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Improved Operational Profitability: Is IIoT a game changer in Asset Performance?

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Executive summary

New philosophies are required for a new age of industry. Real-time information in appropriate business terms, combined with asset performance management and asset control leads to maximized reliability, efficiency, and profitability—safely.

The Evolution of the Maintenance Function: What's in a Name?

Industrial maintenance has advanced considerably over the last two decades. Twenty years ago, the predominant maintenance strategy involved reactive maintenance—waiting for a piece of equipment, sometimes referred to as a plant physical asset, to break, and then fixing it as quickly as possible. Results improved as maintenance engineers developed more sophisticated preventive strategies, analyzing equipment to determine the normal time-to-failure and scheduling maintenance to prevent failures before they occurred. More recently, complex predictive maintenance strategies have been developed, which involve directly measuring equipment conditions, such as vibration or casing temperature, to forecast the probability of failure and then scheduling maintenance procedures to fix the problem before it happens. Today, most industrial operations utilize all three strategies.

As methodologies became more advanced, industrial maintenance communities evolved the name associated with the maintenance function. Traditional maintenance management shifted to asset management then to asset performance management, with each new name intended to indicate the increased sophistication.

The primary objective of industrial companies is to safely maximize profit from production

Although this naming evolution might seem appropriate for indicating increasing levels of complexity, the focus on asset performance management might be both too narrow and too broad when analyzing how to make industrial assets perform better: too broad because the performance of industrial assets involves more than just maintenance strategies, and too narrow because optimal performance of industrial assets should include both transactional management and real-time control aspects.

The primary objective of industrial companies is to safely maximize profit from production, and this requires a two-tier model, encompassing both asset performance management and asset control. When combined with real-time information gathering, reported in appropriate units, this approach creates a balance between the need to maximize reliability and efficiency goals with safety constraints.

Efficiency vs Reliability: The Industrial Conundrum

The performance of industrial assets is a function of both asset maintenance and asset operation. In most plants, maintaining the asset and operating the asset are performed by completely different teams, with completely different—and often conflicting—performance measurements. The maintenance team is typically measured on the reliability of the asset, while the operations team is often measured on the production throughput, or efficiency, of the asset. The problem is that reliability and efficiency tend to be inverse functions; that is, improving reliability typically involves reducing production throughput, and improving production throughput typically means reducing reliability.

No wonder maintenance and operations teams have difficulty cooperating. They are measured in a manner that penalizes one or the other, or both, for cooperating. This industrial conundrum (figure 1) must be solved if manufacturers truly want to maximize asset performance across their industrial operations.

Efficiency – Reliability Conundrum

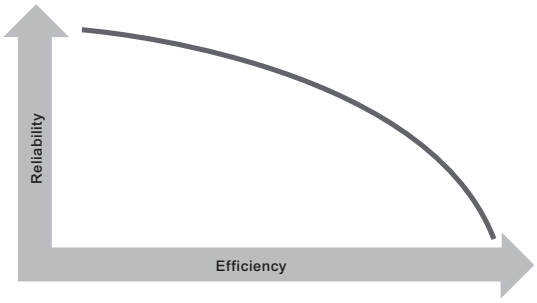


Figure 1

Under the current model, improving reliability tends to decrease efficiency, and vice versa.

The key to overcoming this conflict is developing performance metrics for operations and maintenance that encourage cooperative behaviors. Such a measurement system needs to be indicative of the performance of the assets to the business. Every physical asset in a plant exists to drive value, so performance indicators must measure the value each asset contributes to the operation.

Since business leaders in most industrial operations measure value in financial terms, basing asset performance on financial metrics typically provides the measurement system that will encourage the maintenance and operations teams to cooperate toward a common goal: maximizing the business value from each industrial asset and asset set. Fortunately, developments in business performance measurement systems have resulted in real-time accounting (RTA) systems that utilize plant-sensor data in combination with financial data to model the business performance down to the asset level. These provide the necessary financial contribution metrics.

