Pump Ilot and Remote O&M

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IIoT is Creating New Market Paths to the Pump Market

- The Industrial Internet of Things (IIoT) is a powerful new force shaping the way pumps will be purchased.
- The demand for pump automation and communication of pump health and performance will be driven by IIoT. With the rapid reduction in the cost of high quality sensors and the introduction of wireless technology smart pumps will be communicating with remote operators on an accelerated basis.
- The process of automatically monitoring smart pumps begins with a variety of sensor technologies. Pumps are outfitted with multiple sensors that measure vibration, voltage, current, temperature, pressure and flow rate.
- This data can be analysed initially with edge technology which minimizes the data needed to be transmitted to the cloud.
- A remote monitoring center such as those already being operated by GE, Siemens, MHPS and others then receives the pump data along with other data on all the components and systems.
- For example, the typical pump sub system has several on/off valves. In the future these valves will be monitored along with control valves. This data can also be supplied to the pump companies who interface with the system suppliers and end users to provide advice and possibly operational support and maintenance.

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Pump Company Success Depends on Knowledge

- Not only can the pump companies boost Capex revenues for smart pumps and Opex revenues for service and parts but they can acquire process data to help them design better pump products for specific applications.
- This proliferation of information about pump performance will serve as a giant resource of pump white papers. Proof of lowest total cost of ownership will be automatic.
- The pump companies who best leverage this process and pump performance knowledge will be the most profitable.
- Mcilvaine has coined the term Industrial Internet of Wisdom (IIoW). The rate of progress can be viewed as 1 x IIoT + 2 x IIoW.
- Transmitting all this data to better manage assets is only 1/3 of the opportunity. 2/3 of the opportunity is the improvement of assets and operations.
- Pump companies will be the source of Pump IIoW but only if they understand the new market paths.
- The gas turbine industry is going to be an IIoT leader because remote monitoring of turbines is now common. So, adding balance of plant monitoring will be the next logical step.
- Pump companies need to understand the changing industry structure and the changing market paths.

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The Role of High Performance Pumps in IIoT

- If general purpose pumps are the foot soldiers of IIoT then high performance pumps belong in the armoured division.
- Their performance is much more critical to the outcome of the battle to improve plant performance.
- IIoT promises to revolutionize industry but only if it is accompanied by IIoW (Industrial Internet of Wisdom).
- Decisive classification of high performance pump applications, designs, and materials is critical to IIoT success.
- IIoT will generate continuous performance and condition information about each pump. A large plant could have 10,000 pumps.
- In order to determine which pumps are working best it is necessary to divide the applications and pump types into meaningful groups.
- One can then compare the performance of pumps from different manufacturers in the defined group.

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High Performance Pumps

A high-performance pump is one which is in any of following three types of service.

- Severe Service: Corrosion, pressure, temperature, process operating fluctuations are all conditions that qualify an application as severe service.
- Critical Service: Safety, product purity, continuous operation, and product toxicity are criteria of critical service.
- Unique Service: The distinction is often made between an engineered pump versus an off the shelf or standard pump. In any case, the decision making for unique service pumps needs to be made with prioritization of the lowest total cost of ownership.

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Total Industrial Pump Revenues in 2030 are Projected to be $80 billion

World Industrial Pump Revenues – 2030 - $ billions			
Revenue Source	Total	General Performance	High Performance
Total	80	35	45
Old Route to Market	35	16	19
New Route to Market (Remote O&M)	25	11	14
Additional Revenue (IIoT)	20	9	11
Revenues Attributable to IIoT and Remote O&M	45	20	25

