Sustainable Mining Conference 2010

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Reference Number: 48

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SUSOP®: Embedding Sustainable Development Principles into the Design and Operation of Resource Extraction and Processing Operations

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ABSTRACT

Though many mining and mineral processing companies have embraced the principles of sustainable development (SD), there is still a significant challenge of applying these in a practical sense, either in plant design or as part of day-to-day operations. The high-level nature of sustainability concepts often do not translate easily into workable activities or business case evaluations. This makes it difficult for engineers and company decision makers to understand whether their actions are making a contribution to sustainable development and a long-term business case. While several organisations have their own SD tools that can, to a degree, help identify these opportunities, they are largely ad-hoc and lack the necessary thoroughness to defensibly value these opportunities.

Recognising these serious shortcomings, the Cooperative Research Centre for Sustainable Resource Processing (CSRP) has undertaken the development and trial applications of SUSOP® (SUStainable OPerations), a new concept that is somewhat analogous to HAZOP and the wider risk and safety frameworks used in projects today. The key goal of the SUSOP® research project is to produce a holistic, systematic and rigorous framework for project development, capturing, recording and evaluating SD opportunities and constraints against a chosen sustainability structure (e.g. Five Capitals). SUSOP® is being developed through an iterative process with input from research institutions and engineering companies. This integrated approach ensures that SUSOP®, in its final form, will have the academic rigour and industry realism required to assist the resource sector contribute to societal sustainability by embedding the concepts and processes into the design and operation of their assets in a meaningful and practical manner.

SUSOP® has created much traction with both engineering companies and mining and minerals operators. This conference paper presents an overview of the SUSOP® framework and its current suite of processes as well as highlighting, through practical case studies, its capability to incorporate SD considerations at different phases of an engineering project's development.

Keywords: SUSOP®, sustainable design, sustainability, mining, mineral processing.

INTRODUCTION

Over the last decade, many mining companies and industry bodies, such as the International Council on Mining and Metals (ICMM 2003) and the Minerals Council of Australia (MCA 2004), have developed and adopted sustainability principles and policies as a strategy to demonstrate their and the industry's commitment to building and running operations in a socially and environmentally responsible manner.

There is, however, a serious challenge in applying these high-level principles for practicing engineers developing a new project or running the day-to-day activities at an operational site. Instead of the sustainability principles being intrinsically embedded into corporate systems, they are typically used to ensure that the project or operation is compliant with all the key principles. As a result, new mining operations are routinely designed, built and run in a similar manner to existing operations. They are not, therefore, fully equipped to deal with the critical aspects of sustainability, thus affecting their *licence to operate* (e.g. community encroachment, increasing government pressures, increasing scarcity and subsequent costs of raw materials, water, and energy). In contrast, each project environment and local community offers both a unique set of opportunities and sustainability hazards that can present a wealth of inspiration for new and innovative solutions.

To address issues such as reduced carbon emissions, minimal environmental impacts, and maintaining the societal licence to operate, the ideals of sustainability must become entrenched into management systems through the introduction of a systematic and rigorous mechanism that is based within the organising architecture of a sustainability framework. Such a mechanism will ensure consistency from project to project and result in a more comprehensive understanding of the overall contribution that a new or existing operation can make to overall societal sustainable development.

The Cooperative Research Centre for Sustainable Resource Processing (CSRP) has undertaken the development of a new, holistic mechanism for incorporating sustainable development principles into the design and operation of mineral processing plants, called SUSOP® (SUStainable OPerations). This paper presents the business case for SUSOP®, an overview of its framework and development to date as well as highlighting, through practical case studies, its capability to incorporate SD considerations at different phases of an engineering project development.

BUSINESS CASE FOR SUSOP®

When addressing the need for a sustainability framework, one can approach it from a number of directions. Here we will look at the short-comings of existing practice to illustrate need for a new approach.