Efficiency – Reliability Solution

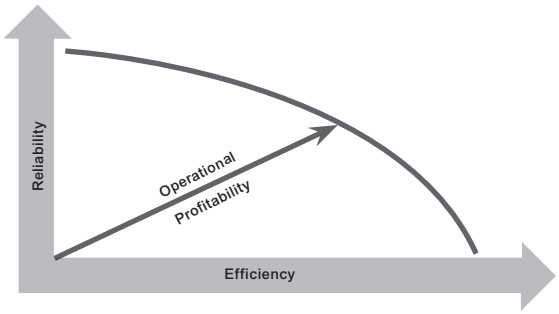


Figure 2

Using business metrics provides a solution that balances efficiency and reliability.

Real-Time Control and Revenue: Igniting the Profit Engine

Industrial companies are in the business of making money. Therefore, their operations should be thought of as the “profit engines” of their business. Traditionally, industrial business and operations functions were performed independently. Operations worked to make products; business teams worked to account for the products made and sold. Since the speed of business has continually increased over the past two decades, this separation has become impractical and ineffective. Decisions being made second-by-second on the plant floor have significant impact on the profitability of the business. Those decisions, whether automatic or manual, must drive maximum profitability for the

business. However, developing a system that ensures these decisions are being made in a coordinated, profit-generating manner is not a trivial task. The key to igniting the profit engine of industrial operations is developing a control and management system that safely maximizes operational profitability.

Real-time process and logic control have been implemented, in one form or another, for the better part of the last 100 years

When designing the optimal control and management system, it is helpful to understand how industrial operations have evolved over the last century. Real-time process and logic control have been implemented, in one form or another, for the better part of the last 100 years. These systems were used to apply real-time controls to maximize the efficiency of industrial assets and asset sets. Over the years, considerable advancements have been made as process control systems evolved from feedback control, to feedforward control, to multivariable predictive control.

Process control operated under management systems designed to ensure effective operation and follow appropriate production schedules. The control systems made decisions in real time (within the time-constant of the process being controlled), while the production management systems made decisions on human schedules, such as daily, weekly, and monthly, commonly referred to as transactional decision-making.

As the sophistication of process management and control systems increased, the efficiency of industrial plants steadily improved, which in turn pushed the process equipment harder and harder, until they reached their thresholds. Plant engineers quickly learned that the solution was to implement safety control systems to ensure the thresholds were not crossed. Additionally, as efficiency increased and the equipment was pushed harder, reliability of assets started to decline. Again, plant engineers learned that the solution was to implement more advanced maintenance techniques that improved asset reliability, including reliability control systems.

The net result was three real-time control systems—process, safety, and reliability—operating in industrial plants to safely maximize efficiency (figure 3). The challenge became operating these three control systems in a manner that would realize the ultimate objective: maximizing operational profitability, safely and reliably.

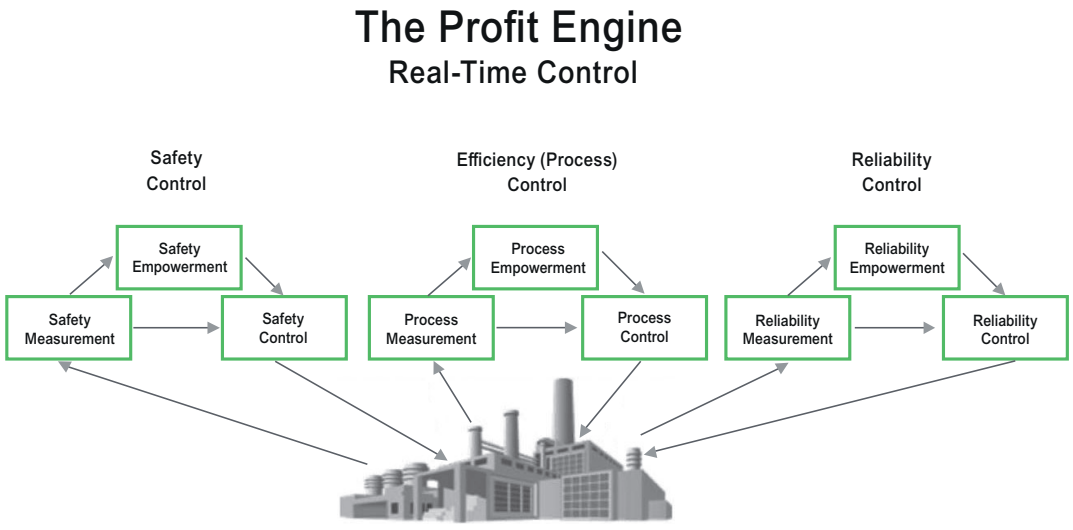


Figure 3

Three real-time control systems that enable a plant to safely maximize efficiency.

