Hidden Opportunities to Improve Tailings Systems without Capital

Summary: While this paper was presented at a technical conference hosted by the University of Alberta (*Tailings and Mine Waste 2009)*, the authors firmly believe that the underlying principles apply to every business in every sector. Business improvement begins with the "abundance mentality" that opportunity exists in every system. Read more to discover how to generate more value without tapping the capital piggybank.

Written by Andy Jones and Ryan Hale

ABSTRACT

Asset systems required for successful tailings management always face significant pressure to increase performance, whatever the stage of the economic cycle. On the upswing, businesses need to commission new assets and generate value to support capital growth plans. At the top of the cycle OEMs cannot meet demand, requiring additional performance from existing assets to continue meeting growth plans. On the downswing and in the trough, unit costs are critical and efficient asset usage becomes essential.

To complicate matters further, actual rates hardly ever meet design expectations—either because we do not achieve those implied in the system design, or if the operating requirements have exceeded original design expectations since start-up. Chronic underperformance requires mechanical assets, planning and operating processes to deliver significant year-on-year improvement.

Businesses typically respond to the requirement to increase an asset's performance by spending money. In every case, however, massive opportunity exists hidden beneath the surface of common belief. Generating capital-free improvement of between 10-30% (and in some cases over 145%) with the existing assets, workforce, and technology is possible in a matter of weeks.

Mechanical slurry transfer systems (e.g., siphons, pumps, dredges), tailings operations or maintenance processes (e.g., cell building, maintenance outages), and asset utilization (e.g., dozers, haulers, side booms) all contain hidden opportunity to improve. This paper includes recent examples from Alberta Oil Sands tailings and mine waste operations that highlight why hidden opportunity exists, how to expose it and how to realize it. The talk will briefly cover the thinking processes, analytical tools, and accountability structures that generate measurable results in 1-6 months.

INTRODUCTION

Between 2007-2009, an established operation in Alberta's Oil Sands faced a series of emerging risks relating to its tailings pond containment and construction. These risks had large financial implications to both current production levels and future capital investment requirements.

In each of these were representative of risks many other businesses both in Alberta and in other industries face. These risks fall into two categories: immediate or emergent. Examples of immediate risks in the tailings environment are rapidly declining water cap or rapidly rising elevation vs. freeboard. Emerging risks include beach and cell construction falling behind plan.

Regardless of their risk, businesses face a choice whether to improve performance from existing systems, or invest in additional equipment and labor. Many businesses choose the latter because they cannot see additional opportunities to improve their existing systems.

The first step in driving improvement is identifying all the opportunities, by measuring the gap between current performance and a standard. When business leaders do not see a gap they have confidence in closing, or any gap at all, they typically feel there is no choice but to invest.

Typical opportunity analysis methods measure current performance against budget, plan, or benchmark (internal or external). While this type of variance analysis is useful for understanding adherence to plan or performance relative to peers, a vast quantity of improvement opportunity will remain invisible. Budgets and targets are negotiated figures that are often divorced from the underlying forces that govern a system's performance.

Zero Based Analysis is a technique that measures the gaps between current performance and the theoretical best, as determined by the first principles governing the system's performance. In all cases, the magnitude of opportunities determined using Zero Based Analysis exceed those measured using traditional variance measures. Often people's assumptions, negative experiences, and "legacy information" cause them to believe that opportunities quantify using Zero Based Analysis are purely theoretical and could never be realized.

This article will explore examples of real-world opportunities identified using zero based analysis, and then rapidly realized using straightforward problem solving techniques to improve the existing systems. After providing a practical overview of how to apply these techniques, we will explore the implications of improvements of this magnitude to the region and the industry.

ANALYSIS METHODOLOGY

The first step in conducting a Zero Based Analysis (ZBA) is to select a representative time period. A 12-month period or a significant length of run since a major system change (e.g., maintenance outage or overhaul) is sufficient. The main point is to value opportunities using past performance data such that an estimate of the future value (when the problems are solved) is realistic.

