Achieving Top-Quartile Reliability

EMERSON

It's Time to Look at Reliability Differently

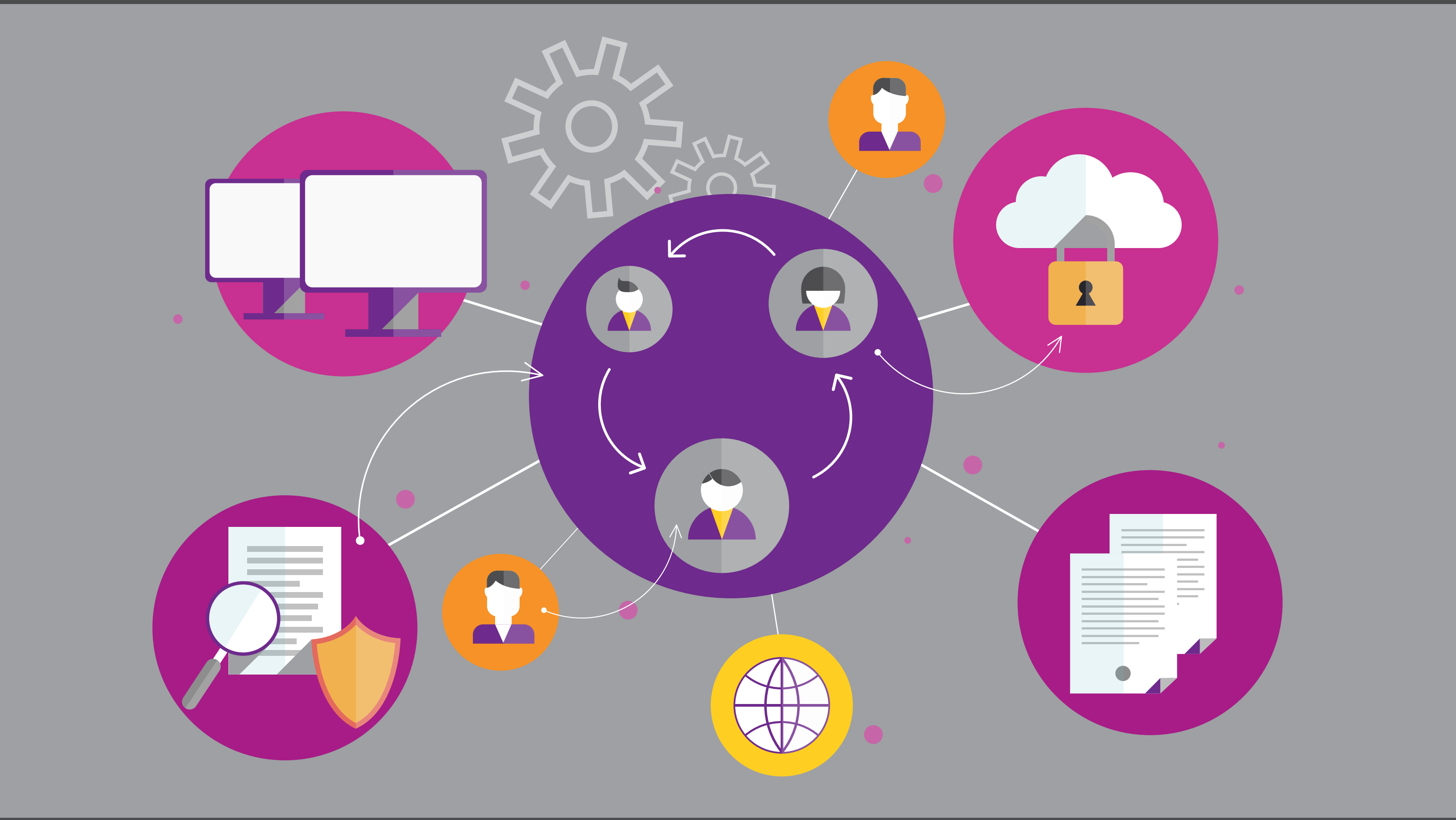
Research shows that a top-quartile performer possesses a set of well-linked elements. Emerson's Reliability Value Chain connects elements in four categories: data, information, knowledge, and action. It sets the path for transforming data into information, then into knowledge, and finally – into action. Ultimately, the ability to achieve top performance is dependent on the robustness of each element and, perhaps more importantly, on the effective connection of all the elements into a continuous improvement cycle.

