Increasing Operations Profitability Using an End-to-End, Wireless Internet, Gas Monitoring System

M. MCDOUGALL
Northrock Resources Ltd.
K. BENTERUD
zed.i solutions inc.

Abstract

Smart-Alek™ is an example of a fully integrated, end-to-end gas measurement and production analysis system utilizing public wireless communications and a Web-browser-only delivery system to provide seamless well visibility to any desktop. Capitalizing on the technology's cost effectiveness and ease of deployment, Northrock Resources Ltd. (a wholly-owned subsidiary of Unocal Corporation) has adopted a grass roots shift in their operations strategy that implements on-the-ground, timely decision-making at the field level. This technology fits Northrock's operations business needs of easy to use, complete, reliable, and cost effective production information delivered in a timely manner to everyone on the team. Previously, Northrock has found that these needs were not adequately met by conventional SCADA technologies. This type of end-to-end wireless and Web technology has enabled Northrock to increase gas volumes with more accurate measurement (Electronic Flow Measurement vs. mechanical chart), and less downtime. Reductions in operating costs were achieved by decreases in well visitation frequency and a redirection of operator "windshield time" to activities that optimize operations profitability.

Introduction

Although advances in SCADA (Supervisory Control And Data Acquisition) have improved gas measurement technology from the 100-year-old mechanical chart methods, costs can be prohibitive to implement an electronic alternative. The following case study investigates how Northrock increased profitability deploying and utilizing Smart-Alek™ company-wide while avoiding these high implementation costs. Smart-Alek™ is an example of a new type of end-to-end electronic Gas Flow Measurement (GFM) system, entitled FINE™. FINE™ is an acronym meaning Field Intelligence (FI), Network (N), and End-User Interface (E)[1, 2].

Background

A comparison of GFM information flow between mechanical charts, SCADA, and FINE™ is given in Figure 1. On the left of this figure is the information flow path of the mechanical chart method. Data gathering using mechanical charts, typically involves daily site visitations by an operator who estimates the previous day's volume from chart readings. This rough estimate is then manually entered into a Field Data Capture system (FDC). Once captured, these rough production volumes are then accessible by operations staff, engineers, and management who use them to make daily business decisions.

Use of the rough volumes in FDC and integrated chart volumes for accounting is error prone and time intensive, and it introduces significant business challenges in the flow of information from the wellhead to the producers bank account. The business impacts of these inefficiencies and errors are as follows:

1. Obtaining on-site daily estimates requires significant operator time.
2. Both on-site estimating and chart integration can be highly inaccurate because of the numerous manual steps required by many people.
3. Accuracy of integrated volumes is highly dependent on fixed meter run parameters and gas composition. These parameters are error prone because they are also stored manually in multiple systems (i.e., log books, spreadsheets, meter detail, and chart integration files), which translates into increased rework costs and potential lost revenue.
4. Chart integrated volumes are typically not reconciled with field estimates resulting in undetected errors that have a direct impact on cash flow, which can be large & long-term.
5. Viewing real-time operating trends with charts requires site visitation, thereby excluding staff other than the operator from understanding actual production behaviour.
6. Chart integrations can take up to a month to process.

As a result of these operating challenges, stakeholders have sought better methods to perform GFM. Electronic Flow Measurement (EFM) has been an alternative to charts for several decades, in the form of custom engineered SCADA systems, as shown in the centre of Figure 1. However, in spite of the costly and serious business challenges in operating with mechanical charts, producers have continued to employ manual methods. Up to this point, Northrock has found that SCADA methods have not been cost effective in meeting these business challenges. This is for three reasons. Firstly, SCADA requires an economy of scale to justify implementation, as there is a baseline of internal infrastructure needed (communications, host software, hardware, support expertise, etc.). Secondly, production data typically gets trapped at the SCADA system level—it generally must be entered manually into other systems. Thirdly, SCADA technology could not effectively meet the daily business needs of Northrock's operations, which included: Ease of accessibility and use for non-technical staff, complete and reliable production information delivered in a timely manner to everyone on the team, and very low technical maintenance to keep the system operating reliably.

