Continuous Improvement Strategies in the Mining Industry.

ASQ Quality Summit and Mining Gala –Saskatoon CANADA

December 2013.
AGENDA

- Safety Moment
- Introduction
- Continuous improvement through Asset Management
  - Capability
  - Utilization
- Q&A
Safety Moment

There are 10 kinds of people in the world
Safety Moment

Those that understand binary and those that do not!
Safety Moment

Do we use Jargon? – WBS, PM+, FEED, PtD, VE, VIA, QA, CAD, NCR, PHA, RFI, MTO, GLD, etc.
WHEN YOU ARE GIVING WORK INSTRUCTIONS OR COMMUNICATING ABOUT WORKPLACE HAZARDS:

Use the same language as your listener – Avoid jargon.
Look at your listener(s) to determine if there is confusion.
Get your listener to repeat what you said back to you in their own words – If necessary repeat instructions.
Write down your instructions – it will force you to think through what you say.
WE CARE

WE CARE advocates an awareness of those elements that SNC-Lavalin considers to be the cornerstones of our daily work, and which apply to the execution of each and every project.

People    Health & Safety    Communities    Environment    Quality
SNC-Lavalin.

OUR MISSION:

- Contributing to the success of our clients through value-added services and continuous improvement
- Global leader in project delivery with worldwide project experience
  - Ongoing projects in some 100 countries
  - International network for over 50 years
  - Offices in over 40 countries
  - Over 34,000 employees worldwide
- One of the largest engineering and construction firms in the world
- Over 100 years of excellence and experience
USCCG Background

*Founded in 1968;*

*Privately held;*

*Staffed by 150 professionals;*

*Offices in Tampa, Mississauga and Milan, Italy;*

*Proven track record of >1,500 successful projects;*

*Two thirds of our work comes from existing clients; and*

*We enjoy some of the highest satisfaction ratings in our industry*

Some USCCG Mining Customers where we helped improve business performance by optimizing their processes and resources (people & equipment):

*Agrium, Intrepid Potash, Peabody Energy, Bridger Coal, Westmoreland Coal, Goldcorp, Barrick Gold, TransAlta, Suncor Energy, Albian Sands (Shell)*
Personal background

• Born and raised in Saskatchewan.

• Working in the Mining/Manufacturing industry for 28 years, all but 2 years in Sk.


• Been involved in major projects, operations management, and quality initiatives, including ISO 9000 certifications, and Business Process Re-engineering efforts.

• Currently the General Manager for the SNC-Lavalin, Saskatoon office and VP Potash, Mining and Metallurgy Division.
What are Mining operations focused on?

- Improved safety and environmental performance
- Improvement in cost per ton, production and quality.
- Reduction in overall operating cost

- Improved availability, more value added utilization of equipment
- Improved maintenance cost and spending
- Better use of data and information at all levels of the organization
- Reduction in non direct cost – SG & A, Corporate Overhead
- Pushing accountability and CI responsibility back to Operations
- Reducing logistics and total delivered costs
- Supply Chain and specifically introducing Spend Management
- Education and training – “make my people more productive in less time given the competitiveness for resources in the market place”
Asset Performance Management.

- Large capital tied up in production related assets.
- Companies are focused inward to maximize returns on Capex through asset management.
- Companies are implementing strategies to maximize both the capability and utilization of that investment (human and capital equipment).
- Safety and Environmental management are a top priority. Structural integrity.
- Link Asset Management Strategies to Business Objectives
Asset Management (people and equipment)

- Asset Management
  - Asset Performance Management
    - Performance
      - Utilization
      - Production
        - Production Management Operating System
        - Lean Principles
          - SMED
    - Capability
      - Availability
      - Maintenance
        - Maintenance Management Operating System
          - PdM
          - PM
          - Project Management Operating System
The Management Operating System (MOS) is comprised of six core elements:
1. Planning
2. Assignment
3. Execution
4. Follow Up
5. Reporting
6. System Audit

System of controls, communication and activity used to achieve the organizational goals and objectives.
Clearly communicates to relevant stakeholders what each member’s roles and responsibilities are and how the goals and objectives will be met.
The detail that underpins the MOS
Tackling Performance

