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Profitable reliability - the next evolution of maintenance technology.

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Executive summary

Manufacturers have relied on various process control methods and applications for well more than 100 years, the primary objective being to increase the plant's throughput, its production, and safety. Maintenance strategies are multiple: reactive maintenance, have been expanded first to preventive maintenance, then to predictive maintenance and finally to prescriptive maintenance. Advancements in technologies are making the direct real-time measurement of asset reliability feasible, taking other variables like safety risks, efficiency risks, and profitability into account.

Profitable Reliability

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The ultimate objective of any industrial enterprise—from plant operations to maintenance—is to maximize and control operational profitability, and safety in real time. This is becoming even more critically important because the speed of industrial business continues to increase. For example, only a decade ago many industrial plants had contracts with their electricity suppliers that designated the price they paid for a unit of electricity for an entire year. Today on the open U.S. power grid, the price of electricity can change every 15 minutes. Trying to manage the business of industrial operations with monthly data from ERP reports is no longer feasible; you need to control it. This starts with controlling operational profitability in real time, which is directly linked to controlling and measuring the reliability of the plant's assets and asset sets right down to the equipment level. But to get to that point, we have to start from the beginning.

Manufacturers have relied on various process control methods and applications for well more than 100 years, the primary objective being to increase the plant's throughput, i.e., its production, and safety. Originally single-loop feedback control was the preferred method, but state-of-the-art process control has advanced significantly over the past 50 years or so. Today, things like coordinated multiple variable approaches, coupled with dynamic process models, have enabled some very sophisticated multivariable predictive control strategies.

These advancements in process control have enabled manufacturers to continually increase the throughput of their operations. But that has come with a risk because as industrial assets are pushed harder and harder, they move closer and closer to their thresholds of reliability and safety. In short, today's assets are under continuous strain, which is degrading their reliability and affecting the overall performance of the operation.

To counter that risk and alleviate the strain being placed on plant assets, industrial maintenance tools and practices, intended to improve asset reliability, have progressed and evolved over the last two decades. Classic break-fix models, otherwise known as reactive maintenance, have been expanded first to preventive maintenance, then to predictive maintenance and finally to prescriptive maintenance. Each of these advancements led to a corresponding increase in asset reliability. But manufacturers were soon stuck in a cycle because even as advanced tools and techniques were being applied to improve asset reliability, process control too became continually more sophisticated, fighting reliability improvements every step of the way.

It turns out that what we need isn't more advanced technology. What we really need to do is rethink how we address this age-old issue, and that begins with how we measure asset reliability in the first place.

In the past, measuring the reliability of industrial assets was limited to analyzing historical asset performance with hopes that past behaviors would be replicated. A much more effective approach though would be to directly measure how likely it might be that a reliability incident would occur. This is what we call reliability risk.

Advancements in data science and the proliferation of condition and process measurements in industrial operations are making the direct real-time measurement of asset reliability feasible. Such measurement will, in turn, make more sophisticated, real-time approaches to controlling asset reliability feasible too. Based on extensive laboratory testing and actual in-plant experience, there is already considerable information on reliability at the equipment asset level. For example, accurate reliability curves, coupled with condition and process measurement, enable accurate measurement of asset reliability risk (see **Figure 1** re: pump failure curves).

Prescriptive maintenance:

Where analytics can show that a piece of equipment is headed for trouble and can prescribe prioritized, pre-determined, expert-driven mitigation or repair.

Predictive Maintenance:

Determining the condition of in-service equipment in order to predict when maintenance should be performed.

