CORE SUSTAINABILITY: A MATTER OF INNOVATIVE DESIGN

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Abstract

As the resource industries mature with respect to sustainability and they redefine their contribution to society's development, it is timely to reflect on how this clouded topic has transformed the thinking of our engineering and scientific practitioners. As we gradually adopt whole-systems approaches, eco-efficiency and other sustainability concepts, what is needed is a carefully considered methodology that leads to a robust project management and design regime.

A three-part definition of sustainability opportunities is offered: having distinctive components of compliance thinking, risk management and innovation. The behavioural aspects of the innovation component are examined in some detail and, from a project standpoint, the initial separation of innovation from highly structured management practices is proposed.

Such an innovation framework can be used to set projects on the path to deep-seated sustainability practices, unambiguously cost-conscious, yet freely developing initiatives that elicit first-class environmental and social outcomes. Case studies draw examples from inside and outside our industry to illustrate project thinking and related design actions to achieve these ends.

Finally, discussion on how to derive competitive advantage from the innovation framework sets the scene for recommendations into future project procedural changes and scientific research.

1 Introduction

Sustainability principles generally do not disallow that human society should use natural resources in a productive and beneficial way. This is provided, of course, that the use does not negatively impact ecological systems, or any present or future users of that resource. Contemporary (largely 1st-world) society expects extraction of metals as useful materials of construction while, simultaneously, demanding 'no harm' behaviour in the extraction operations. That 'no harm' requirement has led to compliance-oriented thinking as the norm.

By 'compliance thinking' we mean that the thinking is deeply seated in the expectation that meeting a standard is what we have to do (or indeed, *all* that we have to do). These are standards of environmental performance, social performance or corporate ethical behaviour. Obtaining a 'licence to operate' in other words.

A 'compliance' view locks us into thinking that the environment 'costs money'. There is a knee-jerk reaction that having a 'nice' environment or being socially responsible might suppress profit and therefore should be resisted.

This is not restricted to the mining sector, of course. Generically, we can consider the diagram in Figure 1 as indicating a rough interpretation of the world's population and its awareness of sustainability. The communities represented at the left are those in poverty, while those close to the right hand side are generally those living in post-scarcity economies. Legislative imperatives (at least perceived ones) have historically dictated that global corporations behave in a manner that maximises shareholder value, almost always value measured in monetary terms. Until a new definition of value is in the statutes, we will be constrained to look for similar 'cost-like' footprint improvements.

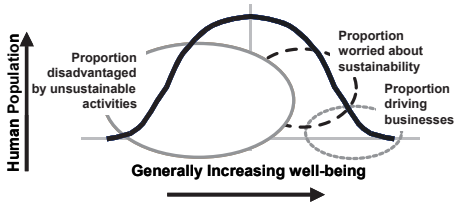


Figure 1: Population Bell Curve

It appears, then, that industry faces a dilemma: on the one hand, projects can be constrained further (with social and environmental parameters that seek to lessen project risks) or perhaps can seek innovation to deliver cost benefits simultaneously with improved environmental and social indicators. If we desire the latter, then innovation must be driven into project design tasks. The project manager, who is traditionally faced with budget and schedule KPIs, should adapt decision-making and team behaviours to suit an innovation approach to sustainability.

This paper seeks to ask: is there a new sustainability perspective for metals extraction? Can innovative systems thinking replace a largely compliance oriented approach?

2 A third approach

The last 2–5 years have seen tremendous advances in resource company attitudes and behaviours – probably not well enough appreciated publicly. However, it could be argued that this welcome progress has been made almost entirely in a compliance framework. There are dozens of sustainability reports issued now and a reader will struggle to find one that has anything other than compliance oriented reporting. The reports tend to conform to a triple-bottom-line approach (that the GRI has helped create) as a necessary risk-reduction (compliance) strategy trying to insulate companies from community expectations that are changing at an accelerating rate. It is easy to be seduced by the notion that reporting within this framework makes a company more sustainable.

What sort of opportunities are we missing by looking at it from only a compliance or risk standpoint? Is there another perspective, a third 'species' of sustainability that has an approach that can take us away from solely compliance or solely risk reduction? A few commentators have developed the conviction that innovation might be the way to address the trade-off mentality that compliance-think means. For example, rather than exclusively ensuring environmental compliance in the process design, an innovation perspective might encompass whole-systems thinking (WST) and identifying opportunities for wide scale synergies.

Taken further, engineering organisations need to interpret corporate sustainability direction (perhaps from existing client SD principles) and provide the design team, at the practitioner level, with a framework and methodology that will lead to a more sustainable outcome. As a start, there is a need to segregate the 'compliance' issues from the front-end-loading thinking and then assemble a suit of tools that can effectively connect the principles to the design task.

