Implementing Wireless & RFID Technology in the Oil Field: A cost saving decision in times of economic downturn

Konrad Konarski
President
Merlin Concepts & Technology

Sam Falsafi
Principal
Shipcom Wireless

Ben Zoghi P.H.d, PE
Professor
Texas A&M

Paul Younan
Investment Advisor
BMO Nesbitt Burns

Table of Contents

Abstract

This whitepaper explores the application areas and value points delivered through the use of wireless infrastructure and automated data collection technology such as Radio Frequency Identification (RFID) in the manufacturing of field products for the oil and gas industry. The focus will be on the following application:

- **Inventory management using RFID**
- **Controlled Work-in-Progress**
- **Asset and Personnel Tracking**

The study explores the value points of the aforementioned technologies to the Product Manufacturing Industry. It provides both a qualitative and quantitative analysis of these value points through customer case-studies, financial audits, laboratory experiments, and outlines how implementing these technologies helps a sustain growth and reduce operating costs in both times of economic downturn and economic prosperity.

The work here-in is a collaborative initiative between Texas A&M University, Merlin Concepts & Technology, Shipcom Wireless and other fincancial and information technology institutions.

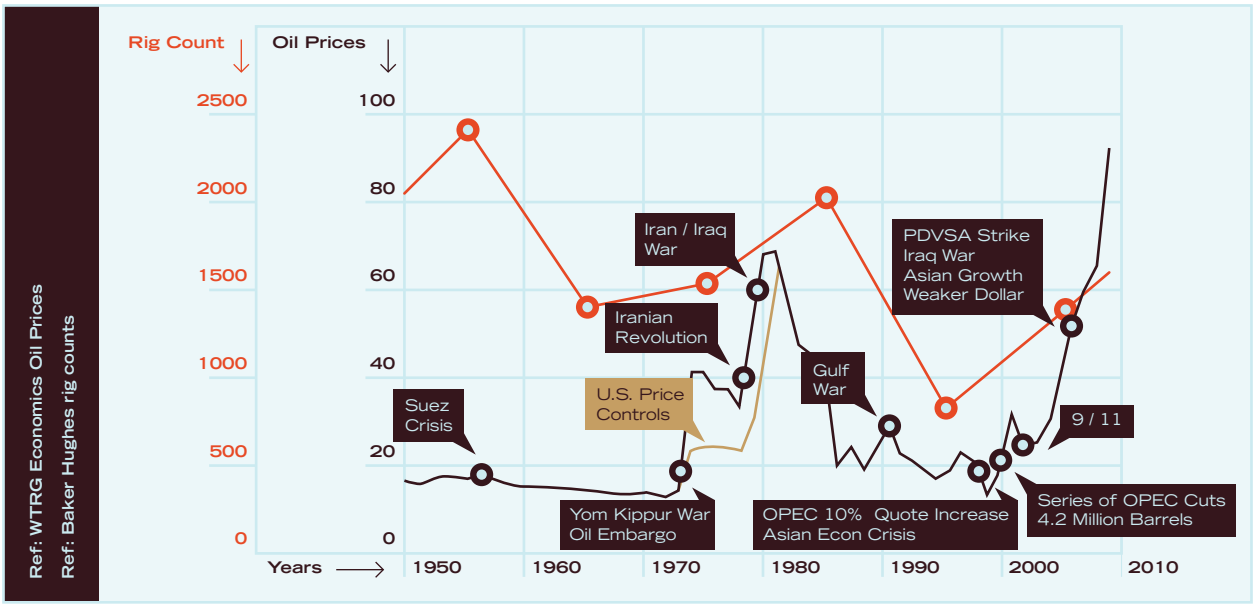
The Industry at a Glance

The current market crisis has bestowed a sentiment of caution among manufacturers. Price points for petroleum have dropped dramatically and rig counts are on the decline. This shift in paradigm has pushed the consumers of oil field products to cancel production orders and limit locking into capital assets to maintain liquidity in these uncertain times. Nation-wide, inventory stockpiles of field products are forming and production is slowing, in some cases to a halt.

The Forecast

In the 80's, following the Iranian oil-crisis, a six year decline in oil prices created a similar slump in field product manufacturing. Historically, petroleum prices have experienced peeks and lulls , and rig counts & field product consumption were quick to follow. Despite these downturns, each time the market returns to its feet the petroleum price begins to rise, and so does the viability of drilling for hydrocarbons, and as such the production demand for products necessary to drill or sustain operations on the rig.

The annual average prices for crude oil in 2009 is expected to be in the range of $50-60 per barrel, while natural gas is expected to average $6.25 Mcf in 2009. The rig count is expected to drop by more than 500 throughout 2009. This market contraction will have corporate and operational shifts upon the underlying field product community.



