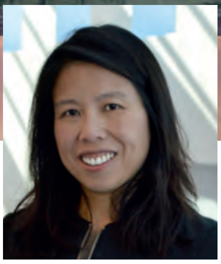

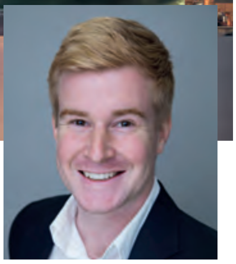

CASE STUDY: OPTIMIZING TRAPAC

Sylvia Wong, Senior Consultant Automation & Systems Integration;
Evan Crawford, Automation & Systems Engineer, HATCH, Ontario, Canada

TraPac's container terminal at the Port of Los Angeles is one of the most fully automated and highly integrated container terminals in the world. Automated horizontal transport, used in conjunction with automated stacking cranes (ASC) and automated rail mounted gantry cranes (ARMG) for the on-dock rail operation has enabled the TraPac terminal to be the safest, cleanest and lowest cost operator in the harbour.

Early in 2016, a small team from Hatch joined the TraPac Automation Projects team, assisting the terminal operator with a portfolio of projects, including the commissioning and Go-Live of an automated on-dock rail system. Like many processes typical at container terminals, on-dock rail involves numerous different components: machines (RMGs, horizontal transport), system solutions (TOS, planning system, crane supervisory control, onboard automation software, surveying), sensors (OCR, lasers), hardware and networking.

TraPac's leadership team wanted a quick ramp-up to design capacity, but the commissioning team was hampered by lack of visibility into the process and equipment conditions. The only tools available to the team at the time were siloed and rudimentary (e.g. log files and databases). At best, the team could check that each individual part was 'working', but it was very difficult to see whether or not the different parts were working well together as components of an integrated process. The team needed a solution which could provide visibility to the millisecond crane telemetry data (gantry, trolley, hoist positions, crane speeds), combined with event data (change in twistlock status, handoffs between one system and another, faults and alarms), and viewed in context of what the crane was doing at the time (e.g. trolleying and gantrying to the rail buffer, or connecting to the remote-control desk to hoist down to the rail car, etcetera).

INDUSTRY BEST PRACTICES

Leveraging experience from commissioning mining and metals assets, the Hatch team recommended TraPac conduct a pilot for a terminal wide production historian. The use of historians to integrate disparate process and equipment data is considered best practice in other industries and the availability of this data during commissioning processes enables faster ramp-up and achievement of the business's objectives.

TraPac agreed with the recommendation and a commercially available historian system was selected. Hatch was confident that their own team had the necessary knowhow for setting up the system quickly and obtaining rapid results. One of the initial challenges of adopting this system was in the setup of interfaces with the data sources. While the 'out-of-the box' system has many different connectors to more traditional control systems (e.g. DCS, PLC, SCADA), the protocols used by TraPac's control systems were different. Data is typically exchanged between TraPac's systems in XML message format via JMS. A custom interface was created which transformed message-centric data to equipment and process data. To enable the system to be scaled and expanded quickly for the full site (including straddle carriers, ASCs, STS cranes), it was important for the message transformations to be configured rather than programmed.

Within 4 weeks of the kick-off for the 'Proof of Concept', the system had been setup and enough data had been collected to enable TraPac to identify the source of one of the problems causing sub-optimal performance in the rail. On examining the crane telemetry (gantry, trolley, and hoist positions) in the context of the crane cycle, it was found that at each transition between different types of moves, the crane would wait before starting the next type of movement. When this data was shown to the crane manufacturer, changes made by their PLC programmer resulted in a 10% reduction in cycle time for the RMGs.

The pilot was declared a success and since that time the system usage has been expanded. To provide enhanced visualizations, Tableau was integrated with the system. The current system is collecting over 20,000 data streams (e.g. the gantry position of a spreader over time is considered one data stream). These data streams include raw data collected from the process and equipment and calculated values (cycle events, metrics).