Asset Management

Performance

Utilization

Production

• Production Management Operating System
• Lean Principles
  • SMED

Capability

Availability

Maintenance

• Maintenance Management Operating System
  • PdM
  • PM
• Project Management Operating System
**Mine Production Objectives**

- **Attainment to Production Goals**
  - Achievable goals
    - Fact based and time phased
  - Effective Playbook
    - Right resources, right place, right time

- **Attainment to Production Cost**
  - Achievable cost targets
    - Fact based driven by accurate cost data
  - Visibility to Muda - Waste
    - Real time and near real time
    - Focus scarce resources on opportunities to effectively reduce cost

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**Tackling Performance**
Core Components of your Management Operating System

• **Develop standards that are safety driven**
  – Use of Lean / SMED techniques
  – Direct and indirect activities

• **Resources capacity planning tools**
  – Direct and indirect resources

• **Time phased scheduling tools**
  – Condition based

• **Opportunity Review Process**
  – Capture actionable data

• **Key Performance Reporting**
  – Right data and Information at the right levels

• **Action Item Data Base**
  – Accountability
Engage the Employees
Employee Involvement Prototype

*Use the 5 M’s to Focus the Prototype Process on the Issues*

*Use the 5 Why’s to dig to the Root Cause*

**Manpower**
- Resource Capacity Planning
- Cross Training
- Skills Training
- Operator Equipment Care

**Measurements**
- Usable KPI’s determined
- Visual performance indicators posted
- Benchmarking as a starting point

**Machines**
- PM’s
- Backlog Work Orders
- PdM’s
- Work History

**Materials**
- Kitted for the job
- Easily located
- Inventory Accuracy
- Ability to run Inventory Reports

**Methods**
- Execution of the Plan
- Predictive Maintenance
- Root Cause Failure Analysis
- Best Practices

**Communication**
- Employee involvement
- Supervisor follow up
- Manager roll up
- Daily / Weekly meetings
- Visual Indicators displayed

*Marietta Miner*

**DAILY REVIEW**
Identified Opportunities
SMED principles in a Quick Changeover

1. Observe current state
2. Differentiate Internal & External
3. Convert internal to external
4. Streamline internal
5. Streamline external
Checklists and Playbooks developed

Project Sheet Process Improvement: Install Jacks on Clusters

Observation: Crews are using ST-20s to lift the Cluster in an attempt to place the cribbing underneath to level the Cluster. Operators identified installing jacks on the Cluster as an opportunity that would help them consistently improve the time it takes to set up a room.

Result: The time required to level the Cluster is inconsistent and is determined by the ground condition, experience of the ST-20 operator, and the action of the crew to get the Cluster level. The new method will have a significant impact on the time required to set up a room.

Desired Improvement: Have the engineering department look into the possibility of having an automatic leveling device installed on the cluster that could automatically raise or lower the Cluster. This would improve the efficiency of the process.

Proposed Design:

1. Install jacks on the Cluster to raise the Cluster to the desired level.
2. Use a leveling device to ensure the Cluster is level.

A. Project Sheet Process Improvement: Develop Transition Bridge between Drive & Cluster

Observation: Transition time per hour and avoid cutting rigging to work on the transition from the Drive to the Cluster. The concept currently involves an operator to move the Cluster to the position of the transition bridge and then an operator to move the Cluster to the Drive.

Result: Once the Cluster is in position, an operator then moves to the Drive. A new concept would be to move the Cluster from the Drive to the transition bridge directly.

Desired Improvement: Reduce transition time and improve safety.

Proposed Design:

1. Use a hydraulic lift to move the Cluster from the Drive to the transition bridge.
2. An operator moves to the Cluster to place the Cluster on the transition bridge.

B. Project Sheet Process Improvement: Stacking Conveyors

Observation: The Torr and Torr is a limiting constraint on the time it takes to develop a room.

Result: The current process is saving 15 minutes per set up time. This additional savings can be achieved by improving the efficiency of the operators.

Desired Improvement: Reduce the time required to set up the Cluster.

Proposed Design:

1. Implement a new system to automatically level the Cluster.
2. Use a hydraulic lift to move the Cluster from the Drive to the transition bridge.

A.

