Unlocking the value of Engineering Information in Facilities Engineering Operations based on ISO 55000

*Sloane Whiteley, Senior Consultant*

*A VEVA Enterprise Solutions*
## Lessons Learned from the Past

**Incident**

<table>
<thead>
<tr>
<th>Offshore O&amp;G: Deep Water Horizon ('Macondo blowout')</th>
<th>O&amp;G Refinery: Texas City Refinery Explosion</th>
<th>Mining: Meikle Mine Explosion</th>
<th>Chemicals: Danlin Plant Explosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest accidental marine oil spill in the history of the petroleum industry</td>
<td>Improper start-up procedure followed causing a chain of incidents leading to a vapour cloud explosion</td>
<td>Application of a mixing motor to solidified PETN &amp; secondary explosion in a nearby storage unit</td>
<td>Rupture of distillation column leading to secondary explosion</td>
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</tbody>
</table>

**Causes**

- Defective cement on the well
- Insufficient process safety controls and safety system.
- Industry best practices and government policies not incorporated into O&M process
- Maintenance systems geared toward a trip-&-fail compliance
- Inadequate worker training & reporting capabilities
- Start-up procedure not regularly updated & hence, incorrect
- Lack of sufficient instructions
- Operators allowed to make procedural changes without performing formal MoC process
- Reliance on knowledge from past-experiences and informal work practices
- No policy for effective shift communication, shift turnover communication, or log-books
- Improper localization of hazardous processes
- Variability & limited awareness of procedures
- Unfocused safety walkthrough inspections
- Lack of understanding of process hazards & controls
- Ineffective worker training
- Workers routinely made changes to steps taken
- Inadequate inspections
- Safety systems switched off to save money
- Non-existent emergency response plans
- Localization of the facility and hazardous processes to a densely populated area
- Underutilized safety devices
- Lack of skilled operators

**Lessons Learned**

- Implement formal training program
- Regularly conduct formal PHAs
- Ensure all regulatory requirements are adhered to
- Incorporate industry best practices into work process
- Develop and Implement process specific operating procedures
- Consistently execute operating procedures
- Execute pre-startup safety reviews
- Implement formal shift handover practices and system
- Follow formal MoC processes
- Provide access to procedural instructions & supporting info
- Process specific operating procedures & consistent execution
- Tools for access to relevant data
- Properly locate assets
- Conduct regular safety reviews
- Formal HAZOP analysis
- Implement program for training & emergency simulation
- Specify alarm limits automated monitoring of operational parameters
- Perform Risk Based Inspection (RBI) and maintenance
- Develop and practice emergency response plans
- Train workers in operational processes and procedures
Operational Integrity Challenges: *Process Safety Information*

**PSM Requirements**
(OSHA Appendix to §1910.119 – Compliance Guidelines)
- Process design & technology review
- O&M activities & procedures
- Emergency preparedness plans & procedures
- Training programs
- ID process related hazards (PHA)

**PSI Challenges**
- Broad spectrum of information & sources (P&IDs, 3D models, HAZOPs...)
- Incomplete, inaccurate handover information
- Operational / in-plant changes
- Long information lifecycle
- Changing regulatory requirements
## Operational Integrity Top Challenges

<table>
<thead>
<tr>
<th>Challenge to Improve Safety</th>
<th>Response %</th>
<th>Domain</th>
<th>Challenge to Improve Safety</th>
<th>Response %</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing a culture of personal responsibility</td>
<td>67.7</td>
<td>Training &amp; Competency</td>
<td>Variations in internal standards and procedures</td>
<td>23.1</td>
<td>Asset &amp; Process Safety Information Management</td>
</tr>
<tr>
<td>Human Behaviors</td>
<td>64.7</td>
<td>Training and Competency</td>
<td>Limited sharing of best practices and lessons learned across the industry</td>
<td>22.1</td>
<td>Asset &amp; Process Safety Information Management</td>
</tr>
<tr>
<td>Tendency to focus on productivity over safety</td>
<td>38.9</td>
<td>Operations &amp; Maintenance Management</td>
<td>Missing or poor quality information</td>
<td>19.5</td>
<td>Asset &amp; Process Safety Information Management</td>
</tr>
<tr>
<td>Management of Change (MoC)</td>
<td>38</td>
<td>Operations &amp; Maintenance Management</td>
<td>Lack of communication / information sharing across the supply chain</td>
<td>18.8</td>
<td>Asset &amp; Process Safety Information Management</td>
</tr>
<tr>
<td>Lack of time to train staff</td>
<td>36.3</td>
<td>Training &amp; Competency</td>
<td>Deficiencies in operating procedures</td>
<td>16.8</td>
<td>Asset &amp; Process Safety Information Management</td>
</tr>
<tr>
<td>Lack of personnel competency</td>
<td>32.7</td>
<td>Training &amp; Competency</td>
<td>Inspection and maintenance</td>
<td>16.8</td>
<td>Operations &amp; Maintenance Management</td>
</tr>
<tr>
<td>Inadequate training</td>
<td>30.4</td>
<td>Training &amp; Competency</td>
<td>Permit to work</td>
<td>9.2</td>
<td>Operations &amp; Maintenance Management</td>
</tr>
</tbody>
</table>