3½
times more

A poor-performing plant will spend 3½ times more on maintenance than a top-performing plant of the same size.

The Reliability Value Chain provides a systematic approach to optimizing asset reliability in top-performing enterprises. Global businesses should strive for consistent, standards-based reliability practices throughout their plants. The short-comings of ad-hoc or laissez faire approaches that allow inconsistent practices are well-documented. Understanding the Reliability Value Chain and addressing imbalances and broken links can bring enterprises into the top-performing quartile.

Chances are good that your organization spends too much on maintenance and receives too little in return. This fact simply means that you have opportunities to improve both maintenance and operations. Executives are interested in this because they recognize significant opportunities to improve profitability, availability, and safety. In fact, a company with multiple plants can uncover even greater savings and significantly increase shareholder value.



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CHAPTER 1:
Achieve Financial Results

Finding bottom-line impact with reliability focus

Manufacturing organizations that consider how asset reliability can improve their facilities often have one main driver: financial performance. In addition to improving production and safety, a strong focus on reliability initiatives will yield strong financial results.

Adjustments in processes, mindsets, and organizational characteristics assist in improving reliability initiatives and achieving optimum financial results.

Reliability Defined

Reliability is the probability that a process or device will do what the user needs it to do under stated conditions for a specified period of time. Translated to the manufacturing world: "What is the likelihood that my manufacturing line will produce quality product at full rate for the next month when operated within its design capabilities?" To maximize the output of the plant, the probability should be as close to 100 percent as possible.

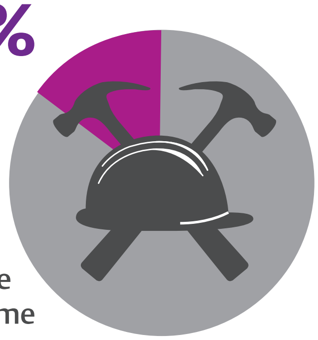
The inherent reliability of a system is a function of its design. A poorly designed system will never be reliable, and no amount of maintenance investment will improve it. A well-designed system enables assets and personnel to perform at their best consistently. Our actions can either preserve this inherent reliability or jeopardize it.

Nearly every job function that has anything to do with assets can impact reliability. Each of these areas of responsibility can sustain the reliability of the overall system or reduce reliability based on their choices:

- **Engineering** can hinder reliability by producing marginal designs that operate outside of the equipment's "comfort zone." But by creating designs that cater to the equipment's optimal performance criteria as well as positioning equipment for convenient cleaning, inspection, and lubrication, engineering can ultimately contribute to reliable machine operation.
- **Procurement** obstructs reliability by selecting substandard parts and equipment that do not meet the OEM specifications. They can also select contract personnel who do not have skills and knowledge to perform quality work. But when well-trained people consult and choose the appropriate equipment, reliability more easily reaches its maximum.
- **Operations** influences reliability negatively by operating the equipment beyond its capabilities or failing to follow gradual startup and shutdown procedures. They can also fail to heed early-warning signs of distressed equipment and neglect to take corrective action in a timely fashion. Reducing these errors in operations and changing the culture naturally builds a stronger Reliability Value Chain.
- **Maintenance** will reduce reliability by not providing routine care that the equipment requires or by failing to use precision techniques in executing a repair. But standard processes as suggested by a healthy Reliability Value Chain improve the results.
- **Storeroom** personnel who fail to care for the parts under their control deteriorate reliability. Contamination with dust, dirt, and moisture can damage precision mechanical assemblies as well as sensitive electronic components. But making sure procedures are followed and records are maintained, stronger reliability results.

An organization with a reliability focus is more likely to proactively address potential issues within each job function. To achieve high reliability, that organization refuses to create an environment where defects are encouraged.

15%
more downtime



A poor-performing plant will experience 15% greater downtime than a top-performer.

Financial Return of Reducing or Eliminating Reliability Losses

While there are several ways organizations benefit by a greater focus on reliability, generally the greatest value comes from the increased availability of the equipment. Assets that operate longer between outages produce more sellable product volume.

Increased reliability also results in a more stable process. Companies in continuous-process industries find a reduction in the incidence of quality losses due to unstable operating excursions. This has a corresponding reduction in waste and scrap costs. And because minor stops and speed losses are reduced due to the stability of the process, reliability has a positive impact on the factors of overall equipment effectiveness: availability, quality, and throughput performance.

