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Production Loss Accounting with the PI System and RtDuet

Understanding where the "bad actors" lie in your process is critical to improving overall plant availability and production levels. In a large-scale distributed processing plant, a centralized tool for capturing and reporting on operational delays is essential.



KPI Dashboard **KPI Reports** Events Reports **R**t**Duet** From *-30d To To Pueblo Vieio Autoclaves B 1-Operations AUT150-Train1 UT250-Train2 AUT350-Train3 (%) (%) 100 BAUT450-Train4 X 2-Maintenance Show 25 entries Generation Company Compan Source MC Path Start Time End Time AUT250-Train2 1/27/2014 7:00:00 PM 1/28/2014 7:00:00 P Grinding Ops AUT250-Train2 1/28/2014 7:00:00 PM 1/29/2014 7:00:00 P AUT250-Train2 1/29/2014 7:00:00 PM 1/30/2014 7:00:00 P Get ime Kilns AUT250-Train2 1/30/2014 7:00:00 PM 1/31/2014 7:00:00 PM Get ime Slaker AUT250-Train2 1/31/2014 7:00:00 PM 2/1/2014 7:00:00 Pt 🗑 🎯 imeBoll AUT250-Train2 2/1/2014 7:00:00 PM 2/2/2014 7:00:00 PM Generatione Crushing AUT250-Train2 2/2/2014 7:00:00 PM 2/3/2014 7:00:00 Pt Grinding

Business Challenge

- Understand the true issues . affecting production
- Improve the quality of . downtime data
- Quantify the effect of . downtimes on the bottom line

Solution

Use RtDuet to leverage the ٠ existing online data in the PI System for automated downtime event tracking

Results and Benefits

- Reduced time spent capturing, validating and compiling downtime data
- Reliable data to support capital allocation decisions

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HDS

Agenda

- Introduction
- Company Background
- Business Drivers
- Solution Details
- Benefits & Lessons Learned
- Summary
- Questions

Barrick Gold: A global company



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Pueblo Viejo Site

- Processing 1000 ton/hour generates revenue of over \$200,000 per hour
- Every minute of production counts!
- Pueblo Viejo will produce over 1 million ounces of gold in 2014



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Business Drivers

- Accurately account for production losses due to plant stoppages and delays
- Focus our maintenance efforts on the issues with the greatest impact on production
- Standardize data collection and calculation of metrics for reporting throughout the enterprise
- Comply with corporate maintenance reporting guidelines

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Requirements

- A standard platform for the collection and reporting of plant downtime information
- Key system requirements:
 - Automatic downtime event detection and logging
 - Manually add downtime events
 - Detect production slowdowns as well as complete stoppages
 - Split a downtime event into multiple sub-events
 - Supervisor approval of downtime events
 - Automatic calculation and reporting of standard maintenance metrics such as availability, utilization, MTBF, etc.

Solution

- PI System and RtDuet (Real-Time Downtime & Uptime Event Tracking)
- Key Features
 - Tight integration with PI Data Archive and PI AF
 - Web-based user interface
 - Open system for integration with other systems and in-house development of reports
 - Easy-to-use configuration tools

How does it work?

The Downtime Event Capture Process



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Trigger Definition

| RtDuet Toolkit | | | | |
|---|--|---|--|--|
| File Tools Help | Configuration Reason Tree Time Usage Model Tag Security Events KPI Configuration Configuration Properties | | | |
| RtDuet Configuration Pueblo Viejo AUT 150 AUT 250 AUT 350 AUT 450 AUT 450 AUT 450 AUT 450 AUT 100_rrain1 Primary Triggers AUT150_rrain1 Brimary Triggers AUT150_rrain2 AUT250_rrain3 | Name AUT150-Train1 Display Text Calculation Server DOMPVMDRA1 Reason Tree Vutoclaves Status Tag \vdompvmpi1\Pueblo Viejo_Autoclaves_1-Operations_AUT150-Train1.DWPStatus Primary Triggers Secondary Triggers | Advanced Visible in Web Pages Split Events by trigger rank Automatically Save Events Automatically Validate Events | | |
| AUT450-Train4 2-Maintenance AUT450-Train4 2-Maintenance S-Sowdowns CCD and Hot Cure G-G CLL CD Destruction G-G CLL G-G CL | Name Tag 0 AUT150_Zero_TPH \\dompyrmpi1\4141_AUT150_Train1_TPH | Operator Reference Active < 10 True | | |

