Implementing a Workflow Solution
Leveraging SCADA and GIS/CMMS
at the Waterford Township DPW

Charter Township of Waterford
Oakland County, Michigan
DPW Assets

- 360 Miles of Water Main and Appurtenances
- 19 Production Wells
- 2 Elevated and 1 Ground Storage Tanks
- 13 Iron Filtration Plants
- 1 High Service Pumping Station
- 355 Miles of Sanitary Sewer
- 62 Sewer Lift Stations
- 15 Township Buildings
- 5 Township Cemeteries
- 230 Vehicle Fleet
Water Infrastructure Features

- 3,500 Gate Valves
- 3,400 Fire Hydrants
- 7,000 Water Main Segments
- 11 Water Treatment Plants
- 3 Elevated and Ground Storage Tanks
- 24,000 Customer Water Leads
Sewer Infrastructure Features

- 8,300 Sewer Manholes
- 8,500 Sewer Main Segments
- 62 Sewer Pumping Stations
- 25,000 Customer Sewer Leads

Totaling over 80,000 features that need attributes maintained and work history tracked
Major Technology Design Criteria

- Utilization of cost effective and open architecture based technologies
- Recognition of evolutionary change
- Focus on people and informational needs
- Recognition of different environments
  - Informational
  - Organizational
  - External/Public
- Ultimate goal of Enterprise Wide Application
Core DPW Technological Components

- GIS
- Asset Management System
- Utility Ticket Management
- Document Management System
- Wide Area Wireless Network
- Fixed Network Meter Reading/Automatic Meter Reading
- Utility Billing System
- Fuel Management System
- Supervisory Control And Data Acquisition (SCADA)
Computer Maintenance Management System (CMMS) Criteria

- GIS is viewed as the backbone application onto which specific applications would be developed to improve operations and data mining.

- CMMS to provide the critical application that would be used to schedule, track and archive all activities and costs.

- A properly selected CMMS would interface directly with the GIS application and would ensure that the GIS would be used daily as a part of the business process. It would also be used to interface with other core platforms for the generation of work orders and activity tracking.
Selected DPW CMMS

- Azteca Cityworks used by Waterford DPW
  - Functions within the ESRI environment
  - Geodatabase-Centric
  - Currently over 240,000 work orders created
SCADA

- Facilitates efficient monitoring, control and optimization of water and sewer operations.
- Generates large amounts of operational information
- Alarms generated provide a major basis for CMMS work orders
Integrating SCADA and CMMS

• Originally developed a basic interface to speed SCADA related work order creation in CMMS, but it was cumbersome, had limited functionality and involved a lot of user interface

• Needed a “middleware” type of software to automatically trigger and populate SCADA related data into work orders in CMMS
Project Objectives

• Integration of SCADA alarms into Cityworks though GE Workflow via Work Order API
• Electronic Standard Operating Procedures (eSOP) - Provide method for documenting proper process and transferring institutional knowledge
• Provide a workflow component for SCADA – Auto task generation
The Solution

GE Workflow Software Integration “Middleware”

• Event Based, Process-Centric
  – Manual task automation
  – Digitized Standard Operating Procedures
  – Alarm Response Management
  – Direct Integration with SCADA and CMMS
  – Service Oriented Architecture – Key to Integration
Workflow: Middleware Solution

- Provides the ability to apply logic to SCADA tags for automatic work order generation in CMMS
- Create Electronic Standard Operating Procedures
- Forms for data collection
Project Overview

Cityworks

- CMMS
  - Primary System for Work Management
  - ESRI Geodatabase-Centric
  - Currently over **230,000** work orders created
Project Implementation

Phase I

- Automated workflows based on SCADA condition events
  - Pump number of starts
  - Pump runtimes

- Automated workflow based on time event
  - Sewer Station Site Inspections – 5-7 inspections per day as part of a 2 week cycle

- Incorporation of Cityworks Work Order API for automatic work order generation from SCADA into CMMS

Phase II

- Integration of Document Management System (OnBase)
- Development of additional workflows by internal staff
Workflow Overview

