ANALYTICS REALLY DO MATTER

Driving Digital Transformation and the Smart Manufacturing Enterprise

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ACRONYM
QUICK REFERENCE
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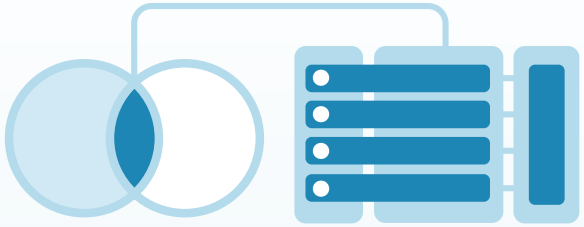
SECTION 1

Critical Upgrade for Industry 4.0: From “Metrics That Matter” to “Analytics That Matter”

A Better Focus for Today's Industrial Enterprise

For the last fourteen years, LNS Research and its predecessors published bi-annual research in partnership with MESA Manufacturing on the use of data in manufacturing. Until now, the research was titled, "Metrics That Matter." This year marks an important shift in focus, examining "analytics that matter." This evolutionary step in the study marks an important milestone to align with how companies conduct their Digital Transformation journey. As companies begin that journey, we talk a lot about Industrial Internet of Things (IIoT) platforms and applications that run on them. However, the heart of a digital enterprise is data and using it to improve enterprise-wide performance. One of the major tools we have to achieve this is analytics. This ebook introduces:

- The results of the 2018 Analytics that Matter survey and the unexpected (and interesting) responses; and
- A data and analytics architecture that fits within the Operational Architecture prescribed by LNS Research and that helps manufacturers achieve Digital Transformation goals.