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User Interface

- GUI runs in Internet Explorer
- Easy to deploy, universal access

| P tDuof | Event | S I | (PI Das | shboard | I KPIF | Reports | Reports Options | 3 | | | | | | |
|---|------------|-------|------------|---------|------------|-------------|----------------------|---------------|---------------------|---------------------------|--------------------------------|--------------------------------------|-----------------------|-----------|
| Real-time Downtime, Uptime & Event Tracking | From | *-36h | | | То То | | 10 | Show | Chart Hide | Left Pane Show Left Pane | 1 | | | Last Up |
| 🖻 🌍 Pueblo Viejo | | | | | | | | | | | | | | |
| Autoclaves | Inse | nt Ed | lit | Paste | Validate | Delete | Select/Deselect All | | | | | | | |
| 1-Operations | | | | | | | | | | 📢 ┥ 🕨 🃂 Pa | ige 1 of 1 of 29 entries | | | |
| 2-Maintenance | _ | | | | | 14.5.5 | | | | | | | | |
| GCCD and Hot Cure | | | | | Start | Time | End Time | Machine Cent | re Duration (hh:mm) | Weighted Duration (hh:mm) | Comment | Reason Code | T.U.C | Туре |
| | a 1 | • | ₽ | ×Θ | 05-Mar-201 | 14 08:57:07 | | AUT450-Train4 | 06:52 | | High sulfers + increased cool | \Autoclaves\Constrained\Ore Mining | Constrained | Secondary |
| CN Destruction | | 1 | ₽ X | ×Θ | 05-Mar-201 | 4 07:00:00 | | AUT250-Train2 | 08:49 | | Getting tons up after clave st | \Autoclaves\Op\Ramping Up | Planned Operations | Secondary |
| Grinding Ops | • | . / | 6 * | ×Θ | 05-Mar-201 | 4 07:00:00 | | AUT350-Train3 | 08:49 | | Temps were low on autoclave du | \Autoclaves\Op\Ramping Up | Planned Operations | Secondary |
| HDS | | 1 | 🔒 🠇 | ×Θ | 05-Mar-201 | 4 05:02:20 | | AUT150-Train1 | 10:46 | | We are limited to 120 TPH of O | Autoclaves Constrained O2 Plant | \Constrained | Secondary |
| Glime Kilns | |) | 1 | ש | 05-Mar-201 | 14 07:00:00 | 05-Mar-2014 08:24:07 | AUT450-Train4 | 01:24 | 00:01 | Ramping up after SIS Trip on H | \Autoclaves\Op\Ramping Up | \Unplanned Operations | Secondary |
| Cime Slaker | | 0 | · • | × | 05-Mar-201 | 4 03:05:31 | 05-Mar-2014 07:00:00 | AUT450-Train4 | 03:54 | 00:43 | Ramping up after SIS Trip on H | \Autoclaves\Op\Ramping Up | \Unplanned Operations | Secondary |
| | |) | G 6 | × | 05-Mar-201 | 14 02:18:20 | 05-Mar-2014 07:00:00 | AUT250-Train2 | 04:41 | 00:49 | Getting tons up after clave st | \Autoclaves\Op\Ramping Up | \Planned Operations | Secondary |
| Grinding | | 0 | · · · | × | 05-Mar-201 | 14 01:01:43 | 05-Mar-2014 07:00:00 | AUT350-Train3 | 05:58 | 01:21 | Temps were low on autoclave du | \Autoclaves\Op\Ramping Up | \Planned Operations | Secondary |
| Cimestone Ops | | 0 | 50 40 | ש | 05-Mar-201 | 14 05:00:16 | 05-Mar-2014 05:02:20 | AUT150-Train1 | 00:02 | 00:02 | Gland Seal Pressure LO LO took | \Autoclaves\COMMON\Pump\4141-PPP-210 | \Unplanned Operations | Primary |

