The Cement Industry and Innovation: *A new way for a new world*

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Change, like the seasons, is inevitable and perpetual

The business environment is in a state of continual flux driven by factors including changing demographics, technology development, swinging market perceptions, ongoing environmental degradation and the rapid flow of global financial capital.

To cope with continual change the cement industry will inevitably like every other industry need to be able to reinvent itself and prepare for opportunities for both failure and success. This requires a degree of entrepreneurship and the cautious investigation and adoption of new technologies.

The drivers of a Change

What are the opportunity signals to entrepreneurial companies and management? How should the changes going on be responded to?

Macro-change 1: Demanding consumers and market competition

One of the features of a market system is the ability for customers to choose what they want to spend their money on. Customers will generally choose to spend their money on what gives them the greatest level of utility, or in other words, what satisfies their need or want the best. It is imperative to understand this in order to evaluate changing markets as in the end they are customer driven.

Cement or concrete is rarely purchased in order to maintain a company's profitability or to support an industry. It is usually acquired to fill a structural, mass or bonding requirement.

From slag to foam, fibre to fly ash, already a wide range of cementitous composites are available. More and better alternative materials are also being developed to satisfy increasingly sophisticated customer specification requirements. The choice of Portland cement concretes by specifiers is becoming less obvious as a result.

To maintain market share in a world with so much choice the industry must innovate and respond to what the customers of both today and the future will want. For example, strength as in traditional ready mix concrete need not necessarily mean heavy and high thermal capacity should not necessarily mean low insulation capability. Exploring the mix of hydraulic cements with non-traditional tensile reinforcing and aggregates will result in concrete products that exhibit a wide range of properties able to optimally fulfil the needs of customers.

[12] Matter can be converted to energy in nuclear reactions as per the equation $E=mc^2$.

If cementitous composites were developed that filled a wider range of requirements then it is likely that more, not less, cement products would be sold. This extra demand and associated sales would then flow on to lift the cement and concrete industry as a whole.

Macro-change 2: The sustainability imperative

The issue of sustainability can now no longer be ignored. A major aspect of global sustainability is derived from the first law of thermodynamics which states that energy cannot be created or destroyed. In most cases[2], this also refers to matter of which cement and concrete are most certainly made. Until we can begin to work more efficiently with the laws of thermodynamics, we will never make quantum leaps in economics. For the keen eye of an entrepreneur, this natural law implies an opportunity for innovation.

Mining of raw material and disposal of waste faces limits. Concrete is the major material used in construction and probably constitutes 20 to 30% by mass of all material flows across our planet. Partly due to environmental and social pressures, the political limits associated with these activities are becoming real today and will only increase in future.

There are also resource limitations. In India and China, where cement manufacture is accelerating at a phenomenal rate, purer grades of limestone are starting to run out and magnesium contamination during the clinkering process is becoming an issue.

At the other end of the lifecycle, waste is the issue. In Europe particularly, governments are getting serious about environmental sustainability, and an obvious focal point is waste. Take the UK for example. 60 million people living on a small island produce over 470 million tonnes of waste[3], with around 140 million tonnes (30%!) coming from, in one way or another, the construction industry[4]. European regulations and progressive taxation on landfill are clear signals that society demands a new paradigm of resource flow.

In a traditional recycling paradigm wastes are sorted for their molecular value rather than general class of properties. Despite beginning to deal with the first law of thermodynamics, this way of recycling is heavily constrained by the second law of thermodynamics, the entropy law or law of increasing disorder, and will never be economic unless a way of very efficiently sorting wastes can be found.

If wastes were sorted in accordance with the class of properties rather than molecular constitution then they would become a cheap resource to make the various cementitous composites previously mentioned. A way of utilising wastes in large quantities and turning them into a resource is possible[5].

The global push for sustainability offers exciting new opportunities for the cement and concrete industry. Wastes are potentially a huge resource. Improvements in recovery and utilisation technologies will one day make them of significant value as aggregates introducing a wide range of new and exciting properties to cementitous composites.