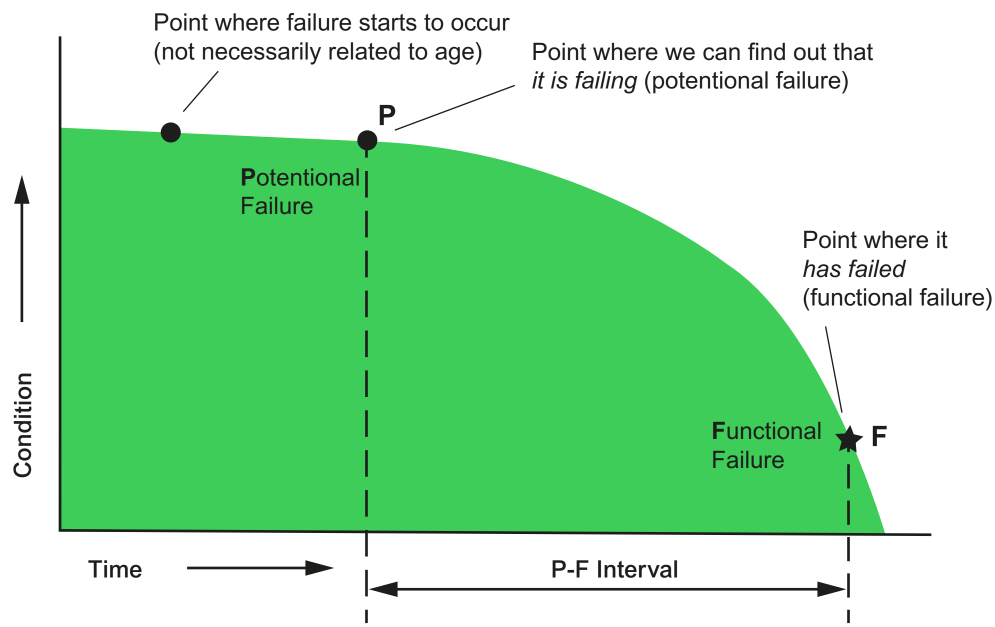
Preventative maintenance:

Maintenance regularly performed while the equipment is still working so that it does not break down unexpectedly and lessen the likelihood of its failing.

Reactive maintenance:

Repairs that are done when the equipment has already broken down, focusing on restoring the equipment to its normal operating condition.

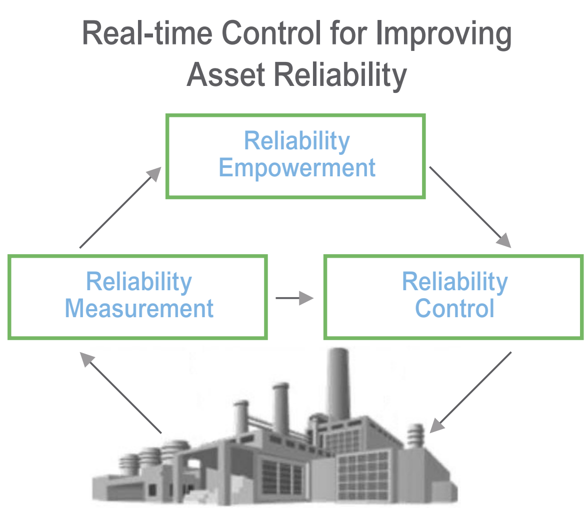
Figure 1



Once the real-time reliability risk of equipment assets is measured, it's a small leap to measuring the reliability risk of higher-level unit and area asset sets of the operation.