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User Interface

 Asset and failure codes are aligned with the Enterprise Asset Management System (EAM)

| dit Event | | | | | | | × |
|------------------|---|------|---|---|--------------|--------|---|
| Ore Grin | ding | | Reason Code | | | | - |
| Start Time | 27-Feb-2014 07:00:00 | 0 | Reason Codes | Cracked | | - | |
| End Time | 27-Feb-2014 13:30:08 | Ō | 🗉 🌟 1-Other | | | | |
| Event Type | Downtime | Ţ | Constrained Conveyor | | | | |
| Comment | Cyclone Feed Pump Impell Shattered into pieces | er ^ | Cyclone Feeder | | | | ш |
| Time Usage Code | Unplanned Mechanical | • | Pebble Crush | ier | | | |
| WorkRequestNumb | 81 | | Pump A111-PPF A111-PPF A111-PPF A113-PPF A113 | P-125A P-125B P-130A P-130B g | | | |
| Rejected Date : | | | ⊕ Coupl ⊕ Frame ⊕ Geart | ling e/Support box | | | |
| Rejected Comment | | | ⊕ Heat I ⊕ Impel ⊕ So C ⊕ A a ⊕ So C ⊕ A a ⊕ So W ⊕ So W | Exchanger ler Vanes racked ammed jear | | | • |
| | | | | ОК | Clear Fields | Cancel | |

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RtDuet & PI in the Control Room



RtDuet User Interface

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RtDuet & PI in the Control Room



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RtDuet & PI in the Control Room



PI Manual Logger

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Shutdown vs. Slowdown

- System captures full shutdown events *and* production slowdown events
- Full Shutdown \rightarrow Equipment is Stopped
- Production Slowdown \rightarrow Throughput is less than equipment capacity
- Shutdown and slowdown events are stored separately for analysis
- Slowdown periods are automatically converted to equivalent full shutdown times
 - A 1-hour slowdown event where the equipment is running at 50% capacity is equivalent to a ½ hour full shutdown event

Key Performance Indicators

| | Nominal (Calendar) | | | | | | | | | |
|---------------------------|---------------------|-----------------|---------|------------------|-----------|----------|--------------------|-----------|---------|--|
| Mobile and Fixed Plant | | | | Maintenance Down | | | | | | |
| | Operatin | | | | | | | | | |
| | Producti | ve | | | у | oduction | 8 | 8 | | |
| Applicable to Fixed Plant | Net Productive | | ance | on Delay | ig Standt | duled Pr | tuled Los | duled Los | ed Loss | |
| / Optional for Mobile | Valuable Productive | Quality Loss | Perform | Producti | Operatir | No Sche | Unscher Failure | Unscher | Schedul | |

| Availability | _ | Available Time (AT) | 0/ |
|--------------|---|---------------------|----|
| Availability | - | Calendar Time (CT) | 70 |
| | | | |

| | | Utilised Time (UT) | ~ |
|-------------|---|--------------------|---|
| Utilisation | = | Calendar Time (CT) | % |

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Reporting

Out-of-the-box dashboards



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Reporting

 In-house reports (Excel, Crystal, etc.)



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Reporting: Pareto

Autoclave Unscheduled Maintenance (Top 10) January-February 2014



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Reporting: Automatic Email

- Quick identification of coding errors after each shift
- Data quality is fundamental Garbage In = Garbage Out

From: dompvmwb1<dompvmwb1@barrick.com> To:

To: Cc

Subject: Process Downtime Summary

Process Downtime Summary: Feb 28 2014 7:01AM

| Area | Hours | Reason | Category | Туре | Comment | Start Time |
|--------------------|-------|--------------------------------|----------------------|----------|--|---------------------|
| AUT150-Train1 | 0.91 | Constrained\Ore Grinding | Constrained | Slowdown | Reducing throughput due to sulfur and density increases. K.Mc. | Feb 27 2014 8:17PM |
| AUT250-Train2 | 0.15 | Constrained\Ore Grinding | Constrained | Slowdown | Mill down, dropped throughput to conserve inventory. K.Mc. | Feb 27 2014 7:00PM |
| AUT350-Train3 | 0.91 | Constrained\Ore Grinding | Constrained | Slowdown | Reducing throughput due to sulfur and density increases. K.Mc. | Feb 27 2014 8:17PM |
| Lime Slaker | 4.28 | | | Shutdown | | Feb 28 2014 12:42AM |
| Limestone Crushing | 1.23 | Conveyor\6183-CVB-540\Belt | Operations-Scheduled | Shutdown | Starting Crusher | Feb 27 2014 8:17PM |
| Limestone Grinding | 0.21 | Constrained\Power | Constrained | Shutdown | ball mill trip on low frequency | Feb 27 2014 11:29PM |
| Limestone Grinding | 0.08 | Constrained\HDS | Operations-Unsched | Shutdown | LIME SLURRY STORAGE TANKS ARE FULL | Feb 27 2014 7:00PM |
| Ore Crushing | 0.07 | Constrained\Ore Mining\No Feed | Constrained | Shutdown | waiting on trucks | Feb 28 2014 1:30AM |
| Ore Crushing | 0.08 | Constrained\Ore Mining\No Feed | Constrained | Shutdown | waiting on trucks | Feb 28 2014 12:41AM |
| Ore Crushing | 0.18 | Constrained\Ore Mining\No Feed | Constrained | Shutdown | waiting on trucks | Feb 28 2014 12:06AM |
| Ore Grinding | 0.1 | Conveyor\3140-CVB-130 | Operations-Unsched | Shutdown | pull cord | Feb 28 2014 4:11AM |