CALCULATIONS AND VISUALIZATIONS

Calculations are used extensively at TraPac. Of particular importance is the use of automated calculations to infer cycle events. When new raw data arrives into the historian, the system triggers calculations using that new raw data. For the STS cranes, for example, the spreader position and twistlock status is used to infer:

- Whether the crane is loading, discharging, or cycling and the size of container being handled
- The amount of time spent coning or deconing
- Time spent waiting for a reservation in order to enter the backreach. By integrating straddle carrier telemetry and backreach occupancy from the horizontal transport control system, the reason the STS was waiting can also be inferred (no room to discharge, no container to load, or waiting for straddle carrier to evade)
- Time required to complete the hoisting/pick-up/ground operation

The calculated cycles are then summarized (as a median value), and presented to users by shift, week or vessel. The figure below shows one example of the visualization of STS cycle data. Each row is for an individual STS crane. The different colours represent different activities or phases associated with the cycle. For client confidentiality, any salient numbers have been removed.

Horizontal transportation required novel approaches to data visualization, since part of the context of straddle carrier issues is the location of the equipment on the apron. The Hatch team thus created a map of where faults were occurring, which proved to be an intuitive tool for these investigations. As seen in the screenshot below, the webpage has interactive filters, so TraPac users can select their own criteria for filtering. Similar views have been created to show when abnormal RC Desk requests occur within ASC Blocks. These views require integration of RC Desk log data and ASC telemetry.