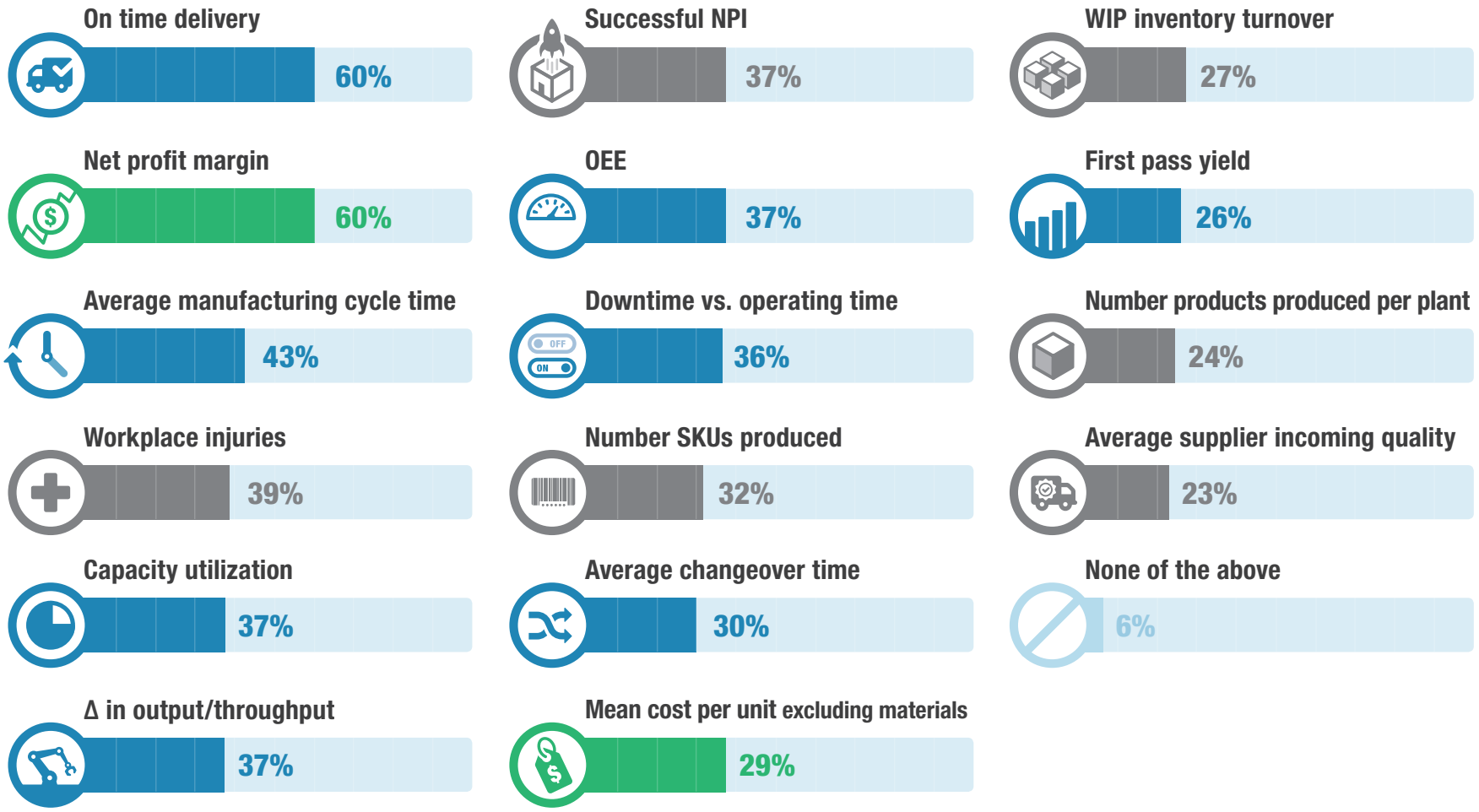


OPERATIONAL ARCHITECTURE by LNS Research is a critical component of Industrial Transformation. It extends traditional enterprise architecture, to holistically manage the convergence of information technology and operations technology. It's an approach to align people, process, and technology in context of the value chain, and in support of enterprise Strategic Objectives.

Click to learn more about **Operational Architecture**

Over the last year or two, analytics applications have appeared from every imaginable source, from large control, IT and cloud vendors to "one man and my algorithm" start-ups. In the industrial world, much of this has been focused on specific applications such as asset performance management (APM) and other maintenance-related processes. For most of operations, the starting point of data use today is simple metrics with nice displays to show the "up to the moment" state of affairs. In reality, very little "live data" moves from operational systems into outside plant data stores. However, that's about to change and it's what will drive deep value — prescriptive control from live analytics. This is the opportunity that drives the shift in focus from metrics to analytics.

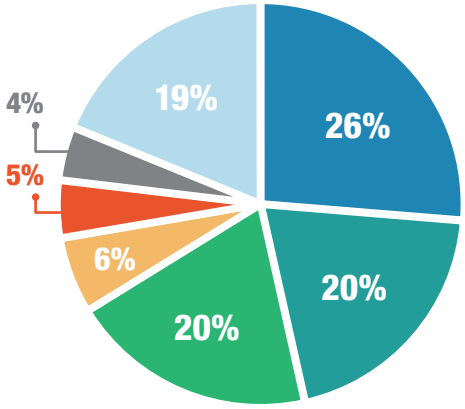
Metrics Will Remain



Demographics

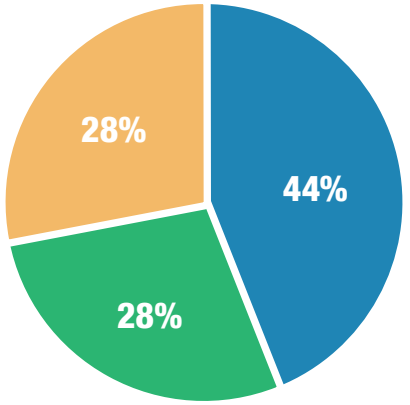
The focus of the survey was across manufacturing executives responsible for operational technology (OT), but the survey was open to all. To the extent possible, we eliminated vendor responses which resulted in a good cross-section of reliable respondents. At the time of publication (June 2018) the total number of responses for this analysis was approximately 350. If you are a manufacturer and haven't yet taken the analytics that matter survey, please participate now. Doing so will give you access to continued research coverage of this and related topics.

Some of the essential starting points for Digital Transformation are somewhat dependent on the specific industry. The analytics that matter survey captured responses across many industries, and this report examines the data according to three main segments: discrete manufacturing, process manufacturing, and batch (or hybrid).



