The Xigu terminal in the Gansu Province of north-central China is critical to PetroChina Northwest’s operations. A vital hub for half a century, it is one of the company’s two main gas and diesel distribution centres. With a total capacity of 370,000 t, its annual turnover is almost ten times that figure.

The revamp of its control system – completed in 2010 – remains a model of the benefits of both tank farm automation and how these are maximised through an integrated approach to terminal technology. It encompassed the supervisory control and data acquisition (SCADA) system, programmable logic controllers (PLCs), batch controllers, tank gauge solutions, terminal management software, movement automation and the manufacturing execution system (MES), as well as security, CCTV cameras, and access control. Gas detectors, firm alarms and fire suppression solutions were also included.

The project offers valuable insights into the benefits brought by well-proven technology that has yet to be adopted by many terminals. It also offers clues as to the developments in technology that leading terminal operators will be looking to adopt in future.

Manual difficulties
The problems the Xigu terminal faced at the start of the decade were far from unique, mirroring those experienced in many plants where automation is limited.

It was heavily dependent on manual processes, reliant on field engineers taking and recording level and pressure meter readings. The process was labour intensive, prone to error, and the data was of limited use for analysis and business improvement.

There was a significant problem with information silos. In total, the terminal had eight separate and isolated oil storage information systems. The data from these separate systems could not be shared between them; there was no consistency in standards, which caused problems for maintenance teams; and software interfaces varied, again increasing the complexity for workers and management and the potential for mistakes. Effectively, there was no information management system at the tank farm.

There was also no safety interlock system. In fact, with little automation and a lack of real time data, overfill protection and safety management capabilities in the terminal were weak.

The lack of automation hampered every part of the process, from loading and unloading to stock management, oil product movement, order management and maintenance. As well as the ongoing drain on reliability and efficiency, the terminal also saw line-up errors, leading to the contamination or downgrading of the product. The lack of coordination between the separate information systems and reliance on manual processes meant piping network path-planning was a constant challenge.

PetroChina addressed these weaknesses, in consultation with Honeywell, by replacing the separate systems with a single, integrated automation and control system, covering the entire terminal. Both the automation and the integration of the operation with the
management and businesses systems under a unified platform were central to the project.

**Solutions for each process**

The aims of the project were, in a sense, simple: capture data accurately and automatically; improve safety and control; boost performance, and promote business integration. Encompassing the truck, rail and pipeline terminals, 31 product tanks, 426 valves (263 of them motor operated), 30 pumps and more than 10 materials. Achieving this involved implementing a number of key solutions:

- A blending and movement system, Honeywell’s Profit® Blending and Movement (PBM) – Profit® Movement Suite.
- A terminal automation solution for loading and unloading both truck and rail, Honeywell’s Terminal Automation Solution (TAS) – the predecessor to the company’s current terminal manager solution.
- A new MES, underpinned by Honeywell’s historian, Uniformance® Process History Database (PHD).

Each system has brought discrete benefits to the terminal, addressing the underlying challenges it faced without automation. With the PBM solution that provided movement management, for example, operations personnel were given clear visibility and control to effectively line-up and control material movements, for safe, effective execution. Automated, path selection algorithms provide operators with flexible line-up options to define the preferred path, for example, but automatically account for issues such as material compatibility, equipment availability and optimal isolation, promoting safety and eliminating errors. Advanced monitoring features, such as volume reconciliation, and material certification workflow support, ensure that movements are safely and reliably executed.

Likewise, the TAS automates all key monitoring and control functions, such as product receipt, gate access control and loading. Quickly configured to record and monitor products, bays, loading areas, meters, tanks, vehicles, marine vessels, wagons, drivers, trailers and customers, it automates terminal workflows for all modes of transport, improving productivity and throughput for smooth and efficient processes.

Finally, the new tank metering system, combined with Honeywell’s Experion® process knowledge system (PKS), has eliminated the need for manual data collection, providing near real time readings and an automated interlock to improve visibility and safety. Events and alarms stored in Experion ensure that no important data is missed and help operating personnel avoid problems through timely notifications.

