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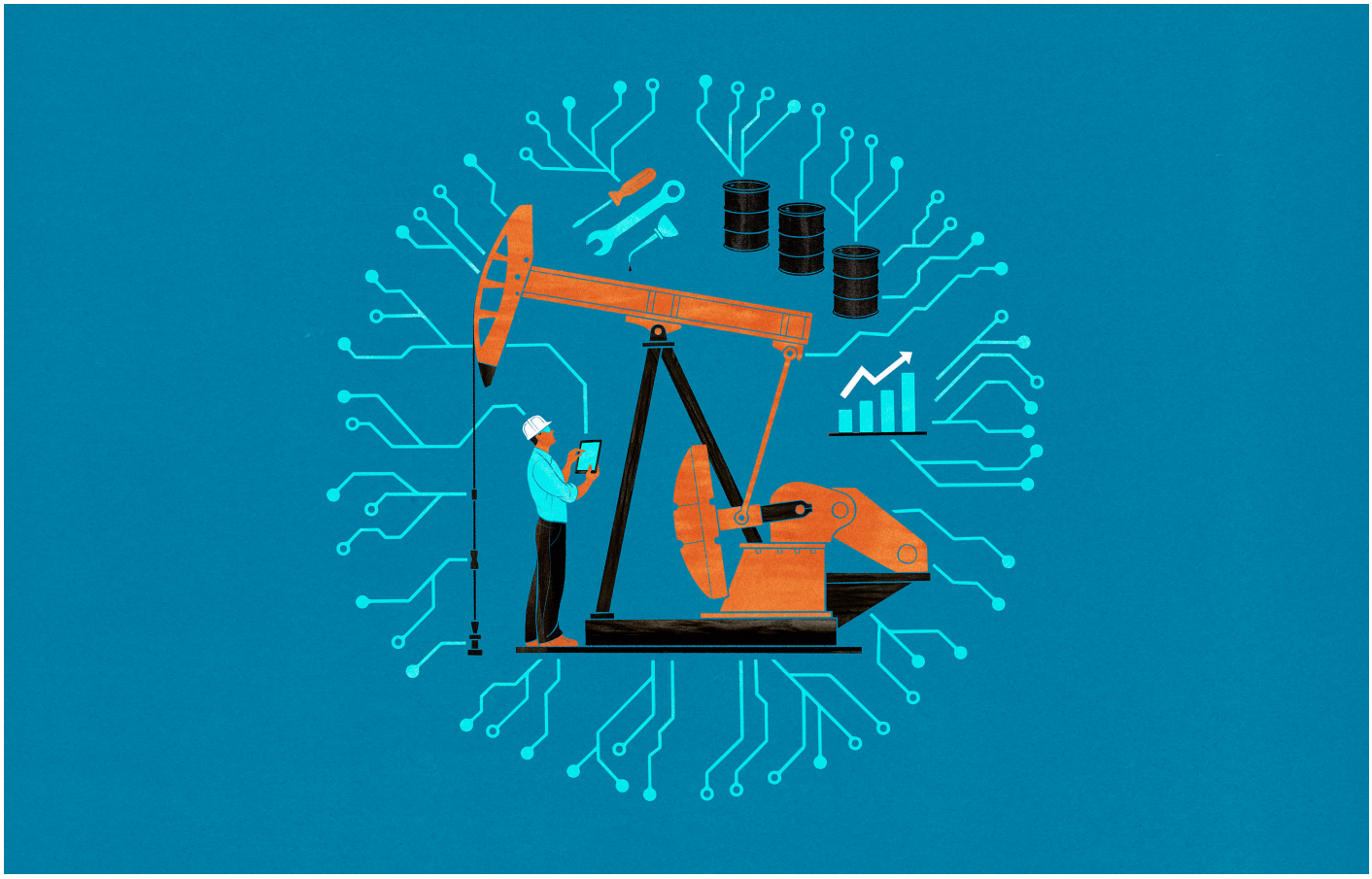


FEATURE

Asset performance management

Driving value beyond predictive maintenance

Andy Daecher, Dipankar Das, Paul Dunn, and Brenna Sniderman

Implemented well, asset performance management (APM) can do more than improve maintenance. By connecting systems across an enterprise, it can deliver insights to optimize operations and safety, and drive financial results.