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Functional Summary

- PI Points provide the equipment operating status to RtDuet
- Control room operators classify each downtime event shortly after it occurs
- A web server hosts the graphical user interface
- PI Data Archive and PI AF data that is generated by RtDuet is replicated in a separate SQL Server database for reporting
- Downtime data is available directly in AF for reporting
- Key data is redirected to PI tags, such as total shift downtime
- The Time Usage Model is used to generate the KPI calculations

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RtDuet System Architecture



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RtDuet in PI AF

| Q \\DOMPVMPI1\RtDuet 2.4 - PI System Explorer | | _ | Rear Di | of the local division of the | Name of Taxablan | | | | | |
|---|---------|---|------------|------------------------------|------------------------------------|--|--|--|--|--|
| File Edit View Go Tools Help | | | | | | | | | | |
| 豫 Database 🛗 Query Date 🔹 🥵 ၊ 🚱 Back 🏐 🗟 Check Ir | S 🗸 🖻 | Refresh 資 New Element 🕞 🔤 New At | tribute | | | | | | | |
| Elements | AUT1 | L50_Zero_TPH | | | | | | | | |
| Elements | General | General Child Elements Attributes Ports Version | | | | | | | | |
| Em Pueblo Vieio | Filter | Filter | | | | | | | | |
| | | Name | A Value | Data Reference | Settings | | | | | |
| | | I Active | True | <none></none> | | | | | | |
| 🖶 🗃 AUT 450 | | Operator | < | <none></none> | | | | | | |
| in a logrations | | 🗉 Rank Index | 0 | <none></none> | | | | | | |
| 🖮 🗇 AUT150-Train 1 | | 💷 Reason Code Check Latency | 0 | <none></none> | | | | | | |
| AUT150_Zero_TPH | | 💷 Reason Code Tag | | <none></none> | | | | | | |
| | | E Reference | 10 | <none></none> | | | | | | |
| | | 🍼 Tag | 229.862976 | PI Point | \\dompvmpi1\4141_AUT150_Train1_TPH | | | | | |
| i i AUT450-Train4 | | 💷 Target is a Tag | False | <none></none> | | | | | | |
| I IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII | | I Target Set Point | 0 | <none></none> | | | | | | |
| 🗄 🗃 CCD and Hot Cure | | 💷 Туре | Primary | <none></none> | | | | | | |
| En CN Destruction | | 💷 Used For Reason Check | False | <none></none> | | | | | | |
| iti⊷ ☐ Grinding Ops iti⊷ ☐ HDS | | | | | | | | | | |
| Ginding Ops Ginding Ops HDS HDS Horizer | | Ised For Reason Check | False | <none></none> | | | | | | |

