KPI, OEE and Downtime Analytics

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An ICONICS Whitepaper
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Visualize Your Enterprise™

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1 About This Document

1.1 Scope of the Document

It is the intent of this document to define and illustrate the collection and use of metric data in determining process efficiency and the reasons for the loss of time or process. An efficient, flexible methodology using the ICONICS BizViz™ and GENESIS32™ software suites is described.

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2 Introduction

2.1 ICONICS Tools Provide Downtime Analytics

The ICONICS GENESIS32 and BizViz products enable plants to significantly improve efficiencies by capturing detailed events, faults, and production information from equipment and operators. ICONICS' data collection methodology allows a customizable data set in an open database format, thus providing the necessary data, for a variety of analytics with the ICONICS reporting, data management and visualization toolsets to enable improvement of the overall production process.

Plant engineers and managers need to make informed decisions and implement best practices and may need to have some of the following questions answered:

- Which machines need to be serviced, replaced, or decommissioned?
- Have my production goals been achieved? Am I on target to achieve them?
- Were the machine and station cycle times within design specifications?
- Are certain production cells or stations bypassed during production?
- What is the total performance and total availability?

Plant and operations personnel can make informed decisions using advanced downtime reporting capabilities. The following white paper explains the ICONICS Downtime Analytics solution and the modules that comprise it.

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3 Determining Which KPI Values Are Important

There are many types of KPIs. Each industry has its own. In this document we will be using OEE and Downtime to demonstrate the collection, analysis, and reporting of system data.

3.1 Definition of OEE and Downtime

We must first define what is OEE and Downtime in order to become familiar with the parameters.

3.1.1 OEE Overview

Overall **E**quipment **E**ffectiveness or **OEE** is a percentage calculation determined by 3 major components. The use of OEE can greatly enhance your ability to analyze the process in question and focus on the root cause of low OEE.

AVAILABILITY: Total time equipment was scheduled to run divided by the total possible time the equipment could have been scheduled to run.

Example: $\frac{\text{Total Scheduled Runtime = 7 hours}}{\text{Total Time in Shift = 8 hours}} = 0.875 * 100 = \mathbf{87.5\%}$

PERFORMANCE: Total time equipment was in cycle producing divided by the total time scheduled to run.

Example: $\frac{\text{Total Time in Cycle = 6.2 hours}}{\text{Total Scheduled Runtime = 7 hours}} = 0.886 * 100 = \mathbf{88.6\%}$

QUALITY: Ratio of good parts produced divided by total parts produced.

Example: $\frac{\text{Good Parts Produced = 900}}{\text{Total Parts Produced = 1000}} = 0.90 * 100 = \mathbf{90.0\%}$

OEE: These 3 percentages are multiplied together then divided by 10,000 to calculate the overall equipment effectiveness (OEE).

Example: $\frac{87.5 * 88.6 * 90.0}{10{,}000} = \mathbf{69.77\%}$

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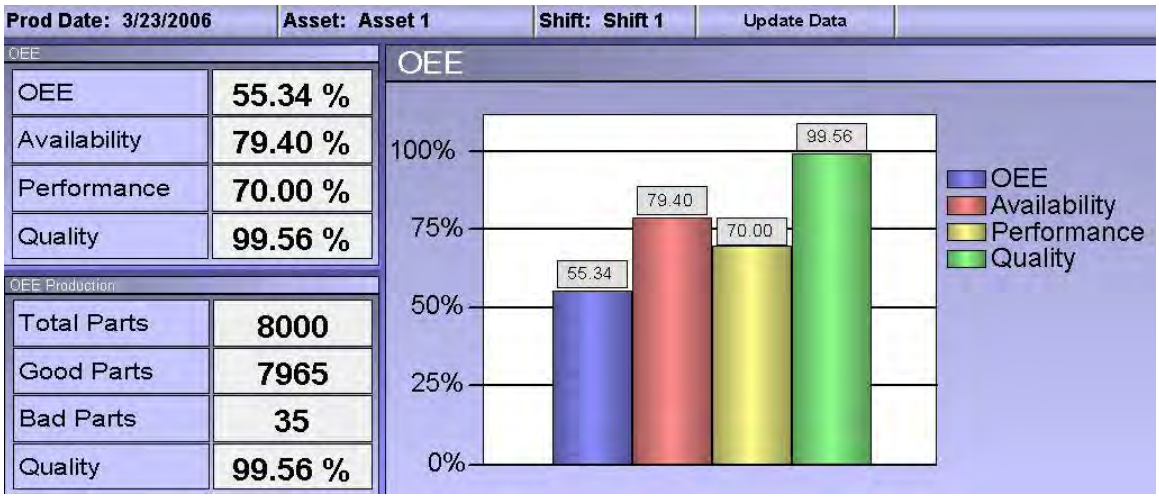
3.2 OEE Visualization

This display shows Historic OEE data delivered to the end user by a typical ICONICS Downtime Application.