Workflow is made up of four main components

• Equipment Model – Models site/equipment and linkage of SCADA values

• Events – Conditional expressions or time based events that trigger workflows

• Workflow Templates – Configured Templates that contain automated process and manual steps

• Schedules – Combines events with workflow templates to initiate workflows

These components create a process driven workflow for managing by exception
Workflow Equipment Model

- Model of site and equipment
- Stores real-time SCADA values for evaluation

Linked SCADA Tags

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Linked</th>
<th>Value</th>
<th>UoM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Status</td>
<td>&lt;N/A&gt;</td>
<td></td>
<td>(SCADA.3_3_PUMP.1.AUTO.F.CV)</td>
<td>&lt;No UoM&gt;</td>
</tr>
<tr>
<td>Runtime</td>
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<td></td>
<td>(SCADA.3_3_PUMP1.TOT.F.CV)</td>
<td>&lt;No UoM&gt;</td>
</tr>
<tr>
<td>Starts</td>
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<td></td>
<td>(SCADA.3_3_PUMP1.NOS.F.CV)</td>
<td>&lt;No UoM&gt;</td>
</tr>
<tr>
<td>Workflow Running</td>
<td>Bool</td>
<td>False</td>
<td>False</td>
<td>&lt;No UoM&gt;</td>
</tr>
</tbody>
</table>
Workflow Equipment Model

- Model of site and equipment
- Stores real-time SCADA values for evaluation

**External Data Link**

*This property is configured to link to external data. The source details are described below.*

<table>
<thead>
<tr>
<th>Data Source</th>
<th>SCADA.3_3_PUMP1_NOS.F.CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Single</td>
</tr>
<tr>
<td>Readable</td>
<td>True</td>
</tr>
<tr>
<td>Writable</td>
<td>True</td>
</tr>
<tr>
<td>Valid Event Variable</td>
<td>True</td>
</tr>
<tr>
<td>Test Result</td>
<td>Test successful - 6</td>
</tr>
</tbody>
</table>

[Test external data link]
Workflow Events – Conditional

- Conditional Expression – Uses values stored in Equipment to evaluate expressions

- Events can be triggered based on multiple criteria

- Events can be set so one or all criteria must be met

- Expressions can also evaluate criteria stored in the workflow process such as a process already running
Workflow Events – Conditional

• Conditional Expression – Uses values stored in Equipment to evaluate expressions

NOS Difference Pump1/Pump2 > 3

Enter Expression: ABS(Pump1NOS - Pump2NOS) > 3

Expression Functions

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td></td>
</tr>
<tr>
<td>ABS</td>
<td>Returns the absolute value of a number.</td>
</tr>
<tr>
<td>ROUND</td>
<td>Rounds a value to the nearest integer or specified number of decimal places.</td>
</tr>
<tr>
<td>LN</td>
<td>Returns the natural logarithm of a number.</td>
</tr>
</tbody>
</table>
Workflow Events – Time Based

- Time Based Expression – Uses date/time expression to determine when event should be triggered
Workflow Template

- Configured steps and processes that are executed automatically and/or with user interaction
- Steps can be modified by workflow authors and services can be added by administrator
Workflow Schedule

• Combines workflow template with events, either conditional or time based to determine if a workflow should be generated
Workflow In Action

When a workflow is triggered, either manually or automatically as part of a conditional or time based event a series of processes occur an email is triggered, notifying appropriate personnel of the workflow and supplying a work order number if generated.