Case Study 1: Whole Systems Thinking (WST)

A simple recent example is a Hatch project trialling a new water treatment technology that is based on red-mud (a waste from Alumina production) where considerable benefits were shown for a metallurgical plant at its water treatment facility that:

- Produces an inert waste (in place of a toxic one), which will reduce disposal costs and considerably reduce environmental risks.
- Can eliminate three sludge-handling processes (settling/clarifying/filtration).
- Can replace certain chemicals (lime, flocculent and others).
- Has a $100k to $200k capital benefit (relocation of tankage).
- Offers five percent lower operating expenses than the existing plant, and
- Uses someone else's (the alumina producer's) waste.

This is typical of WST approaches: a single initiative bringing multiple benefits.

3 Tools

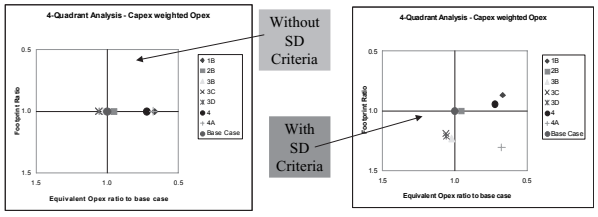
At Hatch, we have begun using three distinct tools: firstly, a 4-quadrant analysis (4QA) methodology, inspired by an environmental-impact versus cost, decision-making tool developed by BASF in Germany (Saling, 2002). The core principle is that we use innovation to drive initiatives that lower cost and impacts at the same time. The types of impact measured or assessed vary from project to project and study to study, but normally things like energy intensity, water intensity and social impact, among others, are used. This is simple decision-support tool. Primarily because the method is graphical (plotting cost vs. footprint) it can transform the single-dimension thinking of traditional NPV-driven analysis into a two-dimensional assessment (Bangerter & Kwak, 2004). This is thought provoking and it demotes trade-off type decisions to second-place status and encourages differentiated decisions around both cost and footprint.

The 4QA is augmented by a procedural foundation encapsulated in our Sustainable Plant Design (SPD) guidelines, which guides the practitioners with detailed and thought-provoking ideas on how to think about sustainable solutions during the design task (Bangerter & Kwak, 2004) – and finally our FuturewatchTM tool, allows an audit of the design decisions against the original SD principles. Further tools are now under development.

4 Education

Having tools that encourage Innovation as opposed to Compliance is a basic building block for bringing those sustainability concepts into the industry – but there are others, and a true grounding in the education system for those concepts seems the most obvious. Unfortunately, waiting for recent graduating classes to influence our business systems, operating plants and engineering design will extend the time taken to adopt the important concepts, so a proactive up-skilling of current practitioners, of all experience levels, is also needed. This is underway in some isolated parts of our industry but it is still a huge task to accomplish a fundamental transformation in the way we design, install and operate plant and equipment.

Case Study 2: 4-Quadrant Analysis



This study examined process-route options for an ore-to-metal integrated facility expansion study in late 2004. It is quite clear that with fiscal-only decision-making (left-hand graph) makes little distinction between options 1B & 4A, whereas with typical footprint criteria added, option 4A becomes significantly differentiated from 1B: thus allowing 1B and even option 4 to be preferred over option 4A.

5 Non-compliance concepts and their uptake

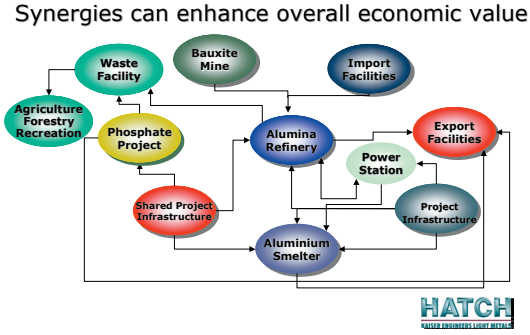
The sustainability texts have a number of engineering-based concepts that warrant inclusion in any innovation driven tool-kit (Hawken *et al*., 1999; Hargroves & Smith, 2005). A thread running through them seems to be eco-efficiency, which has inherent appeal for the (generally, but not exclusively) technocratic practitioners of our sector. Efficiency improvements are pretty much our 'day job' anyway and adding ecological efficiency is not a big stretch. Waste, water intensity and energy intensity reductions are common practice already (inherited from the compliance-think regime) and are suited to innovation driven eco-efficiency guidelines as well.

At best though, eco-efficiency is a halfway house: we need more. A set of operational principles that encapsulates the concepts is an important grounding, and some suggest the four system conditions of The Natural Step[1] as the structure to use in forming strategies. From personal experience, it is amazing how the type of footprint measures needed for each study/project become obvious, when viewed from this framework. And if eco-efficiency is just one thread, we can add, one-by-one, additional Sustainability concepts.