IN THE LAST few years, many asset-intensive organizations, particularly in the mining, power and utilities, oil and gas, and chemicals industries, have turned to industrial Internet of Things (IIoT) and cognitive technologies to help improve a critical area of their business: equipment reliability.[1] Asset performance management (APM) programs, which connect data and trigger actions via systems across the business, can play a major part in driving these improvements. According to a 2018 Deloitte survey, oil and gas leaders rated the big data derived from programs such as APM as the most likely to provide the greatest business value.[2]

However, when asked about how digital technology can be used most effectively within their companies, those same executives ranked APM below both cost reduction in maintenance and operations as well as improvements in safety.[3] This seems to reveal a pervasive and narrow view of APM that may miss the connection between asset performance, broader maintenance and operations improvements, and safety. Merely implementing APM software and digitizing existing processes is not likely to improve core operations and obtain the financial results that executive leaders desire (and investors demand).

Instead, perhaps the most transformative aspect of APM is how it can connect systems across the business, from enterprise resource planning (ERP), to safety and quality, to inventory management. However, many organizations still see APM as simply more advanced maintenance, leading to many siloed APM programs, both in insights derived and benefits delivered. Because asset performance is affected by variables in operations and material supply, companies that fail to connect APM with other technologies and data in the enterprisewide digital supply network (DSN) will not be able to harness its full value.[4]

Today, fewer than 5 percent of companies have achieved an APM program that helps to optimize maintenance, operations, and asset investment decisions to achieve financial results.[5] In this article, we'll discuss how viewing an APM program through three lenses—maintenance, operations, and safety—can help companies gain this much greater impact.

The path to a mature APM program

Asset-intensive organizations tend to face many common challenges:

- Increasing compliance and regulations demands
- The unreliability of "tribal knowledge"—situations in which asset maintenance strategies borne of personal experience are stored just in the minds of workers, and are lost when they leave
- Multiple legacy, manual, and noninteroperable systems, meaning data cannot be easily aggregated to make more holistic decisions; this can lead to unnecessary spending on scheduled

Deloitte has extensively studied the rise of DSNs and how collecting and connecting data across the enterprise can enable more dynamic and efficient business operations. For further information about DSNs' interconnected nature, see *The rise of the digital supply network*. To learn more about how data from connected assets can drive more informed maintenance and decision-making, see *Drowning in data, but starving for insights* and *Synchronizing the digital supply network*.

maintenance as well as significant safety, environmental, and productivity losses due to unplanned asset failures

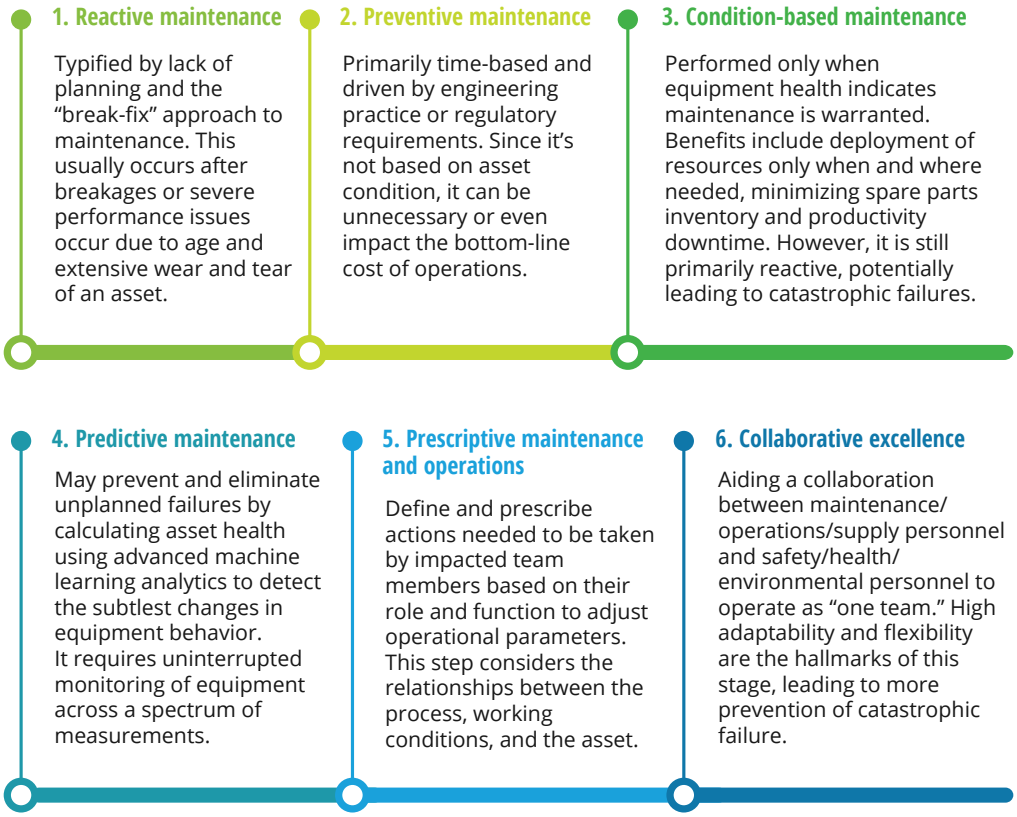
Maintenance strategies have evolved extensively in recent decades, particularly with the maturation of IIoT technology and lower-cost sensors that enable more data-driven decisions. A mature APM program typically merges the digital and physical—or information technology (IT) and operations technology (OT)—to provide maintenance teams with troves of data that can support multiple maintenance strategies, depending on the asset and its level of criticality, ranging from break-fix approaches to predictive methodologies for timing of asset maintenance and replacement. In fact, far from being a "nice to have," APM is often a foundational capability for asset-intensive, process manufacturers as they seek to make their operations more efficient, reliable, and safer.[6]

