Using Six Sigma Tools to Analyze EHS Performance Metrics

May 22, 2014
Introductions

Moderator
Oneil Williams
Manager Strategic Accounts
ProcessMAP Corporation

Guest Speaker
Dean Rossi
President
Safety Culture Partners, LLC
Housekeeping Items

- Attendee microphones will be muted to prevent distractions
- Ensure you enter your **audio pin** if dialing in by telephone
- Submit questions at any time using the “Questions” tool
- Q&A session
- Anonymous polls
- Post-webinar survey
- Contact info
ProcessMAP
Company Overview
INDUSTRY LEADER

GLOBAL FOOTPRINT
World’s Leading Companies Rely on ProcessMAP in 90+ Countries.

EXPERIENCE
13+Years of Innovation. Continued Growth & Long-Term Partnership with Customers.
We empower customers with information to help them preserve the environment, create a safe workplace and ensure the well-being of their employees.

“We help remove the non-value added administrative burden on EHS professionals.”
## Platform Overview

<table>
<thead>
<tr>
<th>Integrated Platform</th>
<th>Cloud/SaaS Model</th>
<th>Multiple Access</th>
<th>Global Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Comprehensive Suite of Modules</td>
<td>• No CAPEX Cost with ‘Pay-per-Use’ benefits</td>
<td>• Supports Multiple Browsers</td>
<td>• Designed for Global Companies</td>
</tr>
<tr>
<td>• Built from ground-up with customer input</td>
<td>• Predictable Annual Cost</td>
<td>• Safe and encrypted access over Internet</td>
<td>• 22+ languages and 100+ currencies</td>
</tr>
<tr>
<td>• Embedded Analytics and Reports</td>
<td>• Safe Harbor Certified</td>
<td>• Mobile capabilities</td>
<td>• Currently used in over 90+ countries</td>
</tr>
<tr>
<td>• Connectors to Internal &amp; External Systems</td>
<td></td>
<td></td>
<td>• Conversions from Metric to English units and vice-versa</td>
</tr>
</tbody>
</table>

**ERP Scale Platform for EHS and Sustainability**
Broad Industry Experience

- Automotive
- Agribusiness
- Electric Utilities
- Healthcare
- Manufacturing
- Media
- Metals
- Mining
- Oil & Gas
- Pharma
- Retail/Distribution
- Transportation
A Sample of Our Customer Base
Objectives of the Webinar

“Using Six Sigma Tools to Analyze EHS Performance Metrics”

- Understanding the importance of having an EHS MIS to capture vital EHS data
- Analyzing the data to see if your changes are achieving results
- The importance of being “graphical” when reporting upwards in your organization
- Analyzing the data to predict when you may be out of compliance
- Learning four key Six Sigma quality tools to help analyze your EHS data
Dean Rossi’s Bio
Dean Rossi
President and Owner, Safety Culture Partners LLC

- 25 years of EHS experience at site, division, and corporate level
- Held multiple EHS positions at GE Plastics
- Past global EHS manager at Stanley Black & Decker
- Past global director of EHS for a division at Ingersoll-Rand
- Most recently, served as the VP, Global EHS at Exide Technologies
- BS in Industrial Hygiene from Purdue University
- MBA, Organizational Leadership & Mgmt Emphasis
- Six Sigma Black Belt
Using Six Sigma Tools to Analyze EHS Performance Metrics
EHS Function Transformation – Maturity Curve

Transforming EHS Function from Chaos to World-Class
Polling Question

What is your familiarity with ‘Six Sigma’?

- Not Familiar
- Familiar with ‘Six Sigma’
- Green-Belt Trained
- Black-Belt Trained
- Master Black-Belt Trained
1. Senior leadership asked to see a control chart of our safety incidents over the years.

2. Your VP Operations, asked if spending the time doing BBS observations is worthwhile.

3. The city wants to lower your waste water effluent BOD limit from 325 mg/l to 275 mg/l; is that O.K.?
   - Your VP of Operations asked
   - How capable are we to achieve compliance at the new level?
   - “If the city does continuous 24 hour monitoring at our outfall, how long on average will it be before we are out of compliance?”
Predictive Phase – One step closer to World-Class Performance

1. Statistical Process Control (SPC) Charts
   • U – Charts (Safety Incidents)
   • I & mR Charts (WWTP)
2. Pollution Prevention Device Capability Analysis
   • How capable are you to maintain compliance?
3. Regression Analysis
   • We changed “x” did “y” change?
4. Student t-test
   • Test two populations before and after changes

4 Tools that Every EHS Professional Needs to Master
Polling Question

How do you convey critical EHS findings and conclusions to Upper Management?

