. Evidence suggests that the benefits of such synergies may outweigh those of global business strategies. There are precedents where the synergies derived from local networks of small- and medium-sized businesses have made these extremely competitive.

How can more context-rich knowing and doing be created and encouraged, and how can this be used to strengthen small- and medium-sized Canadian engineering and business undertakings? A first step would begin with engineering and business education. Any particular discipline or professional specialty could ask where the undesired consequences of design and decision making tend to fall. It would then be possible to consult the corresponding disciplines and specialties as to their knowledge of these consequences and their effects on human life, society and the biosphere. In turn, this knowledge could be used in a negative feedback mode to ensure the desired results are achieved as efficiently, productively and profitably as possible, while ensuring undesired consequences are prevented or at least minimized. Once such negative feedback loops are in place, this new knowing and doing could be incorporated into the teaching and research of any particular discipline and specialty. The negative feedback capabilities could then be expanded by incorporating other relevant knowledge from additional disciplines and specialties.

Opening up the curriculum could begin on a small scale, but once particular aspects have been internalized, others could follow. Over time, it would become possible to equip engineering and management with more and more extensive negative feedback loops to reduce costs incurred in the production of wealth. If economic competitiveness can be improved by addressing some of our more fundamental social and environmental problems, a preventively oriented strategy for technological and economic development would benefit everyone and avoid the present skewing of the distribution of wealth and resultant problems, including the "us-them" attitude believed to be fueling the huge underground economy.

Some precedents

Twice Canada has come close to tapping the potential of preventive approaches for technological and economic growth. The former Premier's Council of Ontario independently came to conclusions supportive of the preventive approach–namely that the Ontario economy could be greatly strengthened by means of a strategy to reduce the costs incurred in producing wealth. Just prior to its disbandment, Premier's Council members had agreed to join forces by co-chairing a round table on professional education. More recently, the Natural Sciences and Engineering Research Council and the Social Sciences and Humanities Research Council discussed a possible new joint program tentatively entitled STS 21, of which a significant component could have been the exploration of preventive approaches, but decided that they were not yet ready to proceed. One doubts these setbacks will be permanent. In 2002, the Canada Foundation for Innovation recognized preventive approaches for the engineering and management of technology as one of 25 leading Canadian innovations. The evidence is now robust enough that it can safely be claimed that whatever country begins to move in this direction will initiate something no other nation will be able to ignore for long.

The engineering profession might consider joining forces with other institutions to create a third initiative to make Canada's way of life more sustainable by exploring the potential of preventive approaches for the engineering and management of technology. By substantially improving the signal-to-noise ratio of desired to undesired effects in technological and economic development, we can address some of the deep structural problems standing in the way of realizing our values and aspirations as a nation. A steering committee could be formed comprising the Canadian Academy of Engineering, the above two federal research councils, interested professional organizations, trade unions and the academic community to tackle three projects. The first would be to make professional education in engineering, management, business administration and accounting use more context-rich knowledge through appropriate negative feedback loops involving the relevant disciplines and specialties. A model for this already exists at the Centre for Technology and Social Development, which awards a Certificate in Preventive Engineering and Social Development. The second would be to create funding programs to permit researchers to cross their disciplinary and professional boundaries to examine what other disciplines and specialties know that could improve the signal-to-noise ratio of desired to undesired effects associated with the methods and approaches of their own fields. The third would be to transfer this knowledge, especially to small- and medium-sized businesses, to create products and systems that have a better ratio of desired to undesired effects by taking advantage of synergies with local conditions.

Based on some 15 years of research, it is highly likely that whatever country initiates strategies for technological and economic development based on a steadily improving ratio of desired to undesired effects will lead industrial civilization in the 21st century. The benefits to our profession could be enormous.

References

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