Applying these various maintenance approaches to assets based on their level of criticality is the beginning of a mature APM program. Figure 1 details the early steps of APM that are most likely familiar to most enterprise maintenance teams. For less critical assets, a reactive or preventive approach may be adequate; for more critical assets, continuous sensorization and monitoring.

FIGURE 1

Asset performance management has different levels of maturity

Asset management approaches range in technological sophistication. Each method detailed below is viable, depending on the specific needs of the organization and the criticality and risk associated with each asset; in fact, a mature APM program will employ all levels.



Source: Deloitte analysis.

As this program evolves to encompass a broader series of approaches depending on the maintenance need and level of asset criticality (as noted in the later steps of maintenance maturity), the organization should further integrate data generated by connected assets to push insights more broadly throughout the enterprise, helping the entire business optimize planning and decision-making.

A mature APM program—in which the maintenance strategy is based on asset criticality and collaborative excellence has been achieved—can also provide benefits to a wide variety of functions and roles, such as equipment health monitoring, asset strategy optimization, management of alerts and compliance, predictive management, and end-of-life calculations.

However, companies should keep in mind that as APM programs evolve to the more mature stages, they often require more sophisticated technological capabilities, such as cognitive and advanced analytics, along with tighter collaboration among various groups, from asset owners and on-site crews to remote teams, original equipment manufacturers, and third-party service providers.[7]

EXAMPLE: APM IN A FRACKING COMPANY

Many organizations are currently focused on the first few stages of a digital APM program,[8] and have not yet moved to a level at which the data is shared more broadly; even simply wading through the wealth of data and reconciling multiple different structures can constitute a significant hurdle.[9]

Let's consider a hypothetical example from an asset-centric business: a fracking company. Today, this company has implemented APM software, and like many of its industry counterparts, it started with one key application: coordinating information to derive insights from an instrumented fleet of nearly identical pumping assets to schedule repairs, manage spare parts, and other activities. As the asset fleet is used at different sites around the region to inject liquid and other materials into the ground, many different variables exist from site to site and crew to crew. However, maintenance teams have not had a line of sight into these potential discrepancies, which could include anything from variance in quality of materials being injected into the ground, to weather conditions, to crew training and performance levels. Further, local operators, who perform most of the maintenance, typically have limited interaction with a coordinated maintenance team because maintenance information is not easily shared across the organization.

The company has implemented new APM software to digitize its current processes and data, and has experienced some meaningful benefits: Within a few months, it was able to see which assets were decaying, allowing it to schedule corrective action between failures, which has led to improvements in mean time. However, the software was not able to identify and prevent several sudden catastrophic failures. When set up properly, digital APM systems should be able to identify the level of wear on each component within an asset. For this company, this hasn't improved the detailed identification of potential failures and thus the ability to have the right repair materials on hand.

At a micro level, this enterprise may think it is doing well because it is measuring success solely through the lens of asset performance—its pumping systems have an overall equipment effectiveness (OEE) in the 90th percentile. But at a macro level, asset productivity still varies greatly depending on the asset, operator, site, and raw material operating conditions. Maintenance may be improving, but the rest of the organization isn't benefiting because the information captured isn't driving overall performance optimization.

