A technologist visits sustainability

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Published online: 7 March 2014

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There was a time, not in too distant past, when Microsoft Word would not recognize the word “sustainability” in a text. Since then authors from all walks of life have written numerous narratives on sustainability or sustainable development. The United Nations and most governments on the planet have come together to promote sustainable development globally and nationally. Industry, especially large multinational corporations, have created their own organizations to promote sustainability. Local governments in every corner of the world are proponents of sustainability with programs titled “sustainable this” or “green that” to implement it. A responsible citizen dutifully separates recyclables from household wastes. Another drives a hybrid or an electric car. Yet another citizen volunteers for a citizen action group to promote solar or wind power. Are these behaviors contributing to sustainability? There can be two short answers, of which the first is: Perhaps. The second answer: We really would not be able to tell without knowing what the other interacting agents in society naturally do. The economy and society are vastly more complex than the simple causal relationship that we use such as “if we do this, that happens.” Profound confusions remain at every level of society about what one is supposed to do about sustainability. From the point of view of the science and engineering research, here is an attempt to make some sense on how this research community might look at sustainability.

The word “sustainability” nowadays is as frequently used to connote its common sense meaning as to reflect the sense that came from the global environmental movement,

generally accepted to have been popularized by the Bruntland commission report, our common future, of the UN-sponsored world commission on environment and development (WCED). No science dictionary has a useful scientific definition of the term. This is not surprising. Even though sustainability has penetrated many fields of science and engineering, the understanding varies from person to person, discipline to discipline. In truth, this is a sociopolitical idea, not a scientific one. Prof. J. Pop-Jordanov of Macedonia has compiled the distinctive ideas that are central to different professions in this context. For instance, for an economist, quantifying the environmental “externalities” is central to assessing human welfare. An ecologist is focused on studying the ways the carrying and regenerative capacities of natural resources are impaired by human enterprise. To a physicist, sustainability is “the ability of biological systems to fight against degradation of energy and resources (entropy) by creating new forms of order (negentropy) using the various inputs of solar energy.” To a chemist or an engineer, however, it is “the challenge to complete material and energy life cycles created by human activities, through new techniques for material design, re-use, recycling and waste management.” Though these disciplinary foci can be highly technical, none of them captures the sociopolitical definition given by the Bruntland commission report: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This report is human centric, and its emphasis of intra- and inter-generational equity is clear. It cried out for an unspecified plan of action to reverse widespread environmental damage to our planet by human activities, depleting finite natural resources in the process, and creating a huge gulf between “Haves” and “Have Nots”. Our common future did not define sustainability per

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se. Prof. Roland Clift of the University of Surrey once wrote that sustainable development is the journey to sustainability the destination.

Of all the understandings reviewed above, the one by the chemists and engineers is uniquely action oriented. But the idea of “new techniques” is directionless. However, after more than three decades since the UN report, a common vision of what scientists and engineers can do, can be constructed. This common vision can be said to have risen from a synthesis of the diverse ideas prevalent in different disciplines. This vision has several components. First, natural resources need to be exploited in such a way that they result in little wastes, use renewable resources as much as possible, especially for energy where fossil energy should be deemphasized. Second, environment should be protected from further degradation, i.e., the products and processes designed by engineers and chemists should be reusable or recyclable, surface and ground water, and air should be protected from further emissions and discharges of harmful components that could adversely affect human health and the ecosystems. Third, the innovative products and processes that give us nutrition, health, and comfort, and higher standard of living should be designed to incent the inventors and yet be affordable by all inhabitants of the planet, so that disadvantaged parts of the planet do not have to practice extant, wasteful, and environmentally harmful products and processes. Lastly, no communities will be subjected to undue environmental and health effects burden resulting from the introduction of our products or processes. All these four items must also be quantifiable on a relative basis. At

least in principle, these objectives, if not entirely within our abilities to achieve, are asymptotically achievable without violating any physical laws. At the global, national, and regional scales, there are important roles of policy actions, however, that could either facilitate or impede progress. The researchers need to understand that. On the hopeful side, as the technological progress marches on, at an ever accelerating pace, the future may bring methods and processes that will surprise us all with new inventions not yet imagined. The four points presented here, it will be noted, cannot help with the attainment of equity, other than by what results when we use material and energy resources to design more efficient products and processes.

We started with the tacit assumption that our current methods of resource use are unsustainable, and there are “sustainable” ways of exploiting them. Our task is to find those sustainable ways. There are others, however, who would argue that because of the concentrating proportions of greenhouse gases in the atmosphere, catastrophic climate change will get us before any other concerns do, and controlling greenhouse gases is singularly paramount now. This is a policy call, and one would not know now what the unintended or unforeseen consequences might be if draconian changes are implemented in energy technologies, or whether they can be implemented at the global scale. Technological research itself has limits on what it can deliver, even when it does deliver the intended outcome, though the researcher is not similarly limited. The best they can do is to inform the policy makers of their science findings and leave the rest to them.