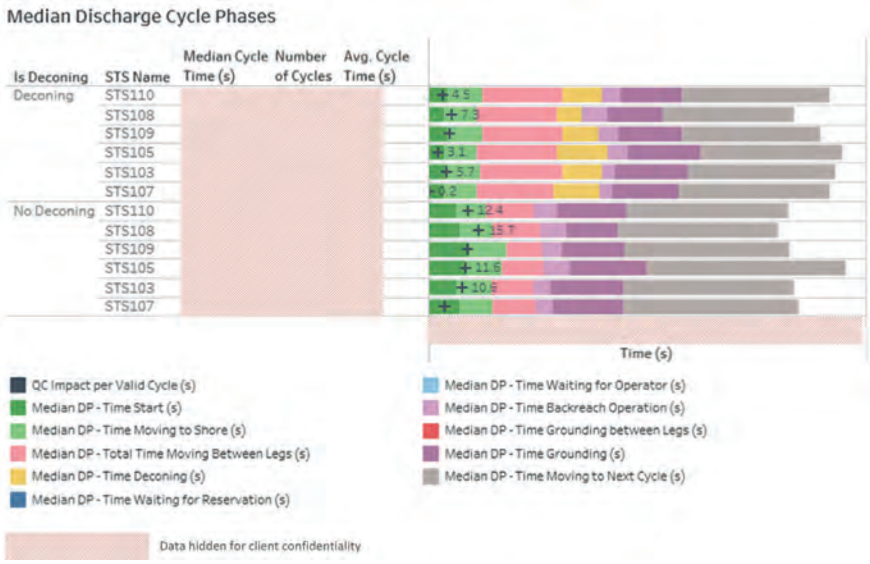

Figure 1: Example STS Cycle Time Breakdown

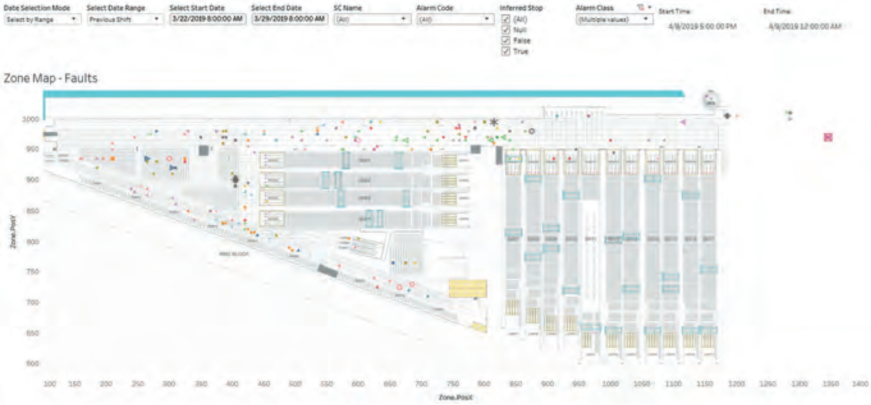
Date Selection Mode: Select by Range
Select Date Range: Previous Shift
Select Start Date: 3/22/2019 8:00:00 AM
Select End Date: 3/29/2019 8:00:00 AM
SC Name: (All)
Alarm Code: (All)
Inferred Stop: ☑ (All) ☑ Null ☑ False ☑ True
Alarm Class: (Multiple values)
Start Time: 4/8/2019 5:00:00 PM
End Time: 4/9/2019 12:00:00 AM

Figure 2: Tableau - Ad-hoc Analysis for M&R

Figure 3: PI Vision used for Trend Analysis. Graph shows different Process /Equipment values over time

There are situations (event re-creation, root cause analysis) when the ability to see raw telemetry data is required. In one situation, early in the implementation of the historian, one of the ARMGs was reported to have reduced productivity. The onboard crane machine system did not provide any specific fault data related to this issue. When the mechanics checked the machine, they could not see any physical problems. On inspection of the crane telemetry, it was quickly noticed that the ‘shape’ of the trend for hoisting did not look normal. This led the maintenance department to identify an issue with a slightly bent flipper (not visible to the naked eye and missed on initial inspection). The problem was fixed within the shift.

ARCHITECTURE

The terminal wide data historian system implemented by Hatch can be generally divided into four parts:

1. Data Acquisition (Connectors/Interfaces)
2. Data Storage (Historian/Database)

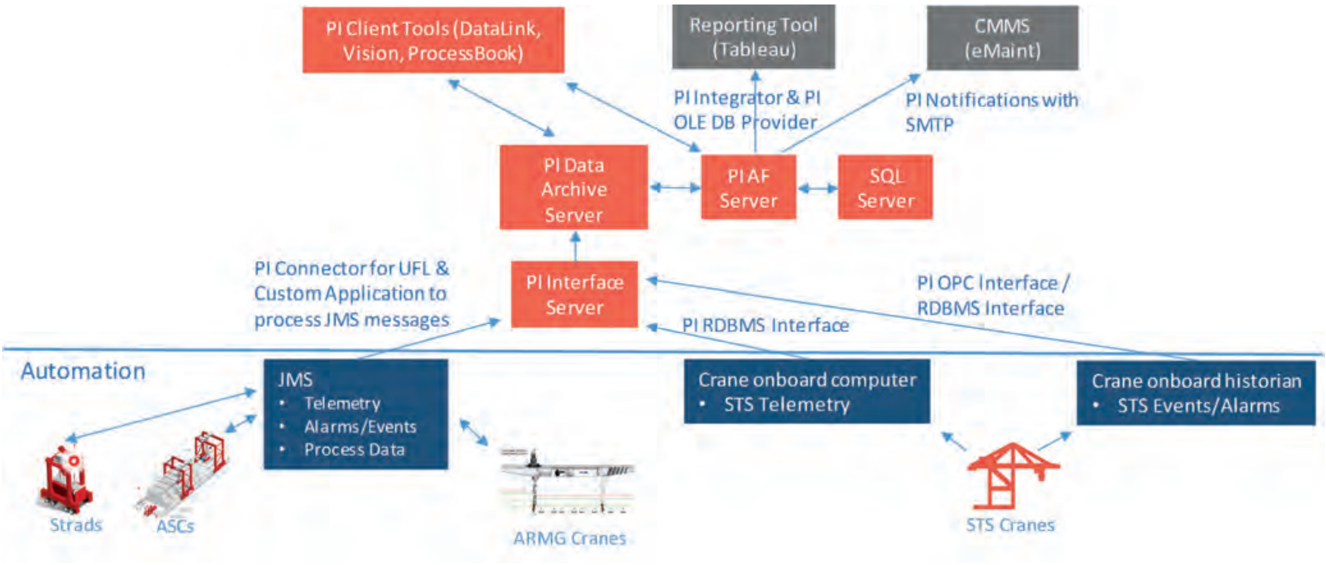

Figure 4: Data Historian Architecture

3. Data Organization and Calculations (Data Framework)
4. Data Visualization (Visualization Tools)

The system architecture at TraPac can be seen in Figure 4.

DATA ACQUISITION

Data for the system is collected from three sources: JMS, log files, and configuration files. These data sources were not in a format that any off-the-shelf interface could use. Therefore, custom applications were required to transform the data into a meaningful structure before ingestion by the data historian.

DATA STORAGE

This project used the OSIsoft PI historian for the data historian due to the team's experience with it on other projects.

DATA FRAMEWORK

PI Asset Framework (PI AF) was used to organize the data based on the area or equipment it is associated with. The data framework provides automated calculations using the collected field data which infer equipment cycle information (STS, RMG, ASC, Straddle Carrier).

KEY CONSIDERATIONS

The TraPac historian is now seen as a core system supporting key operational and maintenance activities. Some considerations for a successful and quick historian implementation include:

- Empowering end users to answer their own questions as they arise. The questions we will have tomorrow are not always known today. For TraPac, one week the site is focusing on why there are so many RC desk requests within the blocks, and the next week, it is about understanding whether one generation of straddle carrier can handle twins better than another. The solution needs to be agile enough to provide these answers without requiring software programming. The solution needs to provide users with the ability to perform ad-hoc analysis.
- Ongoing engagement with the business and other stakeholders. It was vital that the business (automation, operations and maintenance groups) and system vendors provide input to enable the correct data to be collected and modeled in a meaningful way. This is particularly important given that the data is in messaging format and not represented necessarily as process variables. The way the data is transformed and stored, affects how easy or difficult it is to use. For example, the cycle calculations built are based on the attributes the business would like to see.
- The system needs to provide good visualization of aggregated data to enable patterns to be detected, but also needs to provide the very granular data to enable baselining and event reconstruction.
- Collecting as much data as possible and modelling and organizing it properly. In some cases, it is not known ahead of time how a piece of data can be useful. If it is not collected, the data is not available if it is ever needed. Where sensors do not exist, often other data can be used to infer what sensors would have told us.

ABOUT THE AUTHORS

Sylvia Wong has over 20 years of experience in the definition and implementation of systems solutions for process industries worldwide. Her experience spans all phases of the systems lifecycle, from operational systems strategy through to commissioning and operations readiness in new-build and upgrade or expansion projects. For the past few years, Sylvia has held the role of owner's engineer providing consulting services to a client operating a fully automated container terminal at the Port of Los Angeles.

Evan Crawford is a Hatch automation and systems engineer with hands-on experience implementing and integrating systems at client sites. He was most recently involved with the delivery of the TraPac data historian and reporting system; where he was responsible for historian configuration, report creation and client training.

ABOUT THE ORGANIZATION

Hatch is an employee-owned, multidisciplinary professional services firm that delivers a comprehensive array of technical and strategic services, including consulting, engineering, process development and project construction management to the mining, energy and infrastructure sectors. Our organization is passionately committed to the pursuit of a better world through positive change. We embrace our clients' visions as our own and partner with them to develop better ideas that are smarter, more efficient, and innovative. Our global network of 9,000 professionals work on the world's toughest challenges.Our experience spans over 150 countries around the world.

ENQUIRIES

2800 Speakman Drive, Mississauga
Ontario Canada L5K 2R7
Tel: +1 905 491 7579
Web: www.hatch.com/