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Reporting Structure put in place

- From the detail in the area – whether it be in the Mine with the Miner Cards, the Mill with the Operator Rounds or maintenance with the consistent measuring of like KPI’s – the reporting flows up to the OEEs for the site and development of Action Items.
Tackling Capability

Asset Management

Asset Performance Management

Performance

Utilization

Production

- Production Management Operating System
- Lean Principles
  - SMED

Capability

Availability

Maintenance

- Maintenance Management Operating System
  - PdM
  - PM
- Project Management Operating System
Tackling Capability

Mine Maintenance Objectives

- **Response to Failure**
  - Respond to calls promptly & Repair the equipment as quickly as possible

- **Proactive Maintenance**
  - Periodically restore the Capability/Condition of the Equipment
Tackling Capability

Mine Maintenance

Response to Failure

Proactive Maintenance

MTBF

Right Task
At the Right Time

Pareto Losses:
- Operator Training
- Maintenance Involvement
- Mechanical Performance

PM’s and Services
+ Repairs from the Backlog

Tackling Capability
• Engaging the employees in the development of the PM process within the existing CMMS system

• Refining CMMS system requirements to meet the individual needs of the mine

• Classroom sessions to review and ensure understanding of revised roles and responsibilities in the new / enhanced MMOS
Keeping Score Tackling Compliance

- Through the Employee Involvement Prototype process reviewed as a team the individual roles and responsibilities – colour coded down the left hand side

- Are we doing the right activity at the right time – you get a star

- Are we doing the right volume of that activity – closing Work Orders for example – the volume is written in the star

- As process expands more people are brought in to the mix
Bringing Performance and Capability back together …

Asset Management

Asset Performance Management

Performance
  - Utilization
    - Production
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Capability
  - Availability
    - Maintenance
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Detailed Mine Capacity Resource Planning

- Combining Production and Maintenance for an overall view
- Using the improved cycle time for activities
- Based on the required Maintenance PM and Predictive activities

<table>
<thead>
<tr>
<th>Level</th>
<th>Heading</th>
<th>Forecast Ocu. t</th>
<th>HPS Dilution</th>
<th>Forecast Backfill</th>
<th>Stope Type</th>
<th>Drill Type</th>
<th>Ground Type</th>
<th>Heading Size</th>
<th>Loader Stope Type</th>
<th>Remuck</th>
<th>Screen (Ton/Hr)</th>
<th>Specific Gravity</th>
<th>LHD Motors</th>
<th>% of Slush tons</th>
<th>Blast Factor</th>
<th>Rounds</th>
<th>Stashes</th>
<th>Dist. To Remuck</th>
<th>Dist. To Grizzly</th>
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<td>720 Vein-01 W (BK 02)</td>
<td>1.700</td>
<td>1.870</td>
<td>Long Hole</td>
<td>Jackleg</td>
<td>II</td>
<td>3.5 x 0</td>
<td>2.3 m/s</td>
<td>3.5 m/ore</td>
<td>10</td>
<td>2.94</td>
<td>2.12</td>
<td>0%</td>
<td>-</td>
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<td>-</td>
<td>75</td>
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<td>II</td>
<td>3.5 x 0</td>
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<td>75</td>
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<td>2.3 m/s</td>
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<td>5</td>
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<td>611</td>
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<td>Jackleg</td>
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**MANPOWER SUMMARY**

<table>
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<tr>
<th>Period: Jan 12</th>
<th>Productivity Factor = 86%</th>
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<tbody>
<tr>
<td>No. of Days: 31</td>
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**Drive by Heading or Stope**
## Equipment Requirement – Production and Maintenance Driven