Top Challenges to Improve Safety Identified by Robert Gordon University Aberdeen Study
Operational Integrity Challenges: *Operational Lifecycle / Maintenance Management*

- If Standard Naming & Numbering Rules are not Uniformly Applied for ID of Assets across disciplines it is difficult to correlate information about assets
- Functional location structure almost never reflects the process, physical or location based structure
- CMMS Relies on the Assumption that the Plant Configuration is Validated
- Two-dimensional, Static Views of Processes and Facility Layouts are not Fully Effective for Purposes of Hazard Identification
- The Necessary Information is not available at Lower Levels of the Asset Hierarchy

The asset inventory, facility layout & naming/numbering forms the basis of all O&M activities
Operational Integrity Challenges: *Training and Resource Competency*

- Educating the Next Generation of Engineers – Challenges with ‘Traditional’ University Engineering Curriculums

- Conventional Training Methods are not totally effective in Ensuring workers are Adequately Trained

- It is Impractical to Conduct ‘On-the-Job’ Training for Abnormal Situations & Safety Critical Processes

- Plant Maintenance Processes involve Multiple Stakeholders across Multiple Disciplines

- For Offshore and other Remote Sites, Crews are generally Replaced on a Rotational Basis and Onsite Training is not Practical

- Fewer Individuals are Responsible for more Process Units and there is Greater Dependence on Contract Workers for Execution of O&M Activities
## Best Practice Recommendations: A Standards Based Approach (ISO 55000)

<table>
<thead>
<tr>
<th>ISO 55000 Standard Series</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ISO 55000</td>
<td>Provides an overview of the subject of asset management and the standard terms and definitions to be used (6-Elements)</td>
</tr>
<tr>
<td>ISO 55001</td>
<td>Requirements specification for an integrated, effective management system for assets.</td>
</tr>
<tr>
<td>ISO 55002</td>
<td>Provides guidance for the implementation of such a system.</td>
</tr>
</tbody>
</table>

**On-Schedule for Publication & Release in Q1 2014!**
Operations Integrity Management Program Essentials – ISO 55000 Elements
ISO 55000 Elements – A Closer Look...

Asset Management Strategy & Planning
- Asset Management Policy
- Asset Management Planning

Asset Management Decision Making
- Operations & Maintenance Decision Making
- Resourcing Strategy & Optimization
- Aging Assets Strategy

Asset Lifecycle Delivery Activities
- Technical Standards
- Asset creation & acquisition
- Maintenance Delivery
- Reliability Analysis
- Shutdown / Outage Management
- Incident Response

Asset Knowledge Enablers
- Asset Information Strategy
- Asset Knowledge Standards
- Asset Information Systems
- Asset Data & Knowledge

Organization & People Enablers
- Contract & Supplier Management
- Asset Management Governance
- Organizational Structure & Culture
- Competence & Behavior

Risk & Review
- Criticality, RBI & RBA
- Contingency & Emergency Planning
- Asset Performance & Health Monitoring
- Info Change Management & MoC
- Review, Audit & Assurance
Solution Framework for Success

Image Courtesy of the Institute of Asset Management
(Adapted from Asset Management – An Anatomy, Version 1)

Optimal combination

Cusbrisk/performance impact

Training & Competence

Asset Management System

Residual Risk

Asset Information Backbone
(Digital Information Hub)