After determining the time period for historical data, the next steps are to select the system's key performance metric and to construct a theoretical best performance level from first principles. For example, a hydrotransport system for moving slurry can be measured in kilotonnes per day of dry material, and the theoretical best performance is a function of a small number of variables: slurry flow rate, density, and run time. For a controlled beaching operation, the critical variables are mass flow rate of solids, retention rate in the beach zone, and run time. These variables must be set at their design or ideal values to determine the true theoretical best, not a budget, benchmark, previous best, or planned value. This is the critical step in applying ZBA and can be overlooked easily. Practice and self-awareness of assumptions and constraints are fundamental to applying ZBA without leaving any hidden opportunity. Most people simply cannot see these opportunities because of their own assumptions and constraints about what improvements are possible.

After collecting historical data from operations and engineering logs, losses in the following categories can be quantified and expressed in the units of the key performance metric as defined above:

- Planned downtime
- Unplanned downtime
- Standby or idle time
- Turndown rate or slow running hours
- Off-spec production hours

Any difference between the theoretical best, known losses, and the actual output is the error or unknown loss. This data is visually represented in a waterfall or bridge diagram. The examples included here show the opportunities identified for a slurry transport pipeline (Figure 1) and a controlled beaching operation (Figure 2).

In cases where the calculated error is large or there are known deficiencies in the historical data set, supplementing the analysis with information obtained through field observations will improve the accuracy and relevance of the analysis. Extending the example above, operators can keep an hourly log of the reasons for changes in flow rate and density. Collecting this data over a series of shifts creates a snapshot of current system performance, which the ZBA team can put in context with historical data.

The quantitative analysis technique is very straightforward. The essential components, therefore, in order to identify hidden opportunities for improvement from existing systems are the mindsets to challenge assumptions around what is possible and to view problems as opportunities rather than barriers.

REALIZING OPPORTUNITIES

Once a team has identified and prioritized the top improvement opportunities, the next phase of work is to solve problems and then implement solutions in order to realize the measurable results. Many problem-solving methods are available; choosing the right one for each situation and applying it effectively are the main factors that determine the rate of improvement.

The two examples below illustrate how straightforward solutions to problems with high levels of perceived complexity can yield results at a surprisingly fast rate.

Controlled Beaching

As mentioned above, very few critical variables determine the rate of advance in a controlled beaching operation. In one particular operation, a long-held perception that feed quality reduced build rate was not supported by available data (Figure 3). This concern consumed a large amount of engineering resource (analyzing process data) and developed a legacy among operations staff and managers. While determining alternative means of collecting feed quality data, the team developed hourly logging and other tools to isolate the critical variables mentioned above. Having these simple logs in place raised the accountability for shift foremen and crews to maximize hours "turned in" to the cell and hence output (Figure 4).

Slurry Hydrotransport

After design, construction, and commissioning, the slurry transport system had underperformed since startup. Pressure mounted on the operations, maintenance, and engineering staff accountable for the system's performance with each day that passed that the system failed to meet plan. Many people in the organization gave up on the original system, and were busy designing and testing additional assets to bring online that would supplement the siphon-fed stream.

By performing a Zero Based Analysis, the facts revealed that "density below spec" was largest opportunity on the siphon-fed stream, followed by unplanned downtime for blown pump packings/sleeves. While this information itself was not new, the relative magnitude of the specific opportunities was compelling, and the team approached the low-density problem with the mindset that resolving it offered them the shortest path to putting the system's performance back on track. This is another example of how certain mindsets can prevent organizations from improving even when the facts suggest that it is possible.

The team then applied a rigorous problem solving method called Variable Analysis to understand what factors reduced intake density from siphon. By systematically verifying the variables that had the highest likelihood of contributing the problem, the team discovered that intake weights (to reduce buoyancy of plastic intake pipes) were not installed per engineering drawings during construction. During an upcoming scheduled outage, the plates were installed the density immediately stabilized in the target range (Figure 5).