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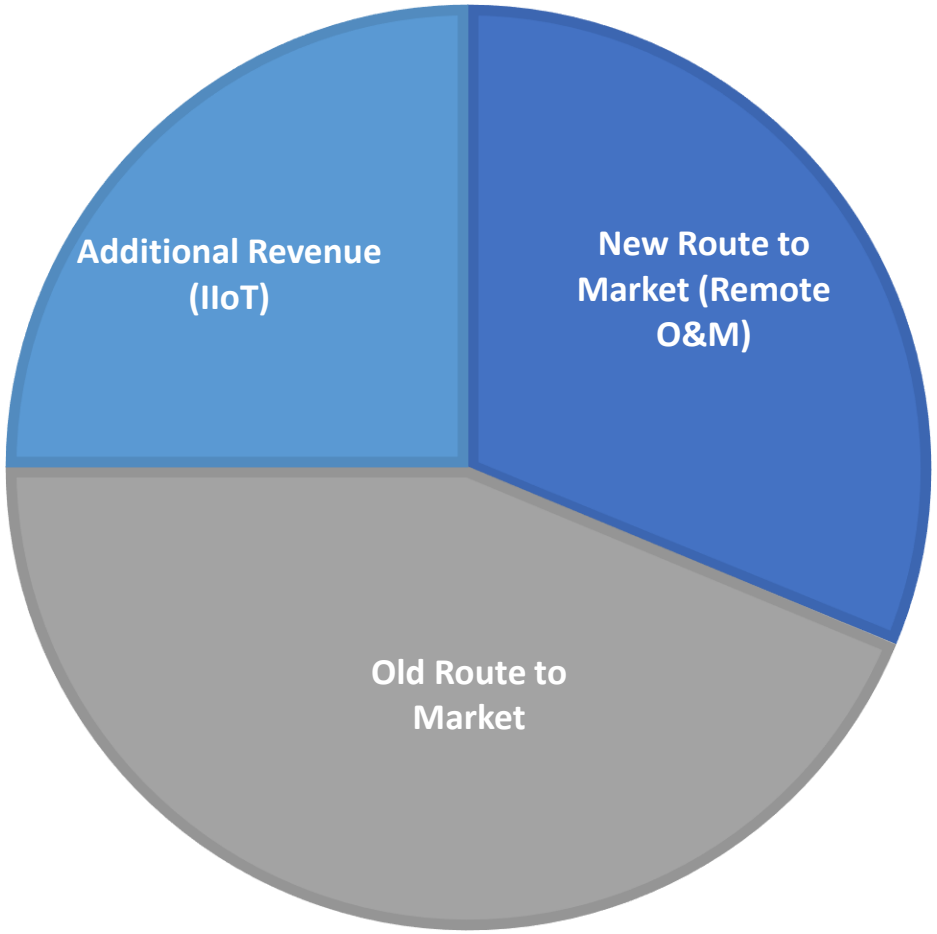
Growth rate will be 13%. So total HP IIoT & Remote market now is $ 4.7 billion

PUMP REVENUES



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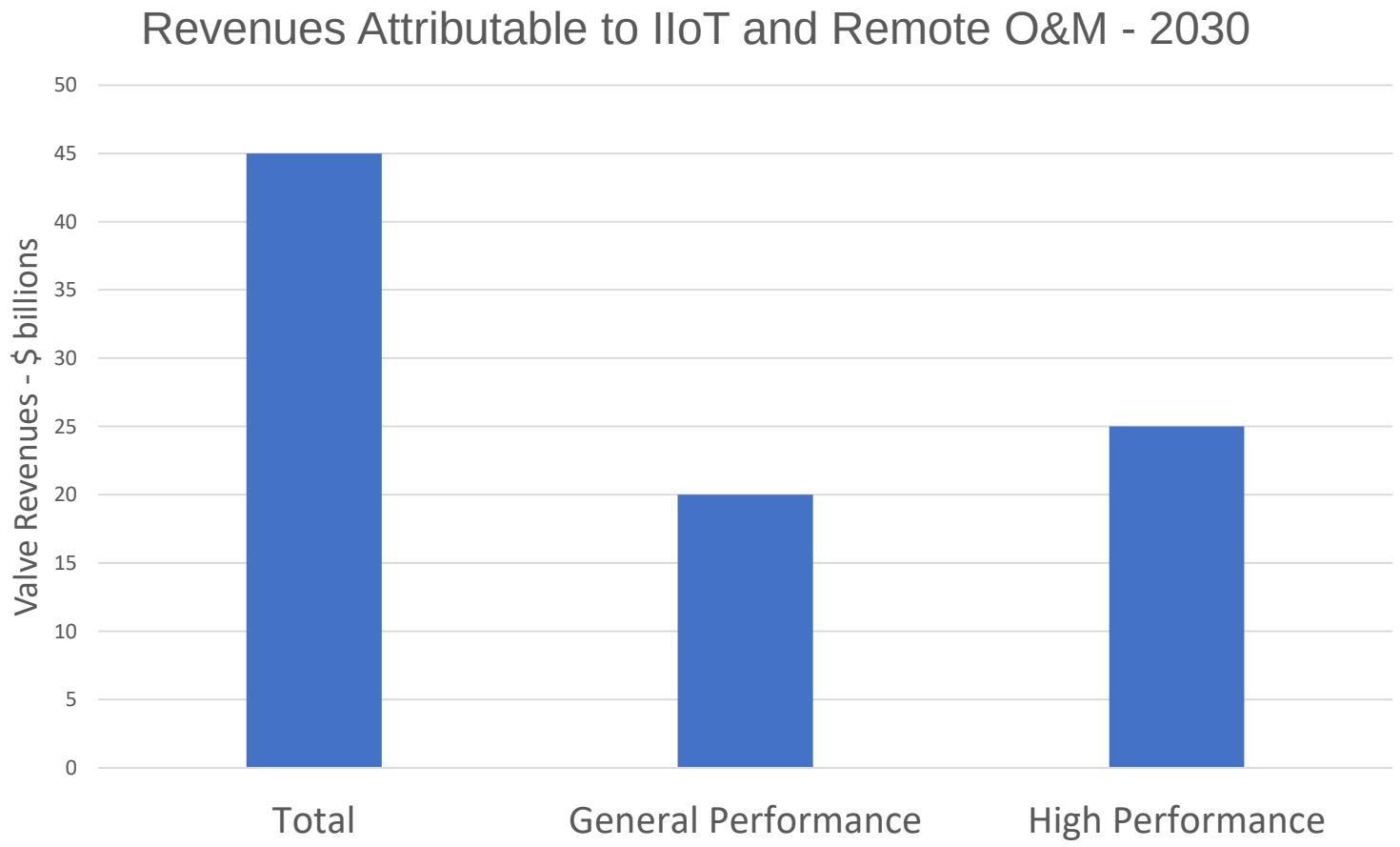
More than 50% of the market will be shaped by IIoT by 2030 up from less than 10% now