3.2.1 Downtime Overview

Downtime is one of the key components of the Performance factor of OEE listed above. Downtime is any time that will reduce the Total Time in Cycle component. In general, break times and lunch times are not considered downtime as they are already included in the Total Scheduled Runtime calculation.

There are many types of downtime reasons. This is a small list of the possible reasons:

- Equipment Faulted: Control system detects an undesirable condition that could cause equipment, part or personnel damage or injury and shuts down process.
- Equipment Over Cycle: Equipment has taken longer to complete a cycle than configured. Usually this is due to operator content such as part loading and unloading.
- Changeover: Equipment is converting from one part type to another. Usually requires tooling or fixture changes. Control system is then notified of the change.
- In Process Maintenance: Components or tooling used within the process need replacement or attention due to wear or other criteria.
- Scheduled Maintenance: Equipment is taken out of production for servicing. Usually this is for preventative maintenance such lubrication or replacement or repair of worn or defective components.
- Starved: Equipment has run out of raw materials or subcomponents and is waiting. Equipment can also be waiting for a part to work on due to preceding station delays.
- Blocked: Equipment is unable to release current part. This can be caused by the fact that there is no more room in finished part container or it is absent. It can also be caused by the next station has not released its part and there is no buffer between them.
- Production Meeting: Supervisor calls a meeting. Usually for quality alerts or scheduling changes.

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These reasons, some automatic and some requiring operator entry, should be entered into the system before restarting so the monitoring application can log the reason as the equipment goes back into production.

3.3 Selection of Production Events and Additional Data

Now that we have some definition of our events that we want to collect, we will need to examine the control system for the proper signals to monitor.

3.3.1 Select Production Events

It is very good practice to define a set of registers or bits in the control system that will always be allocated in every system in order to maintain consistency and ease of implementation on the logging side. If this is done properly the logging system has only to change the control system address in order to connect to the next system's events. We will call this the Common Event Interface. Once this memory is allocated, logic should be developed to connect the actual signals in the system to the Event Interface.

In the control system, events should be selected that give indications of Faulted, Part Present to work on, Starved, Blocked, Cycle Complete and Part Accepted.

3.3.2 Select Additional Data for Events

Once the events to be monitored have been configured in the control system, we must consider how the reporting system will be querying the data. In most cases some additional data is required besides just the event name and time stamp. The following is a list of typical data required for good reporting and ease of configuration.

1. Process ID – Numeric value defined in the database which references the process information and its location in the facility.
2. Production Date – String value which is the date on which these events will be charged. This is not always the time stamp date. This is due to the fact that in most cases events occurring after midnight on the second shift will be charged to the previous day. Alternatively, events occurring before midnight on the third shift are usually charged to the next production day. This value is generated by a Shift Engine Procedure in the database which references a defined shift schedule.
3. Shift Number – Numeric value which represents the current shift. This value is also generated by the Shift Engine Procedure in the database.
4. Part Type or Product – This string value is read from the control system and represents the current part type or product being produced.
5. Serial Number or Sequence – If available, this parameter can increase the resolution of the data down to the individual part being produced.
6. Event Type – This numeric value is defined in a reference table in the database. Each type of event will have a unique value. This will enable reports to query using the numeric value instead of the event name, greatly increasing the speed of queries that report on specific events.

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4 Production Reports

The following sections illustrate how with ICONICS BizViz applications, namely ReportWorX™ and Alarm Analytics™, one can create a robust and scaleable data collection and reporting system that can be easily deployed to many facilities.

4.1 Production Shift Summary Reports

This report shows the Production data for a given shift and day. It displays counts for hourly periods showing Expected Count, Actual Count and Efficiency. Each period is broken up into 15 minute quarters with their respective counts. A production reason entry system is used to allow operators to enter a text reason for any production losses.

Period	Start	Stop	Exp	1/4	2/4	3/4	4/4	Actual	Differ.	Downtime	First WO	Last WO	Efficiency
Period 1	6:15AM	7:15AM	20	2	10	10	3	25	5	7	2156733	2158002	125
Period 2	7:15AM	8:15AM	20	4	8	8	7	27	7	10	2157179	2157887	135
Period 3	8:15AM	9:15AM	15	2	8	8	7	25	10	15	2157014	2156983	166.67
Period 4	9:15AM	10:15AM	20	9	7	7	12	35	15	22	2157921	2156674	175
Period 5	10:15AM	11:15AM	5	11	7			18	13	19	2156674	2157045	360
Period 6	11:15AM	12:15PM	20		2	6	8	16	-4	-6	2158038	2156671	80
Period 7	12:15PM	1:15PM	20	8	7	11	6	32	12	18	2156688	2156352	160
Period 8	1:15PM	2:15PM	15	7		5	6	18	3	4	2156352	2156681	120
Period 9	2:15PM	3:15PM	20	2	5	6		13	-7	-10	2158094	2158245	65
Shift Total			155	45	54	61	49	209	54	79			

4.2 Station Downtime Report

This report shows the downtime duration for each station on the line in the bar length.
Each report also includes a series for the count of occurrences of each downtime cause.