The Technology

Smart-Alek™ is an end-to-end, wireless Internet-based GFM technology that easily delivers well information to any desktop

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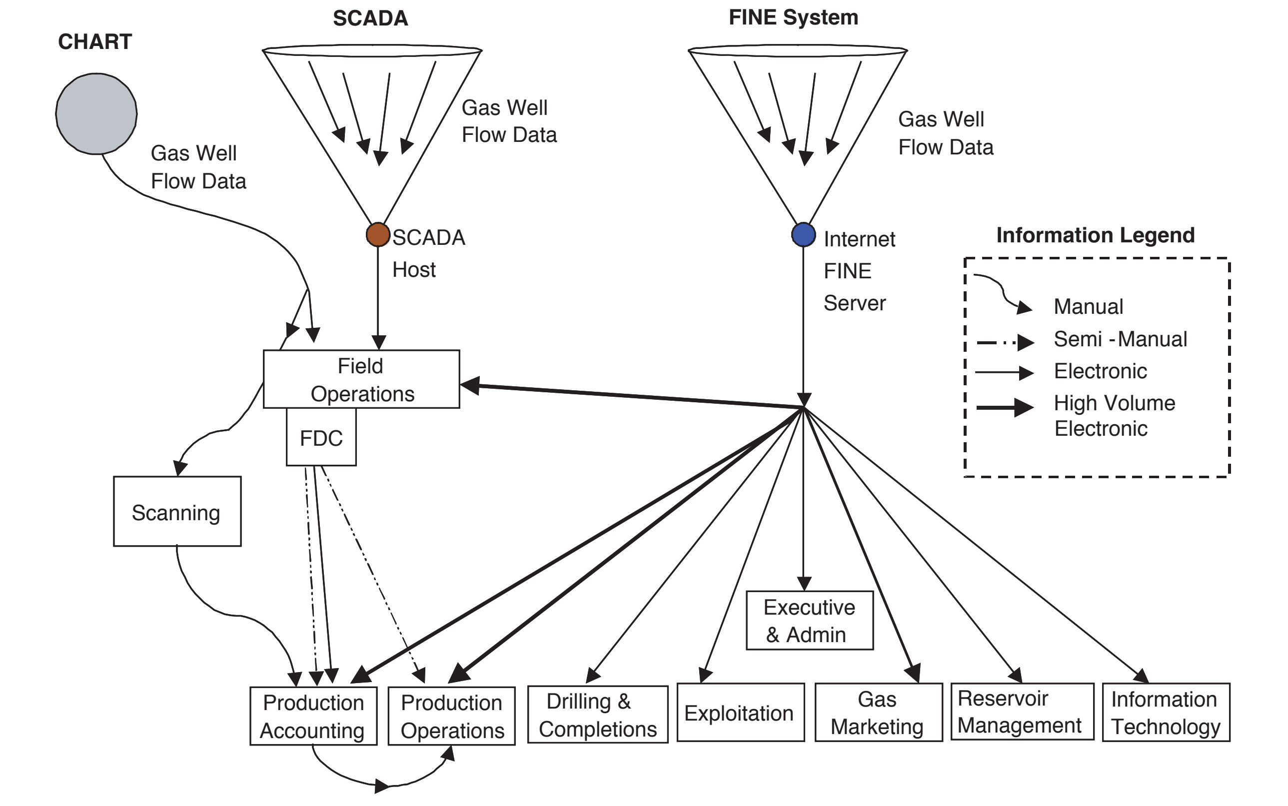


FIGURE 1: Information paths comparison of GFM methods.

Web browser, company accounting program, or business system. It has been proven to reliably operate on thousands of wells in different field conditions. As mentioned above, this type of system has been termed FINE^{TM}[1, 2], [Field Intelligence (FI), Network (N), and End-User Interface (E)]. FINE^{TM} is a system design where the monitoring effort for the user is less than with charts or with SCADA. Using FINE^{TM}, dissemination of live well information is seamless to everyone from operators to managers to investors, who can see the details on their PCs. See r.h.s. of Figure 1 and Figure 2 for a diagram of this functionality.