Improving reliability reduces maintenance costs — often dramatically. It is not unusual to see at least a 50 percent maintenance cost reduction as an organization makes the transition to a reliability focus. Unnecessary maintenance repair work is eliminated because the various functions are no longer creating defects that must be repaired. And with the application of condition-monitoring techniques, necessary corrective action can be taken while the scope of the repair is still small.

A focus on the reliability of the energy systems can also yield significant cost reductions. Energy consumption can be reduced by eliminating steam, compressed air, and water leaks.

Spare parts inventories are reduced by as much as 60 percent because an organization with a focus on reliability understands the operating condition of their equipment, providing enough advanced warning of problems to enable “just in time” parts procurement.

Increased reliability means less transient operation time to deal with repairs. Studies show that the riskiest times for a plant are the transient conditions — shutdowns and start-ups.

Finally, a reliability focus can yield higher asset efficiencies. Assets that are properly cared for over their lives last significantly longer than those that are mistreated. The result is that newer equipment is not necessarily more cost effective.

By focusing on reliability, an organization capitalizes upon its investment in its physical assets by increasing output, decreasing costs, and increasing the longevity of the plant. There are few investments that an organization can make that will yield as many benefits to the business as a strong focus on reliability.

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CHAPTER 2:
Importance of the Reliability Value Chain

A well-connected chain delivers results

Top-quartile performers possess a high-quality Reliability Value Chain. They recognize that achieving top performance depends on the vigorousness of each element and on the strong connections between them. They quickly can turn data into information, then into knowledge, and action.

Reliability Value Chain

Reliability strategy (the analyses used to understand and catalog failure modes) is pivotal to the value chain. For instance, the classifications chosen to characterize asset master data are driven by the requirements of the reliability strategy. Further, asset health analysis is interpreted from an understanding of the failure effects observed from process data and condition indicators. Most importantly, setting the reliability strategy must strike a balance between engineering characteristics of the assets and the capabilities of the organization to perform the functions required within each ring in the chain.

Let's examine each area of the Reliability Value Chain and determine potential opportunities for growth.

Data elements form the foundation of reliability. This foundation includes asset master data: a complete and accurate list of equipment that includes equipment physical attributes, equipment priority, and more. The list must include a logical location hierarchy that expedites analysis; the parts and technical information that relate to the asset; and the appropriate failure codes that help build effective maintenance strategies. Foundational data also includes the maintenance procedures that are performed to monitor and maintain the assets in healthy condition.

This foundational data is used throughout the chain, establishing what conditions indicate poor health. Understanding conditions helps technicians recognize how equipment behaves or fails, which in turn helps define the early-warning signs that identify whether the asset is in distress. Then actions can be taken to prevent failure or mitigate the consequences of failure. These procedures are developed as a result of various analyses such as Reliability-Centered Maintenance (RCM) and Failure Modes and Effects Analysis (FMEA).

Proper and consistent use of these analysis tools for a particular class of asset throughout the enterprise will lead to the optimum set of maintenance procedures for that asset class: how best to maintain and monitor that equipment. Allowing a variety of maintenance procedures to be applied to the same equipment at different plants is an outdated and unacceptable practice in today's modern world of reliability.

Information is derived from asset condition indicators and process parameters that have been collected and analyzed. Asset condition indicators are routinely used to monitor and analyze asset health and come from predictive technologies and condition monitoring capabilities like vibration analysis, oil analysis, and other modes of machinery health monitoring. Process data (temperature, flow, etc.) — available in almost every plant via the distributed control system — is typically used only for plant operation and control. The new standard of practice for top-quartile performers requires leveraging this data for maintenance purposes as well.

In lower performing organizations, process data and the condition indicators often are contained in separate databases with separate access methods. However, an accurate understanding of equipment and process health relies on the connection of data in a robust dashboard for a more holistic picture of overall plant health and problem areas.

Knowledge is the union of asset health analysis and work identification — a culmination of experience. It is the result of interpreting data and information, then drawing conclusions. For example, we might find a high vibration reading on a pump, low discharge pressure, and an erratic discharge flow rate. Together, vibration analysis, experience, and process knowledge might indicate that cavitation is likely the problem. This call would be much more difficult using vibration analysis alone.