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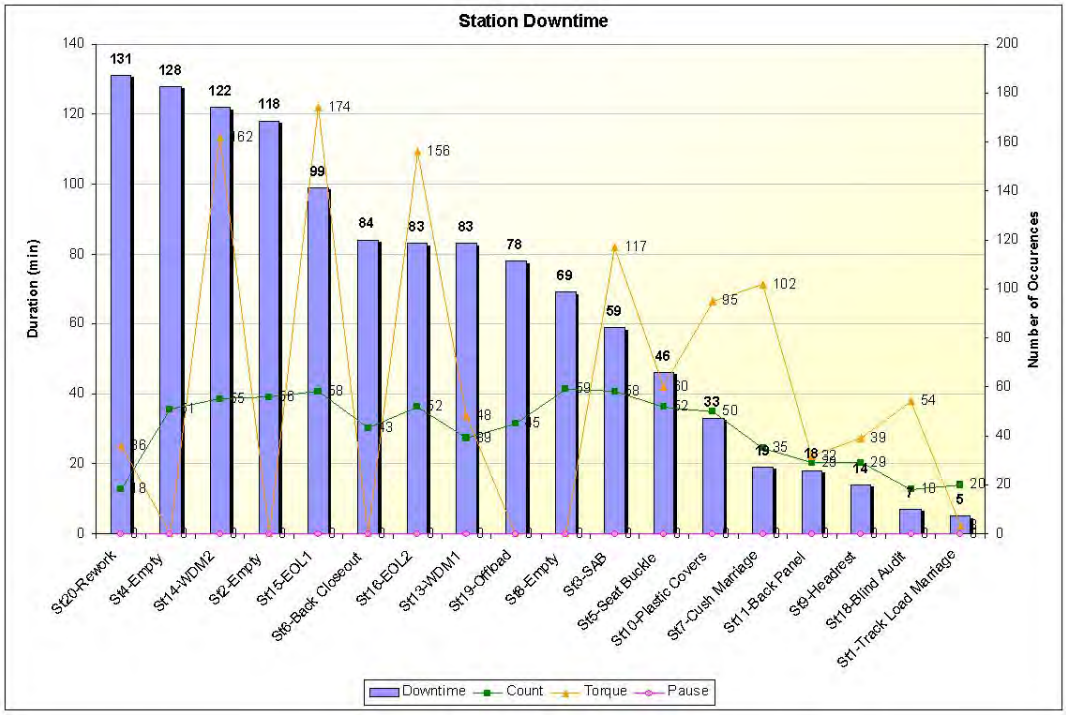
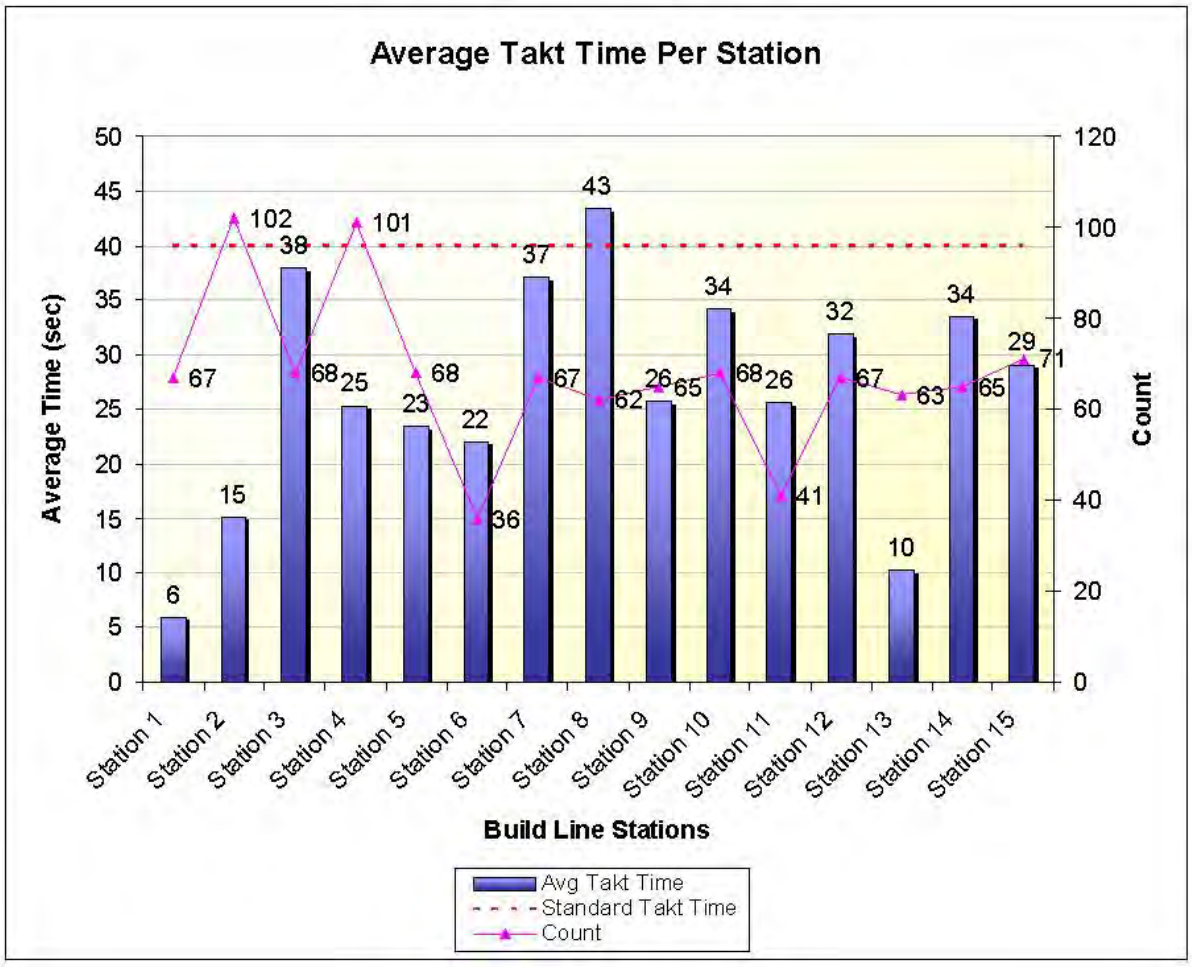