Mix of competing objectives (e.g. preventive expenditure versus residual risks)
Solution Framework for Success

**Asset Information – Desired State**

– Integrated information storage
  - complete digital plant records
  - integrated digital systems
  - common data access

– Robust information delivery standards and policies
  - As built / as modified data consistency

– Information management processes integrated into the business processes they support

**Asset Information**

- Rapidly accessible
- Complete
- Correct
- Consistent
- Trusted
Solution Framework for Success

**PSI Solution Wish-list**

**PSI Wish-List**

- Ability to export information to common applications (MS Word & Excel)
- Rapid/easy means of finding data.
- Access & view data from other data sources
- View information dependencies
- Validation of information
- Configurable reporting
Solution Framework for Success

**Process Safety & Asset Information Solution Needs - Making it a Reality**

![Diagram of Plant Operations Processes]

**Asset Information Backbone (Digital Information Hub)**

.... Information Integration | Validation | Navigation | Collaboration | Reporting ....

![Diagram of Gateway and Information Types]

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End User Information Access—Information Visualization

- Search & Navigate
- Discover & Explore
- Visualize & Interact
Web-Based Access to ANY type of Information

<table>
<thead>
<tr>
<th>A. Hot work</th>
<th>Y</th>
<th>N</th>
<th>n/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to procedure</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Welding</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Flame cutting</td>
<td>X</td>
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<tr>
<td>Grinding</td>
<td>X</td>
<td></td>
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<tr>
<td>Se of electrical equipment (including overhead operated tools)</td>
<td>X</td>
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<tr>
<td>Hot work equipment in good state of repair</td>
<td>X</td>
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<tr>
<td>Within 11m of work all combustible materials are removed</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 11m of work all combustible materials that cannot be removed have been protected</td>
<td>X</td>
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<tr>
<td>Camera - Flash off</td>
<td>X</td>
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<tr>
<td>SW RED TAG (Sprinkler impairment etc) issued for area</td>
<td>X</td>
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<tr>
<td>Fire watch required &amp; fire extinguisher in area suitable</td>
<td>X</td>
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<tr>
<td>Monitor area for 1 hour, then check hourly (4 h) after work is completed</td>
<td>X</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Work at Height</th>
<th>Y</th>
<th>N</th>
<th>n/a</th>
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</thead>
<tbody>
<tr>
<td>Refer to procedure</td>
<td>X</td>
<td></td>
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<tr>
<td>Hazardous Areas</td>
<td>Y</td>
<td>N</td>
<td>n/a</td>
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<tr>
<td>Bulk liquid tank farm</td>
<td>X</td>
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<tr>
<td>LPG tank farm and pipework</td>
<td>X</td>
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<tr>
<td>LPG gas filling booths</td>
<td>X</td>
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<tr>
<td>Chemical process areas</td>
<td>X</td>
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<tr>
<td>Chemical process pipework</td>
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</table>

<table>
<thead>
<tr>
<th>B. Work at Height</th>
<th>Y</th>
<th>N</th>
<th>n/a</th>
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<tbody>
<tr>
<td>Can work at height be avoided?</td>
<td>X</td>
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<tr>
<td>Are weather conditions suitable for work taking place?</td>
<td>X</td>
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<tr>
<td>Ladder</td>
<td>X</td>
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<tr>
<td>Tower scaffold</td>
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<tr>
<td>Fitted scaffolding</td>
<td>X</td>
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<tr>
<td>Roof work - with edge protection</td>
<td>X</td>
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<tr>
<td>Mobile elevated work platform e.g. Cherry picker</td>
<td>X</td>
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<tr>
<td>Person performing work is trained &amp; competent</td>
<td>X</td>
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<tr>
<td>Equipment tagged, inspected &amp; suitable for use</td>
<td>X</td>
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<tr>
<td>Are suitable precautions in place to prevent falling e.g. harness</td>
<td>X</td>
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<tr>
<td>Toe boards &amp; guard rails required</td>
<td>X</td>
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Hot work: To be signed off after work completion:

- Area Monitor for 1 hour after work completed
- Signed:
- Checked:
- Signed:

Fire detectors put back into service:

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Configurable Reports for Identification of Discrepancies in Operational Data & Monitoring of Operational Parameters