Perhaps the most potent one is Whole-Systems Thinking. This is indeed powerful, as it introduces options not available by looking at things with a narrow perspective. The broader view considers the impact of possible improvements on all disciplines, plant areas or departments, where combined benefits may outweigh a marginal cost increase in one area. It is important to look at a package of improvements as a whole, where the combined effect of small savings in some components may add up to a large saving in others. In this way, one can see single design or operating initiatives acting to solve multiple problems.

In the area of Alumina projects and plants, a leading conceptual example (illustrated below), is where incorporation of red-mud or their commercial derivatives could enable an alumina refinery and fertilizer projects to be synergistically linked. Included in the benefits is the use of red-mud to clean up sewerage and industrial waste waters from nearby communities, chemical plants and refineries so that the water can be used for irrigation. Incorporation of red-mud derivatives into desert soils would enhance their fertility, water retention ability and improve the effectiveness of fertilizers used for growing crops. We would expect this to give a producer a significant differentiation.

Case Study 3: Whole Systems Design



Unfortunately, our contemporary, reductionist approach to science and engineering has somewhat reduced our inventiveness in the engineering field, which is also bedevilled by a high-pressure, time-restricted and budget-restricted environment. 'Whole-Systems Thinking' is a great antidote to the loss in inventiveness.

[1]In the sustainable society, nature is not subject to systematically increasing… (1) ...concentrations of substances extracted from the Earth's crust; (2) …concentrations of substances produced by society; (3) …degradation by physical means; and people are not subject to conditions that systematically... (4) ...undermine their capacity to meet their needs.

At high levels at least, another thread can be the adoption of life-cycle concepts, especially the often mooted use of Life Cycle Analysis (LCA) methods for the mining sector. Furthermore, looking at the life cycle of plant, equipment and materials (as distinct from the commodity itself) ensures that decisions made today will achieve the lowest cost and environmental impact over the full life of the operation. Too often a lack of information about the true performance and cost benefits of a better-engineered alternative leads to a poor investment in low quality, inefficient equipment and systems (the 'easy low capital cost option').

Other potential threads include bio mimicry (& the related geo mimicry) as well as the idea of delivering user value and lower resource usage through on-going services rather than a one-off product sale. They all will find more widespread use and contribute to the innovation drive.

The alumina example cited in this section (Case Study 3) draws together most of these concepts (WST, geo-mimicry, LCA & eco-efficiency) and brings an undeniable cost improvement simultaneously with improved environmental and social outcomes: surely a competitive advantage for anyone adopting it. Furthermore, it effectively illustrates the difference between the compliance and innovation models. Being more sustainable (in this case in a design task) gives you better environmental & social outcomes but the reverse is not always true: having rigorous environmental approaches and being a good corporate citizen does not make you more sustainable.

6 Behaviours

Recent experiences have shown that, despite goodwill and personal ethical standards, typical practitioners fail to capture the essence of sustainability and then apply it to plant design activity. Hatch has found this is because these engineers and designers do not feel they have *permission* to adopt the concepts and practice them in their art. This lack of permission seems to come from several sources:

- Project conditions: usually a lack of time, short-term thinking, or perception of 'capital cost ahead of all things' will reduce the willingness to invest personal effort to innovate. The team needs to be given control over the sustainability impacts of the project.
- Poor Leadership: individual managers and senior managers must act appropriately and be perceived as being committed.
- Peer Group: moving away from 'Group-think' and other inhibitors is important – the whole team (and sub-teams) must have common goals, shared vision and understanding; individuals can then give themselves permission to take an innovative approach. A new paradigm is required where belonging to the group requires individuals to think and act sustainably.

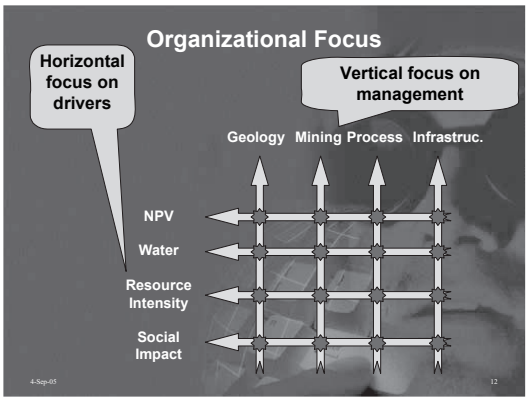
Typical hurdles that this lack of permission manifests as:

- A lack of adequate training in the detail of sustainable practices
- In some cases a lack of personal commitment
- An overwhelming sense of inertia around traditional and highly optimised decision-making processes
- A lack of suitable KPIs for project leaders
- A lack of SD understanding and sense of control by project progenitors and leaders
- Unwillingness to allow the design team to undertake innovation in fields that the project leaders are uncomfortable in
- Lack of client focus on sustainability issues and therefore a lack of rigorous accountability for sustainability
- Lack of a shared sustainability vision through the team
- The previously mentioned focus on compliance issues and a belief that that is all that is needed, and
- Frustratingly, even with good intentions, we can often observe a gradual decay back to the long-held drive to decision-making dominated by the fiscal.