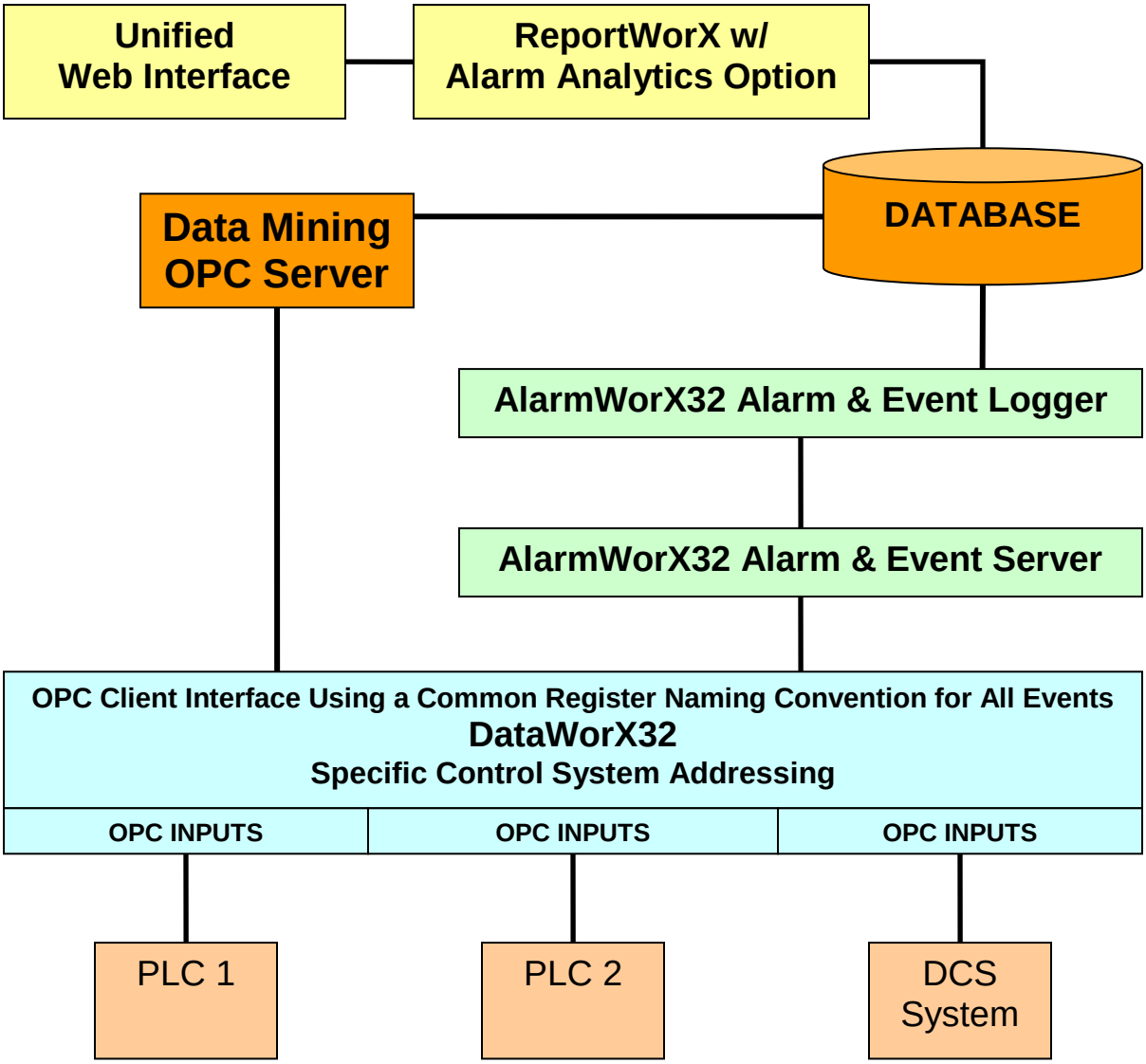
4.3 Average Takt Time Reports

This report shows the Average Takt Time for each station on the line. The count of cycles and the expected Takt Times are also shown.


Average Takt Time Per Station
Average Time (sec)
Count
Build Line Stations
Station 1
Station 2
Station 3
Station 4
Station 5
Station 6
Station 7
Station 8
Station 9
Station 10
Station 11
Station 12
Station 13
Station 14
Station 15
6
15
38
25
23
22
37
43
26
34
26
32
10
34
29
67
102
68
101
68
36
67
62
65
68
41
67
63
65
71
Avg Takt Time
Standard Takt Time
Count

5 Downtime System Architecture