Technology in Times of Economic Crisis

Understanding the value that technology can bring to an organization is fundamental to justifying a financial investment and ultimately successful adoption of the underlying emerging technology. A fundamental dynamic that is inherent with selling any technology is the "value-point". The value point essentially assumes that the technology delivering value to an organization is agnostic in the eyes of the customer, and that a benefit that the technology brings is the true selling point.

If the value point delivered by the technology system outweighs the return on investment timeline set by the corporate and operations staff (typically 12-18 months) and the value point is considered important by that organization, then the investment should be seriously considered.

A rather short-sighted argument is to not invest in a technology system is: economic downturn. An economic downturn is typically associated with the requirement on the part of the end-user to limit future spending, cut current operating costs, and diversify offerings to mitigate losses.

The critical value-points typically are now shifted to saving cost or some derivative thereof. Nevertheless the value-points still exist. As such, a company evaluating a technology system to address these value-points should, under the same pretext of return-on-investment and corporate prioritization, invest in the underlying system that supports their needs.

Suffice to say, **some companies looking to address economic downturns with a technology investment have accelerated ROI cycle times and limited budgets.** These same companies have an adoption acceptance curve that has shifted to represent their new needs, however still have value points that demand technology solutions.

In times of economic crisis vendors must be conscious of changing corporate and operational priorities of their customers, while end-users must be conscious of not losing sight of the value that technology can bring, irrespective of their current economic situation.

Critical Value Points for Field Product Manufacturing

There are several critical value points inherent to the Oil & Gas field product manufacturing industry that are addressable through technology adoption.

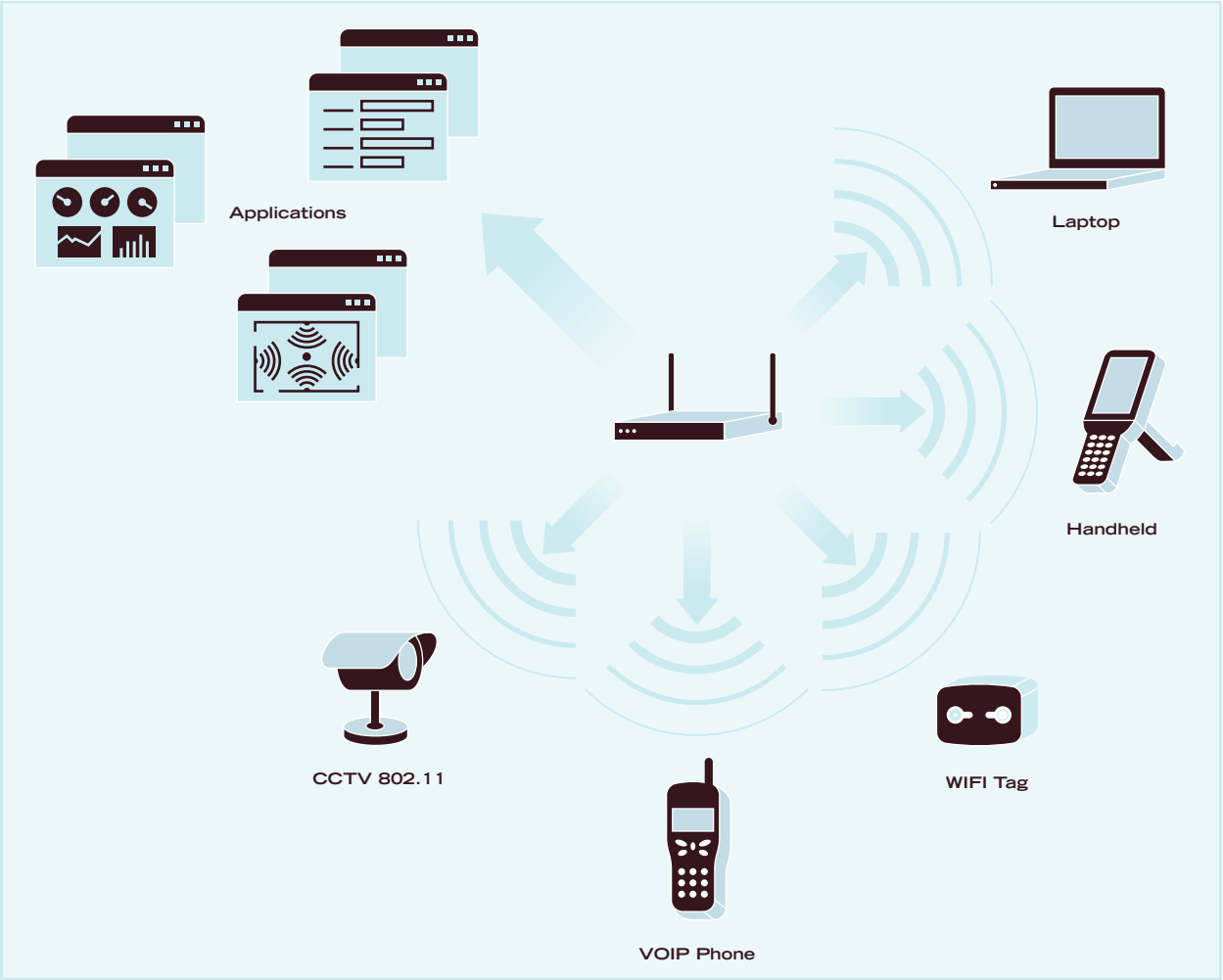
These include but are not limited to:

- Greater Quality Control
- Faster Quality Control
- Optimized Production Scheduling
- Increase Production Throughput
- Increase Production Yields
- Reduced Production Overhead
- Optimized Information Flow to and from Field Worker
- Quicker Response of Field Workers
- Reduced Human Errors during Inspection, Production, and Order Processing
- Reduced Human Errors during Production
- Reduced Human Error during Order Processing
- Improved Customer Service
- Quicker Order Processing
- Enhanced Corporate Wide Operational Visibility
- More Informative Corporate Decision Making
- Scalability to Expand Operations
- Scalability to Reduce Operations
- Reduced Overhead for Product Storage
- Accelerated Auditing
- Enhance Line of Credits Audit Controls
- Minimize Shrinkage
- Access Real Time Inventory
- Improve Product Offering

These value points will be touched up in the upcoming 3 application areas of wireless and RFID technology within the aforementioned market segment.

Wireless Technology at a Glance

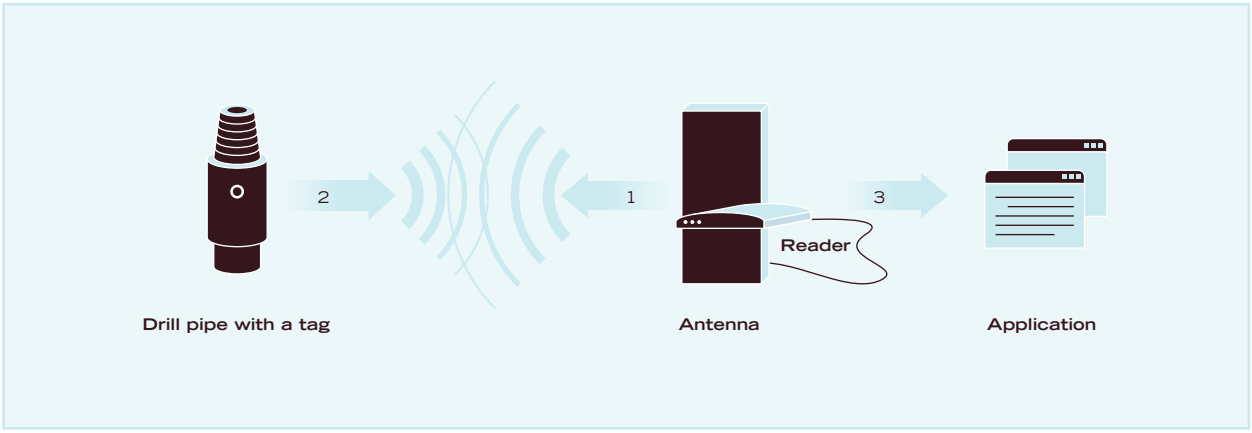
1. 802.11x



802.11x is a set of standards for wireless local area network (WLAN) communication that is developed by the IEEE LAN/MAN Standards Committee (IEEE 802) in both the 2.4 and 5 GHz spectrums. Many hardware devices use this communication protocol to transmit and receive data to and from a wireless infrastructure. The technology can be used for standard data communication, voice and video feeds, and even asset triangulation.

The ability of devices to communicate remotely to a network of 802.11 access points enables field data to be transmitted seamlessly to the application system. This technology is the foundation to enabling shop-floor to top-floor visibility across the oil & gas market segment.

2. Radio Frequency Identification (RFID)



Radio Frequency Identification (RFID) is a wireless data-capture technology. Unlike its predecessor "the Barcode", the technology does not require line-of-sight and has considerably longer read ranges. In addition, this next-generation data capture technology has the ability to reprogram and extends its identification as it progresses through the supply-chain, enabling information to be encoded to the product identifier at any point in its lifecycle.

The wireless ability of RFID, its extended read range, and its capability to modify its identification, has opened the technology to a range of application areas in the Oil & Gas Industry.

Use of Wireless Infrastructure & Data Collection in the Manufacturing of Field Products

Part I Inventory management using Radio Frequency Identification

Maintaining the integrity of inventory is vital to the organization at both field and corporate levels. A well managed inventory can provide the corporation with an accurate visibility into their stock that can enable a variety of operational and financial benefits. The operational and financial benefits are derived from "data" about the current and historical inventory status. Once validated, this corporate data becomes the basis of which various decisions are made across the enterprise.

