New efficiency from our old systems

Whole systems engineering is providing innovative and exciting ways of looking at the overall design and efficiencies of established industry systems. It can uncover significant, hidden, long-term value that provides a strong argument for taking on the often daunting upfront costs associated with change.


RMI

The Rocky Mountain Institute in Colorado is advocating power of whole systems engineering.

MUCH OF THE ART of design for the next industrial revolution will come from asking the right questions. What do people truly need? They need paper, not paper mills; mobility and access, not bigger cars; and energy, not coal-fired power stations. Wouldn't it be great if we could simply re-use paper by our printers de-inking it?

These ideas come from an insight featured in the book *Natural Capitalism*[1], 'To go forwards, think backward.'

Every product we buy, every service we use, has an ecological footprint that goes with it. The size of the ecological footprint depends on the amount of energy and materials needed to make, transport, package, market and approve it. All products have this 'secret life' that most of us never think about.

Significant resource efficiency gains are therefore possible if we think backwards from what service or product we truly need, and work out how we could redesign, recycle and or reuse it in multiple ways.

A whole systems engineering approach, takes a step back from the industrial process and asks how we can optimise the whole to achieve better or as good service, and additional new benefits.

The work of the Rocky Mountain Institute in Colorado, the Wuppertal Institute in Germany and many engineers, designers and research teams internationally, is proving that whole systems engineering design is well worth the effort. Their work has shown that across many generic areas of engineering now, an order of magnitude improvement is possible at negative marginal cost.

Why then are whole system engineering strategies not better known?

Why then are whole system engineering strategies not better known? In the past, they have not been taught in engineering schools that are pressured for time and already have overcrowded curricula. But as the world's environmental problems worsen, the global population continues to rise and the need for new planning and design systems grows.

There is now great interest globally as Engineering Institutions[2], Engineering Professionals[3], the United Nations[4], UNESCO[5], and Universities[6] are already looking to provide professional training material and courses to capacity build engineers to create a more resource efficient and sustainable future

The UN has announced that 2005–2015 will be the Decade of Education in Sustainable Development. Already UNESCO has launched the Global Higher Education for Sustainability Partnership that to date involves over 1000 Universities. Many Engineering Institutions globally and the World Federation of Engineering Organizations (WFEO)[7] have strong commitments to sustainable development and programs like WFEO-COMTECH[8] to provide online educational materials and databases[9].

Therefore, the time is right to develop technical, whole system, design engineering material to provide the technical details of how radical resource productivity can be achieved across generic areas like the manufacture of cars, buildings, motors, pumps and pipes, HVAC systems, computers and much more.

As the authors of *Natural Capitalism* explained, however, often whole system engineering design is not used because people are blinded by what seem to be additional upfront costs.

For instance, if one is building a house, thicker insulation, better windows, and more efficient appliances will cost more, than the standard home. If you are an engineer working for a car company, you'll be told that lighter materials are more expensive options. These statements may well be true – but they are only true when considered in isolation.

1 Hawken, P., Lovins, A. & Lovins, H. (1999). *Natural Capitalism: The Next Industrial Revolution*. Earthscan Publications: London

2 Federation of Engineering Institutions of South-East Asia and the Pacific (FEISEAP) (For sustainable development). **http://sunsite.anu.edu.au/feiseap/** Institution of Engineers, Australia; Sustainability reports, 2001. **http://www.ieaust.org.au/policy/res/downloads/publications/Sustainable%20Energy%20Report.pdf**

3 The next generation of engineers in the UK are demanding that their profession becomes more proactive on Sustainability. UK Forum for the Future's web site. **http://www.forumforthefuture.org.uk/news/default.asp?id=247**

4 **http://www.wfeo-comtech.org/ch2mEngAndSustDev.pdf**

5 UNESCO Global Higher Education for Sustainability Partnerships (GHESP) **http://www.unesco.org/iau/ghesp/ University Leaders for A Sustainable Future: http://www.ulsf.org/**

6 **http://www.acfonline.org.au/na/asp/pages/default.asp**

7 **http://www.wfeo-comtech.org/WhatIsWFEOComTech.html**

8 **http://www.wfeo-comtech.org/** WFEO's response to Agenda 21 **http://www.wfeo-comtech.org/Communications/ImprovingResponseToA21.html**

9 **http://www.avel.edu.au**

As *Natural Capitalism* states, 'The cost-versus-savings graph illustrates what is common sense.' It should cost more to get bigger energy and resource savings and efficiencies right.