High performance pumps will also generate higher margins and profits than general service. They represent a way tor international pump companies to succeed in developing countries

Increase in Revenue from IIoT

- High performance pump sales of $14 billion in 2030 will be made to third parties. The IIoT additions to the pump offerings will boost revenues by $11 billion. As a result, the high performance IIoT pump market will be $25 billion.
- The market share for a specific supplier will be shaped by not only the quality of his smart high performance pump but his willingness to assume a greater role.
- At the very least he should develop his own remote monitoring center and provide analytics and wisdom at higher levels.
- The levels as defined by Honeywell are shown in the following chart.

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Digital Process Management Scope

Level	Device	Function
1	Smart Sensors	Sensor and actuator with no or small amount of local processing and data storage
2	Edge Device/Smarter Connected Sensor	Includes a sensor, some local processing, data storage, power management, connectivity, security and user interface
3	Local system/ Connected Edge	Connect to a gateway, controller or server. Connectivity is mostly local in a closed loop system, could have cloud connectivity
4	Cloud Infrastructure	Allows data to be accessed, aggregated, stored monitored and actuated anywhere in the world
5	Big Data Analytics	Servers with cloud connectivity gather data for advance applications e.g. data analytics, visualization, machine learning

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Supply Hierarchy and Scope

There is also a scope hierarchy which influences potential IIoT. Pump suppliers can seize the opportunity to expand their scope by offering Level 3 programs.

Hierarchy	Deliverable	Level
1	Flow control component products such as valves and pumps	1-3
2	Processes. e.g. separation, reaction, heat transfer, combustion	1-4
3.	Systems e.g. ultrapure water steam generation, wastewater treatment	1-5
4	Plants e.g. refineries, power plants, pharmaceutical, semiconductor	1-5

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Seizing the Opportunity

- A large pump supplier e.g. KSB or a pump supplier with automation divisions e.g. Flowserve, has the opportunity is to be a Level 5 provider.
- At the very minimum the pump supplier has to design his pump for smart sensing. He also should supply the sensors.
- At Level 1 he can sell to suppliers of processes. But by teaming up with Honeywell, Rockwell, ABB, Schneider Electric, Yokogawa or other Level 2 & 3 providers the pump supplier can play a more important role.
- The insights he will receive will allow him to improve his pump products for specific applications.
- The pump supplier can better improve his products with the support of what are called “subject matter experts” of the IIoT community.
- It can be argued that subject matter expertise needs the same degree of organization (IIoW) as IIoT. One example of this is a series of Decision Guides on specific high performance pump applications which are being assembled by McIlvaine.

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Gas Turbine Pump IIoT Opportunities

- Changing Industry Structure: The inventory of existing gas turbine plants is growing at six percent per year and in the next few years the base will grow to two million MW.
- There are 30,000 individual units which routinely require service, replacement or repair of pumps used for intake water, boiler feedwater, condensate, cooling, turbine inlet water injection, reagent delivery, treatment chemical delivery, lubricant and hydraulic fluid circulation.
- The market for pump replacement products, repair and services is $1 billion per year and will grow by more than six percent per year.