Workflow and work order 154828 initiated for 11-2 Saginaw Trail
Workflow In Action

• Appropriate users can view details of the workflow and begin processing workflow
Workflow In Action

- Information from SCADA is displayed in the workflow, along with specific eSOP information for troubleshooting.

```
Instructions

Instructions

Pump #1 Starts: 26  Pump #2 Starts: 16  Pump #3 Starts: 0

If there is no mechanical alternator go to the next step.
Check mechanical alternator:
1. Trip float on/off
2. Trip float 1
3. Is the pump running? Check to ensure Pump 1 is on
4. Turn both floats off
5. Repeat steps 1 - 4 with float 2 and Pump 2 should start
6. Repeat steps 1 - 5
7. If starts do not alternate, replace the alternator and repeat steps 1 - 6 to verify it
8. If it still doesn't work call and email the DPW Electrician.

Enter any comments about work performed
```
Workflow In Action

- Steps guide users through resolution of the issue
- Steps have expiration timers, if steps are not processed in time escalation processes occur (notifications)
Workflow In Action

- Users can view list of completed workflows and can view details of workflows
Workflow In Action

- Managers can also view a complete list of pending workflows
**Workflow In Action**

- Managers can develop workflows based on functions of their group

<table>
<thead>
<tr>
<th>Description</th>
<th>Workflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC System: &lt;&lt;Town Hall Computer Room&gt;&gt;</td>
<td>AC System: &lt;&lt;Town Hall Computer Room&gt;&gt;</td>
</tr>
<tr>
<td>AC System: &lt;&lt;Town Hall Telephone Room&gt;&gt;</td>
<td>AC System: &lt;&lt;Town Hall Telephone Room&gt;&gt;</td>
</tr>
<tr>
<td>Alternating Pump Count Exceeded Limit: &lt;&lt;St</td>
<td>Pump Starts</td>
</tr>
<tr>
<td>Bankruptcy - Notification from Law Firm or Unit</td>
<td>Bankruptcy Notification</td>
</tr>
<tr>
<td>Chiller Failure: &lt;&lt;Town Hall&gt;&gt;</td>
<td>Chiller Failure: &lt;&lt;Town Hall&gt;&gt;</td>
</tr>
<tr>
<td>Excessive Pump Runtime: &lt;&lt;Station&gt;&gt;</td>
<td>Pump Runtime</td>
</tr>
<tr>
<td>Grease Trap/Interceptor Inspection</td>
<td>Grease Trap/Interceptor Inspection</td>
</tr>
<tr>
<td>Heating Failure: &lt;&lt;Town Hall&gt;&gt;</td>
<td>Heating Failure: &lt;&lt;Town Hall&gt;&gt;</td>
</tr>
<tr>
<td>Incident Investigation</td>
<td>Incident Investigation</td>
</tr>
<tr>
<td>Propeller Fan Gas Unit Heater-DPW Garage Ar</td>
<td>Propeller Fan Gas Unit Heater-DPW Garage Ar</td>
</tr>
<tr>
<td>Property Damage Incident Investigation</td>
<td>Property Damage Incident Investigation</td>
</tr>
<tr>
<td>Pump Station Inspection: &lt;&lt;Station&gt;&gt;</td>
<td>Pump Station Inspection</td>
</tr>
<tr>
<td>Sanitary Sewer Overflow</td>
<td>SSO Reporting</td>
</tr>
<tr>
<td>Sidewall Propeller Fan: &lt;&lt;DPW Garage Area&gt;&gt;</td>
<td>Sidewall Propeller Fan: &lt;&lt;DPW Garage Area&gt;&gt;</td>
</tr>
<tr>
<td>The heating system at Town Hall-1st &amp; 3rd flc</td>
<td>No Heat/Low Temperature</td>
</tr>
<tr>
<td>Tube Heater: &lt;&lt;DPW Garage Mechanic Area&gt;&gt;</td>
<td>Tube Heater: &lt;&lt;DPW Garage Mechanic Area&gt;&gt;</td>
</tr>
</tbody>
</table>
Workflow In Action

• Workflows are based on actual processes that need to be documented and replicated as needed
These Workflows can represent tasks that are routinely completed or tasks that are rarely executed, but must be done in a specific manner.
Future Steps

• Finish Document Management Integration

• Develop Additional Workflows Internally

• Integration with Cityworks Work Order Tasks

• Conversion of SCADA alarms from stand alone package into Workflow

• Integration of Neptune AMI events into Workflow
http://www.twp.waterford.mi.us

THANK YOU!

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