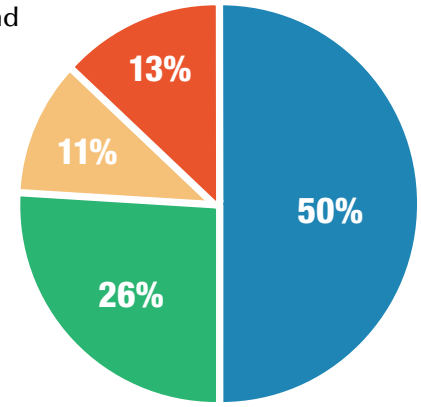
DISCIPLINE / ROLE

- Operations
- Engineering
- Information Technology
- Quality
- Maintenance
- Research and Development
- All Others



INDUSTRY

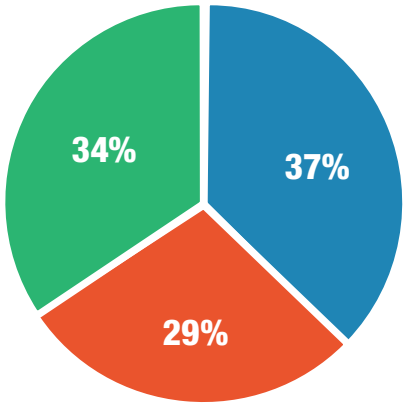
- Discrete Manufacturing
- Process Manufacturing
- Batch Manufacturing



GEOGRAPHY

COLOR BY HQ LOCATION

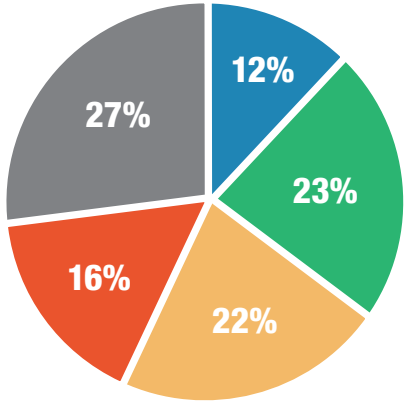
- North America
- Europe
- Asia / Pacific
- Rest of World