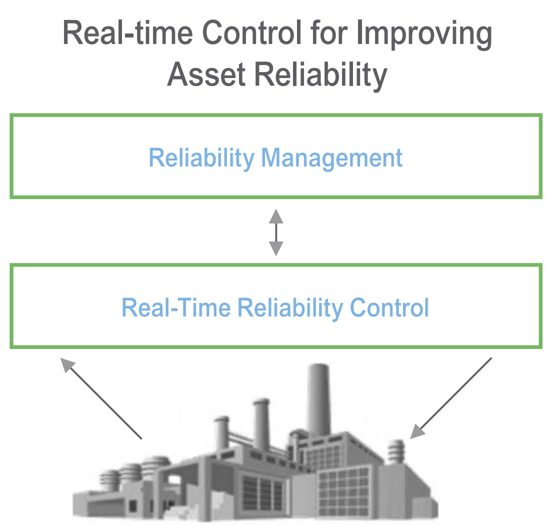
After real-time reliability risk is measured, real-time reliability control becomes possible (**Figure 2**). Real-time reliability control significantly and positively extends traditional maintenance management. For example, if it is likely for a compressor to fail within the next six hours, i.e., the risk is high, the real-time reliability controller, in the form of the process operator (but which could eventually become an automatic asset controller at some point), might immediately respond to slow the rotation of the compressor, thus extending the reliability time threshold and avoiding a short-term failure. This gives the organization the time it needs to optimally and more permanently respond to the condition.

Figure 2



The availability of real-time reliability control will lead to a two-level asset reliability model for industrial operations (**Figure 3**). At the lowest level will be real-time control offering, real-time reliability risk measurement, and the appropriate control response to increase the reliability of the asset. At the upper level will be more sophisticated asset reliability management functions, such as prognostics and maintenance planning, and scheduling. Together this two-tier approach will work to increase asset reliability, which naturally leads both to driving more from every asset in the operation and to increasing the plant's operational reliability.

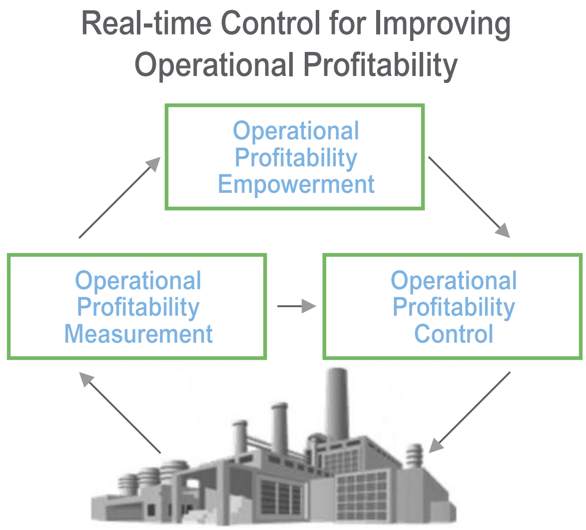
FIgure 3



Although the two-tier approach will result in stronger reliability risk management and control, by itself there is no direct tie to improving operational profitability, safety, which, as we know, is the ultimate objective. It is tempting to assume that any increase in asset reliability directly translates into operational profitability improvement, but this might not be the case. For instance, if the compressor in the above example is slowed down to extend its time to failure, the short-term result will be a reduction in operational profitability because throughput will be reduced too.

Therefore, the best way to ensure operational profitability is positively impacted by this new approach to real-time reliability control is to directly measure operational profitability factors in real time, right at the asset level. In fact, as with a reliability control loop, an operational profitability control loop can be developed once the profitability factors are measured (**Figure 4**).