New and improved composites made with Portland cement and changes to the binder itself such as suggested by TecEco Pty. Ltd. should always be driven by economics, which is in turn defined by

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[3] United Kingdom Environment Agency at http://www.environment-agency.gov.uk/subjects/waste/232028/169145/176602/?lang=_e valid 15/05/04

[4] Smith, Griffiths, Kersey, *A mass balance of the UK construction industry*, Viridis, London, 2002

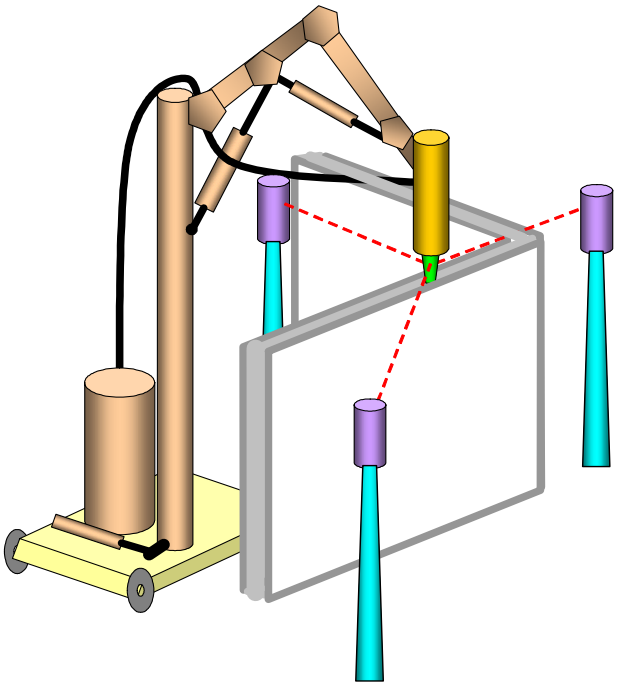
[5] (See http://www.tececo.com/files/Background_Information/MakingRecyclingEconomic090504.pdf for a another brilliant suggestion).

levels of technology. As Paul Zane Pilzer[6] states "By enabling us to make productive use of particular raw materials, technology determines what constitutes a physical resource." Pilzer goes on further to explain that definitional technologies are those that enable us to make use of particular resources.

With over two tonnes of concrete per person on the planet produced annually on a global basis, it is an obvious move for the cement industry to look at how to incorporate both more, and a wider range of waste to make cementitous composites. Australian R&D firm TecEco Pty. Ltd. (TecEco) is leading the way by investigating innovative and very promising new calcium-magnesium blended binder materials with their tec-cement, eco-cement and enviro-cement.

Macro-change 3: Ongoing technology evolution

Cements and concretes, as with most technologies across the globe, are changing to better meet the needs of customers ahead of the competition. The construction industry is very conservative and the changes have been slow, such as the increase in the alite/belite ratio over the last twenty years and incorporation of supplementary cementitious materials as well as fibres. Cements and concretes probably need to change much more quickly to meet the challenges of the future.



Challenging the traditional construction paradigm is robotics. In the USA and elsewhere in the world researchers are looking at using robots to literally "print" buildings. It's all quite simple from a software, computer hardware and mechanical engineering point of view. The difficulty is in developing new construction materials with the right Bingham plastic rheology so they can be squeezed out like toothpaste, yet retaining their shape until hardened.

TecEco cement concretes have the potential of easily achieving this kind of rheology.

The one material fits all purposes approach will increasingly have only limited relevance. Concretes will need to evolve from being just a high strength grey material, to a smorgasbord of composites that can be squeezed out of a variety of nozzles for use by a robotic workforce for the varying requirements in a structure.