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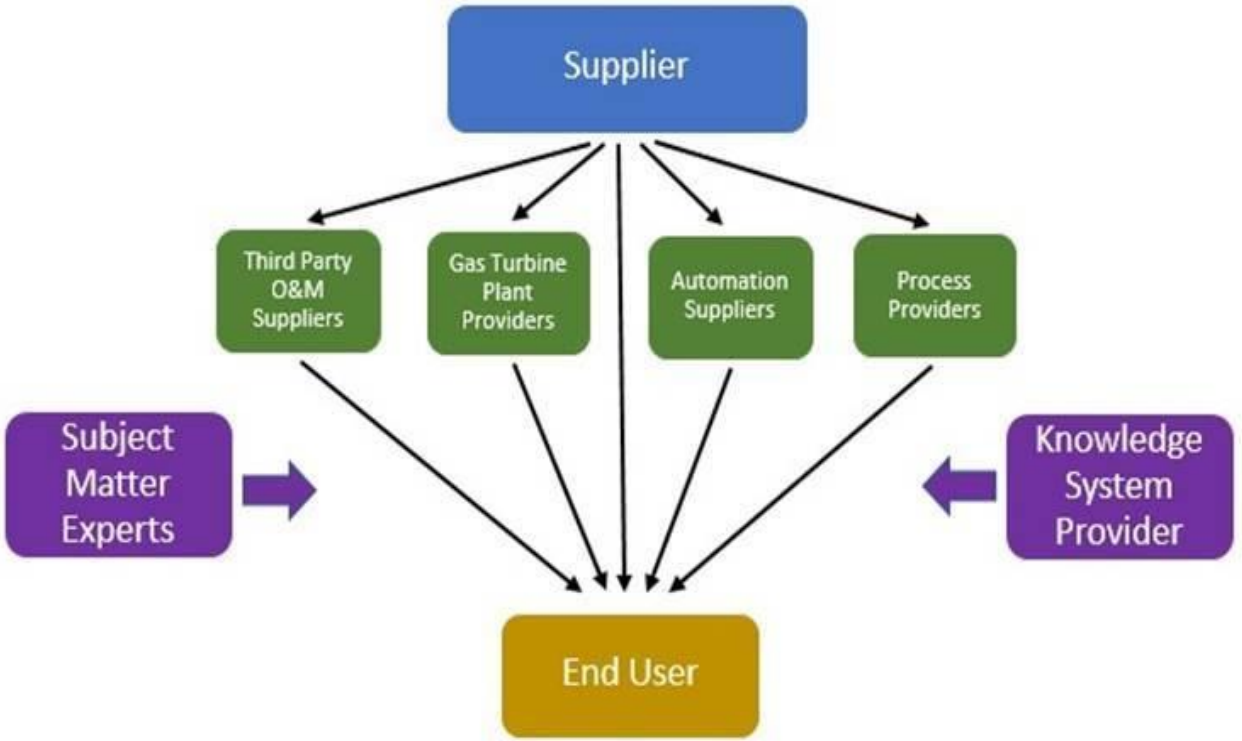
Changing Paths to Market

IIoT is creating new channels to market in contrast to the sale directly to a single end user.



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End Users

- Large end users are creating fleetwide purchasing and monitoring systems. Southern Company operates over 280 power generation units at 73 power plants including gas turbine, combined cycle, steam (coal), hydro and solar. Southern Company implemented the first phase of their fleetwide monitoring and diagnostics (M&D) center in 2007.
- Duke Energy is growing its fleetwide monitoring and diagnostics center. Duke's efforts promise to result in maintenance savings and availability improvements, while increasing equipment health visibility and optimizing logistics of maintenance.
- The one hundred largest operators of gas turbines around the world account for the majority of purchases. Therefore, working with them should be a high priority.

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Gas Turbine Plant and Process Providers

- Gas turbine suppliers have remote monitoring centers primarily focused on the health of rotating parts such as turbines. However, this is being expanded.
- MHPS just opened a remote monitoring center in the Philippines. It is positioned to monitor the balance of plant in addition to the turbines.
- Suppliers of heat recovery steam generators, ultrapure water, emission controls and water treatment are also purchasers or influencers relative to products.
- Nalco has a water quality remote monitoring center which operates around the clock.

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Automation Suppliers

- ABB can provide all required gas turbine control and protection functions utilizing the very same ABB DCS platform that controls the rest of the plant.
- The typical gas turbine functions implemented include fuel control, start-up sequence, speed-load-temperature closed loop control, overspeed protection, anti-surge protection, generator protection, auxiliary control, condition monitoring, auto-synchronization, excitation, frequency control, etc.
- ABB is positioned to add the pump controls to their platform.
- Yokogawa has various programs including one which monitors the wastewater from the plant.
- The automation supplier can be working directly with the end user and not necessarily through the process supplier.

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Pump Industry Should Lead not Follow

- Emerson's use of Seek software allows incorporation of insights and background data which can be opportunistically displayed to help solve problems as they occur. The question is who is going to supply these insights.
- Mcilvaine believes the pump industry should take the lead and not wait to be contacted by digital process management companies such as Accenture and Genpact.
- The analysis and pump inventory can be done company by company. Since a few hundred gas turbine operators account for the majority of the world's gas based power generation the task is simplified.
- Mcilvaine is moving forward with a beta site for Berkshire Hathaway Energy (BHE) which operates hundreds of gas turbine and other power plants. The provider of the boiler feedwater and other pumps at each plant is identified.
- This is the first step toward analysing performance.

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O&M Third Party Providers

- Many gas turbine combined cycle power plants are operated and maintained by third parties. The developments in remote monitoring are making it more attractive to sub contract to a company specializing in O&M.
- These providers include specialized service companies such as Wood Group and EthosEnergy, power plant operators such as Uniper and RWE who are leveraging their experience to help others, and the plant suppliers such as Siemens and GE who have build/own/operate (BOO) contracts.
- Pump suppliers have an opportunity in an expanding gas turbine market to take advantage of the IIoT driven changes and to increase not only revenues but gross margins and profits as a percent of those revenues.
- This will require direct high level communication with several types of organizations.

