

## Title: **Environmental Entrepreneurs: the Missing Link on the Road to a Carbon Constrained World**

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### Abstract:

Engineers are at the forefront of the transition to a carbon constrained world. New technologies are needed that will allow the world to adapt whilst ensuring a good quality of life for all its inhabitants. Only through the innovation and entrepreneurship that engineers can provide will these technologies be conceived and delivered.

However it must be recognised that a vital link is required to facilitate the work of engineers. Connections between the technical and financial communities are essential to achieve desired outcomes. Through an understanding of both new sustainable technologies and the world of finance, the 'environmental entrepreneur' can make connections and innovations in how technologies are financed and adopted by the community. The paper considers the theory of innovation cultures and how this can be applied to assist the transition to a carbon constrained world

Key Words: innovation culture, entrepreneur, environment, cleantech, carbon constrained.

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### **1. Introduction**

Engineers are at the forefront of the transition to a carbon constrained world. New technologies are needed that will allow the world to adapt whilst ensuring a good quality of life for all its inhabitants. Only through the innovation and entrepreneurship that engineers can provide will these technologies be conceived and delivered.

There is however a missing link that is vital in facilitating this transition. This link requires highly numerate people able to conceive innovative solutions to complex problems, understand both technology and regulatory issues and have the entrepreneurial ability to implement new solutions: all skills possessed by engineers. Without this link, clever inventions will not be commercialised and the world will continue on its current unsustainable path.

This link is the connection between the technical world and the financial world. To underpin the growth of sustainable industries, or clean technologies as they are becoming known, requires a special type of innovation. Through an understanding of both new sustainable technologies and the world of finance, the 'environmental entrepreneur' can make connections and innovations in how technologies are financed and adopted by the community.

For entrepreneurial engineers, a role facilitating investment in sustainable technologies provides an opportunity to become the missing link on the road to a carbon constrained world.

## 2. Innovation and Entrepreneurship

*We ought not to be over anxious to encourage innovation, in case of doubtful improvement, for an old system must ever have two advantages over a new one; it is established, and it is understood.<sup>1</sup>*

Management theorists struggle with the concept of innovation because it defies the structure and linear nature of other management topics. Managers also struggle with change as it requires them to dispense with what has worked for them in the past. Companies that have made 'giant leaps' have been examined for common characteristics with only limited success. Companies that grow around a single idea can be linked to the entrepreneurial personality of the founder. A more difficult task is to identify common characteristics of large corporations that have succeeded through continuous innovation. The need for any company to embrace change, innovation and disruptive technologies to succeed in the longer term is not disputed. However, combining this requirement with the need for structure and control in the short term is a problem that is not easy to resolve.

Leonard<sup>2</sup> has identified the following five key activities found in successful innovative organisations and claims that these are all required for innovation to prosper:

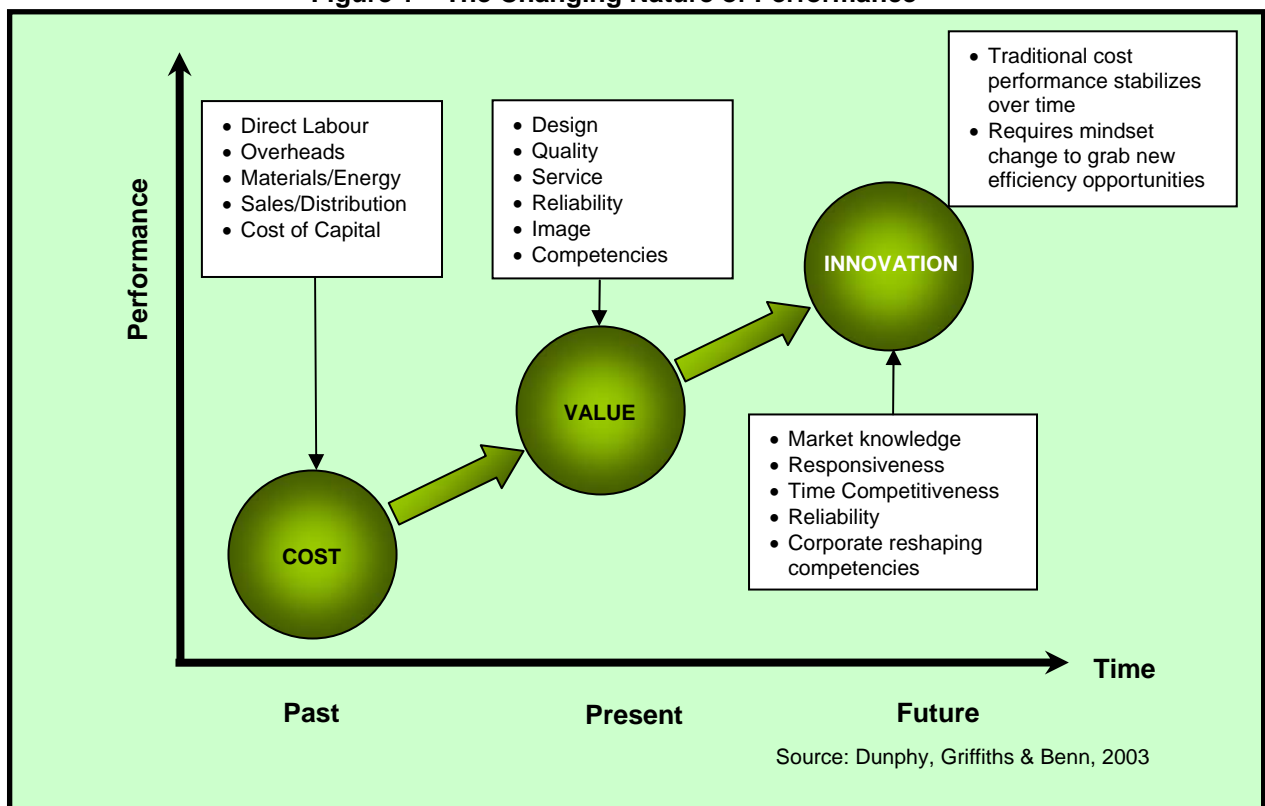
- (1) integrating problem solving across different cognitive and functional barriers;
- (2) implementing new methodologies and process tools;
- (3) experimenting and prototyping;
- (4) importing and absorbing technical knowledge from outside; and
- (5) learning from the market.

Other theorists who have considered the topic include Hamel<sup>3</sup> who identifies ten 'rules for designing an innovative culture'. These include creating a cause rather than a business, listening to new voices, designing an open market for ideas and 'divide and divide and divide the business'.

Some of the larger pharmaceutical and IT companies have strived to achieve ongoing innovation by establishing small independent business units that act as idea generators distanced from the conformist culture of the parent company.

There is a growing consensus that to enable companies to survive in an environment that is changing with ever increasing speed requires a complete rethink of management behaviours. In Australia, leading thinkers such as Professor Dexter Dunphy subscribe to the theory of internal change agents leading to an innovation culture that enhances a company's performance (Figure 1). Dunphy et al state that 'practices designed to enhance human sustainability and social capital within the organisation (such as empowerment, teamwork and continuous learning) are linked to the capacity to innovate and escape from the rigid models of operation and production'<sup>4</sup>. This theory expands to consider how the innovation generated by changing the behaviour of companies from within will lead to a more sustainable world.

**Figure 1 – The Changing Nature of Performance**



Farkas and Wetlaufer<sup>5</sup> have considered how leaders of successful organisations that have embraced change managed to achieve innovation. They found that there was a belief amongst the leaders that maintaining an old method of operating was sure to lead to failure in achieving extraordinary results and that it was only through constant renewal that their companies would thrive. To achieve innovation and growth these companies 'embrace ambiguity, uncertainty and upheaval'.

*The common theme that links [entrepreneurs] is sound judgement, ambition, determination, capacity to assess and take risks, hard work, greed, fear and luck.<sup>6</sup>*

By applying the themes above entrepreneurs are able to create value from innovation. The value may be in the form of social, environmental or economic benefits. An important consideration is that entrepreneurs do not have to be only those that start their own companies. The most important entrepreneurs are those that are embedded within organisations and are able to make changes from the inside and harness the strength of large corporations to achieve innovative outcomes.

The huge transition to a low carbon economy requires changes to all aspects of the economy and society. It requires innovation in everything that we do and entrepreneurs to deliver this innovation into value adding activities.