**An integrated answer**

The benefits from simply increasing automation are substantial. Eliminating manual meter readings delivers immediate benefits for safety and productivity, taking workers out of the field to allow them to be redeployed to higher-value work. Likewise, automating loading operations significantly boosts efficiency. The truck servicing time for filling a 20 t capacity truck at the site was reduced by 40% from 50 min. per truck to 30 min. after TAS was implemented. Since the system allows self-service by the truck driver, the number of operators required per shift for the process was also reduced from 16 to just two.

With field-proven technology, the benefits realised at the Xigu terminal are readily available to almost all tank farms that remain without substantial automation. Individual solutions for discrete parts of the process can deliver fast returns on investments.

Nevertheless, there are substantial benefits from implementing a fully integrated solution, both at a hardware and at a software level. On the one hand, the ability to communicate with field devices and systems from a range of different suppliers can be essential in some terminals to reduce costs by retaining existing investments. Honeywell’s Experion PKS supports many different communication protocols such as Foundation Fieldbus, HART, Modbus, etc., as well as the integration of other systems, such as digital video and mobile devices. On the other hand, where a terminal can use solutions from a single supplier, the speed of commissioning, depth of diagnostic information available in the control room and ease of maintenance are significantly enhanced.

Arguably, even greater benefits are felt from software integration. At the simplest level, workers benefit from a consistent, familiar interface, whatever part of the process is being examined, making them more productive and likely to make better decisions. More fundamentally, the ability to seamlessly share data in the right format across systems provides operators with greater visibility and faster access to richer data across the plant and processes from which to drive efficient, safe operations. In addition, the operational data can be easily and accurately transferred to the business layer to drive business improvements.

At Xigu, all automated readings, movement monitoring and loading data, as well as manual inputs into an order

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**Figure 1. PetroChina Xigu terminal case study.**
management system where required, were integrated tightly together and with the site’s enterprise resource planning (ERP) solution and MES (Figure 1). Operators have complete visibility of the product as it moves through the terminal and continual access to accurate, up-to-date data on tank levels, inventories, transfers and deliveries.

Meanwhile, management and other business users have access to key performance indicators and a variety of web-based visualisation and analysis tools. Decisions on the business level are taken based on rich and continually updated historical data drawn directly from the SCADA system, in turn tightly integrated with the movement solution, TAS and ERP.

The result of this integrated solution is improved safety, fewer incidents, more timely execution of shipments, receipts and movements, and overall improved business performance.

**Looking ahead**
The level of integration and automation possible continues to evolve. It has advanced significantly even since the start of the decade. Tools such as Honeywell’s terminal planning and scheduling solution, (which was not available at the time of the Xigu project) provides users with a complete oversight of plans and present operations. For example, users can schedule and track when shipments will arrive, how they will be handled, the impact on inventory, and related orders and deliveries. The plan can then be downloaded to PBM and Terminal Manager for execution, and then monitored in real-time.

Among the developments with the most significant potential for driving enhancements to efficiency in future is the Cloud. Bringing information into the Cloud enhances analytical capabilities (given the potential for big data analytics and Cloud-based computing), as well as the ability for a company to gain a global view across multiple sites. Secure access to information for third parties, such as product owners and customers, can also be more easily accommodated using the Cloud.

There is also significant potential to combine smart devices in the fields such as batch load controllers with Cloud control to reduce or eliminate the need for operator input for simple control functions. Truck dispatch and truck loading operations, for example, could be executed from the Cloud.

**Conclusion**
While many terminals still have to implement even the most basic automation, the most forward-thinking terminal operators are already moving on to these solutions.

Honeywell continues to develop solutions that can be deployed in an evolutionary, staged approach, where the benefits realised at each stage of implementation can justify and fund the next stage of implementation. This way, terminal operators at any stage of automation implementation can make significant gains through an integrated approach to terminal operation.