Without better collaboration between the maintenance, operations, and supply sides of the business, the company will not be able to use APM to its fullest value. For most companies, this will require a large organizational shift that includes taking a new and expanded perspective of both the opportunity and benefits. Next, we'll show how this enterprise can view APM through three broader lenses, which could increase the benefits.

Beyond maintenance: The real APM opportunity

For many companies, maintenance, operations, and safety and compliance organizations function in silos; they may even have conflicting goals and motivations that drive incompatible behaviors.[10] In the case above, for example, the fracking company could improve its analytical methodology across the organization by connecting these traditionally siloed groups to share data. This could lead to deeper insights and a more integrated approach to operations and maintenance, resulting in more optimized production and a longer life for their pumping assets—as well as improved safety.

To achieve this collaboration, a foundational understanding of the full scope of asset management should be laid across the enterprise. This scope should extend into three key areas of the business: **physical and mechanical**; **operational**; and **safety, health, and environmental (SHE) risk**. It serves to note that while we are trying to separate them for the purposes of explanation, these areas and their benefits generally blend together in practice.

PHYSICAL AND MECHANICAL: UNDERSTAND ALL THE VARIABLES THAT AFFECT PERFORMANCE

An APM program should start with an evaluation of all required parameters to address reliability, integrity, corrosion, and performance for all physical mechanical equipment. This can help adjust the maintenance program to an optimum mix of condition-based maintenance and run-to-failure, depending on each individual asset. This process includes the following key steps:

- **Assessing equipment criticality.** Reviewing and classifying all equipment into critical, important, and ordinary classes.
- **Analyzing maintenance based on reliability.** Evaluating potential failure modes and damage mechanisms of all critical and important classes of equipment, as well as the causes and remedies to develop proactive mitigation strategies.
- **Developing equipment strategies.** Defining proactive, preventive, and corrective maintenance strategies for all classes of equipment.
- **Assessing impact of operations on maintenance.** Evaluating the variables that affect asset performance while in the field, ranging from feedstock in a pump to the training or work habits of the site crew.
- **Continuous monitoring.** Adding sensors to critical and important assets that allow continuous monitoring—not portable sensors on a time- or variable-based schedule, which may help provide a high-level trend line, but won't illuminate day-to-day information that can indicate impending catastrophic failure. Continuous monitoring drives a more complete understanding of each asset.

Appropriate monitoring and management of maintenance can lead to overall improvements in business and operational efficiency.[11] For example, an oil and gas refinery was hampered by a time-consuming, labor-intensive inspection process. Combining IT and OT processes, the company built an integrated, scalable solution that generated real-time insights, continuously monitored the current and future state of assets, and generated alerts in cases of issues. The benefits of these actions included better worker safety and asset availability, less unplanned downtime, and improved OEE and throughput—leading to a 50 percent reduction in costs.[12]

Example: The difference connected data makes

Going back to our fracking example, suppose that in addition to implementing APM software, the company chose to invest in additional permanent sensorization for continuous monitoring and built a repository for data aggregated from the pumping assets systems related to ERP, downtime, safety, quality, and control systems. The maintenance organization can predict machinery life further into the future and is also better able to flag and antici-

pate specific part failure on that asset. This would allow it to begin to understand how parameter changes could affect impending catastrophic failure.

OPERATIONAL: INTEGRATE DECISION-MAKING ACROSS FUNCTIONS

Most process manufacturers are familiar with the concepts and steps described in the previous section but may find it challenging to achieve some of them due to organizational divides between maintenance and operation.[13] Collaboration with operations can be critical to realizing the broader potential of APM. Companies can use APM data to optimize supply of equipment and materials, as real-time data generated by continuous monitoring can allow technicians to perform more accurate root cause analysis. In this way, teams throughout the organization can understand the process parameters that can lead to failures or reduced asset performance, enabling them to align more effectively across the supply network, improving planning and reducing inventory, loss-of-market, and logistics costs.[14]

For example, one mining company found itself too reliant on manual reporting and monitoring processes that consumed many resources. To better understand, predict, and optimize its operation asset performance, it developed an APM capability to track the health, safety, and efficiency of the assets. The insights generated went beyond improving asset maintenance and monitoring to improving the safety, efficiency, and optimization of the larger site. Ultimately, this was used to analyze, model, and assess equipment condition and future performance extended into other business functions and operational areas, enabling leaders to make more informed operational, maintenance, and capital investment decisions across the organization.[15]