### 3. Engineering Innovation

All of the many changes that are required for the carbon transition involve engineers in their conception, development and implementation. There are many examples of sustainable innovations that are currently in the process of becoming reality through the applied skills of engineers of all disciplines. Some examples are provided below:

- **Civil Engineering** - concrete-saving wind turbine tower foundations<sup>7</sup>, designing structures using less carbon intensive materials and designing low carbon concrete<sup>8</sup> to change the profile of the built environment.
- **Geotechnical Engineering** – the potential to develop base load power generation capacity through the development hot dry rock (HDR) technology using 'in-situ nuclear energy'<sup>9,10</sup>.
- **Mechanical Engineering** – the development of wave and tidal power technologies that harness energy from the sun and the moon respectively<sup>11,12</sup>.
- **Materials Engineering** – designing reflective coatings that make solar thermal mirrors more efficient<sup>13</sup> and the development of thin film photovoltaic technology that can be used on windows and roofing materials<sup>14</sup>.
- **Transport Engineering** – improvements in public transport effectiveness and the development of hydrogen and fuel cell powered vehicles<sup>15</sup>.

All of these wonderful examples show how engineers are providing the disruptive technologies that will enable emissions in Australia and globally to be reduced. It must not be forgotten, however, that all such prospects require finance.

Many engineers are mindful of the need for sustainability and efficient resource use. This may be due to their closeness to and understanding of the finite nature of resources and waste absorption capacities. This insight has enabled great progress to be made in technological options. If coupled with equal creativity in business models and financing structures, then technology will form the foundations of global sustainability.

#### **4. Financial Innovation**

As innovative solutions with the potential to have the greatest impact are disruptive technologies, they often struggle to come to market. Incremental changes that achieve improvement in cost and/or quality are easy to finance and commercialise. They do not threaten the incumbent players and they improve returns for investors. Referring to the innovation theory of Dunphy et al in Figure 1 the next stage, after cost and quality, requires a 'mindset change'.

Hence the commercialisation of new technologies requires an entire rethink of how projects are delivered, how communities operate and how finances are structured. A recent example of innovative financing is the Hepburn wind farm<sup>16</sup> that will deliver community level renewable power generation driven by the community itself. This has enabled the community to become part of the sustainability solution whilst building strong community ties: outcomes that could not have been achieved through buying green energy from a large energy company. The project, when completed, will therefore deliver economic, environmental and social benefits.

On a larger scale, there is an innovative development that takes the community funding model to a higher level<sup>17</sup>. The plan is to build a 100MW wind farm and then sell an interest in the project to the public through 100,000 licences. The funds from this will be used to build a second wind farm and the process can continue. The licence holders will be encouraged to buy power from *their* wind farm through a dedicated retail channel. Add in the vision of domestic wind turbine assembly and a charitable foundation to invest in renewable energy technologies and the project holds massive economic, social and environmental potential.

Another finance structure that enables the community to become part of the solution is the emergence of buying groups that enable the bulk purchase and installation of technologies such as solar panels. The buying power of a group ordering the same product for delivery and installation in the same suburb, makes the adoption of such technologies more affordable.

Additional affordability of clean technology products may be achieved by the provision of finance through new and existing household mortgages. When paying off items such as solar panels over a 25 year period the annual cost of the additional debt is more than set off by savings in power bills. It is only when the capital cost is to be paid up front that the economics are not compelling. The introduction of such an option would be a powerful project for a high street bank to use as a point of differentiation.

## 5. The Environmental Entrepreneur

The combination of technological and financial innovation opens up the road ahead to a sustainable world. By engaging with both industry and financial institutions under the banner of clean technology, the environmental entrepreneur is able to deliver multiple benefits for all concerned. Based on this achievement, the clean technology sector will be the success story of the next 20 years. Already, its global revenue has grown exponentially over the last few years and growth is set to continue for many years to come. Research and forecasts by Clean Edge<sup>18</sup> indicate that the clean energy sector alone had global revenues of US\$77.3Bn in 2007 and this is forecast to rise to over US\$250Bn by 2017.

In Australia, the definitive measure of clean technology performance is the ACT Australian CleanTech Index<sup>19</sup>. This tracks 73 clean technology companies listed on Australian exchanges with combined forecast FY08 revenues of over A\$13Bn. If the Australian growth matches the global forecasts, annual revenue for the Australian clean technology sector could exceed \$40Bn within the next 10 years.

The potential of clean technology is huge. The technological innovation exists to enable it to be fulfilled. What has been missing is the link between technology and finance and the ability to produce innovation across both of these sectors. Technical knowledge, experience of regulatory environments and risk management and an understanding of project and corporate finance are the essential foundations required for this role. As important is an ability to drive innovation and deliver change through entrepreneurship.

This link now exists in the form of the environmental entrepreneur.

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