- Informal verbal communication
- Written communication with no data
- Written communication with data in spreadsheet format
- Graphical presentation with detailed analysis
What is this

We need to learn to get “Graphical”!
Statistical Process Control Charts

- A graph used to study how a process changes over time
- **Central line**: Average, **Upper line**: Upper control limit and **Lower line**: Lower control limit
- Lines determined from historical data
- Provides ability to draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation)
- I & mR Control charts for variable data used in pairs
- Top chart monitors the average, or the centering of the distribution of data from the process while the Bottom chart monitors the range, or the width of the distribution
- If your data were shots in target practice, the average is where the shots are clustering, and the range is how tightly they are clustered
Six Sigma Tools for EHS

• SPC Charts
  – I & mR
    • Plotting Workers’ Comp. data
    • Waste water Effluent data
    • Number of Injuries, BBS Observations etc.
  – u Chart
    • Safety Incident Rate data
      – Attribute data with changing variable sample size like number of hours worked per month.

• Regression Analysis
  – Used to determine relationship between two variables
    • Ex. Impact of number of BBS observations on reduction of injury rates

• t-Test
  – Used to determine if there is a statistical improvement after a change was made
    • Ex. Did our injury rates/Workers’ Comp Cost reduce after implementation of Ergonomics program

• Capability Analysis
  – Used to determine how “capable” you are to stay within your permit limits
    • Ex. City wants to reduce your waste water permit limits by 25%. Are you capable to stay in compliance?
Description: Individuals and Moving Range Chart (I&mR). Plots in a time series. Shows where 99+% of your data should lie.
Statistical Process Control Charts

TRIR u-Chart (Jan. 2003 - Jan 2007)

- PPE Prgm
- Temp EE Prgm
- Ergo Prgm
- BBS Prgm

UCL = 11.20
\( \bar{U} = 3.59 \)
LCL = 0
**Statistical Process Control Charts**

**Description:** I & mR Chart of rolling 12 month Workers’ Compensation Costs before and after Implementation of an Ergonomics Program

![I & mR Chart for Rolling 12 month Workers' Compensation Costs](chart.png)
Control Chart Examples

Total Zinc SPC Chart

- X
- Ave. X
- UNPL
- Monthly Permit Limit

mg/l

Mar-03 May-03 Jul-03 Sep-03 Nov-03 Jan-04 Mar-04 May-04 Jul-04 Sep-04 Nov-04 Jan-05 Mar-05 May-05 Jul-05 Sep-05 Nov-05 Jan-06 Mar-06 May-06
Polling Question

How would you describe this process?

- Stable and in control
- Mean is below the permit limit
- Small degree of variation
- None of the above
- All the above
Control Chart Examples

Any concerns here?

Special cause variation
What does this chart tell you?
What does this chart tell you?

- Nothing – There’s no problem here
- We’re OK – Those data points are not normal
- This process normally runs above the permit limit
- There are no special cause variations here
What happened?
**Student t-test**

- A method of testing hypotheses about the mean of a small sample drawn from a normally distributed population when the population standard deviation is unknown.
- Formulate a null hypothesis, which states that there is no effective difference between the observed sample mean and the hypothesized or stated population mean—i.e., that any measured difference is due only to chance.

In EHS, for example, the null hypothesis could be that implementing an ergonomics program has had no effect on injury rates or workers’ compensation spend. In general, a t-test may be either two-sided (also termed two-tailed), stating simply that the means are not equivalent, or one-sided, specifying whether the observed mean is larger or smaller than the hypothesized mean. The test statistic $t$ is then calculated. If the observed $t$-statistic is more extreme than the critical value determined by the appropriate reference distribution, the null hypothesis is rejected. The appropriate reference distribution for the $t$-statistic is the $t$ distribution. The critical value depends on the significance level of the test (the probability of erroneously rejecting the null hypothesis).
Injury Rate “t-test” before and after implementation of an Ergonomics Program

When the “p-value” is <0.05; then “Significant Change"

p<=0.009
Regression Analysis

- Simple tool to use
- Can be done on excel
- Testing to see that when you changed “x” . . .
  - X = anything i.e. flow, number of BBS observations, chemical adds, etc.
- . . . That “y” changed positively or negatively
  - Y = anything i.e. concentration, number of injuries, ppm, etc.
You implemented a Behavioral Based Safety (BBS) program over a year ago.

The VP of Operations said she hasn’t seen any changes in the injury rates since starting the BBS program.

The VP of Operations said that it takes too much time to perform the BBS observations and asked “can we cut the number of BBS observations by 50%?”