Example: Enabling real-time, data-driven decisions from operations to procurement

In our fracking example, if the crew uses asset performance information to understand different variables and their associated cost and risk factors, it could be equipped to make the optimal decision on production parameters to extend the life of an asset. It may be able to change pump speeds, adjust the feedstock to a less corrosive grade of sand, or communicate with the production manager on whether the job has been fulfilled to an adequate degree. Further, technicians can use the data to more accurately calculate potential mitigation strategies based on actual, real-time equipment conditions, and those insights can carry forward to other sites and other teams.

SAFETY, HEALTH, AND ENVIRONMENTAL RISK: FROM COMPLIANCE TO PREVENTION

Within the process industry, insurance premiums are often based on annual or biannual safety risk evaluations, much of which is impacted by asset performance and reliability. By considering SHE functional areas such as barrier management, APM can reduce associated risks, resulting in lowered insurance costs, improved safety, and increased uptime. The Occupational Safety and Health Administration (OSHA) defines eight specific hardware barriers, many of which are serviced by both rotating and nonrotating equipment, defined as “safety critical equipment.” A typical APM approach would not include analytics to cover required failures that make hardware barriers operate as desired; instead, they focus on

factors such as vibration and pressure to predict a mechanical failure. An integrated approach covering a holistic requirement of reliability and safety reduces the risk of safety, increases asset reliability, and directly impacts the bottom line cost in the form of lower risk insurance premiums.

Example: Business results from improved safety

Let's take another perspective on a process industry pump fleet. A corrosion inhibitor pump to the atmospheric column overhead in a refinery is a defined safety critical equipment listed under "Protection Systems Barrier" (one of eight OSHA-listed hardware barriers intended to prevent accidents such as flammable material release, fire, and potential explosion). This barrier is managed by ensuring two things: that the pump is always on, and that the required flow is maintained consistently. If either one of these two conditions fails, the barrier is impaired. By providing a more holistic information set, taking a pump out of operations is not just an operational decision but ensures that the plant operates within the safety boundary reducing or stopping unwanted incidents.

Implementing change: From expanding perspectives to realizing results

For many companies, a mature APM program will necessitate significant changes for its entire organization. Actions in several talent areas can help organizations accomplish a change of this scale:

New skill sets. As technology changes the way roles are executed, the need for nontechnical and critical thinking skills will likely continue to grow throughout industrial manufacturing and the supply network, particularly as capabilities such as APM mature.[16] Role requirements at the individual level could also likely shift. A recent study by Deloitte and the Manufacturing Institute found that six out of 10 open production positions are unfilled due to talent

PULLING IT ALL TOGETHER: A GULF OIL PRODUCER CASE STUDY

A large Gulf oil producer defined an integrated approach to APM in its megagreenfield refining and chemicals complex. While it was evaluating various specialized technologies, it started with an overarching solution design that would ultimately promote collaborative operations. It first identified various process interactions between diverse groups, including supply chain; operations; health, safety and environment; asset reliability; and process engineering. It also identified all the people and roles that would be impacted.

With this information, the company was able to define the information needs at each decision point and then redesign its people-process-technology map to facilitate a more integrated working model. This exercise helped develop both functional and nonfunctional business requirements that needed to be met by the overall architecture and the shortlisted applications. Then the requirements for analytics, machine learning, and process automation were defined along with the digital interventions designed to meet the personal requirements to operate collaboratively. The company's final goal was to develop an integrated procurement solution that identifies the failure mode and effects analysis (FMEA) parts list based on the predicted failures; analyzes inventory; and develops a procurement process to make resources available at the point of failure.

This company also expanded its APM journey to digitize the SHE barrier management beyond e-work permits and barrier breach identification. A single IoT-based analytics solution has reduced the risk of safety breaches caused by both hardware and humans, reducing the company's overall risk rating between 5–12 percent, resulting in significant insurance cost savings.

shortages; the top two skills in demand are technology/computer skills and problem-solving skills.[17] Many new skills needed to drive APM's cognitive and cloud initiatives historically have not been that prominent within manufacturing companies. As the demand in skills shifts to this technological/human hybrid, many workers may need help to adapt to this new environment and working with new types of professionals. This change may require a strategy that combines training and hiring to meet new demands.