### Period: Jan-12
### Days: 31

### Equipment Forecast

|                   | Number of units Available | Capacity Plan Hours | MTBF | Forecast # of failures | MTTR | Forecast Breakdown Hours | Forecast Planned PM hrs | Forecast Available Hours | Forecast % Availability | Forecast % Utilization | Forecast Hours Mtc & prod’n | Forecast Pcs Req’d |
|-------------------|---------------------------|---------------------|------|------------------------|------|-------------------------|-------------------------|-------------------------|-------------------------|----------------------|---------------------|---------------------|------------------|
| **Loaders**       |                           |                     |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| Production Remote | 6                         | 937                 | 4.0  | 234                    | 4.9  | 1,148                   | 90                      | 2,482                   | 67%                     | 38%                  | 2,175               | 3                  |
| Production 3.5 m3 | 1                         | 303                 | 5.0  | 61                     | 4.5  | 273                     | 29                      | 442                     | 59%                     | 69%                  | 605                 | 1                  |
| Backfill          | 3                         | -                   | 20.0 | 0                      | 4.5  | -                       | 0                       | 2,232                   | 100%                    | 0%                   | -                   | -                  |
| Development 2 m3  | 4                         | 867                 | 5.0  | 173                    | 7.0  | 1,213                   | 83                      | 1,679                   | 56%                     | 52%                  | 2,163               | 3                  |
| Development 3.5 m3| 4                         | 165                 | 5.0  | 33                     | 7.0  | 232                     | 16                      | 2,729                   | 92%                     | 6%                   | 413                 | 1                  |
| **Trucks**        |                           |                     |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| Remuck            | 3                         | 668                 | 6.0  | 111                    | 5.9  | 657                     | 64                      | 1,510                   | 68%                     | 44%                  | 1,390               | 2                  |
| Backfill          | 3                         | -                   | 6.0  | 0                      | 5.9  | -                       | 0                       | 2,232                   | 100%                    | 0%                   | -                   | -                  |
| Development       | 3                         | 986                 | 6.0  | 166                    | 5.9  | 981                     | 96                      | 1,155                   | 52%                     | 86%                  | 2,075               | 3                  |
| **Jumbos**        |                           |                     |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| Production        | 4                         | -                   | 6.5  | 0                      | 2.5  | -                       | 0                       | 2,976                   | 100%                    | 0%                   | -                   | -                  |
| Development       | 3                         | 345                 | 6.5  | 53                     | 4.5  | 239                     | 33                      | 1,960                   | 88%                     | 18%                  | 617                 | 1                  |
| **Jacklegs**      |                           |                     |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| Production        | 7                         | -                   |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| Development       | 7                         | -                   |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| **Toyotas**       |                           |                     |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| All U/G           | 5                         | 1,240               | 30.0 | 41                     | 2.0  | 83                      | 119                     | 3,518                   | 95%                     | 35%                  | 1,442               | 2                  |
| **Misc.**         |                           |                     |      |                        |      |                         |                         |                         |                         |                      |                     |                    |                  |
| All u/g misc.     | 7                         | 868                 | 8.0  | 109                    | 3.5  | 380                     | 83                      | 4,745                   | 91%                     | 18%                  | 1,331               | 2                  |

*Capacity plan hours are based on assumed average daily operating hours of 8 per day for Toyotas and 4 per day on Misc. equipment.*

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It’s fact-based, driven by fully integrated production and maintenance requirements.
Summary

- HSE responsible
- Increased production, at lower $/ton
- Effective CRP
- Capability, Utilization and MOS
Summary

- Fundamental change of work processes and behaviors.
- Discipline and Accountability is easier to see and therefore achieve.
- MOS provides defined roles and responsibilities through playbooks.
- Consistent MOS audits leading to CI of the system. Closed loop system.
- Tangible financial benefits predicted, delivered
- KPI Reporting to those accountable and above
- Only works with complete employee involvement.
DISCUSSION POINTS
WE CARE embodies SNC-Lavalin’s key corporate values and beliefs. It is the cornerstone of everything we do as a company. Health and safety, employees, the environment, communities and quality: these values all influence the decisions we make every day. And importantly, they guide us in how we serve our clients and therefore affect how we are perceived by our external partners. WE CARE is integral to the way we perform on a daily basis. It is both a responsibility and a source of satisfaction and pride by providing such important standards to all we do.

WE CARE about the health and safety of our employees, of those who work under our care, and of the people our projects serve.

WE CARE about our employees, their personal growth, career development and general well-being.

WE CARE about the communities where we live and work and their sustainable development, and we commit to fulfilling our responsibilities as a global citizen.

WE CARE about the environment and about conducting our business in an environmentally responsible manner.

WE CARE about the quality of our work.