Using the ICONICS GENESIS32 HMI/SCADA platform and the ICONICS BizViz manufacturing intelligence suite we can put together a very modular and flexible architecture which can be easily adapted to your particular system requirements. The following diagram shows a typical configuration for a collection system:



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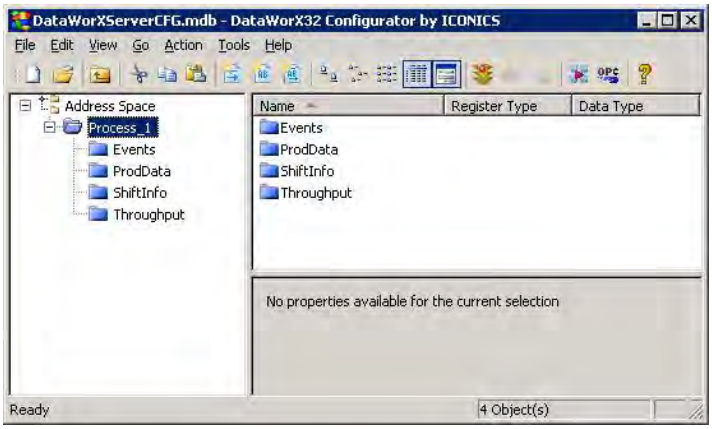
6 Application Overview

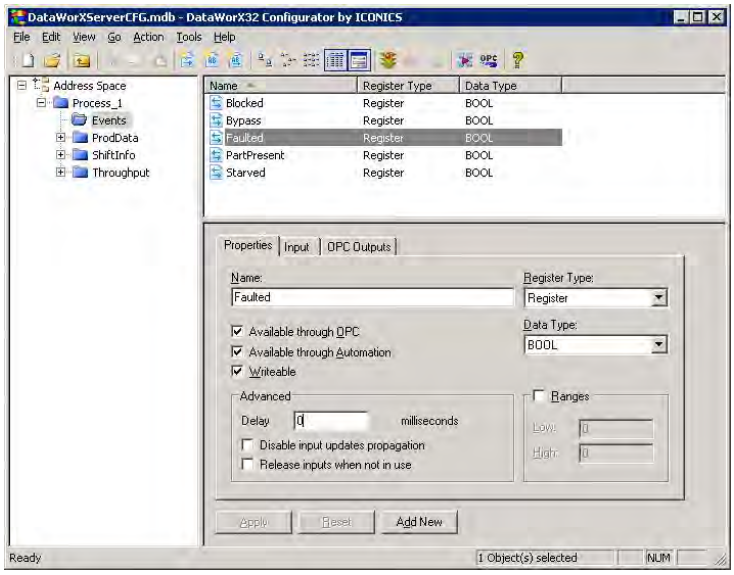
The following sections illustrate how with ICONICS GENESIS32 and BizViz Applications one can create a robust and scaleable Downtime data collection and reporting system that can be easily deployed to many facilities.