The FINE^{TM} networking system is unique when compared to SCADA-based EFM systems in the following ways:

Field Intelligence (FI) Device

The on-site gas flow measurement, power, and communications hardware is self-contained, very small, and can be put anywhere in a Class 1, Division 1 hazardous location. This is possible because it operates on a very low power budget (i.e., 10mW average). To a non-technical field operator, this translates into a trouble-free, safe, and reliable operation of measurement hardware.

Data-Push and End-to-End Protocol

In the FINE^{TM} System architecture, the remote instrument (the FI) is the communications master, and the central server responds

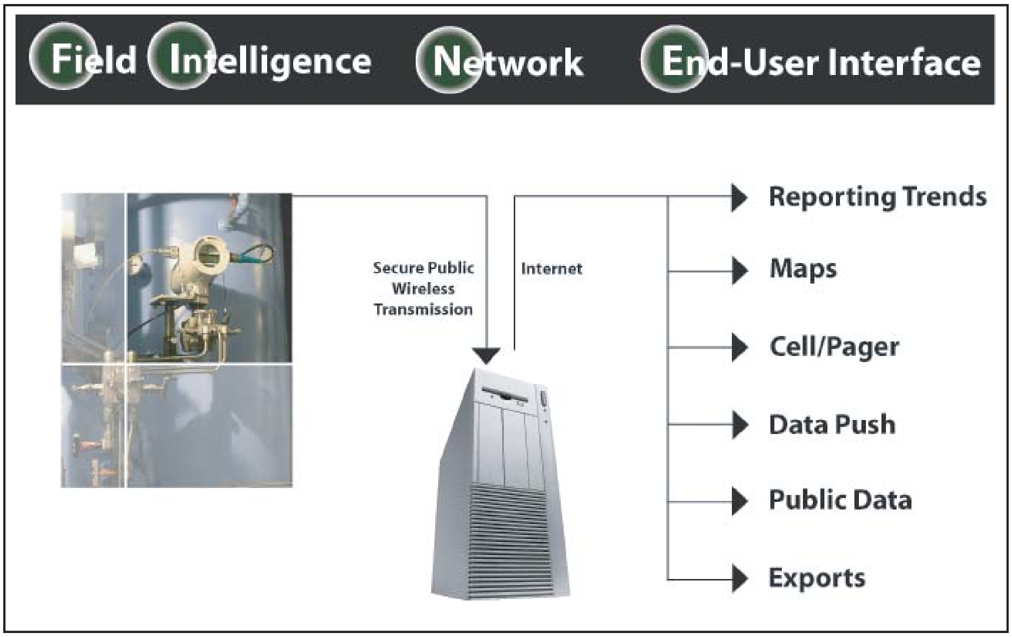


FIGURE 2: FINE^{TM} system for gas flow measurement.

to its reports and requests. A proprietary Application Layer Protocol (ALP) was developed for secure FI-to-server communication over public media. This enables a "data-push" type of system data operation from the field. By doing so, the uncertainties of multiple interfaces and occasionally unreliable communications media are mitigated (i.e., holes in data are avoided)[3, 4].

Asynchronous Central Web-Based Network (N)

The central server system is built around the most recent Oracle Internet database technology. It is therefore well suited for responding to current or past time data requests and reports originating from remote, autonomous measurement devices, end-users, and applications. This is the Network (N) component of the FINE™ System.

Web-Based End-User Interface (E)

The central server Network provides a seamless interface to the End-User Interface (E). This interface utilizes a secure Web-browser that provides visibility to current flowing conditions and up to five years of historical trending to any desktop or laptop computer anywhere on the Internet. It also has an alarm notification to alphanumeric phones and text pagers, and automatic data exporting to other client applications.

From Northrock's perspective, the FINE™ System offers several implementation advantages over a SCADA-based, corporate-wide flow information system:

- Field deployment is quick and easy, as is getting secure on-line access for various user configurations.
- Implementation justification does not depend on the economy of scale.
- Remote access, isolated wells are practical for electronic visibility.
- Operation is easy to use and robust for field and head office staff that otherwise may have a fear of breaking the system.
- Integration of acquired SCADA host systems is possible by tying them in to the FINE™ System.
- Wireless infrastructure costs savings are realized because public wireless providers are used (i.e., cellular and satellite-based).
- Reduced maintenance costs result from fewer onsite and network system components.