How do you respond to her?
BBS Observation Data

<table>
<thead>
<tr>
<th>Month</th>
<th># of Monthly BBS Observations</th>
<th>Monthly TRIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-12</td>
<td>150</td>
<td>4.75</td>
</tr>
<tr>
<td>Feb-12</td>
<td>250</td>
<td>3.60</td>
</tr>
<tr>
<td>Mar-12</td>
<td>200</td>
<td>3.85</td>
</tr>
<tr>
<td>Apr-12</td>
<td>425</td>
<td>1.65</td>
</tr>
<tr>
<td>May-12</td>
<td>375</td>
<td>2.45</td>
</tr>
<tr>
<td>Jun-12</td>
<td>400</td>
<td>2.00</td>
</tr>
<tr>
<td>Jul-12</td>
<td>125</td>
<td>6.00</td>
</tr>
<tr>
<td>Aug-12</td>
<td>410</td>
<td>1.85</td>
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<tr>
<td>Sep-12</td>
<td>250</td>
<td>5.25</td>
</tr>
<tr>
<td>Oct-12</td>
<td>355</td>
<td>2.95</td>
</tr>
<tr>
<td>Nov-12</td>
<td>180</td>
<td>4.85</td>
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<tr>
<td>Dec-12</td>
<td>150</td>
<td>5.50</td>
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<tr>
<td>Jan-13</td>
<td>425</td>
<td>2.25</td>
</tr>
<tr>
<td>Feb-13</td>
<td>365</td>
<td>1.85</td>
</tr>
<tr>
<td>Mar-13</td>
<td>420</td>
<td>1.75</td>
</tr>
<tr>
<td>Apr-13</td>
<td>400</td>
<td>1.65</td>
</tr>
<tr>
<td>May-13</td>
<td>575</td>
<td>1.30</td>
</tr>
<tr>
<td>Jun-13</td>
<td>500</td>
<td>0.85</td>
</tr>
<tr>
<td>Jul-13</td>
<td>600</td>
<td>0.25</td>
</tr>
<tr>
<td>Aug-13</td>
<td>450</td>
<td>1.35</td>
</tr>
<tr>
<td>Sep-13</td>
<td>380</td>
<td>1.85</td>
</tr>
<tr>
<td>Oct-13</td>
<td>425</td>
<td>1.10</td>
</tr>
<tr>
<td>Nov-13</td>
<td>225</td>
<td>4.10</td>
</tr>
<tr>
<td>Dec-13</td>
<td>285</td>
<td>2.15</td>
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<tr>
<td>Jan-14</td>
<td>450</td>
<td>1.25</td>
</tr>
<tr>
<td>Feb-14</td>
<td>380</td>
<td>1.50</td>
</tr>
</tbody>
</table>

Difficult to tell in a table format.

Remember . . . “a picture paints a thousand words”.
Let’s Plot the Data

Number of Monthly BBS Observations -vs- Monthly Recordable Rate

Monthly TRIR

Number of Monthly BBS Observations

Monthly TRIR
Right click to add a “trend line”. Then click add the “$R^2$” Equation. When $R^2$ values are <0.80; then there is NO statistical correlation between the “$X$” and the “$y$”. When >0.80 then statistically significant.
Now that you’ve seen the data, what do you tell to VP of Operations?

- Agree to 50% reduction
- Recommend that we continue as we are
- Recommend doing MORE observations
Let’s start by plotting the data in an I&mR chart. The permit limit for BOD at this outfall is 325 mg/l.

Looks pretty good right? But how “capable” are we of staying in compliance?
Take all the data from the SPC charts along with the permit limits to run a “capability analysis”

USL = Upper Spec Limit (Permit Limit). To calculate a “sigma value” take either the Cpk or Ppk and multiple by 3. Here the sigma value = 1.48 X 3 = **4.4 Sigma**.
What do the Sigma Levels Mean?

... if we took 24 hour composite samples on a daily basis ...

<table>
<thead>
<tr>
<th>Sigma Level</th>
<th>Days between running “out of compliance”</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>1,000</td>
</tr>
<tr>
<td>3.0</td>
<td>161</td>
</tr>
<tr>
<td>2.0</td>
<td>15</td>
</tr>
</tbody>
</table>
What if the city wants to lower your permit limit from 325 to 275? What is your capability at that point?

USL = Upper Spec Limit (Permit Limit). To calculate a “sigma value” take either the Cpk or Ppk and multiple by 3. Here the sigma value = 0.92 X 3 = 2.8 Sigma
Assuming composite 24 hour sampling every day, these sites' constituents will have a permit exceedance on average...
If you capture data and have a permit limit, you can calculate your capability

- Storm Water
- Waste Water effluent constituents
  - Metals
  - BOD
  - COD
  - pH
  - Flow
  - Etc.
- Fence line air monitors
- Industrial Hygiene exposure monitoring
- Differential pressure gauge readings
In order to bring true business value, you must be “predictive” to become “preventative”. Using simple six sigma tools can assist.

Don’t take “statements” and “tribal knowledge” as facts; show me the data!

There are NO “silver bullets” to increase EHS performance that builds business value; but there are many pieces of “silver shot”

In God we trust; all OTHERS bring DATA!
Polling Question

Does your company have a formal ‘Six Sigma’ or Lean Six Sigma Program?

☐ Yes – I have not participated
☐ Yes – I have participated
☐ No – My company does not offer a Six Sigma program
1. If your company offers a six sigma program sign up to be a green belt

2. Partner with your quality people, they have the tools to assist you in evaluating your data

3. Add value to your company – Being “predictive” is the best way to be “preventative”

4. If you are not using an EHS MIS to capture your vital data you may be missing out on opportunities to be “predictive” and “preventative”.
Thank You!

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Visit us at www.processmap.com

<table>
<thead>
<tr>
<th>For questions about ProcessMAP’s platform solution, please direct inquiries to:</th>
<th><a href="mailto:owilliams@processmap.com">owilliams@processmap.com</a></th>
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