We must have accurate data and solid experience to know what is good and what is normal. The foundational data, if rendered properly, will establish what is normal for each asset. The deployed monitoring technologies will alert us when abnormal conditions are reached, so that an expert can review the information and diagnose the problem.

Action translates knowledge into a traditional work management process: planning, scheduling, and work execution plus supply chain management. When abnormal conditions are found and proper diagnosis is established, a work order can be generated to correct the condition. But in lower-quartile performers, inefficiencies and associated costs arise because repairs come mostly from urgent equipment failures. This is a very reactive way of working which can be eliminated with effective deployment of technology available today.

Organizational priorities can also cause reactive maintenance. For example, an analyst might say there is something wrong with the equipment, but the operators might not bring the machine to a stop for repairs because they cannot see, smell, hear, or feel anything wrong with the equipment. Operators and managers need to understand that while it may feel counterintuitive to remove a seemingly healthy machine from service, in the long run that machine will deliver more reliable production if removed from service now for a short, well-managed restoration.

Top-quartile performers rely on solid data, information, and knowledge to obtain a diagnosis. The plant workers trust the diagnosis, they know how to fix the problem, and they have the tools to put the plans into action. Knowledge guides them to the right actions to avoid unplanned downtime and excess repair costs. A fully connected Reliability Value Chain effectively delivers results.

Understanding and improving each ring in the Reliability Value Chain–and the links between them– lead to significant reductions in maintenance spending and significant decreases in unscheduled downtime.

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CHAPTER 3:
Connect the Chain

Laying a good foundation

Whether top performers or lower performers, most companies have all of the elements of the Reliability Value Chain. But the elements themselves — even when optimized — do not drive value. The connection points between them do. Top-quartile plants have linked all of the elements effectively.

Recognizing Broken Links and Fixing Them

For companies wanting to improve performance, a place to begin repairing the chain is between knowing and acting. Most plants measure equipment conditions, analyze alarms, and recommend work activities, but the operations organization might not trust the information because it emanates from a faulty foundation of master data. In addition, operations might not understand, appreciate, or respect what the science and technology is telling the organization to do. These issues can be changed through processes and training. The improvements will bolster the link between knowing about a developing problem and acting on it before significant consequences occur.

There is plenty of work to do in terms of properly linking the elements in the chain and changing the culture of an organization. From the bottom up, operators must understand and value technology, analysis, and actionable intelligence. From the top down, executives must understand the business case — financial and otherwise — associated with insisting on non-negotiable reliability standards and best practices. When the business case is established, understood, and believed by the executive management team, the rewards systems start to change as well, and this enables culture change within the organization from top to bottom.

Once the foundational problems are addressed, personnel need to understand what the information indicates. In the long run, trusting the knowledge leads to better results. Specifically, the organization will attain better performance and lower maintenance expense by taking machines out of service before they fail catastrophically.

Standardizing Key Areas

Across an enterprise, the master data sets the stage for success, but standardization does not end with master data. Beyond master data, the way an enterprise analyzes pieces of equipment and identifies the ways they fail is also important and benefits from standardization. If one facility uses one failure code and another facility uses another code, the two sites will never recognize they could be dealing with similar issues. That means the enterprise needs consistency in the method by which it determines how and why equipment fails. Standardized codes help ensure consistency so that patterns can be seen more easily.

Reliability-focused organizations have two common characteristics:

- **A relentless desire to understand the operating condition of their assets, so they are not surprised by an unexpected failure.**
- **The firm expectation that the equipment is not supposed to fail. Any failure is caused by a correctable error that, if understood, can be eliminated in the future.**

Consistent criticality rating is key in helping to determine what failures are important. Facilities across an enterprise need to base criticality on a core set of priorities rather than opinions of the person on duty that shift, or recent history fresh in the minds of the plant workers. This enables enterprises to deploy resources where there will be the most benefit.

Experiencing Top Performance

While implementing standard maintenance practices is a large task that requires solidarity of purpose, standards, tools, and experienced partners, the return on investment is large and long-lasting. Further than that, without non-negotiable enterprise-wide standard practices, an enterprise can bleed costs and chase solutions that have little effect.to proactively address potential issues within each job function. To achieve high reliability, that organization refuses to create an environment where defects are encouraged.