These exist because FINE™ integrates complex technologies within itself as an end-to-end system, transparent to the user. With FINE™, Northrock's non-technical personnel have utilized this technology as a tool for focusing on the core business of making more money, rather than being distracted by the technology itself. This was the primary reason that Northrock chose to adopt the FINE™ System for its corporate-wide electronic GFM needs over one based on SCADA technology.

Technology Application to Operations

With FINE™ functionality, Northrock has realized the following key operational and business advantages:

- Early problem detection and response for wells and facilities, resulting in decreased downtime.
- Operator "windshield time" has been redirected to more effective activities by not needing to collect daily estimates and charts.
- Reduced production accounting errors, which saves rework time for operators and production accountants.
- Access/surveillance of non-operated and contract-operated wells.
- FDC and integrated volume discrepancies are eliminated by having a single production information source simultaneously available to everyone.
- Increased cross-departmental collaboration.

Increased Revenues

The following are some of the primary operations benefits where revenues have been positively impacted. Ancillary benefits to other parts of the organization were also observed but are not included in the scope of this paper.

Improved Revenue on Wells Operated By Others

Where day-to-day operational control has been relinquished to wells Operated By Others (OBO), unnecessary downtime and reduced production often results. This is because the motivation of OBO personnel is different than that of the well owner, as they do not have the same operating mandate. Introducing electronic visibility with the FINE™ System to OBO wells enabled Northrock staff to positively impact revenue in numerous situations.

Reduced Well Downtime

With timely notification by FINE™ System callout and response by operations personnel, lost production due to well downtime has been reduced.

Example: Regional Downtime Reduction

By implementing a new operations strategy using the FINE™ System in the Rocky Mountain House region, a dramatic impact was realized on independent well downtime. A sample set of 17 wells was selected with a history of operating on mechanical charts and the FINE™ System. Production periods with plant shutdowns were excluded from the data set. Based on a seven-month period, it was observed that the downtime was reduced from 4,272 hours in 2001 (charts) to 2,551 hours in 2002 (FINE), which is approximately a 40% reduction. This reduction in downtime resulted in an increase of 2.3% of production over the baseline volumes. Given the production levels of this well sample set, the resulting annual revenue increase was approximately $51,000 *per well* at a gas price of $5.00/mcf. This increase in production was realized by effectively using the FINE™ System visibility and call-out functionality to respond, as needed, to independent well downtime events.

Example: Avoiding Freeze-Off With Plant Down

In February 2003, a Northrock operator received an alarm callout indicating high line pressures at three gas wells. The operator logged onto the FINE™ System from home using a Web browser and remotely checked the flow trends. The three wells were joined at a common header, which flowed to a mid-stream plant (see Figure 3). Knowing the pipeline configuration, the operator concluded that the mid-stream facility was down. The operator promptly went to each site and isolated the wells and facilities from the pipeline. By doing so, the in-line fuel gas was preserved for heating the process buildings, and the wells were shut-in before pressure conditions caused hydrates to form. This resulted in reducing what could have been a significant downtime event and decreased operating costs associated with clearing hydrates.

Well Production Optimization

Using FINE™ to provide regular data access and trending has been a catalyst to enable workflow innovation within operations at Northrock. This has occurred by analyzing both historical and real-time flow and pressure trends, and relating it to actual operating conditions.

Example: Line Pressure Optimization

In the Ferrier region, there were five wells feeding into a compressor station. A sixth well was added to the system in February 2003 upstream of the compressor. Using the FINE™ System, field staff noticed line pressure fluctuations of +/- 800kPa on the six upstream wells and a corresponding direct impact on production at the compressor (see Figure 4 for the pressure and flow plot at