If an organization has visibility into their stock they may:

- **Respond more efficiently to customer inquiries and sales orders**
- **Enhance production scheduling**
- **Reduce shipping and handling time**
- **Optimize Inventory Storage**
- **Determine the liquidity of the organization**

The process intelligence that enables these assessments is only as good as the data that it is based on. **Accurate, Granular**, and **Timely** data is what enables informative decision making. Radio Frequency Identification provides a data-collection methodology that facilitates the acquisition of product identifiers faster, more accurately, and with greater flexibility than any other automatic identification and data collection technology.

RFID tags can be shaped and attached to virtually any field product. As these products are stored away into inventory, moved to alternate locations, inspected, or shipped, a corresponding RFID data-capture device can record the tag identification numbers and associate these identification numbers to particular activities performed on that part.

Accuracy of Data Collection Using RFID:

An optimally configured RFID system provides 100% read accuracy. When taking into consideration the complex shapes of field products and inventory work flows this is far superior to a barcode based data collection system. Scanning field products reliably at each read point means being able to assure that the information system visibility of the inventory accurately reflects its actual state.

Granularity of Data Collection Using RFID:

Using RFID as a product identifier allows for a unique serialization of the product. This implies that inventory parts no longer have to be bundled at the Stock-Keeping-Unit (SKU) level, but rather are uniquely identifiable. Such that identical parts with different manufacturing dates, lots, production runs, or otherwise can be distinguished.

Timely Data Collection Using RFID:

The technology is wireless and so provides the ability to capture the data with a much greater flexibility than compared to a traditional barcode. In fact the reason RFID tags capture data in a more timely fashion is because they allow, in many cases, for data-capturing to happen without human intervention. As such, these data-capture points are the equivalent of a dedicated employee working 24/7 to promptly capture inventory information as it presents itself in the field of view. This sort of timeliness is a tremendous tool to gaining insight into the inventory.

Part Ia Inventory Management of Couplings

A coupling is a short length of pipe that serves to connect the ends of adjacent casing together. It has internal female threads that are machined to match the external male threads of the casing.

Typically the manufacturing process of the coupling requires that a full length pipe be cut into specific length joints that are then threaded and machined accordingly to create a final product. This process can have multiple SAW (cutting) stations, CNC (threading) stations, phosphate coating, quality control, shrink wrap, and shipping locations. Coupling Manufacturing brings together a complex workflow, variable product types, and sizable production volume.

These variable product types leaving production and entering inventory must be segregated accordingly into stock so as to allow for outgoing shipments to take place seamlessly. Such that shop floor workers can process sales-orders effectively by knowing where each product is located and by understanding how many of that particular product is available.

Company Profile

Employees	200
Production Volume	2,500,000 Couplings / Year

Solution Profile

RFID Hardware	5 RFID Mobile Readers (hand-held), 2 RFID Forklift Readers, 2 RFID Printers
Auxiliary Hardware	7 Wireless Access Points
Software	RFID Middleware, RFID Dashboard, Integration /w Inventory System

Critical Value Points Addressed

Optimized Information Flow to and from the Field Worker

The 5 RFID Mobile Readers are equipped with 802.11g network cards that synchronize with the wireless access points throughout the facility. Inquires made to the system to locate coupling inventory are retrieved from the centralized application server and returned to field operatives instantaneously. Also, product movement of coupling stock is immediately pushed back to the application server so that the next

shop floor worker can instantly have visibility to this inventory and/or location change.

Quicker Response of Field Workers / Faster Order Processing

User specific tasks and functionality are provided to the shop-floor worker carrying the RFID Mobile Reader. Dispatchers send picking requests that are then matched against the nearest field operatives in that location, or total work-load of a particular operative, or a combination of a variable amount of filters. Alerts are sent to shop-floor personnel based on their user profile and task responsibility. Such that, picking for orders, moving products to address spacing issues, or other related activities can be performed quicker.

Reduced Human Error during Order Processing

In conjunction with the optimized information flow, that allows field operatives to validate the sales orders against the centralized application server data, the RFID tags themselves contain product identifier and quantity characteristics that are validated against when processing the orders. This means both forklift readers and mobile readers will cross-reference product type against the processed order. An invalid selection immediately prompts an audible or visual alert to prevent a loading error from occurring.

Improved Customer Service / Improved Product Offering

With the real-time controls of an RFID pick and put-away infrastructure, the system is able to provide an accurate and timely view of the current state of inventory, in addition to the current state of orders being processed. Customers inquiring about available coupling stock can be provided with a more reliable "picture" of the products they can acquire. Furthermore, customers inquiring about their own orders can be provided with a qualified status report of their order.