Award-Winning Success

PolyOne has shown the profitable results of strong enterprise-wide standards. PolyOne recently earned an award from Uptime magazine for being the best emerging reliability program of the year. PolyOne leveraged Emerson's standards, set their own, and applied them consistently worldwide — including how they perform maintenance work, how they ascertain equipment conditions at sites, and how they measure performance. In a three-year roll out across more than 50 sites, results show the following:

- **Reduced maintenance spending by 12%.**
- **Safety incident rate is nine times better than industry benchmark.**
- **Planned vs. corrective work orders: After the project at 64%.** ***Previously at 45%***
- **On-time delivery reached an all-time high of 95.4%.**
- **Wave implementation strategy has allowed for a quick and successful integration of recent acquisitions.**

These results translated into significant financial benefits meaningful to shareholders and to those at the highest executive levels. PolyOne could not have achieved those results without enforcing consistent, best-practice standards across the corporation for their global fleet of assets. And they took advantage of Emerson's wealth of existing knowledge standards to accelerate their implementation.

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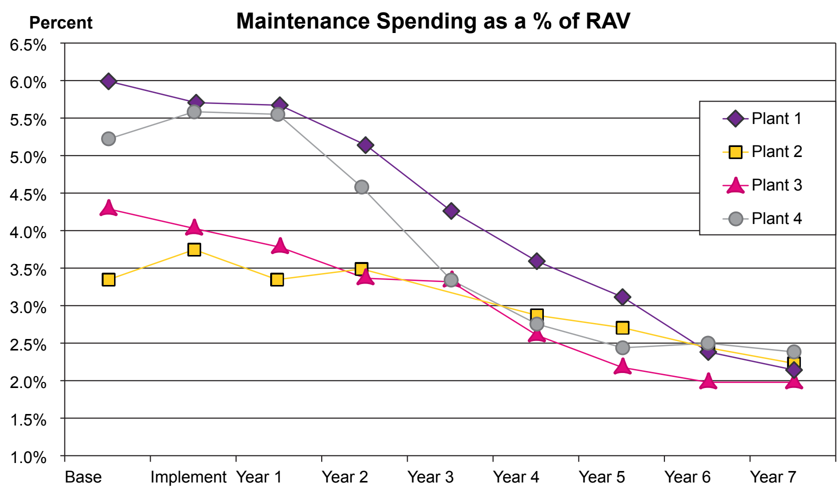
CHAPTER 4:
Drive Standardization

Establishing enterprise-wide standards to increase ROI

The establishment of a strong Reliability Value Chain is important in each facility. And the value increases by orders of magnitude when applied to an entire enterprise.

Consistency is critical in enterprise-wide implementation. If each location has the same standards for maintenance and reliability practices and for foundational data taxonomy, engineers can find information easily from other plants to learn common lessons and share best practices. Without standards, the work is formidable and opportunities are invisible.



With proper techniques, percent goal can be achieved independent of the starting point. (RAV = Replacement Asset Value)

Implementing Change

The chart here shows a real-life reliability journey for four plant sites within the same enterprise. The graph shows maintenance spending as a percentage of replacement asset value (RAV). Each site began its journey from a different performance point. All the sites attained the 2% benchmark as they put in place asset data standards and began a consistent application of predictive and preventive technologies, sound work management, and shared lessons learned. And, although the project time could have been greatly reduced by using certain techniques, all the sites arrived at the benchmark together.

The project was successful, but it required seven years — more time than if the team had leveraged industry expertise, experience, and existing intellectual property. They created their own standards and self-implemented their roll out. They lacked the advantage of having experienced consulting partners who have done the work before and are familiar with the pitfalls.

By partnering with an experienced consultant, facilities can gain an advanced starting point and an effective global roll out of best reliability practices. Creating standards from scratch is very time consuming. Emerson's Reliability Consulting, for example, has invested over 120 thousand work-hours creating libraries of intellectual property, technical content, standards, and tools designed to accelerate and optimize the process of rolling out best reliability practices at a single plant or a large-scale enterprise.

> ***"Reliability has become a strategic priority with non-negotiable standards – much like standards of financial reporting and safety have been for years."***
>
> *– Bunge*

Developing and Rolling Out Corporate Standards

When rolling out enterprise-wide corporate standards, leveraging standards and technical content is best practice. Organizations must start by carefully planning the roll out and creating a play book that defines the corporate standards – the rules that all sites will use going forward. This is best done by selecting an existing set of best practice standards and gathering representatives from each site in facilitated sessions to understand, accept, and ensure each site's needs are considered.