6.1 DataWorX™32: Centralized Common Naming Architecture

The ICONICS DataWorX32 product provides a centralized common naming architecture and is simultaneously an OPC Client and an OPC Server. In a typical Downtime Reporting system DataWorX32 is used to provide an interface layer to all of the client applications and control systems. It translates the control systems' internal address space into the Common Event Interface. It also provides a place to store all current information about the production data, including current shift information and throughput data.



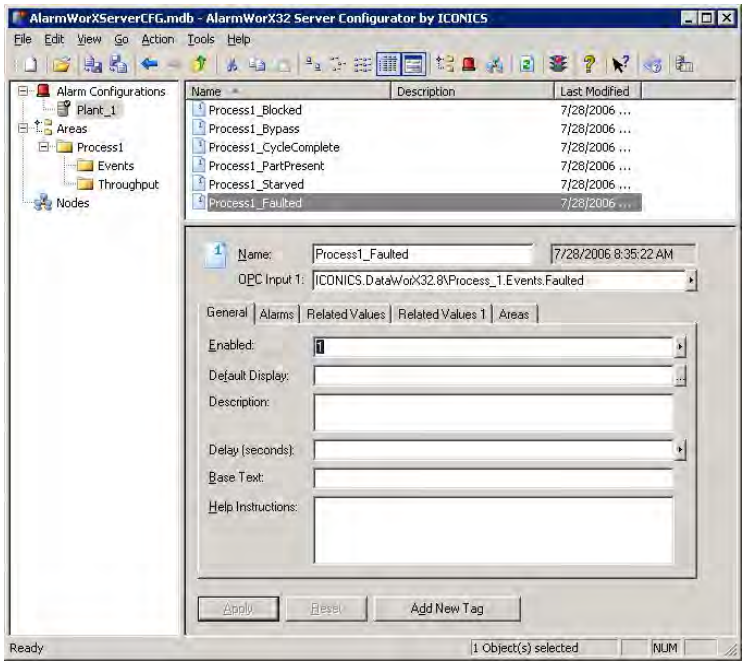
DataWorX32 Downtime System Folder Structure



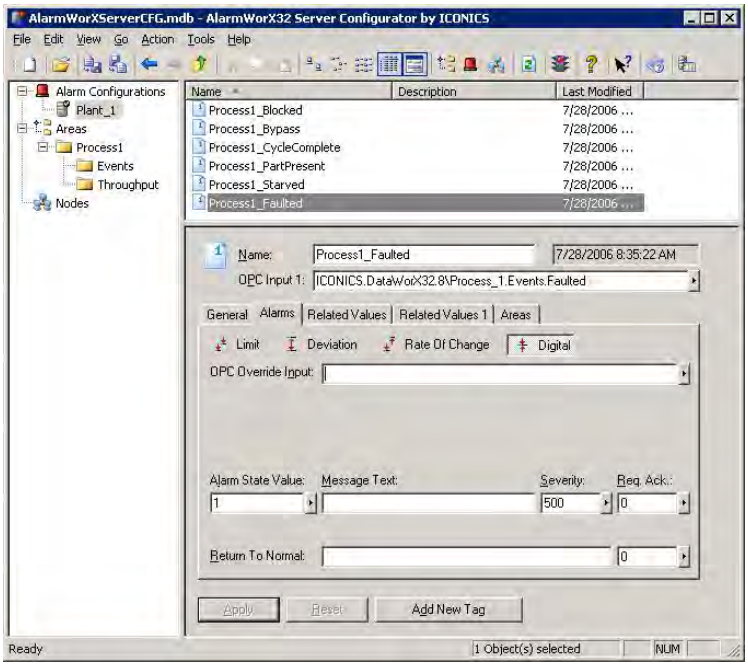
Downtime Event Registers in DataWorX32

6.2 AlarmWorX™32 Server: OPC A&E Downtime Event Notification

ICONICS AlarmWorX32 is an OPC Alarm & Events Server for delivering real-time alarm and event information throughout your enterprise. In a Production Monitoring or Downtime Reporting application it is primarily used to monitor control system events coming from DataWorX32. It will monitor and capture triggers from the control system along with the necessary related data and generate OPC A&E Events to be picked up by the AlarmWorX32 Logger.