Improved Corporate Wide Operational Visibility / Better Corporate Decision Making

Understanding the movement of products throughout inventory, the processing times of the orders, and all the other data collected throughout the work-flow provides the "top-floor" (corporate & operations managers) with the ability to understand their business at a much more granular level. If orders are taking too long to process, products

are being moved in and out of inventory locations inefficiently, or any other work-flow related activities are ineffectively being executed, then decisions can be made to reengineer operational processes so the business runs more efficiently and effectively. The visibility the system provides enables a more informative view of the business that facilitates better corporate decisions to be made.

Reduced Overhead for Product Storage

Inventory stock-holding is partially a factor of the lack of insight into consumption or demand. Having the ability to not only look in "real-time" into the inventory levels but also to, at a very detailed level, look into the historical analytics of product movement, facilitates this consumption visibility. Data capture stations enable product workflow tracking that provides this visibility and record keeping. This makes possible the ability to forecast consumption and demand, reduce the required safety net to address demand, and thereby reduce the overhead required for product storage.

Improve Line of Credits and Audit Controls

Field product production binds both human resources and capital while raw materials are processed into the final product. Customers purchase these field items with a promissory note/contract that stipulates full payment upon delivery of an order. Even when a partial advanced payment is provided, the manufacturer still has to support a significant majority of the production costs prior to the customer paying for the delivered product. Financial Institutions offer the option to buy raw material on a credit line. This empowers the product manufacture to undertake orders that require a large upfront investment to deliver. These institutions evaluate the process controls of a manufacturer to determine if they have a clear understanding of their cash-flow and of the resources and capital tied into a particular manufacturing job.

- **Data-capture stations (barcode & rfid) allow the manufacturer to track the status of a production order**
- **Application systems link these orders with customers, the product delivery dates, and their payment terms**
- **Data fusion makes available a wide variety of information that can control the risk inherent in the sales cycle**

The financial institutions that perform audits to determine if the manufacturer is capable of undertaking production runs while assuring that payment is made and lines of credit repaid, evaluates and determines the size of these credit lines by the risk involved in both the production of the goods and in the assurance that the customer will pay upon delivery. The product is created with a regimented production and quality control process supported by data-capture stations and application systems and the capital tied into the manufacturing process is controlled through a financial software module. This end-to-end visibility mitigates risk and assures that the product manufacturer remains in good standing with the financial institutions, enabling, among other benefits, the increase of their line-of credit.

Part II Using Radio Frequency Identification to Control Work-in-progress

Field products move through various manufacturing steps that can include heat treatment, machining steps, and various quality assurance stations.

RFID technology provides a unique serialization to every product moving through production. Application systems link the RFID product identifier captured by wireless antennas in the production environment and associate it to the manufacturing process information.

Production information that can be associated includes:

- **Heat-Treatment T°**
- **Electro-Magnetic Inspection (Wall Thickness, Grade .etc)**
- **Hydro-Test (Psi)**
- **Threading (Lead, Taper .etc)**

This means that every product running through production has a unique product specification and quality control data associated to it. This information can then be used to validate products against their designated work-orders. Field items not adhering to work-order requirements such as wall-thickness, heat treatment temperatures, or otherwise can be immediately identified, located, and appropriately addressed.

In addition these identifiers can be used to automatically adjust production variables as the products move through various stages of its work-flow. For instance adjusting CNC configurations or temperature values in a furnace can be done by capturing these identifiers, retrieving work-order specifications and pushing the appropriate configurations to field equipment so that the product adheres to the requirements.

Finally, from an operations and corporate level perspective, having a detailed visibility into the production environment enables an improved ability to manage the flow of goods and allocate resources to process these goods.

Company Profile

Employees	400
Production Volume	200,000 Tons of Casing / Year

Solution Profile

RFID Hardware	12 RFID Mobile Readers (hand-held), 8 RFID Fixed Readers, 2 RFID Forklift Readers
Auxiliary Hardware	Specialty Tag Mounting Equipment, 12 Wireless Access Points, 3 Fixed Barcode Scanners
Software	RFID Middleware, RFID Dashboard, Integration /w Heat Treatment Logger, Visual Threading QC Station, EMI Logger

Critical Value Points Addressed

Better & Faster Quality Control

Quality control is a vital part of assuring field products are meeting specifications after the manufacturing steps have been performed on them. Integration with quality control field equipment loggers enables data to be quickly captured and directly associated to production items as they pass in front of RFID or Barcode data capture

stations. The application systems themselves improve the ability to record the data while the data capture systems improve the ability to associate that data back to the individual field product.

Here are two application system screenshots that collected manufacturing data that was fused to a RFID product identifier.

Optimized Production Scheduling, Throughput, and Yields

- **The Production scheduling is a dependant on the capacity of a line, the demand for a particular product, and the time a product takes to produce**
- **The Throughput of a line is a function of production scheduling, the machining capacity of the line, and its downtime**
- **The Yield Rate is a function of the raw material quality, machining integrity, and quality controls**

Radio Frequency Identification provided visibility into product movement throughout the manufacturing process and enabled the ability to address changing conditions of the line in real-time.