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Schneider Electric makes Pumps Smart

- At the Offshore Technology Conference 2016 in Houston, four companies showcased an intelligent pump to demonstrate a variety of technologies that address industry challenges and help businesses operate more efficiently.
- The process of automatically monitoring this pump begins with a variety of sensor technologies. The pump is outfitted with multiple sensors that measure vibration, voltage, current, temperature, pressure and flow rate.
- IIoT gateways designed to connect operational technology to information technology, specifically for brownfield applications, need to be open enough to support a range of sensors, including new sensor technologies as they are merged into the IIoT platform.
- A single intelligent gateway aggregates data from all of the connected sensors and chooses whether to conduct local processing at the asset for event triggers and alarms.
- By shifting from a manual-route-based maintenance routine to one that uses online monitoring for critical and near-critical assets, businesses can monitor more machines more often and enable their workforces to spend more time diagnosing and managing assets instead of walking or driving around to take measurements.
- The ability to compute power on the asset can help analyze the data in near real time and improve the probability of catching transient phenomena.
- This ability also reduces the required network bandwidth because dynamic measurements such as vibration are often run at tens of thousands of samples per second.
- There is no reason to excessively stream megabytes of data from a healthy pump all the way to the cloud.

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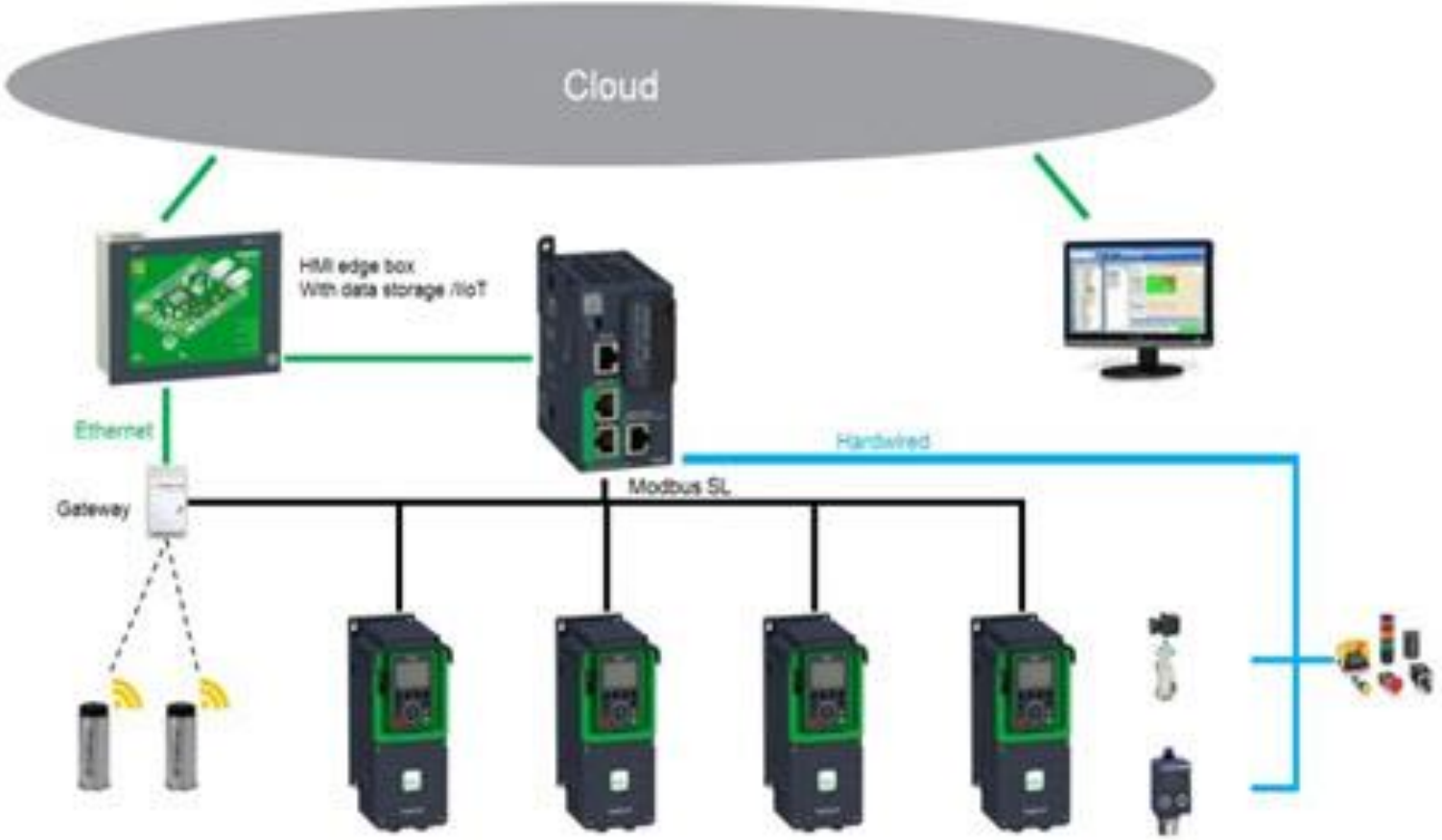
Smart Pumping Systems along with IIoT Reduces the Total Cost of Ownership

Schneider Electric Blog covers remote monitoring combined with VFD and software to create cost effective pump operations. This article is included in the intelligence system. By remaining connected with pumps, *the manufacturers know the location of the pumps and are also able to provide timely support and spare parts to their customers. The connected Variable speed drives with active QR codes can be used for diagnostics and also to give information easily to operators for support.*



KSB Pumpmeter provides Comprehensive Monitoring

KSB's PumpMeter enables comprehensive pump monitoring. Operators can see at a glance whether the availability of their pumps is at risk and if they are operating economically.