Consider first that sustainability can be defined in innumerable ways, but that in essence we are speaking of societal sustainability; the ability of humans to continue indefinitely living in a purposeful and valuable way. If we accept that we live in an unsustainable world due to environmental and societal problems and that sustainability is about creating a world that is again capable of indefinitely sustaining society, then we can illustrate the resources sector's role in that. By contributing to societal sustainability a "sustainable" operation (such as a mine) is one that makes an overall positive contribution, rather than a negative one.

Investment decisions in resource projects are based on the answer to three fundamental questions: (a) is it technically feasible?, (b) does it make financial sense? and (c) will government/community/owners of the resource allow it? This last question is really about licence to operate, the social contract and the regulatory environment.

In its historical efforts to come to grips with its contribution, the mining sector has attacked the problem in two ways. Firstly, the sector has made a concentrated effort to abide by ever-changing community expectations in adopting environmental practices and community consultation to gain a licence to operate. This compliance-oriented thinking is often a result of legislatively driven expectations, but increasingly directly driven by the community. Secondly, there is a drive to lower water and energy consumption per unit of production via efficiency initiatives. Although these efforts are aimed squarely at meeting societal expectations, they differ in being likely to offset the costs of implementation with a reduction in the costs of consumption.

Examination of virtually all resource company websites will produce a set of corporate principles for Sustainability that echo these two approaches.

So why SUSOP®?

Experiences among the authors has led us to put forward the following industry drivers for the development of SUSOP®:

- Legislated project processes are largely embodied in the environmental approvals processes which are dominated by toxicology limits and free, prior, informed consent approaches. There is no driver for innovation and therefore there is little scope for engineering contributions to sustainability.
- Coupled with this is the recent government water and energy programs that focus at only these two specific "hot buttons", rather than adopt a whole-systems approach. Putting these two independently into project design may be sub-optimal.
- A reluctance to involve community stakeholders in early stages of projects lest it drives up expectations.

- Despite their existence, corporate SD principles are not yet driving design or operating behaviours. There is a lack of sustainability objectives and there are other procedural omissions from project processes. Furthermore, there is a continuing fear of anticipated loss; specifically loss of financial rigour in project proposals or loss of operating profitability.

- There is an absence of an industry standard. Such standards give a great deal of certainty to design teams and to owners selecting between competing options.

This last point, lack of a standard, has resulted in a plethora of different approaches in owners' organisations and more particularly in engineering design consultancies. Choosing between one's own approach and those of a consultant, or various consultants, is an added degree of uncertainty in how to deliver best practice in sustainability. This also makes it difficult for regulators to uniformly apply sustainability principles to development proposals.

The fundamental aim of SUSOP® is to provide a standard approach to translate sustainability principles into operating practice and design and to do this without compromising financial rigour.

SUSOP® METHODOLOGY

Overview

The SUSOP® process methodology has been developed through a collaboration of researchers and practicing engineering consultants, with the express intention of creating a mechanism that can incorporate principles of sustainability into process design and operations with recognition of the current practices and constraints within the industry. Iterative reviews and application to case studies have led to the current SUSOP® mechanism. This mechanism is designed to be integrated into the project development cycle, in order to provide appropriate guidance, tools and deliverables to fit the level of detail and opportunity available at each phase of a project (Corder, McLellan et al. 2010). The mechanism in its current form is described below, along with an overview of the development and learnings from its deployment in case studies to date.

SUSOP®

The basis for the structure and concept of SUSOP® emerged from a review of literature on publicly available methodologies and tools for designing processes that contribute positively to sustainable development (McLellan, Corder et al. 2009). This review indicated that there was no existing methodology that presented a practical and widely applicable sustainability integration mechanism. However, some of the existing methods for life cycle assessment (Azapagic 1999; Stewart 1999) and sustainability-related decision-making (Petrie, Cohen et al. 2007) were used as a comparison and starting point in the development of an approach that could fulfil the perceived needs of the industry.

The SUSOP® mechanism is intended to be applied across the full project and production life cycle illustrated in Figure 1, albeit with a different level of detail and scale of focus at each project phase.