This includes:

1. Understanding usage rates of machining equipment to allow for appropriate maintenance to be performed.
2. Enabling the ability to re-align/re-prioritize production in accordance with new

demand.

3. Improving the quality of raw material by tightening the levels of quality control.
4. Identifying product yield drops across various points in production and promptly addressing these issues.
5. Automatically programming field equipment as per work order requirements.

Some Quantitative Results:

Operation Teams consistently experienced a 10% increase in throughput across thread lines because of the increased product visibility and quality control provided by the RFID system. Thread-lines now had upstream visibility into arriving product that allowed them to be configured accordingly with no production delays.

Usage rates of lathes was cross-referenced against each product moving through the line and allowed for a more effective maintenance model that reduced down time by 6%.

Yield Rates across the Electro-Magnetic Inspection Stations improved dramatically by up to 25%. This was due in part to improved quality control procedures at the heat-treatment lines and also to the fact that each work order running through the system was immediately visible to a corporate-wide dashboard system that quickly altered operations teams when yield rates were dropping. Catching these defects at the EMI station and quickly pushing this data to corporate decision makers allowed for the majority of the remaining work-order to be halted and production variables upstream changed to address these issues prior to them being detected at the station.

Part III Personnel and mobile asset tracking using RFID and 802.11x networks.

Moving products in and out of inventory, staging products during production, machining products, and loading them for shipping is not only about the items you produce or the equipment you use to produce them but is also about the workers that support these processes and the equipment that helps move the product from one location to another.

It is just as an important to understand the operations flow of workers as it is to understand the product work flow.

RFID technology combined with wireless network infrastructure can provide the ability to locate personnel across multi-acre facilities. It enables the ability to record movement through these facilities and provides:

- **Effective Evacuation Controls**
- **Prompt Dispatching Capability**
- **Optimized Personnel Positioning & Scheduling**
- **Allocation of Responsibility**
- **Capture Time and Attendance**
- **Enhanced Security**

This means workers tasks and movements throughout the production facilities can be monitored, analyzed, and optimized.

Company Profile

Employees	600
Production Volume	100,000 Tons of API Tubing / Year

Solution Profile

RFID Hardware	4 Mobile Asset Tags for Forklifts, 12 Mobile Asset Tags for Personnel
Auxiliary Hardware	25 802.11 a/b/g Wireless Access Points, Mobile Computers, Mobile Forklift Readers
Software	Visibility Dashboard

RTLS Inventory / Location Match

RFID Enabled Forklift

Critical Value Points Addressed

Reduced Human Error during Order Processing / Optimized Information Flow to and from Field Worker

When cross-referencing the asset location of forklifts and service personnel (obtained by triangulating the location of wireless devices installed on forklifts using wireless access points) and the location of products to be moved or shipped (obtained through other data capture systems and extracted from the application data store) the application system provided process intelligence in the form of:

- **Validation of Pick-List**
- **Recommended Picking Routes**
- **Analysis of worker efficiency (where they've been, how long they take to do a particular task)**

Quicker Response of Field Workers / Improved Corporate Wide Operational Visibility

Connecting the field worker to a corporate wide infrastructure via portable PDAs or forklift mounted computers has enabled the ability to actively delegate operational commands from the top-floor (corporate & operational managers) that included:

- **Product movement**
- **Production scheduling**
- **Order Loading & Processing**

In addition, field workers can actively collect and transmit field data using these mobile computers that included:

- **Picking Order Progress**
- **Inspection / Quality Control Feedback**
- **Issues with Production Machinery**

Better Corporate Decision Making

Connecting the field workers to the 802.11 wireless networks enables top-floor

decisions to be made with shop-floor level visibility. Understanding both product and worker movement, while simultaneously monitoring the production, shipping, and quality control processes enables prompt response to unpredictable circumstances and effectively mitigates inefficiencies. Having this granular knowledge enabled the ability to monitor processes to verify they adhere to corporate expectations. This can include setting Key Performance metrics for order loading times, production yields through particular stages, active workers in a particular area, and other related indicators.

Some Quantitative Results:

Loading Time Windows were cut from 45 minutes per truck to 30 minutes per truck when knowledge of field operatives' movement discovered that larger windows of loading led to workers being in active and less efficient.