This control revolution is tied to the ever-increasing speed of business, initially caused by the deregulation of electric power in various countries throughout the world. This led

to frequent price changes, which in turn affected other energy and material costs, and ultimately the value of product, eventually rippling into consumer outlets such as Amazon and Google.

The speed-up generated new philosophies on how industrial businesses operate, moving away from outdated monthly ERP data towards new metrics that influence profit. To govern these new variables, real-time control strategies are required for maximum, and safe operational profitability.

The first challenge for real-time business control is real-time measurement at the level of application. This was solved with the creation of real-time accounting, which was invented by Schneider Electric (U.S. Patent 7,685,029). RTA utilizes sensor-based business data to calculate energy and material costs, production value, and operational profitability contribution in real time, right down to the asset level of a manufacturing operation.

Once the RTA measures are available, real-time operational profitability control can be implemented. As with the earliest process control systems, the first approach to real-time operational profitability control can be manual—that is, empowering the industrial workforce to make good, profit-improving decisions in real time. Just as manual process control systems proved to be very effective in the early phases of the industrial revolutions, manual profitability control systems can be extremely effective. Providing operators, maintenance personnel, engineers, superintendents and plant managers with the real-time business measures they require to make good, profit-enhancing decisions transforms them into profitability controllers (figure 4). Currently, automatic profit controllers are under development.

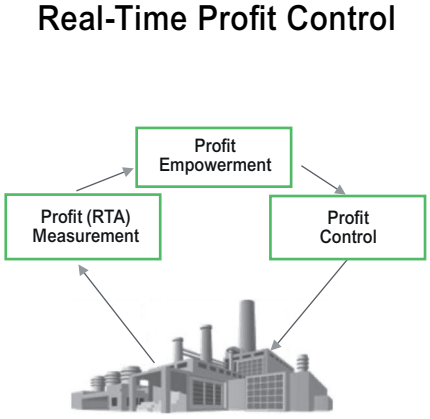


Figure 4
Information in real-time turns operators into profitability controllers.

The two key questions remaining are how efficiency, safety, and reliability influence interaction, and how profitability control works with them. These issues are easily resolved by understanding that the objectives of control and optimization systems are essentially the same. Therefore, the language used for optimization systems is quite useful, and can be applied as such: The objective of real-time control in industrial operations is maximizing operational profitability and efficiency within safety and reliability constraints.

By considering the problem in this way, a natural relationship forms between the four real-time control strategies, which merges them into a single strategy as shown in figure 5. Profitability control is cascaded to efficiency control because the primary function is maximizing profitability and the secondary function is maximizing efficiency. The safety and reliability control principles work to

effectively govern the constraints to profitability, minimizing the probability of a safety or reliability incident while simultaneously maximizing operational profitability. All four control strategies are required to work together to maximize operational profitability, both safely and reliably. When these control strategies are unified, real-time control drives the profit engine of the plant.