### Corporate OIM Summary (HLO Energy)

<table>
<thead>
<tr>
<th>Category</th>
<th>Atlanta</th>
<th>Bridgeport</th>
<th>Calgary</th>
<th>Denton</th>
<th>Edmonton</th>
<th>Freeport</th>
<th>Greenville</th>
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<tbody>
<tr>
<td>Process Safety Culture</td>
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<td>Asset Integrity / Reliability</td>
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<td>Contractor Management</td>
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<td>Training / Performance</td>
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<td>Management of Change</td>
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<td>Operational Readiness</td>
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<td>Conduct of Operations</td>
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Summary of Key Capabilities Provided by The Asset Information Backbone

• **Features**
  – Structured & Unstructured information is searchable, viewable & available to all authorized users.

• **Benefits**
  ✓ *Navigate information content* via intuitive breakdown structures, object links & hot-spotted drawings and models
  ✓ *Search, retrieve & visualize* content
  ✓ *Create and run reports* to identify data quality issues
  ✓ *Print & export report content* in standard formats (e.g. CSV, XML & MS Excel)
  ✓ *Mark-up & annotate content* & participate in *real-time collaboration* sessions with users across multiple locations.
Solution Framework for Success

*Taking the ‘Traditional’ Asset / System Capabilities a Step Further – Control of Work (CoW)*
Inadequate CoW is almost ALWAYS the cause of Personal Injury & Major Incidents!!!
Solution Framework for Success

Control of Work (CoW) – Work Permit Management

- Visualization of permits across the facility
- Electronic activation / deactivation of Work Permits & Isolation Certificates
- Ensure Work Permits adhere to defined approval process
- Benefit = Improved regulatory compliance and safety

Color-coding & plotting of work permits in accordance with a plan of the facility

Electronic authorization of work permits
Solution Framework for Success

*Control of Work (CoW) – Integrated Information*

- Enables access to all related data & documentation corresponding to each Work Permit area
Summary of Capabilities Provided by the Maintenance Management System (CoW Context) – AVEVA WorkMate

- Support for work planning & execution
- Configurable workflow for safe execution of work orders
- Support for barcode scanning for auto-activation / de-activation of work permits
- Electronic Signature capability for sign off on work permits (including full audit trail / logging of signatures)
- Graphical overview / visualization of active work permits
- Link to all information associated with Work Permits (e.g. P&IDs, HSE datasheets, Procedures...)

![AVEVA WorkMate Interface](image-url)
Solution Framework for Success

Competency Development – Training Solution Wish-list

Training Solution Wish-List

- Realistic training for Emergency situations
- Means to practice infrequently performed tasks & Hazardous Processes
- Simulation of ‘real-world’ conditions in training exercises
- Anticipation of worker behavioral response in abnormal situations
- Appealing to next generation workforce
Multi-User Virtual Worlds

- Fully interactive, ‘real-world’ environment where multiple workers can perform pre-defined tasks
- Relevant workflows for training, collaboration, planning & operations
- **Benefits**: Increased situational awareness & facility familiarization

Storytelling

- Sequence of individually-driven, interactive animated environments to demonstrate the progress of a particular process or production schedule
- **Benefits**: Improved stakeholder comprehension, communication and speed to proficiency

Applications for Engineers

- Custom visualization tool for engineers, offering an immersive experience of a 3D-model-based environment, with embedded links to data & document management systems as real-time data feed sources.
- **Benefits**: Increased safety, enhanced remote asset surveillance & troubleshooting & improved collaboration for solving issues
Solution Framework for Success

*Training Solution – Embedded Information Portal*
Sample Application demonstrating a Multi-User ‘Lock-Out / Tag Out’ activity for removing a condenser
# Operations Integrity Management Solution Benefits

**Excellence in Operations Integrity Management / Optimized Safety Performance**  
*(ISO 55000 Compliance)*

## Asset & Maintenance Management
- Emergency Preparedness
- Compliance with Asset Information Standards
- Integration of CoW into Maintenance Activities
- Improved Incident Response Rates Coupled With Complete Set of Asset Information

## Training & Competency Development
- Resource Competency Assurance
- Assurance that Workers Understand SOPs and Execute Tasks Accordingly
- Assurance that Workers Do NOT Execute Work Orders Without Consideration of CoW Requirements
- Reduced Number & Frequency of Injuries & Incidents

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**Asset Information Backbone**
Thank you