It comprises three major elements of activities:

1. Sustainability opportunities and threats identification (SUSID)
2. Sustainable development (SD) assessment
3. Decision support

These elements, with their constituent activities, are highlighted in Figure 2 and Figure 3. This paper will focus on the elements in Figure 2.

SUSID includes the three activities of Familiarisation, Goal Scoping and Opportunities Identification. These activities are focussed around a workshop process, with key participants including core project staff (e.g. process engineers and plant designers), environmental and community experts and an experienced, SD-knowledgeable facilitator. Familiarisation involves the study participants arriving at a shared understanding of the project context and core sustainability principles and frameworks. The default sustainability framework for SUSOP® is the Five Capitals (FF 2005), which comprises the social, human, manufactured, natural and economic capitals. The project context as a whole includes an understanding of the key technical and financial characteristics of the proposed project, the ecology of its surrounding region and the social context at the local and regional levels. The connections the project has to the chosen sustainability framework and the most relevant sustainability principles such as the ICMM's ten principles, or its own corporate sustainability principles or policies is also paramount. Goal Scoping can involve the development of project-specific SD goals, or an adaptation and review of corporate goals so that the participants can see the relevance of these to the project at hand. This element is an extension of the Familiarisation process and provides a useful framework against which to check the outcomes from applying the SUSOP® process.

Opportunities Identification is one of the most vital activities of SUSOP® – especially at the concept or pre-feasibility stages where there is greatest potential for uptake of alternative project designs (Corder, McLellan et al. 2010). This activity uses structured workshop techniques, including specific prompting elements based on widely accepted sustainability concepts, to identify ideas and opportunities that could potentially improve the SD contribution of the project. The best ideas often require the participants to break out of their disciplinary or project area design silos to draw connections across plant, societal and environmental boundaries. Threats caused by the project to sustainable development will also be identified and mitigated or avoided. Both threats and opportunities are listed in a SUSOP® register. These are then carried forward in the process by the project team across the project development cycle for further attention in subsequent stages.

SD Assessment comprises the evaluation of the opportunities. These activities use tools and investigation to evaluate the opportunities on the basis of their SD impacts (positive and negative), and to represent these graphically as the impact attributed to each of the five capitals. One of the recent developments in the evaluation process has been the realisation of the importance of clustering opportunities into "concepts"

based on thematic or project area relationships. These concepts can then be more readily examined and compared for overall impact.

The Decision Support element includes the “SD Balance Sheet”, Decision Support Analysis and Ongoing Review. The “SD Balance Sheet” presents the SD impacts of the numerous opportunities or concepts under consideration. In the early phases of project development, there may not be sufficient data available to create a quantitative comparison, so semi-quantitative methods such as risk matrices can be adapted to fit the purpose. The Decision Analysis section applies multi-criteria analysis, scenario analysis and other related tools to identify a preference for one or more of the identified opportunities. This gives the user the ability to transparently test their assumptions against the goals of the project and the company. Ongoing Review involves the integration of SUSOP® activities into the project development cycle. This activity, which is carried by the project team, ensures that the registered opportunities continue to be examined as the project progresses through subsequent phases of development.