AlarmWorX32 Server Configuration – General Tab



AlarmWorX32 Server Configuration – Alarms Tab

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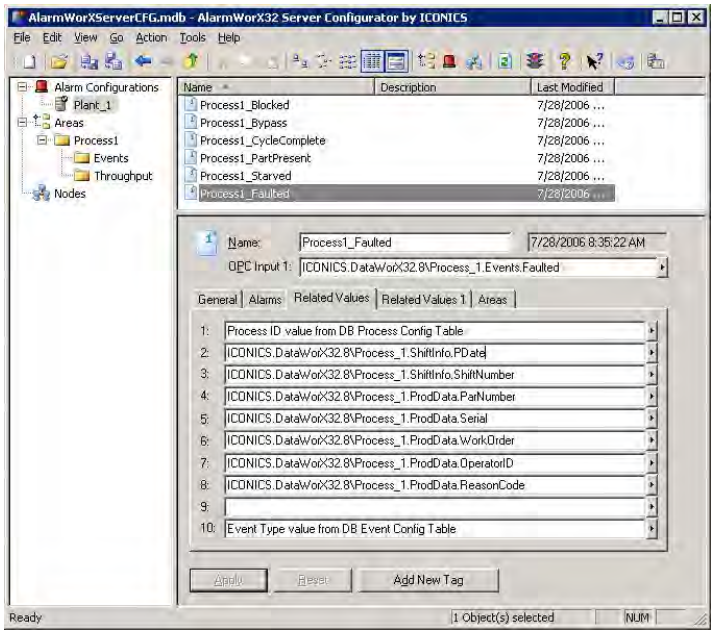
There is also a Related Values tab for associating additional values to a certain Event. When used is conjunction with the AlarmWorX32 Logger these related values can then be reported on and filtered on.



AlarmWorX32 Server Configuration – Related Values Tab

6.3 AlarmWorX32 Logger: OPC A&E Downtime Event Capture

Many automated lines have hundreds or even thousands of stoppages per week. It is not practical to involve operators in every one of these events. By utilizing ICONICS AlarmWorX32 Logging for downtime event data capture and ICONICS ReportWorX for downtime reporting, pertinent information can selectively be filtered and distributed to plant operators as necessary.

6.4 ReportWorX™: Powerful Real-time Reporting and Analytics

ReportWorX is a powerful, advanced reporting tool based on Microsoft Excel that is easy to learn and can integrate information from any data source, including popular HMI, SCADA, MES and control systems. The ability of ReportWorX to connect to real-time OPC data in addition to databases such as SQL, Oracle, SAP, AspenTech, OSI PI and more, makes it the perfect compliment to the GENESIS32 data collection products for advanced Downtime Analysis. ICONICS offers the following pre-configured templates as part of its Downtime Analytics module, or customize your own templates with ReportWorX' easy-to-use data mining wizards:

- Production Shift Summary
- Station Downtime
- Average Takt Time

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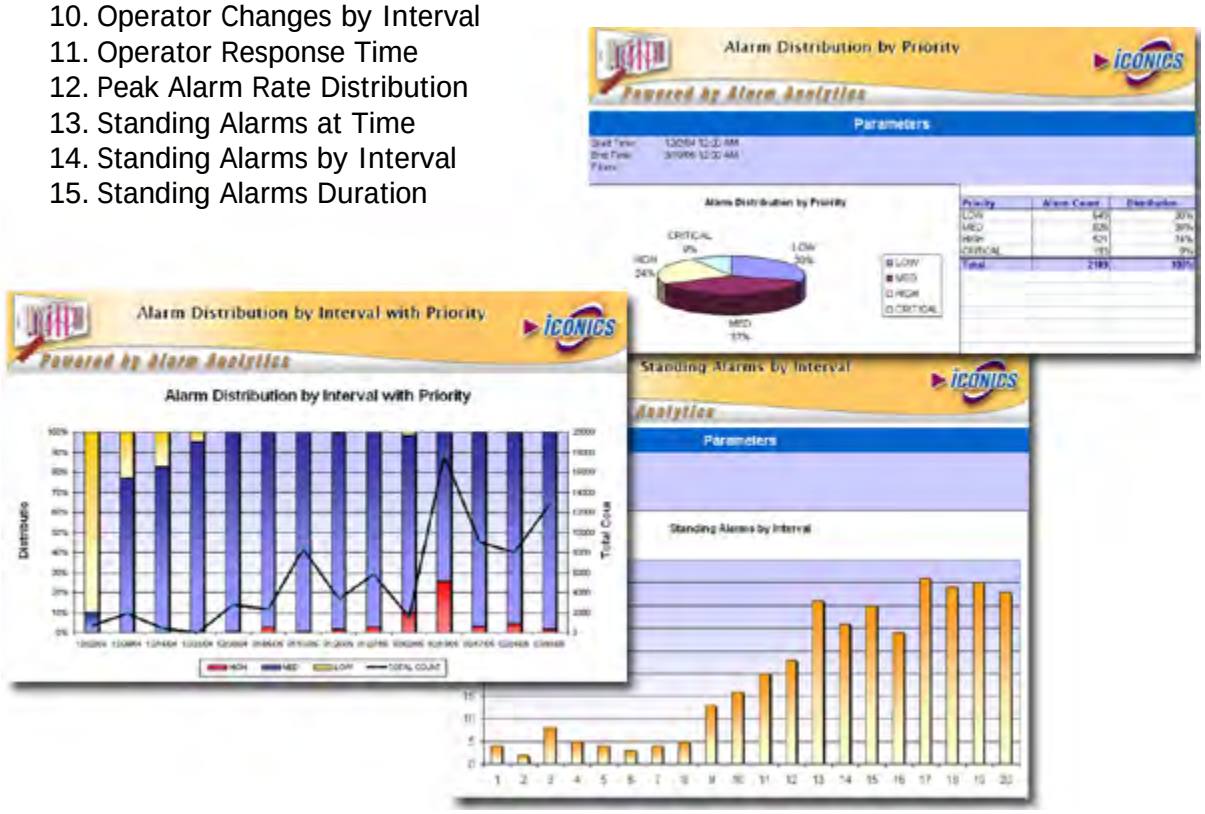
6.5 Alarm Analytics: Industry Standard Based Alarm Reporting