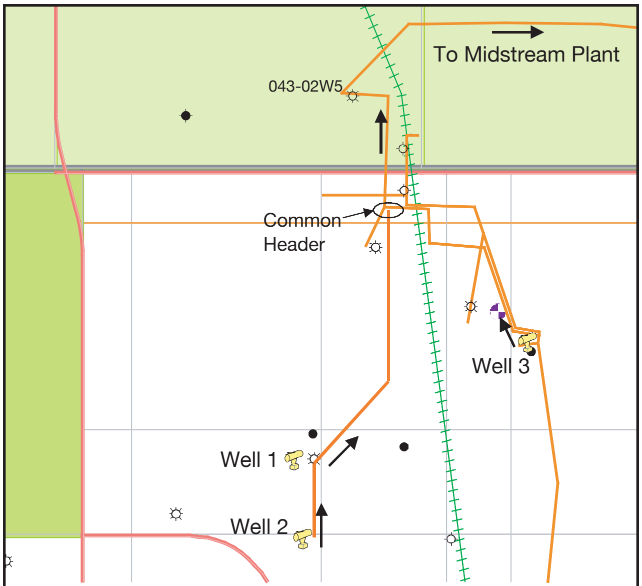


FIGURE 3: Avoiding three well freeze-off with plant going down.

one of these upstream wells). By making some minor compressor modifications, the suction pressure was reduced and the throughput was increased by 15% from 280 E^3M^3/day to 320 E^3M^3/day. Field staff found this problem by creating custom, time-filtered trends over extended periods of time (i.e., months). Using chart-based trending data this would have been complicated, if not impossible, because of wide flow variations and trend data being trapped on weekly charts. To do this with a SCADA system would have required a historian interface, which typically is too technical for the field staff to use. This example demonstrates innovation that can happen at the field level when they have access to reliable source data and the ability to trend both short and long-term operating conditions. In this instance, a quick optimization decision translated into $7,000 per day of additional revenue (at $5.00/mcf) on this set of wells.

Improved Accuracy and Measurement Program

Most gas wells eventually will need mechanical intervention such as plunger lift, coil tubing, and flow timers that cause flow spikes. If charts are in use, measurement clipping will most likely occur, which can be avoided with EFM. Accuracy with EFM is improved by elimination of clipping and systemic errors in chart handling. In Reference (2), a case study was summarized comparing mechanical chart volumes on plunger lift wells to volumes measured by the FINE™ System. It was shown that mechanical chart clipping on the differential pressure pen trace resulted in a loss of 9% of computed volumes. Using the FINE system this clipping problem was corrected on numerous Northrock wells, and booked volumes increased as a result.

Introducing the FINE™ System to Northrock field operations was used as a vehicle to introduce a new measurement program. This was because the flow information and fixed data (gas analysis, orifice, and meter run sizes) used in calculations were now visible to all users, and changes (including recalculations) were traced in API Chapter 21 compliant, online event logs[5]. This enabled Northrock stakeholders to work collaboratively, to identify inconsistencies affecting revenue, and to apply corrective measurement practices.

Reduced Operating Costs

By applying the FINE™ System to gas well monitoring, Northrock also realized a reduction in operating costs. These improvements have been observed in the following three areas: More effective work practices, preventative maintenance, and regulatory compliance.