Energized by their breakthrough, the team applied the same Variable Analysis method to the largest pump downtime problem. Bench inspection of the pump seal assemblies showed a dimensional mismatch causing premature packing failure.

In both cases, the variable analysis method provided rigor to verify values that were previously assumed to be in spec.

The end result of these changes was an immediate gain in throughput (Figure 6). Realizing additional opportunities using similar methods became the ongoing work of the leadership team in that asset area.

CONCLUSIONS

In the authors' experience, results like these are available in every system and every asset because the largest opportunities are hidden from view by constraints and assumptions. These examples suggest that over 200% improvement is available in tailings systems for containment construction and material transfer, of which 100% improvement can be realized in a matter of months.

This suggests that existing mining systems already operating in Alberta could support at least an additional 1,500 million Tonnes per day[i].

Alternatively, the region could reduce capital spending by 50% for the same production level, for a savings of $6 billion per year, based on estimates of more than $12 billion per year for equipment and machinery in Alberta's mineral industries[ii].

Although these figures might seem impossibly large and would need to be explored using more specific analysis to debottleneck integrated production sites, the magnitude of potential improvement within existing systems should capture the attention of Alberta's industry leaders and prompt them to question what hidden opportunities exist within their current assets.

FIGURES & TABLES

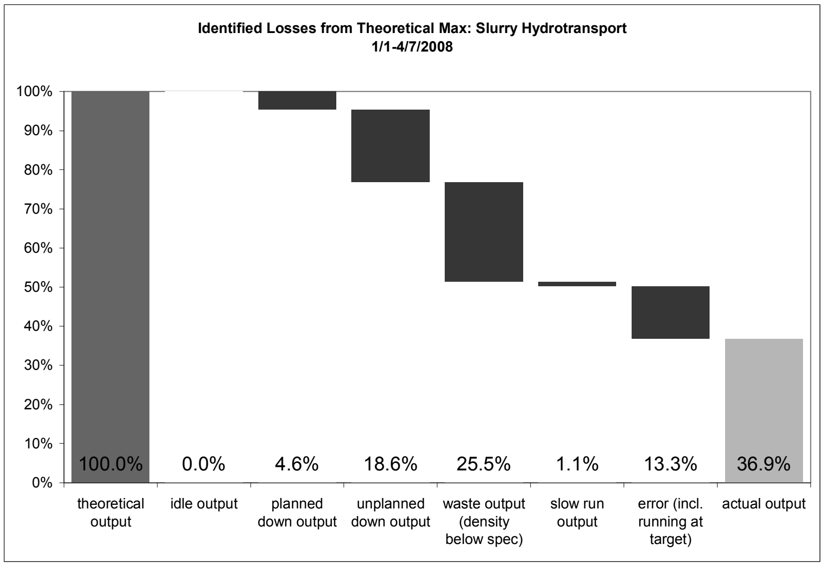

Figure 1. Waterfall diagram shows six standard categories of output loss

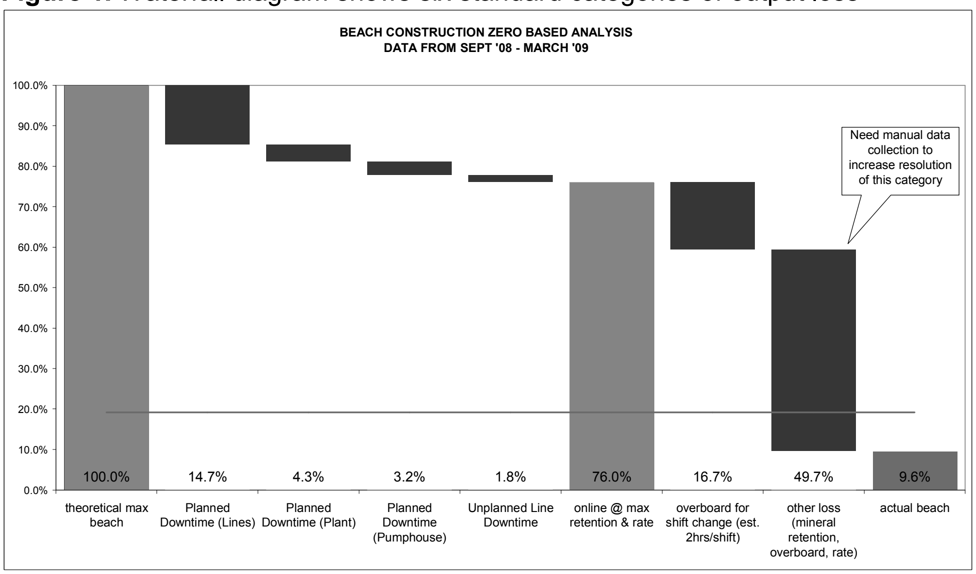

Figure 2. Waterfall diagram illustrates large opportunities when comparing actual performance to theoretical best

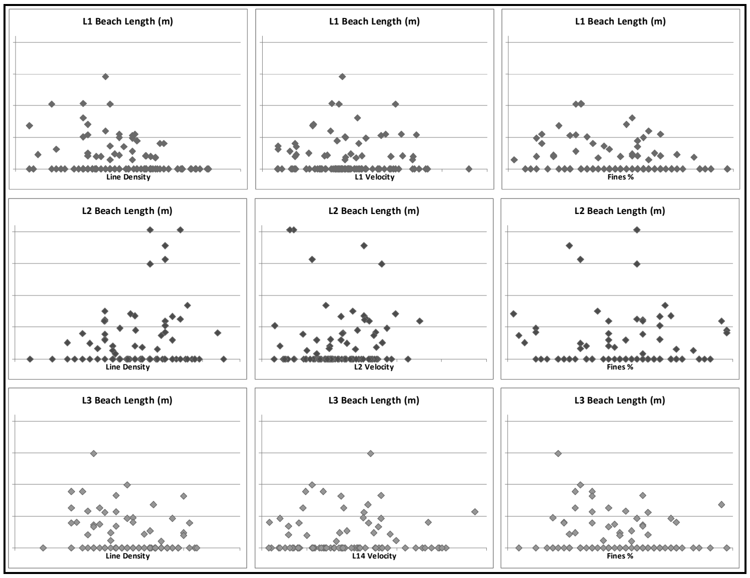

Figure 3. Weak correlations between feed quality and beach advance indicate another process variable has greater leverage on system performance. Chasing for more detailed or representative data of a perceived problem was a distraction from generating improvement by maximizing run hours in the beaching zone.

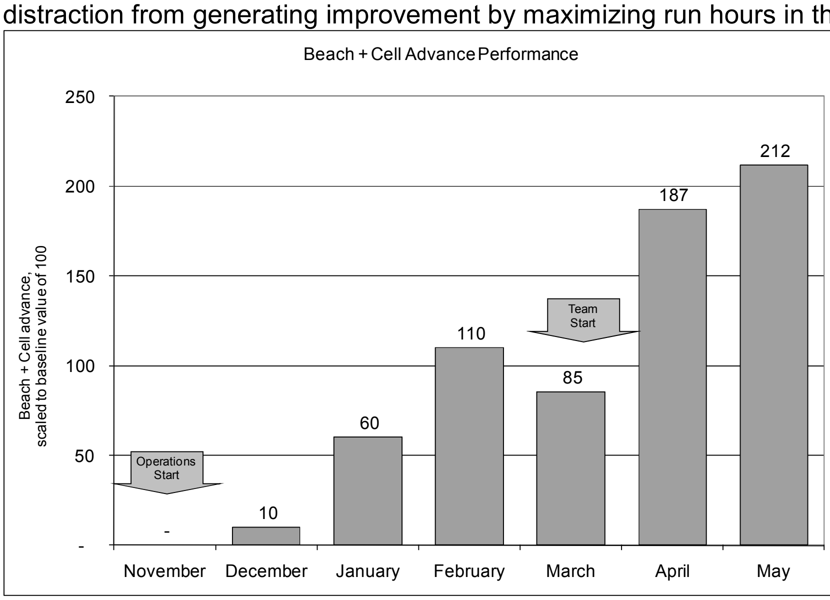

Figure 4. Weekly beach advanced with greater crew accountability--feed parameters unchanged.