McKenzie-Mohr & Smith in their well-known text on sustainable behaviours (1999) cite a number of encouraging factors around behaviour at the community and personal level; can we extrapolate for behaviours in project teams? For example:

- Humans tend to want to behave consistently; so once encouraged to apply sustainability practices, the behaviour should tend to continue
- Self-perception is important; therefore, we can surmise that if a practitioner sees themselves as 'sustainability-conscious', they will act as such
- Group cohesion is important; so workgroups within projects should self-reinforce.

Case Study 4: 2-tier Reporting



In this major study in 2004, innovation was driven by a second-tier reporting process: temporarily segregating the 'constrained' environment of projects from the free-thinking environment of innovation – not only setting aside time, but also reporting innovation across boundaries AND completely separate from the traditional reporting structures. Under these conditions, innovative ideas will be encouraged to surface and encouraged to be put up for evaluation.

At Hatch, we have two initiatives in this area. Firstly, we have some studies where teams have been organised into 2-tier reporting structures that segregate the 'compliance' issues from the front-end-loading thinking. For example, the former might mean ensuring environmental compliance in the process design (generally handled in the traditional project reporting), whereas the latter would be responsible for whole-systems thinking and identifying opportunities for wide scale synergies; this handled in a second tier overlaying the traditional. (Bangerter & Kwak, 2004).

Second, we have commissioned a body of research at the PhD level to examine behaviours2. If at the personal level there is an understood body of strategies for success, how might we put strategies in place for study teams, or the whole corporation? Put officially: *How to integrate sustainability as a core dimension of the decision-making process.*

7 Conclusion

Becoming more sustainable is a particular challenge for an industry that depends on digging up non-renewable resources and turning them into window frames, car bodies and electricity. From inside the industry at least, we see a growing and genuine desire to be more profitable by designing and operating for sustainability. To do this, companies need the ability to adopt and demonstrate a process that conforms to the changing world paradigms.

Our industry, and its engineers in particular, must go beyond environmental planning and environmental engineering to develop a framework for delivering benefits that:

- Drive sustainability principles into the heart of the design and operation of mining and metals enterprises.
- Foster cross-disciplinary approaches to innovation.
- Force decisions to be made with all technical, fiscal, environmental and social consequences clearly in mind.
- Allow mining companies a methodology that demonstrates to regulators, community, shareholders, financiers, and other stakeholders – a genuine commitment to sustainability.

[2]Jointly sponsored by Hatch, the University of Queensland's Sustainable Minerals Institute and the Centre for Sustainable Resource Processing

Meanwhile, we have to take a pragmatic view that driving sustainability concepts and practices into the heart of the design process is the key to achieving a successful, sustainable plant design. Engineering design practices, tools, systems and methodologies should be prepared around true eco-efficiency parameters, adopt whole-systems-thinking and consider life-cycle impacts for the design task. Experience dictates that the application of these sustainable plant design practices is most likely to succeed if (Bangerter & Kwak, 2004):

- The principles are well documented and explained.
- All stakeholders agree on what sustainability means.
- Sustainable plant design is treated as a core process.

Is there a new sustainability perspective for Mining & Metals? Perhaps, but undoubtedly there is a different, alternative course and at the very least some of us should be breaking out of the compliance mould.

Acknowledgement

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References

Bangerter, P. & Kwak, J. (2004) Sustainable Plant Design, in Proceedings Metallurgical Plant Design & Operating Strategies, Perth, (The Australasian Institute of Mining and Metallurgy: Melbourne).

Hargroves, K. & Smith, M. (2004) The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century, Earthscan, London.

Hawken, P.; Lovins, A. and Lovins, H. (1999) Natural Capitalism, Creating the Next Industrial Revolution, Earthscan, London.

McKenzie-Mohr, D. & Smith, W. (1999) Fostering Sustainable Behaviour, (New Society Publishers: Gabriola Is, Canada).

Saling, P. et al. (2002) Eco-efficiency Analysis by BASF: The Method, in Life-Cycle Management, pp 1–16 (Ecomed: Landsberg, Germany).