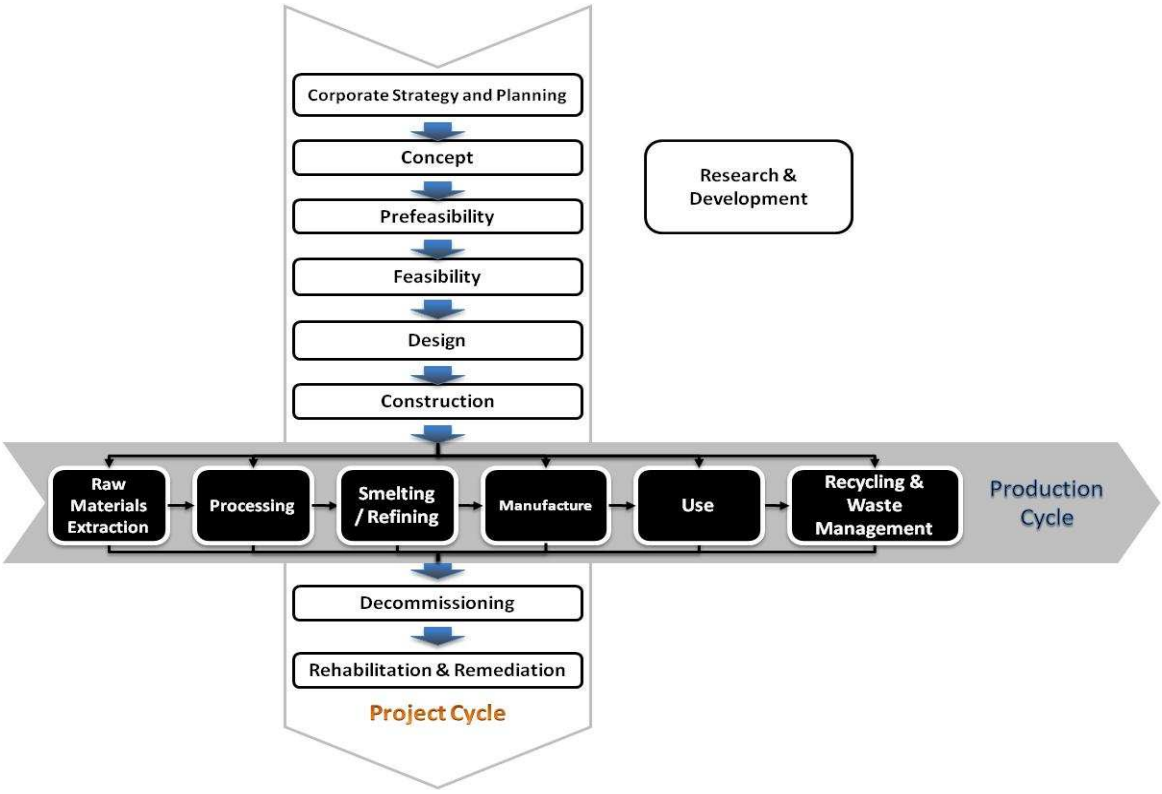

Figure 1: Project-Production Cycle

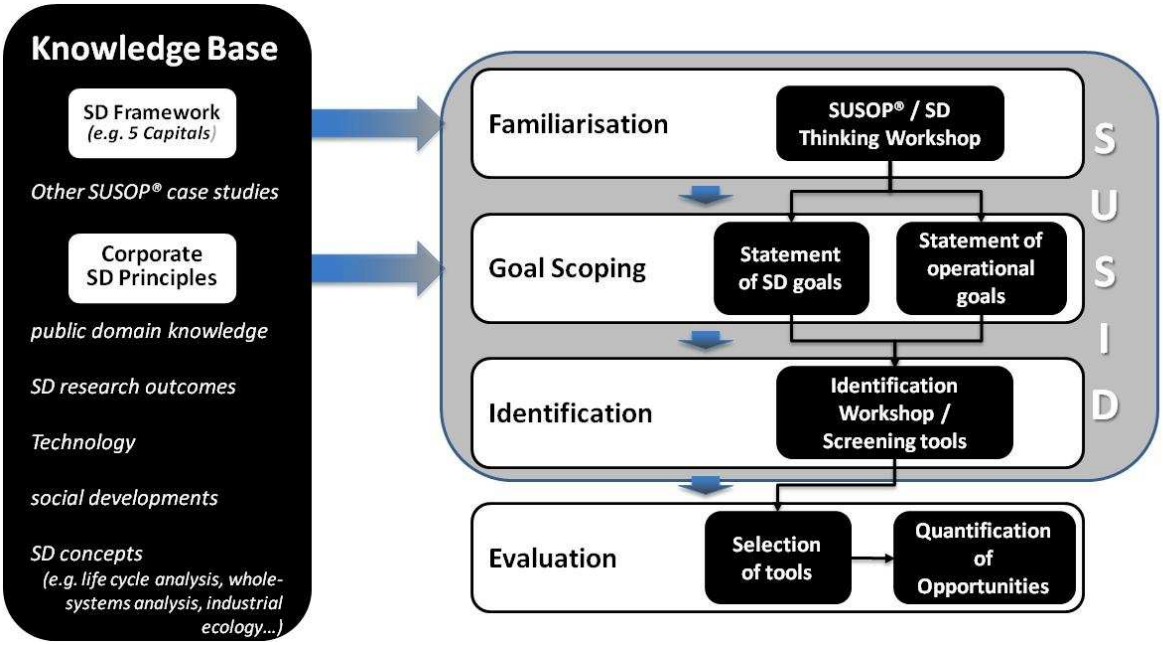

Figure 2: SUSOP® SD Opportunities Assessment

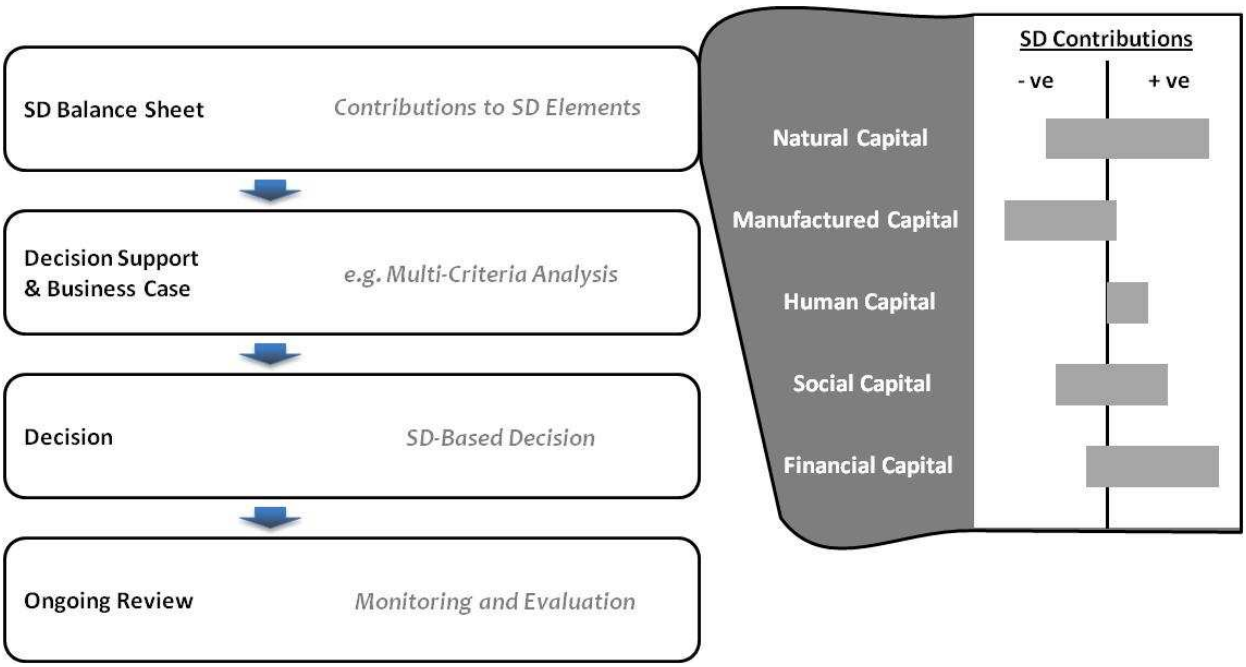

Figure 3: SUSOP® Decision Support

Development and Deployment of SUSOP®

SUSOP® is being developed through a collaborative effort of researchers and industrial participants. The initial driver for its development was the recognition that there is no practical and systematic incorporation of SD principles into the design and operation of industrial projects. The collaborative nature of this effort has driven the SUSOP® approach in a direction that recognises the importance of selecting the most appropriate tools to provide appropriate coverage of SD principles at each phase of the project development cycle.