Figure 1 - Robotic Construction of Cementitious Composite Walling

The main inhibiters to evolution in the industry are the prevailing archaic formula-based standards essentially developed at the beginning of last century. Standards are important for society's protection, but to allow creativity and innovation, would be a much better servant if they were performance rather than formula based.

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[6] Pilzer, Paul Zane, *Unlimited Wealth, The Theory and Practice of Economic Alchemy*, Crown Publishers Inc. New York.1990

If standards were performance rather than formula based, innovation would return to reward the industry with a fascinating abundance of composites. TecEco for example are developing composites in which Portland cement is still a major proportion, but in which all sorts of materials and wastes are included such as fibres, sawdust and plastic many of which are also carbon sinks. Expected outcomes include new and improved materials with exciting property mixes such as tensile strength and/or compressive strength, insulation capacity and/or heat capacity, lighter weight, greater durability and better rheology during the plastic stage.

Ongoing change, through political, environmental, economic or social pressures is like the seasons; inevitable and perpetual. Governments can force change perceived as desirable through legislation, a better solution however is for change to come proactively from industry. Responding entrepreneurially and profitably to changing global conditions requires lateral thinking.

Part Three: Adjusting the sails to suit the wind

Innovation is essential for our survival on the planet. We must learn to live more sustainably. For businesses, conditions and the flow of capital are becoming more dynamic and fluid.

The cement and concrete industry has some inherent problems that naturally restrict the rate of adoption of new technologies to meet these challenges:

- Expensive manufacturing infrastructure
- Low margin product
- Proliferation of formula based technical standards
- Industry culture – "It's always been done this way"

One of the simplest ways a company board can encourage an entrepreneurial mindset is to ask the fundamental business-planning question, "What is our business?"

Failure to ask this question and to identify the true definition of your business and markets can often lead to an organisation missing the most obvious and fundamental of available opportunities.

As stated on the website of global consulting firm Price Waterhouse Coopers[7], "Identifying and articulating a customer-driven, profit-oriented business strategy that makes optimum use of your company's strengths is a challenge you must face if you are to be among tomorrow's winners. It will drive all of your strategic choices regarding which products to sell, which marketing approaches to pursue, which customers to serve, and which distribution channels to use. It is becoming even more important to choose just where and how you will compete."

A classic case of an industry failing to ask this question was the railway industry as the automobile came into fruition. When the automobile was being invented, rail was the primary source for mass transportation across the country. Here is where the railroad companies made a fatal flaw. They defined their business as the "rail business". However, had they defined themselves as being in the "transportation business" they would have easily identified alternative growth opportunities for their business faster and, perhaps, fended off decades of decline before capitalizing on the mass movement of goods.

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[7] http://www.pwcglobal.com/extweb/indissue.nsf/DocID/081CCF47AF0C362B85256826004EB643 16/05/04

Properly identifying the business a company is in uncovers opportunities for growth through the production of goods and services more in line with the changing needs of customers.

What business is most cement companies in?

Most management currently within cement companies would, quite possibly unconsciously, limit themselves to the following business definition:

"What's grey is great and all we make goes out the gate."

How ready is a company that adopts this definition going to be for an increasingly turbulent 21st century? How long until new materials are developed that can react to meet specific clients needs rapidly and effectively in areas that was traditionally the domain of the grey powder that goes out the gate? How long will the marketing departments be able to hold off the winds of change?

What about preparing for the change that is inevitable by adopted a business definition such as the following?

"Providing a self - hardening material based on geological resources that can be adapted and optimised to meet the current and future needs of every possible customer"

This article is a challenge to the captains of our industry. What level of thinking is required to effectively bring your organisation and industry into the new century? What are the developments occurring of which you should be aware and supportive? Have you ever analysed the needs of your customers and compared them to the grey powder you supply? How will your company be placed in relation to the rapidly changing technical paradigm we all live in? TecEco Pty Ltd is a company that is addressing many of these questions.

Ignorance may be an excuse for today but negligence starts tomorrow.