ICONICS' Alarm Analytics product enables plant personnel to Visualize, Analyze, and Manage alarm information in accordance with the industry's best practices. It is based on EEMUA and OSHA alarm management specifications, and therefore ensures proper analysis of alarms and events in a manufacturing plant. That analysis can reveal significant opportunities for improving current operations and mitigating abnormal situations. The ICONICS Alarm Analytics module captures and analyzes all alarm and event information to identify frequent alarms, chattering alarms, cross-correlated alarms, and many more alarm-related issues. This module also records, analyzes, and displays operator-initiated process changes, which then yield significant insight into the performance of the entire system.

In addition to the insightful reports that are provided as part of ICONICS ReportWorX, you can leverage Alarm Analytics to perform an in-depth analysis of events generated by ICONICS AlarmWorX32. Here are some of the pre-configured industry standard templates that you can take advantage of as part of your Downtime Reporting package:

1. Alarm Distribution by Interval
2. Alarm Distribution by Interval with Priority
3. Alarm Distribution by Priority
4. Alarm Rate Distribution by Interval
5. Alarm Tag Chattering
6. Alarm Tag Frequency
7. Alarms from Worst Actors by Interval
8. Average Alarm Rate per Minor/Major Interval
9. Cross-Correlation Analysis
10. Operator Changes by Interval
11. Operator Response Time
12. Peak Alarm Rate Distribution
13. Standing Alarms at Time
14. Standing Alarms by Interval
15. Standing Alarms Duration



7 Summary

The previous sections illustrated how ICONICS GENESIS32 and BizViz applications can be used to create a robust and scaleable data collection and reporting system that can be easily deployed to many facilities.

A Cost-Effective Solution

Many automated lines have thousands of stoppages per week. It is not practical to involve operators in all of these events. Using the tools provided as part of the ICONICS BizViz Suite of Manufacturing Intelligence products a broad list of capabilities are provided at a fraction of the cost associated with comparable customer solutions, especially when the cost of supporting these custom applications is considered.

- Logic is configured directly within the BizViz and GENESIS32 Suite of products, thus allowing consolidation of configurations at an ideal level for each situation, as opposed to many configurations defined in distributed hardware controllers such as programmable logic controllers, distributed control systems or other remote devices.

- Flexible reports are defined as required.

- This solution works with existing software and infrastructure. There is no need to replace existing data collection systems, HMIs or control systems.

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Founded in 1986, ICONICS is an award-winning independent software developer offering real-time visualization, HMI/SCADA, energy, fault detection, manufacturing intelligence, MES and a suite of analytics solutions for operational excellence. ICONICS solutions are installed in 70% of the Fortune 500 companies around the world, helping customers to be more profitable, agile and efficient, to improve quality and be more sustainable.

ICONICS is leading the way in cloud-based solutions with its HMI/SCADA, analytics, mobile and data historian to help its customers embrace the Internet of Things (IoT). ICONICS products are used in manufacturing, building automation, oil & gas, renewable energy, utilities, water/wastewater, pharmaceuticals, automotive and many other industries. ICONICS' advanced visualization, productivity, and sustainability solutions are built on its flagship products: GENESIS64™ HMI/SCADA, Hyper Historian™ plant historian, AnalytiX® solution suite and MobileHMI™ mobile apps. Delivering information anytime, anywhere, ICONICS' solutions scale from the smallest standalone embedded projects to the largest enterprise applications.

ICONICS promotes an international culture of innovation, creativity and excellence in product design, development, technical support, training, sales and consulting services for end users, systems integrators, OEMs and Channel Partners. ICONICS has over 300,000 applications installed in multiple industries worldwide.

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