PumpMeter comprises:

- Pressure sensors
- Analyzing unit
- Display unit

It monitors:

- Suction pressure
- Discharge pressure
- Differential pressure
- Head

For optimum status monitoring, it alternately shows the measured and calculated values on an easy-to-read display.

PumpMeter continuously analyses the pump operating data. It establishes a load profile and makes the operator aware of energy saving potential that could be leveraged by using a variable speed control system.

PumpMeter replaces the pressure gauge upstream and downstream of the pump, the pressure transmitter for the control functions and additional monitoring equipment.

Standardized interfaces allow the data obtained to be used by a central process control system. Using PumpMeter simplifies commissioning of a pump with variable speed system

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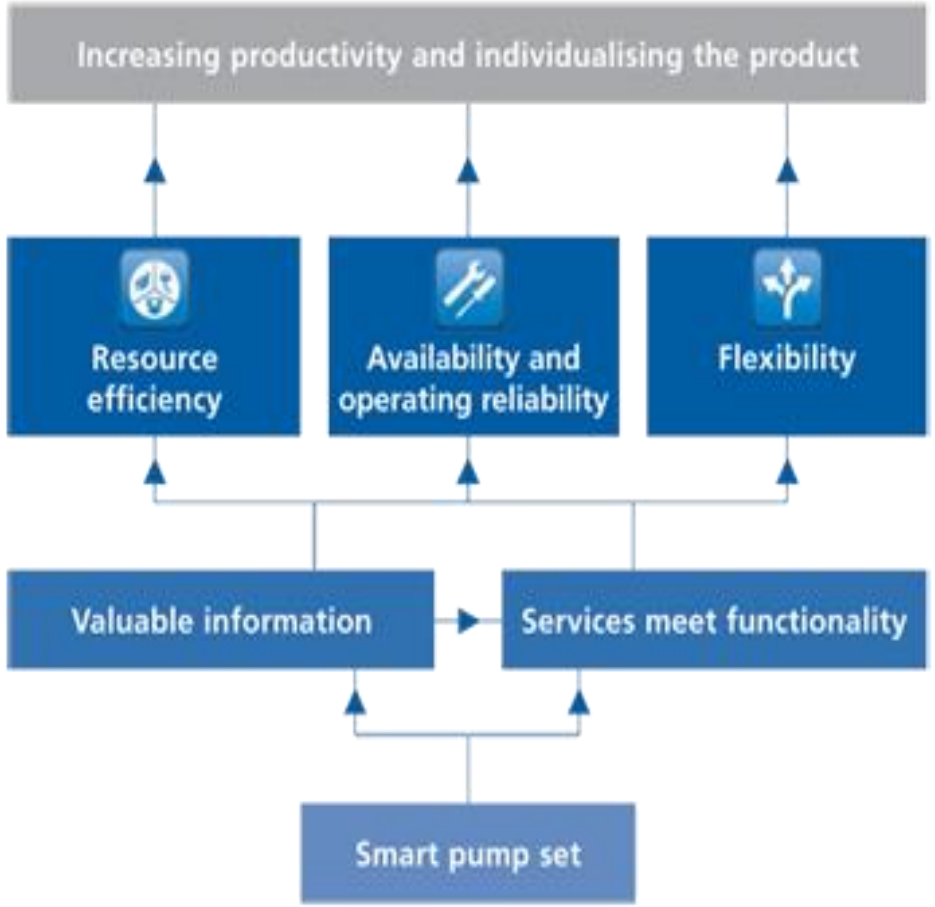
Pumpmeter and PumpDrive in the Digital Industry

With its innovative functions, KSB's smart pump set plays an important part in the success of Digital Industry. With valuable information and standalone functions, this pump technology helps to ensure that productivity can be increased and products can be individualized.

Three factors form the basis for the economic success of systems in Digital Industry:

- Increased resource efficiency and optimized use of materials
- Increased availability and operating reliability through perfect equipment management
- Greater flexibility via short-term reconfigurability

KSB pump sets equipped with the PumpDrive variable speed system and the PumpMeter monitoring unit can be connected easily with other components to create networks. This allows them to supply valuable information and to automatically optimize the way they work – thus maximizing efficiency and operating reliability.