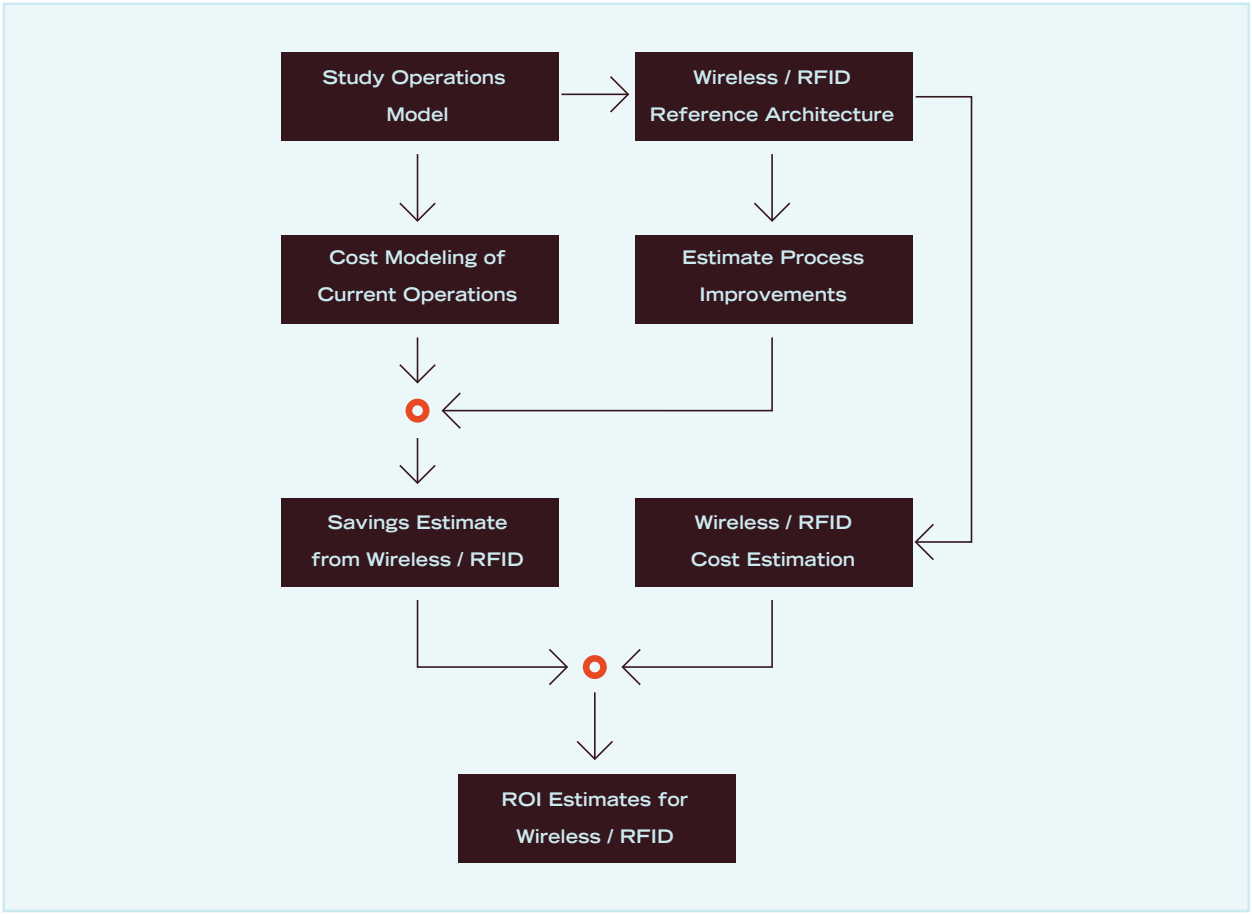
Picking time was improved by 10%, this was partially attributed by the recommended routing of field operatives to item locations via the mobile computers. This was also attributed to the data capturing and control of inventory during put-away processes that assured that inventory location was accurately recorded.

Downtime of machinery was reduced by 13%. Machinery included forklifts and production machinery all together. This was attributed to immediate feedback of downed machines via the mobile computers carried by the field operatives.

Return on Investment

Given today's economy and the need to do more with reduced resources, budgets, etc., organizations are looking to improve efficiencies across departments and business units. This means reviewing the current processes and improving them, or putting processes in place where nothing formal currently exists. Process improvement initiatives are becoming a focal point for organizations – regardless of their size or industry – and Executives want to see the positive monetary impact from these initiatives. Here is where Business Impact and ROI analysis comes into play to measure the effectiveness of an organization's process improvement initiatives.

The following steps were followed to calculate the ROI for the various applications:



A business impact analysis was conducted using an application scoring methodology, as an essential component of the organization's business continuance plan; it included an exploratory component to reveal any vulnerabilities, and a planning component to develop strategies for minimizing risk. The result of analysis was a business impact analysis report, which described the potential risks specific to the application studied.

One of the basic assumptions behind this exercise was that every component of these 3 wireless /RFID applications were reliant upon the continued functioning of every other component, but that some are more crucial than others and required a greater allocation of funds, prioritized by a higher business impact score in the Oil Field Product Scoring Matrix showed here under.