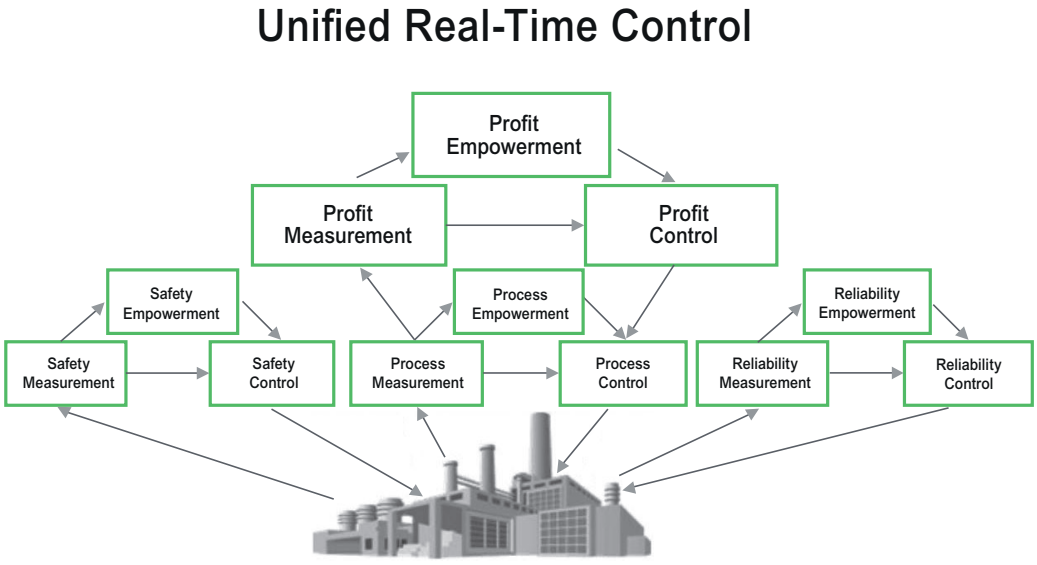


Figure 5
Four control types merge into a single, unified strategy.

From Asset to Enterprise: Performance Control and Management

Industrial plants are comprised of a hierarchy of assets and asset sets, from single pieces of equipment, all the way up to the plants comprised of them, and finally to enterprises. Therefore, maximizing the performance of industrial operations can be accomplished by maximizing the performance of the assets and asset sets. Approaching unified control strategies from an asset perspective offers benefits over traditional process-centric approaches by aligning efficiency and safety control, which have traditionally been process-centric, with reliability control, which has traditionally been asset-centric.

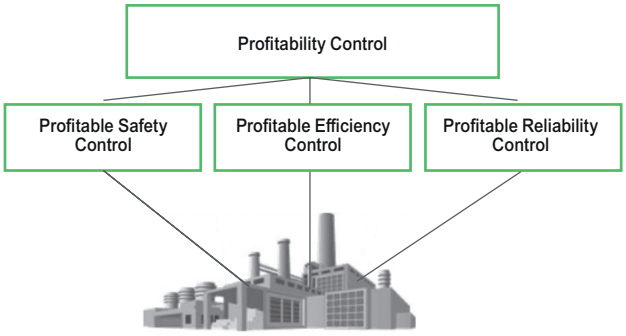
Since profitability control is just emerging, it could be approached either way, but an asset-centric approach tends to simplify the development of the real-time control strategies. One aspect of the overall strategy of maximizing operational profitability is the unified real-time control approach, previously described. Figure 6 presents a simplified version applied to industrial assets. Profitability control is superordinate to efficiency, safety, and reliability control, mediating the interactions between them.

The resulting subordinate control strategies are referred to as profitable efficiency control, profitable safety control, and profitable reliability control. The combined control strategies, applied in an asset-centric manner, are referred to as asset performance control.

Maximizing the performance of industrial operations can be accomplished by maximizing the performance of the assets and asset sets.

Asset Performance Control Strategy

Figure 6
Three real-time control systems that enable a plant to safely maximize efficiency.

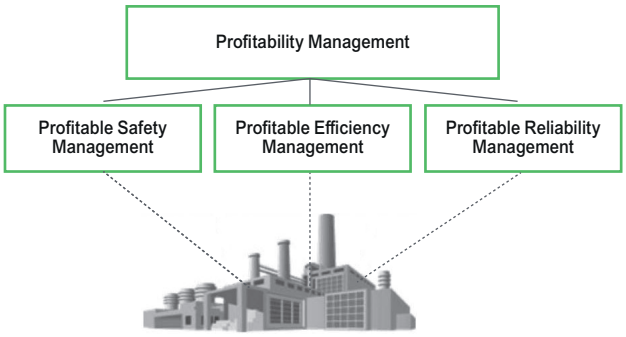


Controlling these critical variables provides only a part of what is required. Truly maximizing the operational profitability of an industrial operation requires both effective real-time control and transactional management strategies working in concert. In fact, the transactional management strategy required has the same basic components as the control strategy as presented in Figure 7, and is referred to as asset performance management. The primary difference is that the functions at the asset performance management level operate on transactional timeframes.

Asset performance management is undergoing a huge transformation based on the introduction of Industrial Internet of Things technologies. These enable highly sophisticated analytics of the vast amounts of data produced in industrial operations to help safely and reliably optimize operational profitability. Emerging techniques, such as prognostics, virtual reality and data mining are offering tremendous improvements for industrial operations.

Asset Performance Management Strategy

Figure 7
Three real-time control systems that enable a plant to safely maximize efficiency.