REVENUE

COLOR BY COMPANY REVENUE

- Small: <$250M
- Medium: $250M-$1B
- >$1B



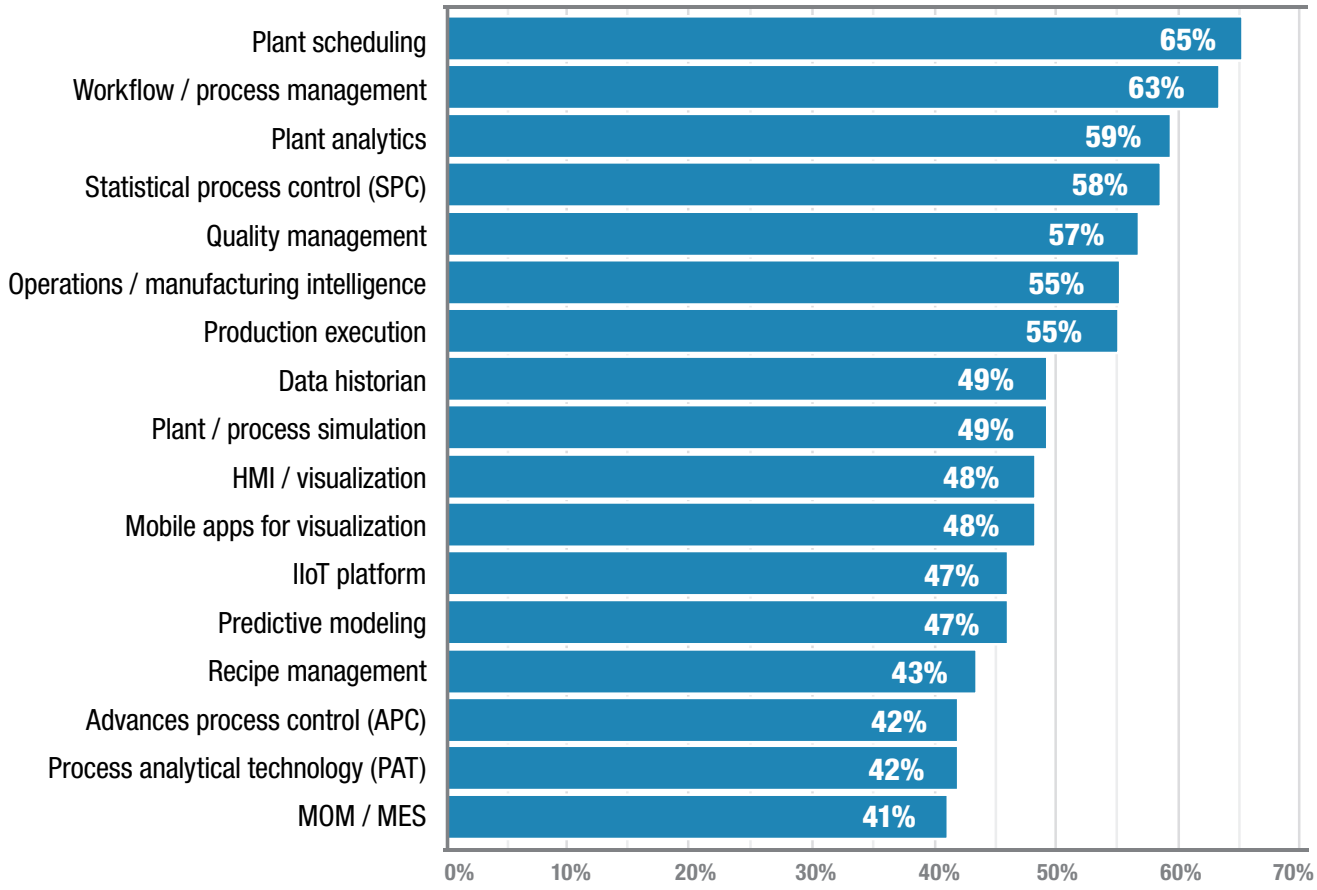
JOB TITLE

- Senior Executive
- Director
- Manager
- Consultant
- All Others

Today's Norm: Beyond Point Solutions

Before the days of integrated manufacturing operations management (MOM) systems, automation and supervisory control were made up of many "point solutions," single function programs with a tendency for limited communication and from multiple vendors. Although MOM has taken over much of the functionality, a lot of these solutions persist in many plants. To get at least some value out of analytics, the first step is to collect relevant data from centralized systems plus the older systems dotted around the plant. As always, there is a broad range of responses, from companies with advanced automation, integration and analytics, to those that still use Excel or paper forms for most of the reporting.