In large enterprises, best practice is to roll standards out in a wave approach. Select sites to be in the first wave. Later waves — done by employees within the organization — learn from previous wave employees.

Bunge, a $50-billion global company with 88 plants worldwide, wanted to develop a business case for performance improvements using reliability best practices. The goal was a $200 million annual profit enhancement.

Emerson's reliability consultants spent four months with Bunge leaders reviewing and modifying Emerson's standards library. First dismayed at the amount of time required for planning, Bunge leaders later realized the value of that time. The roll out was more effective and was completed sooner with proper planning up front.

For the roll out, Bunge's 88 sites were divided into world regions which were further divided into "waves." Emerson's reliability consultants provided support for the first of the wave-one plants in each world region (the "accelerated" plant). People from other wave-one plants were brought to the accelerated plant and were used as implementation resources. Then those individuals went back to their plant and led the implementation at their own wave-one plant.

At those wave-one plants, people from wave-two plants helped as implementation resources. Then those individuals went back to their plants to lead. Eventually, the final wave plants needed very little consulting assistance. They had the knowledge to implement the programs; they were equipped with the standards, libraries, and tools.

Over the complete roll out, standards remained consistent. Years later, Bunge sites still use the techniques and standards, and there is no tolerance for deviation from standards.

Conclusions

Reliability, much like financial reporting and safety reporting, should rise to a strategic priority in any industrial company. Executives should insist on consistent standards to drive meaningful business results.

PolyOne and Bunge are just two of the organizations that have deepened their financial and safety successes through a concentration on reliability improvements. Many organizations are positioned to reduced their maintenance spending and increase their returns. Along the way to the financial goals, personnel from operators to executives will see the results in improved efficiency and safety.

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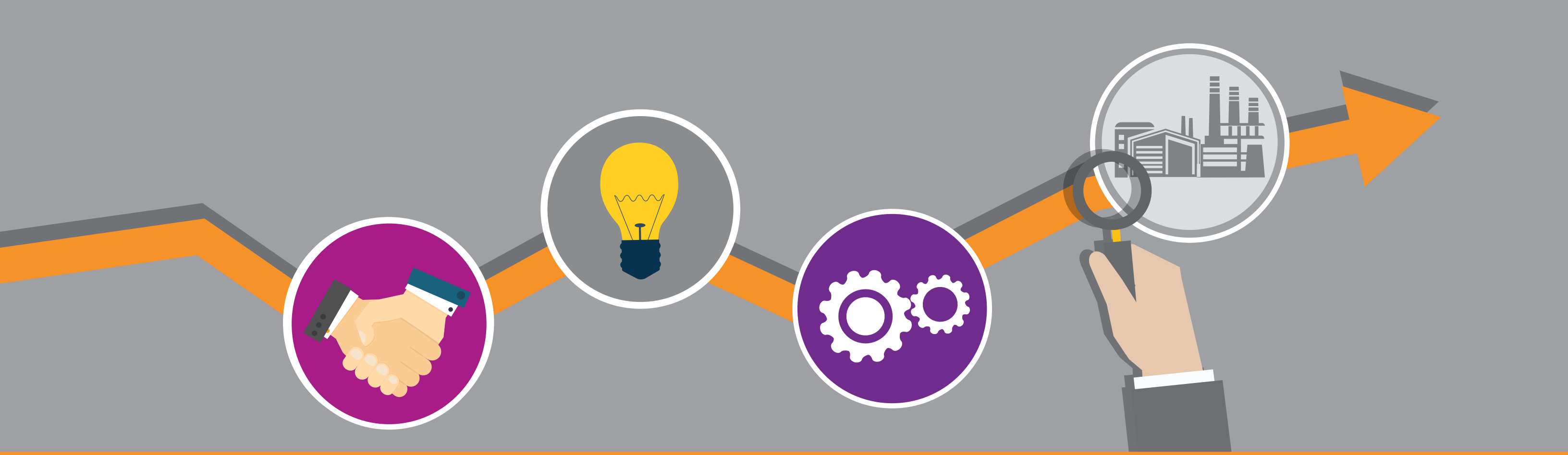

As a trusted advisor to some of the world's most successful companies, Emerson has collaborated in bringing the most complex projects to successful implementation. We look forward to collaborating with you, too.

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Emerson
1100 Buckingham Street
Watertown, CT 06795
+1 860 945 2300
www.emerson.com/reliabilityconsulting

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