KSB System Efficiency Services

- KSB Pumps Inc. is offering pump system operators a new on-site performance monitoring and analysis service. System Efficiency Services (SES) combines on-site data collection with KSB's deep expertise in pump operations to provide pump owners with a comprehensive picture of how their system is running.
- The starting point for SES is the collection of multiple system parameters (power consumption, pressures, flow rates, pump and motor vibration, pump speeds, etc.) at a number of locations on the system and over a range of operating conditions. "These measurements give us the information we need to understand exactly how the system is running", reports Gary Zeidler, Manager of KSB Pumps' Service Division. "By comparing the system characteristics to performance curves provided by the pumps' manufacturers, we can learn a lot about how efficiently the pumps are operating in the system." Zeidler continues: "If we find that pumps are spending a lot of time operating at low levels of efficiency, we can recommend changes that will reduce energy costs and usually mean smoother running and longer pump life." Online monitoring of pump performance can also be useful for trouble-shooting and for identifying performance problems before they cause equipment failures.
- SES monitoring is done on-site in customers' facilities. The instrumentation can be installed without the need for drilling into existing equipment. Once the analysis is complete, KSB's engineers provide a comprehensive report that outlines areas for improvement and potential cost savings. The analysis will also recommend a preventative maintenance program that is optimized for the operating environment.

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Computerized Maintenance Management Systems provide Lower Total Cost of Ownership

(excerpts from an article by Mike Pembertson of IIT in 2014 Pumps and Systems)

- Engineers and suppliers are still oversizing pumps, for a variety of reasons. Some prepare for increased demand, imagining future capacity increases that never come. Pump optimization activities allow an increase in the level of condition monitoring through broader use of intelligent motors, pumps with embedded chips, VFDs and wireless vibration monitoring.
- These tools offer real-time information on pump system performance. Pumps are not considered to be an integral component of the process automation architecture. As a result, plant information systems—such as distributed control systems (DCS) and computerized maintenance management systems (CMMS)—typically lack continuously monitored asset data for diagnostic use.
- Although the DCS monitors most of the key process parameters required for traditional process control, up to 60 percent of the pump systems lack a flow measurement on the discharge line. For all practical purposes, almost all of the work orders and asset information is manually entered into the CMMS. Furthermore, other underlying assets, including compressors, blowers, fans and control valves, are rarely connected to the CMMS.
- The lack of information is a missing link in an e-manufacturing strategy. It can mean that large potential cost savings go unrealized.
- With consideration given to proper mounting, alignment and lubrication, the three primary determinants of pump reliability are speed, distance operated from BEP and impeller diameter.
- If a mill optimizes 30 percent of existing pump systems, overall mill process availability will dramatically increase while pump seal and bearing failures will significantly decrease. Reliability improvements can be predicted, and past work orders and CMMS records can be used to estimate annual maintenance costs. In many cases, process control benefits can be identified in terms of reduced raw material variability, and life-cycle-cost savings can be estimated based on current costs compared with optimized costs.

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Paper Mill Bleach Plant eliminates Oversized Pump Problem with Systems Based Solution from ITT

- A paper mill bleach plant was suffering financial losses from an oversized pump. It was determined that nearly two-thirds of the facility's valves were less than 50 percent open. Many of them were less than 25 percent open. One key pump system had a capacity of 6,500 gallons per minute (gpm), but the average load was only 2,750 gpm—52 percent of total capacity. The peak flow demand was only 5,200 gpm. The 10-inch ball-valve installed in a 14-inch discharge line was undersized. The large pressure drop and associated vibration were causing valve wear, pipe cracks, gasket leaks and frequent downtime. Also, it was difficult to keep the control loop tuned, which required manual operation of the modulating valve. The pump experienced almost 10 failures per year, all of which occurred while the pump was running and during startup and shutdown.
- Stabilizing the control loops and reducing pressure inside the system turned a frequently failing pump into a properly functioning component of the system. The bleach plant witnessed $18,000 in energy savings in 2002. Energy savings in the same process had climbed to $32,000 in 2013 as energy costs increased. Beyond the efficiency improvement, plant representatives also reported that the systems-based solution saved them more than $1 million annually in downtime and repair costs.

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Grundfos Remote Management

Overview

- Grundfos Remote Management is a secure, internet-based system for monitoring and managing pump installations in commercial buildings, water supply networks, wastewater plants, agricultural irrigation systems, etc. Pumps, sensors, meters and Grundfos pump controllers are connected to a CIU271 (GPRS Datalogger). Data can be accessed from an Internet PC, providing a unique overview of your system. If sensor thresholds are crossed or a pump or controller reports an alarm, an SMS (text message) will instantly be dispatched to the person on duty. Changes in pump performance and energy consumption can be tracked and documented using automatically generated reports and trend graphs. This can give an indication of wear or damage, and service and maintenance can be planned accordingly.

Applications

- Grundfos Remote Management is a secure, internet-based system for monitoring and managing pump installations in commercial buildings, water supply networks, wastewater plants, agricultural irrigation systems, etc.