Scoring Matrix Oil Field Product Manufacturing

Sr No	Business impact	Multip. Factor	Inventory Management of Couplings		Control Work-in-progress		Personnel and Asset tracking	
			Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Paper Reduction	2	3	6	6	12	2	4
2	Asset Security	1	2	2	3	3	3	3
3	Asset Visibility	4	5	20	5	20	6	24
4	Operation Transparency	5	6	30	6	30	3	15
5	Human Error Reduction	3	4	12	4	12	4	12
Total Business Impact Scores				70		77		58
Business Impact Score Measurement				70		77		58

Scoring methodology

The scoring methodology is based on a criteria ranking, where the criterias are listed and each criterion will carry a multiplication factor based on the priority. Each criteria will get a score from 2 to 6 which is then multiplied by the multiplication factor.

Scoring values

Significant	6
High	5
Med	4
Low	3
Insignificant	2

As the business environment becomes more competitive, organizations search for methods and technologies to improve their processes in order to make them much more effective and efficient while at the same time reducing costs to give them the competitive edge. The challenge for an organization is to discover what segment of the organization requires process improvement initiatives, and what are the appropriate initiatives.

To establish accurate ROI numbers during and after implementation the following points need to be noted:

Typical Tangible Benefits in the Oil Product Manufacturing Sector:

Tangible Benefits	Impact
Reduce Supply Chain Costs	3-5 %
Increase in Revenue due to better visibility & accuracy	2-7 %
Revenue lost due to Out-of-stock Inventory	8-9%
Capital Assets optimization	20%
Increase productivity	20-30%
Labor cost reductions	7-8%
Savings in Inventory	10-30%
Increase in Sales due to proper deliveries / shipments & improved demand forecasts & reduced out of stock inventory	20-30%

Typical Soft Benefits

Inventory in Warehouse and Production	Labor
Increase Visibility	Increase Visibility
Increase Accuracy	Increase Accuracy
Increase Velocity due to real-time information	Increase Velocity due to real-time information
Improved Decision Making	Increased Visibility into Consumption
Reduce Excess Inventory reducing Working Capital	Increased Labor Efficiency
Reduce Carrying Cost of Inventory	Increase Gross Profit
Reduce Shrinkage (Theft / Disappearance)	Decrease Labor Costs due to Manual Entry
Reduce out-of-stock Inventory	Decrease Labor Costs due to Errors
Better Supply-Chain Forecasting	Speed finished goods through production
Increase Labor Productivity due to searching or waiting on inventory	
Reduced Shipping Costs	
Increase Service Levels	
Increase Inventory Turns	
Speed finished goods through production	

Conclusion

The aforementioned case studies and the values that 802.11x and RFID technology brought forth within these businesses have provided fundamental improvements in critical areas of their businesses. The decisions to adopt these technologies were made on the basis of the perceived value and financial return or savings that the system would provide. Out of the three companies that implemented these systems, two had done so after the economic downturns in the late fourth quarter of 2008. Although budgetary constraints and cost cutting were factors that revised corporate decisions and expectations with respect to investing in information technology systems, the basic understanding and consensus amongst the companies was that, given a strong enough business case, irrespective of the current economic situations of the marketplace, capital needs to be invested in these systems, since they will save money, or increase revenue, or improve audit controls, or some combination thereof.

Moving forward into 2009 will likely see further downturn in many different business sectors. Petroleum field product manufacturers are no different. They will have to deal with a considerable decline in production and profit. Nevertheless, savings and risk mitigation must not be seen only as lay-offs, sell-offs, or budget cut-offs. Savings and risk mitigation can have a much more positive and lasting effect on a business when it is enabled through information technology investment.

Contact

Merlin Concepts & Technology

Konrad Konarski
16770 Imperial Valley Dr.
Houston, Texas 77060
United States of America
Telephone: +001 877 2 608060
Fax: +001 281 2 608063
E-mail: kkonarski@merlinconcepts.com
Website: www.merlinconcepts.com

BMO Nesbitt Burns

Paul Younan
1501 McGill College
Montreal, Quebec H3A 3M8
Canada
Telephone: +001 514 2 863547
Fax: +001 281 2863522
E-mail: paul.younan@nbpcd.com
Website: www.bmonesbittburns.com

Shipcom Wireless

Sam Falsafi
11200 Richmond Ave. 552
Houston, Texas 77082
United States of America
Telephone: +001 713 4 708283
Fax: +001 281 5 585255
E-mail: sfalsafi@shipcomwireless.com
Website: www.shipcomwireless.com

Texas A&M University

Dr. Ben Zoghi PhD, PE
Fermier Hall
College Station, Texas 77843
United States of America
Telephone: +001 979 8 454074
Fax: +001 979 6 763533
E-mail: zoghi@entc.tamu.edu
Website: rfid.tamu.edu

Copyright

PUBLISHED February 2009

Copyright Status

Disclaimer of Liability