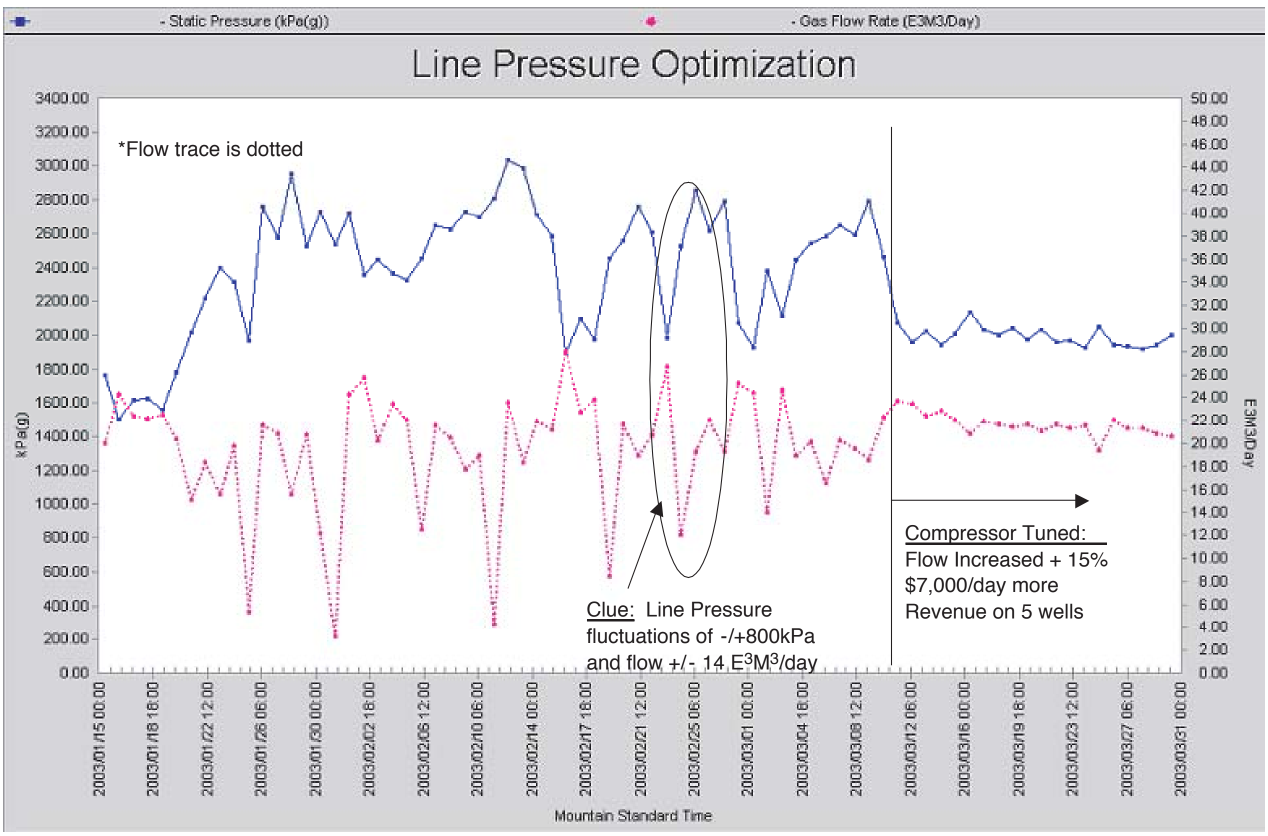


FIGURE 4: Line pressure optimization on leg of pipeline network.

More Effective Work Practices

A) Proactively Solve Problems

Using FINE™, Northrock has found that operating problems are visible before they become serious, and by taking timely corrective action, costs and losses are minimized. The daily routine of the operator now starts with a review of well operating conditions via the FINE™ System. Problems are identified and the day's activity is planned to deal with them. Many operators now do this at home prior to starting their run.

B) Visibility Anywhere

Utilizing mobile Internet access to the FINE™ System (wireless equipped laptops, and text-message pagers and cell phones), Northrock operators are now informed of costly on-site problems while they are on their daily run. This enables them to make intelligent, informed decisions at every turn in the road, as opposed to simply recording daily well conditions.

C) Reduced Well Visitation Frequency

Well visitation has been changed from daily to "as required" (bi-weekly or weekly) based on risk analysis and using FINE™ visibility. This allows extra operator time to be directed towards other value-adding activities.

D) Increase in Operated Well Count

Decreased visitation frequency also allows more wells to be operated by the same staff. This was confirmed in several different operating areas. Note that additional contract operating opportunities have also significantly impacted lifting costs.

Example: Increase in Well Count—Ferrier

An example of reducing operating cost is the Ferrier Field, which is spread out over an area of 30 townships. Northrock had a very active drilling program in this area. By utilizing the FINE™ System exclusively, it was possible to add wells and facilities very efficiently while only adding one operator. In this example, the well equivalent count was increased from 36 to 87. Refer to Figure 5 for more detail. This field also includes 15 contract-operated wells, which generate revenue of $150,000/year. The actual "operator cost" per well has decreased from $870/well/month to $335/well/month, including the contract operating revenue offset. The time reallocation from daily well visitation now allows for an additional 50 hours per week to target problem responses, preventative maintenance, and optimization efforts.