To date, two live case studies have applied the process – at the concept and pre-feasibility stages respectively. These case studies have led to an improvement of the existing SUSOP® approaches and the development of a more appropriate structure to fit with the level of available data and time at these two project phases. Further insights from the case studies are highlighted in the following section of this paper. From an industry point of view, the two case studies produced a set of identified and evaluated SD opportunities and constraints, which are feeding into the company's decision making processes in the subsequent project development stages.

CASE STUDIES

This section outlines in general terms the outcomes from two SUSOP® case studies. In order to maintain client confidentiality, specific information on each case study has not been included.

Case Study 1: Site Selection for New Mineral Processing Plant (Concept Phase)

The Developer was faced with a deadline for site selection due to pending expiration of retention leases. The standard business practices employed by the developer could not provide definitive guidance on which sites to retain and which to forgo. The SUSOP® approach provided clear points of difference between the sites, identified several business-related SD risks and opportunities and produced a development plan which identifies and manages two key business risks related to high operating costs and ongoing viability.

An initial workshop was held to identify the sustainability goals and opportunities related to each of the proposed locations. Members from the SUSOP® research team plus company personnel and their consultant engineers (who had worked on the environmental and social aspects of this potential operation) participated in the workshop. Nearly 70 possible opportunities across all aspects of sustainability were identified, which were then clustered into linked groups of opportunities.

Based on the range of clustered opportunities, a staged integrated plan (refer to Figure 4) for implementing renewable energy and local skills was developed as a means of avoiding high energy and high expatriate labour costs. Not only would the plan support the aim of developing a low operating cost operation, but would also achieve a number of sustainable development benefits, such as increased skill levels for individuals, lower greenhouse gas emissions, and more secure energy supply to the local community. This, along with the other key identified opportunities, was then used as the basis for making a recommendation on the most favourable site location.