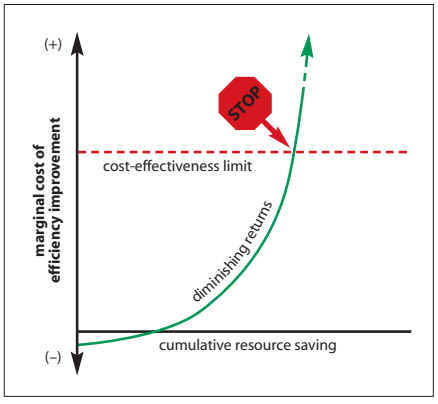
The key is to analyse the whole system both in terms of resource usage and costs, to identify potential synergies and unforseen savings. This can be achieved, for example, through closing loops on resource flows, or finding innovative methods of integrating systems.

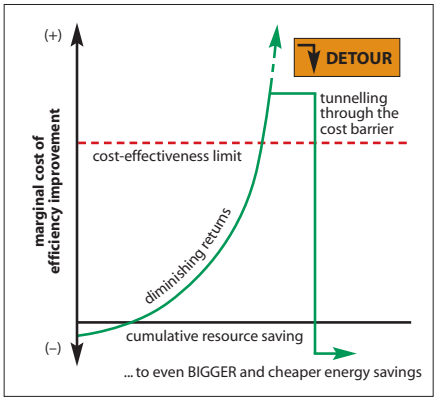
Whilst it can seem counter-intuitive, design engineering that optimises the costs across the whole system, can often 'tunnel through the cost barrier.'

It is therefore in our interests that more engineers are trained in these win-win opportunities, and that bold strides are taken by those controlling and leading current industrial processes. Leading by example will encourage wider industry to knuckle down.

Charlie Hargroves, Mike Smith and James Moody

Charlie Hargroves, Mike Smith and James Moody are from *The Natural Edge Project* – a volunteer-led initiative to raise awareness and action on national sustainability priorities through partnerships across organisations. **http://www.naturaledgeproject.net**





As published in *Natural Capitalism*, Earthscan 1999

A guide to whole systems

The Rocky Mountain Institute is committed to improving engineering design education and has initiated a project to develop a Whole Systems 'Design Integration Guide'. The guide will detail a range of case studies drawn from many engineering disciplines. With calculations and benefits analysis, it will be peer reviewed by the peak engineering, academic and corporate bodies.

To assist in the development and dissemination of the project, a Whole Systems Engineering Alliance will be initiated with the Australian team from The Natural Edge Project, supported by CSIRO and Engineers Australia, to work with RMI to assist in the development of the Design Guide and in the formation of the Alliance to enable it to reach a global audience of engineers.

Far left: normally, finding value by seeking resource savings through efficiency changes has a cost limit. Left: with a whole-systems view, diminishing returns and up-front costs can be 'tunnelled through' by hidden value in larger resource and productivity savings for the same or less cost.

Ancient wisdom in a new city

THIS PICTURE shows a scale model of the 'new' city of Ningbo in China which Australian consultancy Hassell recently won an international competition to design with Hyder engineers.

Ningbo was actually built in AD700, and Hassell's innovative, modern city plan compliments the ancient centre by incorporating its time-tested sustainable practices.

Principal at Hassell, Robin Edmond said 'we secured the commission because we didn't try to re-invent the wheel. Instead, we combined twenty-first century technology with traditional Chinese agricultural practices in conserving soil, resources and water.'

'We combined twenty-first century technology with traditional Chinese agricultural practices in conserving soil, resources and water'

'For example, Ningbo is made up of a myriad of canals because it is prone to flooding. We decided to continue the tradition of using canals for flood protection, drainage and transport but enhance their capacity for other purposes such as water supply and treatment for recycling in a modern sustainable way,' Mr Edmond said.

'We estimate the 'new' Ningbo, which will house 350 000 people on 4000 ha of land, will use less than half the energy of a contemporary western city through high efficiency wind generators, solar power, and methane 'eggs' in all housing, and public transport corridors to minimise private vehicle use.

Hassell

'Given China's high urban growth rate, Ningbo will be a vital benchmark for the planning, design and construction of future Chinese cities.'