Preventative Maintenance

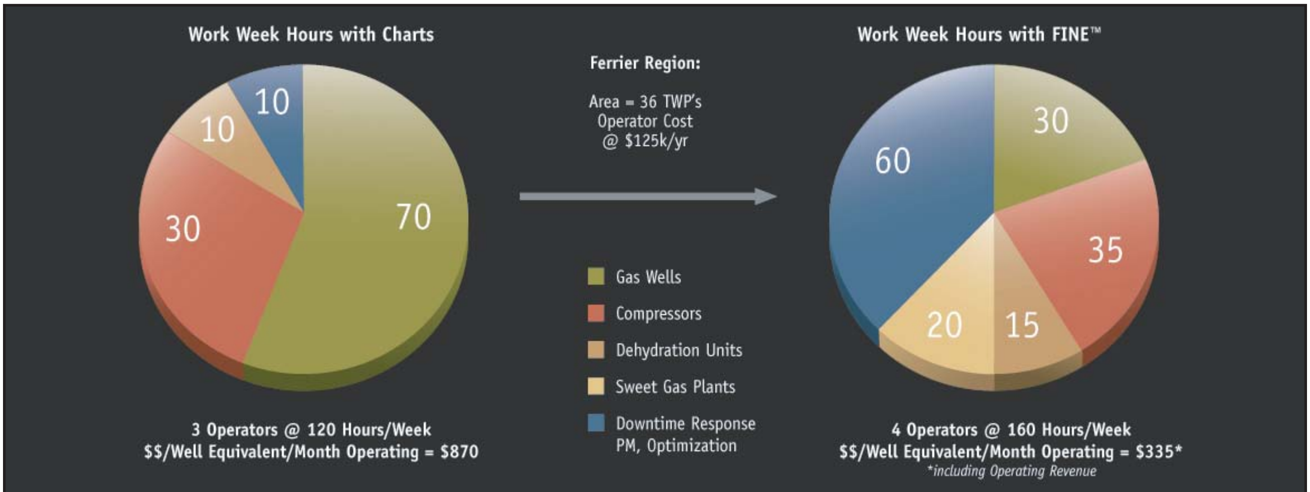
A significant win with this new operating strategy in Northrock is that operators are now available to do preventative maintenance and minor repairs instead of paying third parties for these services. This has been achieved by the use of a Web-based preventative maintenance program (i.e., master scheduler), which is complementary to the Web browser based FINE™ System. This allows the operators to effectively manage the preventative maintenance requirements from their truck.

Regulatory Compliance

Non-compliance carries escalating consequences that can materially impact a company's ability to do business. These increasingly stringent requirements put more and more time pressure on operating staff. Northrock found that using this field operating approach, they were able to address the new regulatory compliance activities with existing manpower. This was because a portion of the operator's time previously spent on manual data collection was redirected to develop and implement owner/user programs (e.g., pipeline manuals, pressure vessel ABSA program, electrical programs, etc.).

Changes In Operation Strategy

Northrock realized these business benefits by using the FINE™ System because of a simultaneous initiative to change grass roots work-processes at the field level. The following steps were taken to achieve these results:



Wells & Facilities	Well Equiv.	Visit Frequency	Weekly Hours	% Total Hrs	Type of Operating Activity	Wells & Facilities	Well Equiv.	Visit Frequency	Weekly Hours	% Total Hrs
20	20	daily	70	59%	Gas Wells	49	49	weekly	30	19%
4	12	daily	30	25%	Compressors	7	21	daily	35	22%
4	4	daily	10	8%	Dehydration Units	7	7	bi-weekly	15	9%
0	0	–	0	0%	Sweet Gas Plants	1	10	daily	20	12%
–	–	–	10	8%	Downtime Response PM, Optimization	–	–	–	60	38%
	36		120	100%	= Totals =		87		160	100%

FIGURE 5: Ferrier region operator workload change with FINE™.

Step 1: Assess leadership potential of key field people.
Step 2: Develop a strategic plan that is frequently seen by field staff.
Step 3: Name a champion to lead the change process.
Step 4: Inspire field operations that "change" is good and encourage operators that they are under-utilized.
Step 5: Introduce the FINE™ System technology.
Step 6: Train and equip field operators on the use of the technology to eliminate their fear of breaking the system.
Step 7: Take business metrics for an area or field right down to the front line operators.
Step 8: Demonstrate leadership by continually revisiting the business with operators.
Step 9: Empower field operations with decision-making authority and accountability once they have demonstrated an understanding of key business drivers.
Step 10: Catch people doing things right and reward them. This behaviour will deliver the best long-term results.