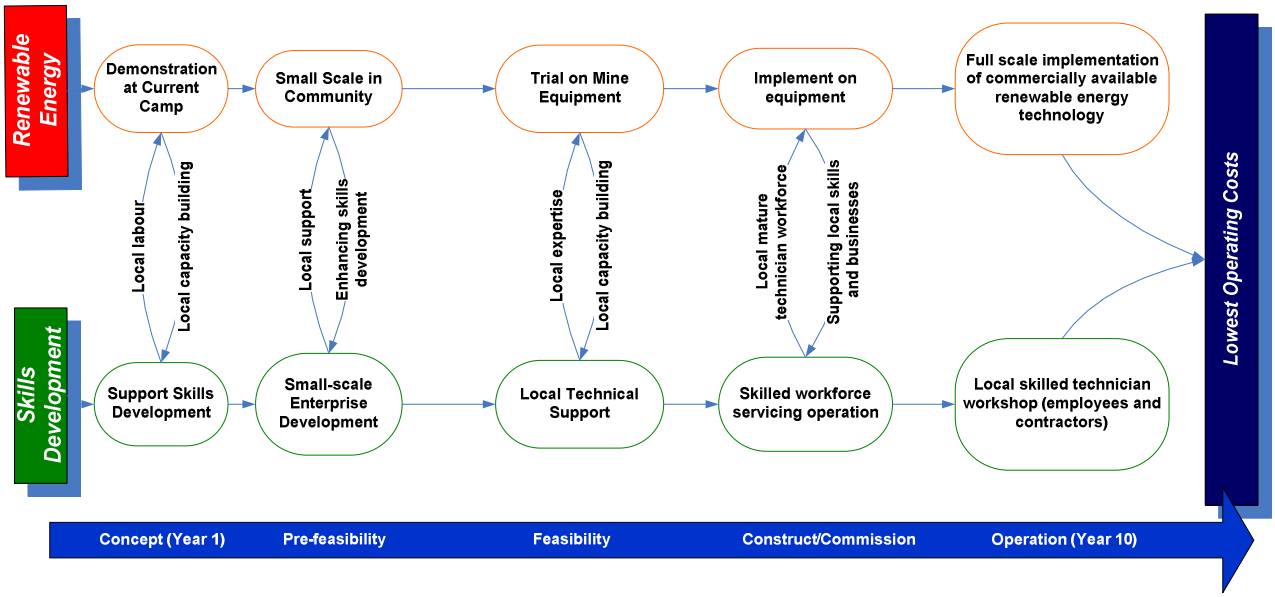

Figure 4: Staged Integration Plan

Case Study 2: Effluent Management for Mineral Processing Operation (Pre-feasibility Phase)

An operating company is examining the sustainability performance of a range of proposed effluent treatment options at a mineral processing operation. The aim of this study is to apply the SUSOP® mechanism in identifying sustainability opportunities and evaluating the sustainability benefits and impacts of the proposed options.

The initial workshop was held to identify the sustainability goals and opportunities related to each of the effluent treatment options. Members from the SUSOP® research team plus representatives from the operating company and their engineering consultants (who previously undertook an engineering study of the different effluent treatment technologies) participated in the workshop.

A detailed analysis of the identified sustainability opportunities related to the effluent options was then conducted by the SUSOP® research team ahead of a 2-day "prioritisation" workshop. The key aim of this second workshop was to use the SUSOP® mechanism to produce a shortlist of key sustainability opportunities that demonstrate the sustainability benefits and impacts of the effluent treatment options.

From this study opportunities have been identified to improve the current operations and further opportunities identified for consideration in future expansion of operations.

LEARNINGS FROM THE CASE STUDIES

By applying the SUSOP® concept to two "live" case studies, valuable learnings for improving the SUSOP® process have emerged. Each case study has produced learnings which have been fed back into the process to make it considerably more robust and effective in generating opportunities for delivering both sustainable development benefits and improved business performance. The key learnings are summarised below:

- The selection of attendees for the SUSOP® workshop is important. There is some flexibility with the makeup of this group but it should contain client personnel directly working on the project as well as those who are familiar with sustainability. There must also be an experienced SUSOP® facilitator who actively drives the opportunity identification process in SUSOP® in the same way that a HAZOP facilitator drives the hazard identification process. At this stage it is anticipated numbers should ideally be between 8 to 12 participants (but this could vary).

- It is critical that all attendees in the SUSOP® workshop understand the true context of the project under consideration. As much information as practically possible should be provided, including the project history, the project team background and the analysis, the options already covered and the relationship of this project to other projects in the company's portfolio.

- Recording and reporting of risks and opportunities is important if they are to be integrated into the ongoing project plan. Flagging sustainability "highlights" and "show stoppers" is important to guide project development.

- A good approach is not simply to produce a single prioritised list of all the opportunities, but to sort the opportunities into different categories. This approach can assist the client in understanding when and where to implement these opportunities. For example, some opportunities have huge benefits but are not applicable in the short-term and need to be captured for the future. Other opportunities might apply to specific location options or context.

- Clustering of linked opportunities into "concepts" can provide a more useful approach for understanding and appreciating the dependencies between the individual opportunities and the overall sustainable development benefits. For example, the development of local enterprises can be linked with potential by-product re-use opportunities to improve both resource utilisation and enhancement of the local economy and skills.

The SUSOP® development team is currently integrating these learnings into the development of the first edition of the SUSOP® Foundation Manual due to be published in the second half of 2010.

WHAT SUSOP® DELIVERS THAT'S DIFFERENT (AND BETTER) COMPARED WITH THE NORMAL PROJECT PROCESSES

As SUSOP® requires a commitment from the project developer, it is important to understand the benefits and value that SUSOP® will deliver, over and above, the standard project management systems. As a point of comparison, although the HAZOP process can be time-consuming, it is widely accepted and ingrained into the current project management systems because practitioners appreciate that it makes an effective and efficient contribution to a safe operation. In the same way, SUSOP® is building recognition with the industry as an approach that delivers both sustainability benefits plus improved business performance over the lifetime of the operation and beyond. The main characteristics of SUSOP® that support this are listed below.