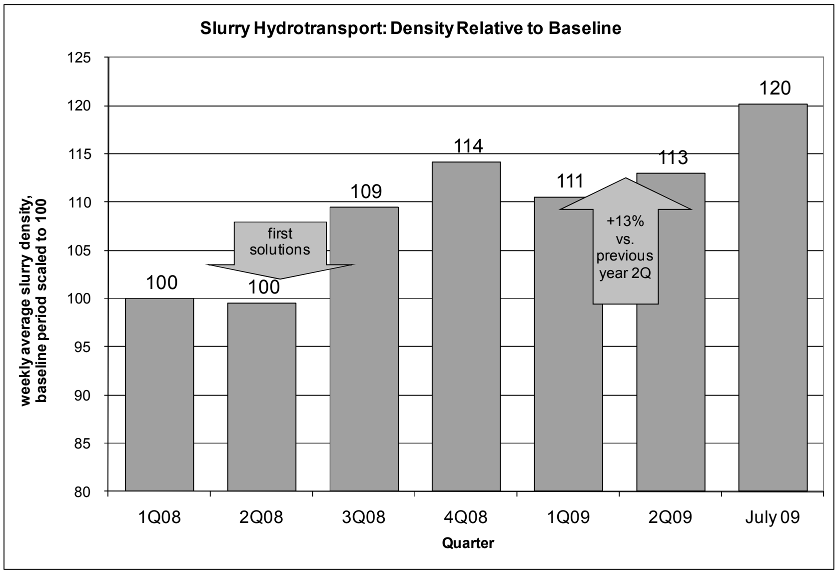

Figure 5. Step change in slurry density seen after correcting a problem that was present since commissioning

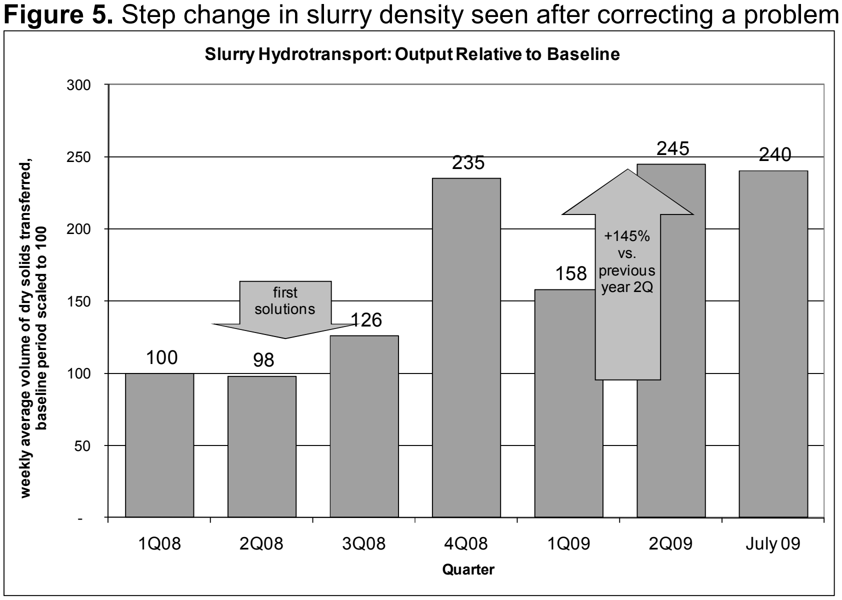

Figure 6. More than doubling the output of a chronically underperforming system benefits both the finances and the morale of the business

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[i] Author's calculation from 2011 projections in *Investing in our Future: Responding to the Rapid Growth of Oil Sands Development*, 29 December 2006, p. 39.
[ii] 2008 intentions for Alberta's Mineral industry, Table 44, *CMY 2007*, Statistics Canada.