Mindset shifts. As required skills shift, mindsets may need to shift as well—both organizationally and individually. In a recent Deloitte survey of industry executives, 94 percent pointed to digital transformations such as APM as a top strategic priority. At the same time, just 19 percent believed their organization needed significant cultural change—and just 15 percent felt the composition and skill sets of their workforce would need to change dramatically to accommodate these transformations.[18]

This could pose a problem because organizational processes can fail if the strategy and purpose behind them aren't adopted across functional groups. Getting workers to understand the broader vision could be critical to the success of this type of enterprisewide change. Further, for cultures accustomed to a clear divide between operations and maintenance, accepting a more holistic, broader, and interconnected approach to data transparency and decision-making poses a potentially significant challenge.[19]

Performance metrics. Alongside the mindset shifts, performance and production metrics should be aligned to the new vision. Operational and SHE metrics may need to be added to KPIs, alongside the more traditional maintenance and productivity measurements.

How to get started wherever you're at

The opportunity of a holistic APM program is enormous, though the level of change it demands can be daunting for many organizations. As companies embark on their journey to a mature and transformational APM program, it's important for business leaders to consider the following principles:

- **Evaluate where you're currently at in the APM maturity journey** but understand the full spectrum of opportunities. Then, look for specific opportunities within your organization—for example, high inventory costs or maintenance budgets, or limited visibility into operations performance—to implement new value-added APM capabilities and scale them.
- **Take an expanded view of the value of a mature APM program by evaluating opportunities via three key lenses:** 1) physical and mechanical, 2) operational, and 3) SHE risk.
- **Focus on data transparency throughout the organization**, allowing data to cascade through the organization so that optimal decisions can be made, both on micro and macro levels. This may also necessitate a focus on connecting teams and functions so data can be effectively aggregated and used.
- **Don't forget how essential change management can be.** Identify the links between the opportunities identified through each lens, and how they affect individual roles throughout the organization, from operator to C-suite. Assess the degree to which roles and skills should evolve and collaborate, and add reskilling, training, and hiring programs as needed.

The technologies that power APM are expected to only continue to accelerate, enabling asset-intensive organizations to improve their performance, but only if they understand how to embrace the concept at all levels.

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About the authors

ANDY DAECHER is a Deloitte Consulting LLP principal leading Deloitte Digital's Internet of Things practice. He has worked in the high-tech industry for 25 years, advising clients on the strategic use of technology to optimize their businesses. Daecher specializes in advising executives on the practical applications of emerging technologies, effective management of IT organizations, and execution of complex, transformational, technology-enabled projects. He is based in San Francisco.

DIPANKAR DAS is a managing director for Deloitte Digital supporting digital transformation for downstream oil and gas, LNG, and the chemicals industry. He has over 30 years of industry experience in oil and gas/LNG and chemicals for core industry operations, crude oil trading and risk management, technology solution architecture and delivery, as well as digital enablement. Before joining Deloitte, he was the managing director for Accenture in the United Kingdom and the United States. A chemical engineer by profession, Das holds an MBA and a master's degree in operations research and a fellowship in energy economics from East West Centre. He is based in Costa Mesa, California.

PAUL DUNN is a specialist leader with Deloitte Consulting LLP. He has 26 years of experience in the process control and automation industry, working within industries such as power generation, chemicals, pulp and paper, and food and beverage. He works with clients to understand and act upon the confluence of information technology (IT) with operational/manufacturing technology (OT) to bring tangible financial value to life. His recent emphasis at Deloitte has been bringing traditional predictive maintenance techniques together with analytics to ensure that clients are achieving operational gains in addition to optimizing asset performance. Dunn is based in Charlotte, North Carolina.

BRENNA SNIDERMAN is a senior manager and subject matter specialist at Deloitte Services LP's Center for Integrated Research. She focuses on cross-industry themes and trends, specifically as they relate to additive and advanced manufacturing, Industry 4.0, the Internet of Things, and advanced technologies. She works with other thought leaders to deliver insights into the strategic and organizational implications of these technologies. She is based in Philadelphia.

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Contacts

Adam Mussomeli
Principal
Deloitte Consulting LLP
+1 203 905 2646
amussomeli@deloitte.com

Andy Daecher
Principal
Deloitte Consulting LLP
+1 415 783 6525
adaecher@deloitte.com

Stephen Laaper
Principal
Deloitte Consulting LLP
+1 312 513 7900
slaaper@deloitte.com

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