- SUSOP® offers a rigorous, holistic approach to assess a project with respect to the wider environment in which it will operate and, in doing so, allows project decision makers to identify and review innovative and integrated solutions that incorporate environmental and social contexts. Rather than leave these issues to specialists working on their own, SUSOP® ensures a cross-disciplinary approach incorporating project development personnel from the outset.
- The SUSOP® process does not compromise on satisfying the defined financial objectives (e.g. NPV, Rates of Return on Investment, etc.). In fact, SUSOP® helps to secure financial outcomes by reducing inherent or hidden business risks.
- SUSOP® brings social, human and environmental considerations early on in the conceptual phase allowing any key issues to be "engineered out" in the project development rather than "managed" once the project is complete. It drives SD issues into the design and project management processes leading to better outcomes via more ideas, better design, and a more robust licence to operate.
- SUSOP® also identifies critical sustainability issues that would not necessarily be identified through the normal project management process but could result in a major business risk to the project or operation. These issues could be technically feasible and financially attractive but might, for example, generate significant stakeholder concern or even outrage and, thus, affect the operation's social licence to operate.
- Alternative and price competitive resources may exist that could impact an operation's viability such as renewable energy, industry waste heat, re-processed industrial and residential effluents, and organic and inorganic by-products from nearby industrial operations. SUSOP® has been developed to take into account these alternative resources which may require upfront decision making to investigate, develop and secure for the benefit of the project.
- The SUSID (Sustainability opportunities and threats identification) feature of SUSOP® allows for the generation and discussion of SD ideas which does not ordinarily occur in normal project processes (except, perhaps, for energy/water savings workshops which are driven usually by access or security issues, not from a sustainability perspective).

CONCLUSIONS

There are serious challenges for practicing engineers to apply high-level sustainability principles in developing a new project or running the day-to-day activities at an operational site. To address key sustainability issues such as reduced carbon emissions, minimal environmental impacts, and maintaining the societal licence to operate, the ideals of sustainability must become entrenched into project management systems.

This paper has presented an overview of SUSOP® which is a new, holistic mechanism for incorporating sustainable development principles into the design and operation of mineral processing plants. SUSOP® aspires to improve the overall contribution that a new or existing operation can make to societal sustainable development.

To achieve this aim, SUSOP® goes beyond the conventional business case for a project and takes into account all direct and indirect costs and internal and external business risks.

SUSOP® is being developed by the Cooperative Research Centre for Sustainable Resource Processing (CSRP), a collaboration of research and industry organisations, through a "live" case study approach that is delivering valuable learnings and outcomes for both the development of SUSOP® and the industry clients.

To continue the development and enhancement of SUSOP®, the development team are seeking new "live" case studies from industry. Of particular interest are case studies involving stages of the project –production cycle (refer to Figure 1) that were not covered in the two case studies reported here, namely concept and pre-feasibility. By undertaking more "live" case studies across the project–production cycle, SUSOP® will become a thoroughly "road-tested" approach for incorporating the essence of sustainability and enhancing business performance into mining and mineral processing operations.

The first edition of the SUSOP® Foundation Manual, which will focus on the concept and pre-feasibility project phases, is due to be published in the second half of 2010.

ACKNOWLEDGEMENTS

The development and trial application of SUSOP® is carried out under the auspice and with the financial support of the Cooperative Research Centre for Sustainable Resource Processing (www.csrp.com.au), which is established and supported under the Australian Government's Cooperative Research Centres Program.

The SUSOP® research and development team comprises industry participants, Hatch and GHD, and research providers, the University of Queensland, University of Technology Sydney, CSIRO, University of Newcastle and Curtin University of Technology.

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