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PI Event Frames

\\DOMPVMPI1\RtDuet 2.4 - PI System Explorer Edit View Go Tools Help File 🖀 Database 🛗 Query Date 🔹 🛃 🔇 Back 🏐 📕 Check In 🧐 🖌 Refresh 🔛 New Event Frame vent Frames Event Frame Search 5 L Event Frame Searches Event Frame Search 1 Filter - By Event Frame Search 2 Name 3/2/20... [2.13:24:45] 3/5/20... Start Time End Time △ Template Primary Element Weighted Duration Created By Event Frame Search 3 - By Event Frame Search 5 AUT450-Train4_20140302_193223 3/3/2014 2:07:21 AM AUT450-Train4 3/2/2014 7:32:23 PM RtDuet Downtime Event 19.06 RtDuet2012CalcEngine i → ⊢ → wt duration = 0 0.88 AUT450-Train4 20140303 062710 3/3/2014 6:27:10 AM 3/3/2014 7:00:00 AM RtDuet Downtime Event AUT450-Train4 RtDuet2012CalcEngine -transfer Searches 🗄 🗄 🥣 🕁 Transfer Search 1 AUT450-Train4_20140303_070000 3/3/2014 8:47:57 AM RtDuet Downtime Event AUT450-Train4 4.37 RtDuet2012CalcEngine 3/3/2014 7:00:00 AM AUT450-Train4 20140303 174120 3/3/2014 5:41:20 PM 3/3/2014 7:00:00 PM RtDuet Downtime Event AUT450-Train4 4 4 2 RtDuet2012CalcEngine Н AUT450-Train4_20140303_190000 3/3/2014 7:00:00 PM 3/3/2014 10:57:20 PM RtDuet Downtime Event AUT450-Train4 8 91 RtDuet2012CalcEngine AUT450-Train4 20140304 000554 3/4/2014 12:05:54 AM AUT450-Train4 1.26 3/4/2014 1:34:12 AM RtDuet Downtime Event RtDuet2012CalcEngine AUT450-Train4_20140304_034745 3/4/2014 3:47:45 AM 3/4/2014 4:25:47 AM RtDuet Downtime Event AUT450-Train4 0.86 RtDuet2012CalcEngine AUT450-Train4 20140304 051020 3/4/2014 5:10:20 AM 3/4/2014 5:42:30 AM RtDuet Downtime Event AUT450-Train4 0.37 RtDuet2012CalcEngine AUT450-Train4 20140304 055805 3/4/2014 5:58:05 AM 3/4/2014 7:00:00 AM RtDuet Downtime Event AUT450-Train4 0.53 RtDuet2012CalcEngine AUT450-Train4 20140304 070000 RtDuet Downtime Event AUT450-Train4 10.53 RtDuet2012CalcEngine 3/4/2014 7:00:00 AM 3/4/2014 10:29:42 AM H AUT450-Train4 20140304 102942 3/4/2014 10:29:42 AM 3/4/2014 7:00:00 PM RtDuet Downtime Event AUT450-Train4 510.3 RtDuet2012CalcEngine AUT450-Train4 20140304 190000 3/4/2014 7:00:00 PM 3/5/2014 2:42:19 AM RtDuet Downtime Event AUT450-Train4 462.32 RtDuet2012CalcEngine 12.25 AUT450-Train4 20140305 024219 3/5/2014 2:42:19 AM 3/5/2014 3:01:11 AM RtDuet Downtime Event AUT450-Train4 RtDuet2012CalcEngine AUT450-Train4_20140305_030111 RtDuet Downtime Event AUT450-Train4 4.33 3/5/2014 3:01:11 AM 3/5/2014 3:05:31 AM RtDuet2012CalcEngine AUT450-Train4 20140305 030531 3/5/2014 3:05:31 AM 3/5/2014 7:00:00 AM RtDuet Downtime Event AUT450-Train4 43.91 RtDuet2012CalcEngine AUT450-Train4 20140305 070000 3/5/2014 7:00:00 AM 3/5/2014 8:24:07 AM RtDuet Downtime Event AUT450-Train4 1.89 RtDuet2012CalcEngine

3/5/2014 8:57:07 AM

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AUT450-Train4 20140305 085707

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RtDuet Downtime Event

RtDuet2012CalcEngine

AUT450-Train4

0

Benefits

- Less time spent compiling data and generating reports
- More time spent analyzing the results
- Improved identification of process bottlenecks
- Reliable source of data to justify capital expenditures
- Greater visibility to the impact of short duration yet frequent events

Indirect Benefits

- Greater overall involvement at all levels of the organization in tracking and evaluating production losses due to downtimes
- Tracking production slowdowns has the added benefit of motivating operators to take the necessary actions to consistently maintain production levels above the minimum threshold

Project Challenges

- Teaching operators to use consistent criteria when classifying downtimes (eliminate bias among operators)
- Initial difficulties accessing RtDuet data
- Managing the continually evolving requirements of end users (supervisors, managers, etc.) as they became familiar with the benefits of the system

Future Plans

- Implement RtDuet in remaining plant areas still not using the system
- Incorporate RtDuet data in dashboards for large displays in central areas
- Add greater detail to the reason code tree
- Possibly expand downtime data integration in the PI AF plant hierarchy (for reporting and ease of navigation)

Conclusion

- Accurate downtime tracking can provide a wealth of insight into the true factors affecting your productivity
- Teaming RtDuet with your existing PI System can simplify and improve downtime tracking in your plant

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- HANK You



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Usage Statistics

- 28 machine centers being monitored and coded (many more just being monitored
- Daily KPIs are generated for each of these machine centers
- Average of 33 events/day are being generated and coded across the plant