For optimal results, asset performance management must work together with asset performance control. The output of the asset performance management systems provides the targets, or set points. The asset performance control strategies work to maintain optimal operation, as well provide immediate reaction to real-time plant activities, such as a piece of equipment approaching failure. This is illustrated in Figure 8.

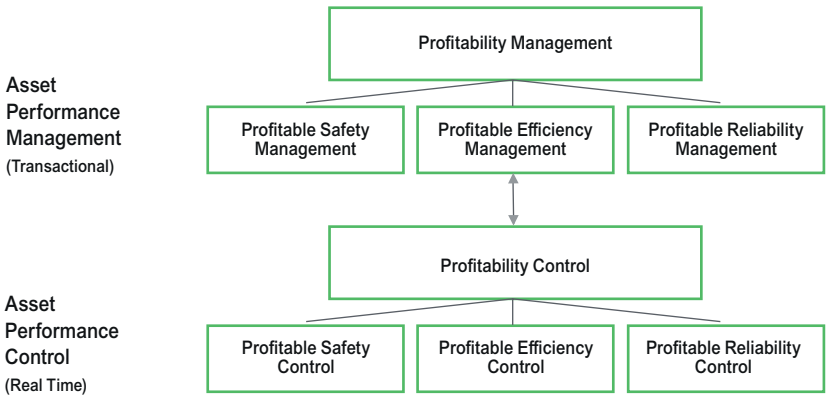


Figure 8
Strategy that maintains optimal operation but remains reactive to equipment faults.

Conclusion: Unified Management and Control Generate Value

Utilizing this two-tier asset performance management and control model, manufacturers can realize a more complete perspective, and can leverage technology to ignite the profit engine of their businesses. The primary objective of industrial companies is to safely maximize profits. To this point, automation and information technologies have been applied to meet this objective, but have fallen short.

Building a unified management and control strategy is the best way to drive operational profitability, safely and reliably. Figure 9 provides an expanded view of the profit engine, with profitable efficiency, reliability, and safety called out across the management and control levels. Approaching industrial operations from this simplified perspective is what is needed to drive the expected results from manufacturing and production facilities.

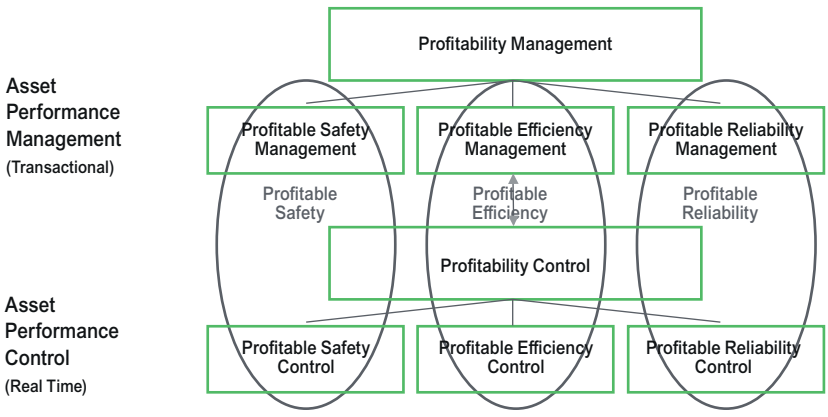


Figure 9
The Profit Engine.

It is time to use automation and information technology the way it was designed, it's time to convert your production operations into the profit engines of your business.

About the author

Dr. Peter Martin has over 37 years experience in industrial control and automation. He has authored numerous articles, technical papers, and books. He holds multiple patents. Fortune named Dr. Martin a Hero of U.S. Manufacturing. He was also named as one of the 50 Most Influential Innovators of All Time by Intech, and received the Life Achievement Award by the International Society of Automation (ISA). In 2013 Dr. Martin was elected to the Process Automation Hall of Fame, and was selected as a Fellow of the International Society of Automation. In 2017 he was named as one of the 30 Internet of Things Executives Whose Names You Should Know by CRN. In 2018 he was named to the Measurement, Control and Automation Hall of Fame. He holds BA and MS degrees in Mathematics and an MA degree in Administration and Management, a Master of Biblical Studies degree, a PhD in Industrial Engineering, and a PhD in Biblical Studies.

Other resources

- Igniting the Industrial Profit Engine – White Paper
- Profitable reliability – The next evolution of maintenance technology – White Paper

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