Conclusions

In utilizing the FINE™ System, Northrock has concluded that:

1. Gas well wireless measurement technology is now available to economically replace mechanical charts without requiring complicated and specialized technology training and support.
2. Deploying the technology alone will only allow people to realize a small portion of the potential benefits. There must be a vision and strategy to change operating practices by thinking "out of the box."
3. Significant Production Accounting benefits can be realized by getting data to flow seamlessly into existing reporting systems.
4. The ease of implementing the FINE™ System can enable a "grass roots" shift in the operation strategy towards timely decision-making at the ground level.
5. The FINE™ technology was a catalyst to help change Northrock's operating strategies. By adopting both a change in technology and new innovative work processes, revenues and productivity have increased, while operational costs have been reduced.

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Authors' Biographies

Marlon McDougall, P.Eng., is a professional engineer with 15 years of experience in the upstream oil and gas business. He spent the first two years of his career as a field engineer with Halliburton Services, gaining experience in stimulation, completions, flow control, and artificial lift. For the next seven years, he worked as a production engineer for Suncor in Fort St. John and Grande Prairie. His initial focus was on optimization, specializing in gas lift, but he soon branched into facilities design and construction. McDougall was intrigued by the SCADA world and the potential it had to revolutionize how we do business. Understanding the technology, costs implications, producers, and true benefits of SCADA became a focus. In 1998, he went to work for Northrock Resources and opened up a new district office in Grande Prairie to support the aggressive growth strategy of the company. McDougall built up a staff of 25 and was responsible for operations, optimization, facilities construction, and project management. During a two-year period, the Northrock Grande Prairie district tied in over 100 wells and was able to deploy a "fit for purpose" automation strategy using traditional SCADA, which had a dramatic impact on lifting costs. Production grew from 2,500 boe/d net to over 10,000 boe/d. In 2000, he moved to Calgary as manager of production operations, responsible for a staff of 90 spread across four district field offices, as well as the production engineering, facilities engineering, and construction groups. McDougall was able to focus his team on a measurable program of volume and cost optimization across a net production base of 34,000 boe/d. Introduction of zed.i solutions' Smart Alek™ system was a catalyst that allowed radical change in how Northrock managed its business. In 2003, Northrock restructured into business units and McDougall took on the role of area manager for Central Alberta, including all engineering and operations functions. He is currently responsible for managing the asset base and efficiently growing the business for this area.

Kevin Benterud, M.Sc., P.Eng., is a professional engineer with 15 years of experience in electronic and telecommunications product design, and led the zed.i solutions' technical team in developing the Smart-Alek™ System. Kevin completed his University of Alberta graduate studies in 1990, in conjunction with Telecommunications Research Labs, Edmonton working on the development of new fibre optic transmission technologies. From 1991 to 1993, he worked with AGT (now the Telus R&D Group). First, in a system analyst role, and then developing reliability enhancements to existing microwave transmission facilities. The microwave systems research was published at the 1993 International Conference on Communications, Geneva, Switzerland. In 1993, Kevin joined Z.I. Probes and was involved in product development of the suite of well-testing tools including the down-hole Pressure Gauge Recorder, the down-hole Shut-In Tool, the Surface Data System (SDS), and Windows software development. In 2000, Z.I. Probes began a corporate transition into the application of Internet-based wireless gas flow monitoring, and the development of Smart-Alek™ began. In conjunction with the CTO, Kevin led the design and development of the Smart-Alek™ instrument, and then transitioned into the network and Web development for the system. In the spring of 2002, after a successful product launch of the Smart-Alek™ system, Kevin transitioned into the marketing and sales team. Since that time, in his role as manager of business development for zed.i solutions (formerly Z.I. Probes), he has developed a number of tools to assist clients in evaluating where Smart-Alek™ can best add value for them. In this role, Kevin works directly with partnering gas producers to create business value by utilizing well visibility with Smart-