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Whole System Design: An Integrated Approach to Sustainable Engineering

Peter Stasinopoulos, Michael H. Smith, Karlson 'Charlie' Hargroves and Cheryl Desha, London, Earthscan and Australia, The Natural Edge Project, 2008, 183 pages, US$ 136.50 (hardcover), US$ 38.95 (soft cover, 2009)

Reviewed by Don Bailey

Whole System Design: An Integrated Approach to Sustainable Engineering is intended to address the perceived need to redesign development; not simply to harm the environment less, but rather to be truly restorative of nature and ecosystems, and society and communities. The authors are members of the Natural Edge Project, an independent think-tank based in Australia that operates as a partnership for education, research and policy development on innovation for sustainable development. Their approach provides a path to expanded system horizons and more comprehensive solutions.

The book aims at explaining the importance and relevance of a Whole System Approach to Sustainable Design, to show how the approach will enhance the design process and to help society achieve ecological sustainability. It builds from definitions and fundamentals to applying the enhanced process elements and demonstrating a competitive advantage through case studies.

The authors define 'A Whole System Approach' as 'a process through which the interconnections between sub-systems and systems are actively considered, and solutions are sought that address problems via one and the same solution'. 'Sustainable Design' refers to the 'design and development of systems that, *throughout their lifecycle*

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- Consume natural resources (energy, materials and water) within the capacity for them to be regenerated
- Do not release hazardous or polluting substances into the atmosphere beyond (their) assimilative capacity
- Avoid contributing to irreversible adverse impacts on ecosystems
- Provide useful and socially accepted services long term
- Are cost effective and have a reasonable rate of return on total life-cycle investment, and preferably are immediately profitable. (p. 5)

The process begins by asking the right questions: What is the required service, including service frequency and expected life? What is the optimal service that delivers the most benefits for the least cost in terms of environmental and economic sustainability? What are systems-operating conditions, including external interactions and load variations?

The next step involves benchmarking against the optimal system, not merely against the best existing system. Then comes designing and optimising the whole system, preferably using a multidisciplinary team and accounting for all-measurable ecological impacts.

Designing and optimising subsystems in the right sequence is critical: choosing people before hardware, demand before supply. Designers should use mathematical modelling and do life-cycle cost analysis. They should track technology innovation and design to create options for an envisioned future based on Sustainable Design.

Detailed flowcharts illustrate the process, and relevant case studies demonstrate how to apply the process elements.

The book concludes with detailed 'Worked Examples' including designs for an industrial pumping system, a passenger vehicle, an electronic computer system, a temperature-controlled building and a domestic water system. Modelling led to a factor-five reduction in pumping system life-cycle costs through increased pipe diameter to reduce flow friction, optimised piping layout and reduced pump horsepower. The optimised passenger car uses only electric power facilitated by a 57 per cent reduction in weight and improved aerodynamics, and the car is almost fully recyclable. Designs for the computer system, temperature-controlled building and domestic water system are equally effective.

Whole System Design includes a challenge to go beyond conventional thinking. It seems only natural to expand the process to more formally increased interaction with economic, governmental and societal systems in the quest for sustainability, as illustrated in Figure 1.

For example, can passenger-car design teams consider Whole System transportation issues such as road congestion and urban sprawl? Can the process generate a definition of a consortium with incentives to produce and manage performance of whole transportation system designs? Can the design team involve the government to identify supporting regulations and cost-effective subsidies and tax incentives? Can the process deal with impact on employment, retraining requirements and worker relocation? Can the design team consider education to shape cultural mores to accept optimal whole system designs (just as advertisers do)?

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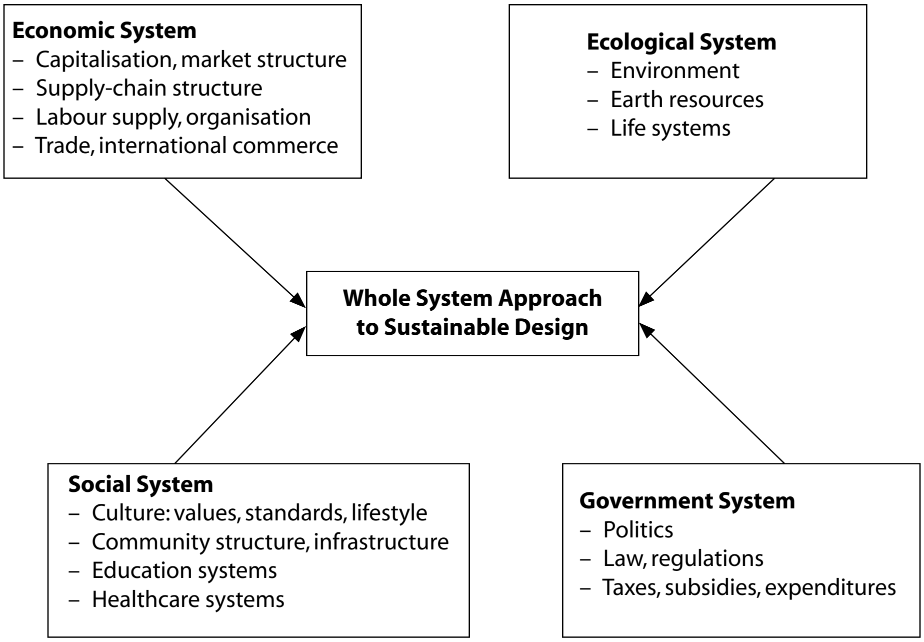

Figure 1

Source: Reviewer's own.

Stasinopoulos *et al.* have demonstrated the dramatic reductions in ecological impact achieved using enlightened system design approaches. *Whole System Design: An Integrated Approach to Sustainable Engineering* documents for students a significant step in the evolution of systems technology.

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