Features and benefits

- Complete status overview of the entire system you manage
- Live monitoring, analysis and adjustments from the comfort of your office
- Follow trends and reports to reveal opportunities for energy-reducing performance optimization
- Plan who receives SMS alarms with easy-to-use weekly schedules
- Plan service and maintenance based on actual operating data
- Share system documentation online with all relevant personnel

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Sulzer Remote Pump Monitoring

Pump users need to be assured their equipment is operating at peak performance. Sulzer provides monitoring and diagnostic services designed to deliver key benefits to end users:

- Optimized energy consumption
- Pump performance matched to process needs
- Extended or eliminated scheduled service intervals
- Remove ‘bad actors’
- Minimize the risk of emergency shutdowns due to pump failures

Remote monitoring, although more expensive initially to set up, has the advantage of being continuous and automated. This makes the process more reliable, providing earlier warnings when rotating equipment has a change in operating conditions

Conversion of data to knowledge

- When visiting a customer site, experienced engineering staff will typically review the following parameters:
- Flow
- Dynamic head
- Power absorbed
- Efficiency
- Net Positive Suction Head (NPSH) available/required
- Temperatures
- Vibration levels
- Piping interfaces
- Bearing support and lubrication
- Seal arrangement including piping arrangement

On line data delivered remotely can duplicate the customer site experience

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Altizon Platform for Remote Pump Monitoring

Industrial water pumps can be installed in a variety of remote locations with lots of variations in the overall environments. It was vital to build resilient sensor appliances that can work in hostile environments with a high degree of temperature and humidity variance. The appliance would need to work in locations where connectivity and power is not reliable.

The pump manufacturer had sensors available that would measure the vital parameters of the pump.

Based on the hardware specifications provided by the Altizon Hardware team, the manufacturer built a connectivity module that would transmit parameters measured over GPRS or over the Ethernet (if available). Altizon provides a Hardware Design for Manufacturing service to customers to build custom hardware IoT modules that enable connectivity.

This connectivity module had out-of-the-box capability of safely and reliably transmitting the pump parameters over to Altizon's Datonis® platform.

Datonis acted as the central sensor data repository all connected pumps.

Rules were set up within Datonis which would automatically notify the manufacturer's support team in case any anomalies were observed in the operation of the pump.

Datonis® seamlessly integrated with the IT infrastructure of the manufacturer so that trouble tickets could be automatically raised and attended to in case of failures, thus completing the feedback loop for the operations team.

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Weir Synertrex Monitoring Flow Control Equipment at a Platinum Mine

- Weir's Synertrex system uses advanced sensing technology to monitor the performance of flow control equipment.
- The product is currently being deployed at a platinum mine in South Africa, where it has been set up to monitor parameters on cyclones, valves, slurry pumps and screens. Mechatronics engineering refers to the design of computer controlled electromechanical systems and, while the end product–in this case a pump–is essentially mechanical in nature, the electrical and computer systems are critical to its operation. Howard Jones notes that, in terms of pumps, mechatronics is generally used to allow for remote monitoring and maintenance.
- As a result of the drive towards optimizing efficiency, mining and industrial sectors have started to push for the centralisation of processes, which is also beneficial to customers in terms of reducing their operational costs.

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Flowrox Smart Solutions

- Flowrox Smart Solutions™ allow process conditions, equipment status and performance to be monitored on a handheld device.
- The heart of the Flowrox Smart Solutions™ is the Flowrox Malibu™ platform, an operator-friendly user interface that connects plant performance and equipment. Malibu™ enables users to solve challenges before they become problems. All new Flowrox Smart Pumps and Smart Valves are IIoT enabled:
- SMART pumps & valves are delivered with the Flowrox Malibu™ user interface
- Malibu is easy to operate, enabling access to all product-related information, documentation, online monitoring & preventive maintenance tools
- SMART positioner delivers detailed information on valve operations
- Flowrox SPVE is the first pinch valve in the world capable of complex analytics and IIoT ready
- SMART pump sets are equipped with intelligent instrumentation, motor diagnostics and controls for continuous measurement and extensive feedback
- SMART sleeves and other embedded instruments provide vital in formation about the operation, condition and health of components

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Colfax Screw Pump Monitoring

- Cavitation Monitoring - Cavitation measurements across the pump´s rotating screws feed the control system which adjusts operating parameters accordingly: -
- Preventing cavitational pump wear - Protecting film support (three screw pumps) - Optimizing pumping with air/liquid mixtures (two screw & progressive cavity pumps)
- Wear detection active measurement of housing and rotating screw wear enables predictive maintenance scheduling pressure monitoring inlet and outlet pressure readings adjust pump controls to ensure compliance with process requirements.
- Temperature monitoring fluid and pump component temperature readings log process conditions and, when applicable, automate controls for cooling or heating pump support systems.
- Vibration monitoring horizontal and vertical vibration reading track micro pump movements as process conditions evolve
- Seal and lubrication system monitoring temperature, pressure and leak detection monitoring identify undesired performance before failures occur.
- Remote communications remote operations, monitoring and/or alarms enable centralized equipment, management with limited on-site equipment management.
- Smart monitoring software reads, logs and displays pump operating and performance characteristics. - Includes programmable alerts, alarms and reports - Electronic log book of operating parameters and maintenance - Incorporated in Colfax Fluid Handling´s proprietary controls systems - Feed for customer´s existing equipment control systems.
- Automatic spare parts purchasing and inventory control.
- Proprietary control system optimally operates the pumps according to desired process conditions and real-time conditions as noted above. Optional local or central control system operations

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