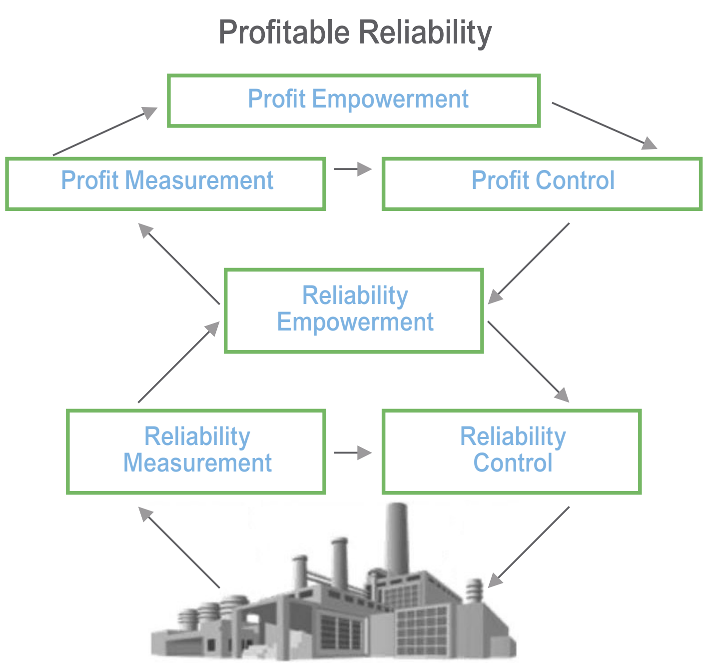
Figure 4



Using real-time accounting can enable profitability measurement, which would then empower the workforce, through specialized asset analytics software, to control the real-time profitability of the operation. In **Figure 4**, we see a functional model, not necessarily a physical model. The line from Operational Profitability Measurement to Operational Profitability Control can only be deployed when automatic reliability control is a reality. Since the technology isn't quite there yet, in the current state, as with real-time manual reliability control, the operator is the real-time profitability controller too. However, as technology continues to advance, in the near future, both reliability and profitability control could happen separately and automatically.

The question that arises is how does real-time operational profitability control tie to real-time reliability control, i.e., how does increased reliability drive operational profitability. From a control theory perspective, profitability control would cascade to reliability control (**Figure 5**).

Figure 5



This enables reliability control to be implemented in a manner that drives optimal profitability. The output of the operational profitability controller serves as the set point for the reliability controller. However, since both these real-time control domains are in their infancy, it might be best to think about how process control was accomplished early in the Industrial Revolution, when relatively little experience with real-time control existed. At that time, process operators performed the control functions manually. Gauges provided the data they needed to implement real-time process measurement, which empowered them to control the processes more effectively.

In like manner, empowering today's industrial workforce with real-time operational profitability data, along with process control and real-time reliability risk information, will turn them into operations and business performance managers. Operators will be able to adjust set points and see the impact they and their adjustments are having, not only in the process, but on the profitability and reliability of the assets too. They can then apply this feedback to make operating and business decisions maximize operational profitability without significantly increasing reliability risk. Likewise, plant maintenance personnel can determine their maintenance activities from the profitability and reliability risk information provided by the control system, and adjust their actions and responses accordingly. Since both these operators and maintenance personnel work from the common objective of improving operational profitability, they will work much more collaboratively. In one real-world example, in a gas operation in which the real-time profitability metrics were in place and operating, the maintenance team and operations team started planning maintenance schedules together, focusing on contracts that included financial penalties for not meeting the terms and commitments on time. Because they were able to keep the operations and assets up and running long enough to meet the contracts, they helped increase operational profitability for the business.

We can therefore see that a profitable reliability approach that combines real-time reliability risk control, real-time operational profitability control and higher-level reliability management will go a long way toward helping industrial manufacturers meet their short and long-term operations, and business objectives. Profitable reliability control is the next evolution of maintenance technology solutions. The result will be greater levels of operational profitability, safety, and reliability.

About the author

Dr. Peter Martin is a recognized leader and innovator in automation and control. He has been a practitioner in the field for over 37 years; has authored three books, coauthored two, and been a contributing author for three more; and has published dozens of articles and papers in these disciplines. He holds or has pending multiple patents in the areas of real-time business measurement and control. He was recognized by *Fortune* as a Hero of U.S. Manufacturing, by *InTech* as one of the Fifty Most Influential Innovators in Control, and by *Control* as a member of the Automation Hall of Fame; he has also received ISA's Life Achievement Award. Peter Martin has a B.A. and an M.S. in Mathematics, an M.A. in Administration and Management, and a Ph.D. in Industrial Engineering, as well as a Master's and a Doctorate in Biblical studies.

- New Industrial Automation System Topologies – White Paper
- Igniting the Industrial Profit Engine – White Paper

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