Manufacturing Applications Adopted

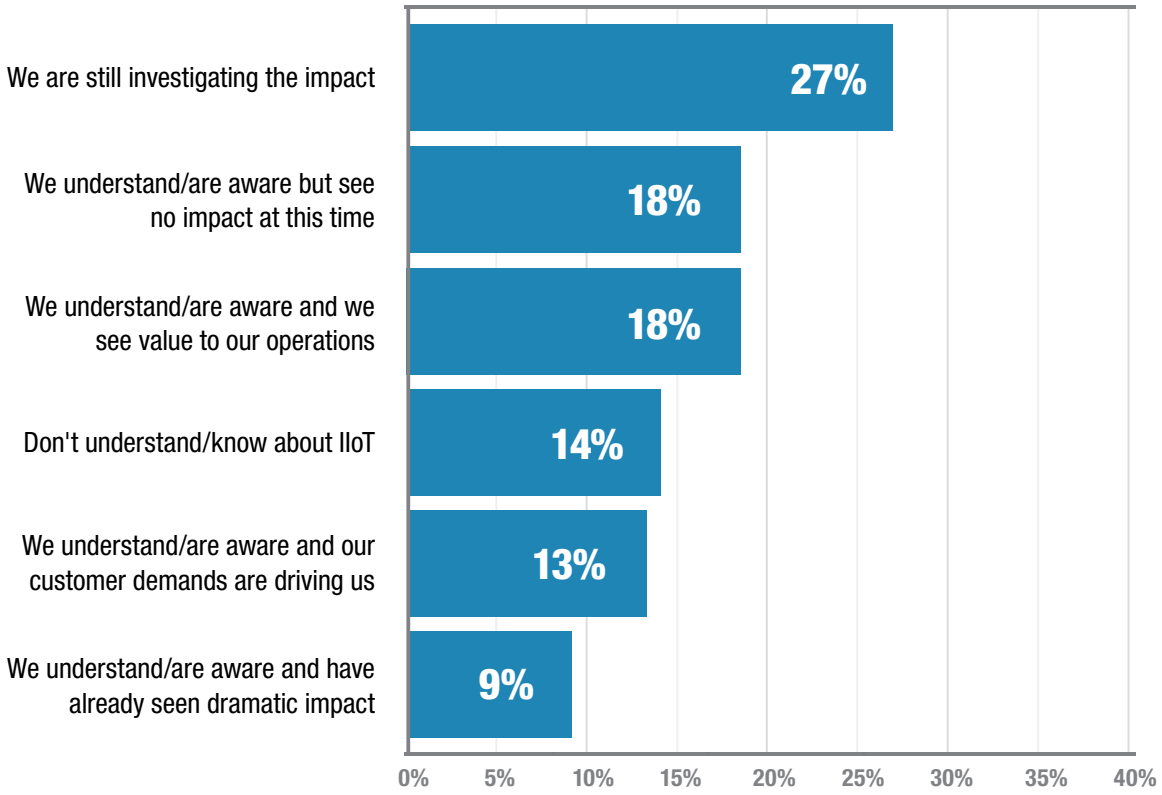


Today's Norm: Beyond Point Solutions *(Cont.)*

One of the clear trends that we see is that companies are looking at their Strategic Objectives and realize that some form of Digital Transformation is a necessity to stay competitive for the next 3-5 years. Companies that are not already highly digitalized recognize that the first step to a digital future is data gathering. There are many ways to initial data gathering, from SCADA, to building an IIoT platform across the enterprise.

When we drill down to examine just process manufacturing, we learn that systems implemented is considerably different than the manufacturing industry overall. Cuts like this can help manufacturers better to focus on what will bring maximum benefit to them when making Digital Transformation plans. In the following pages, we will look at a broad cross-section of results and what they mean to manufacturers.

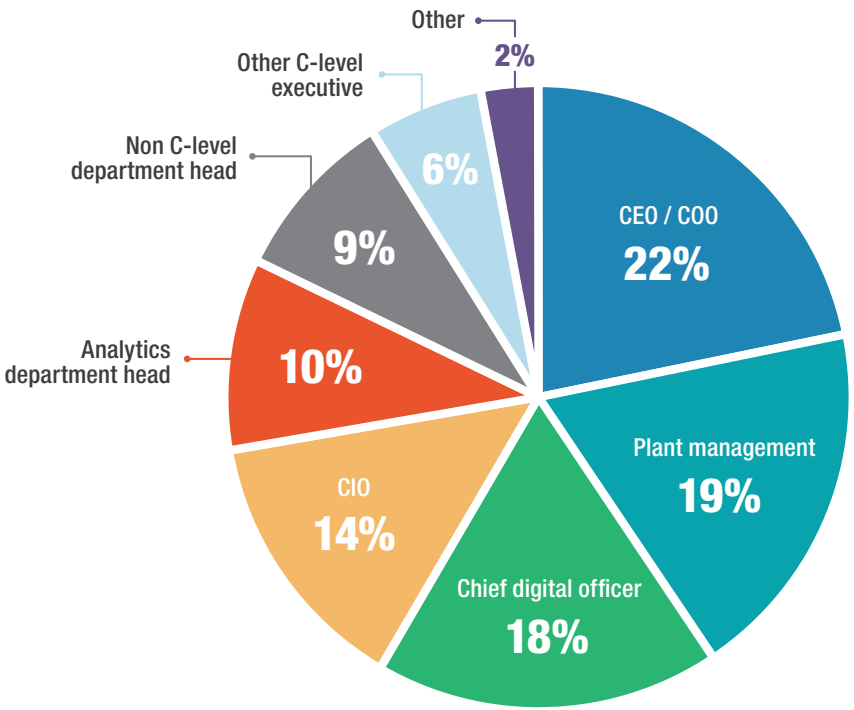
How does the IIoT impact your business today?



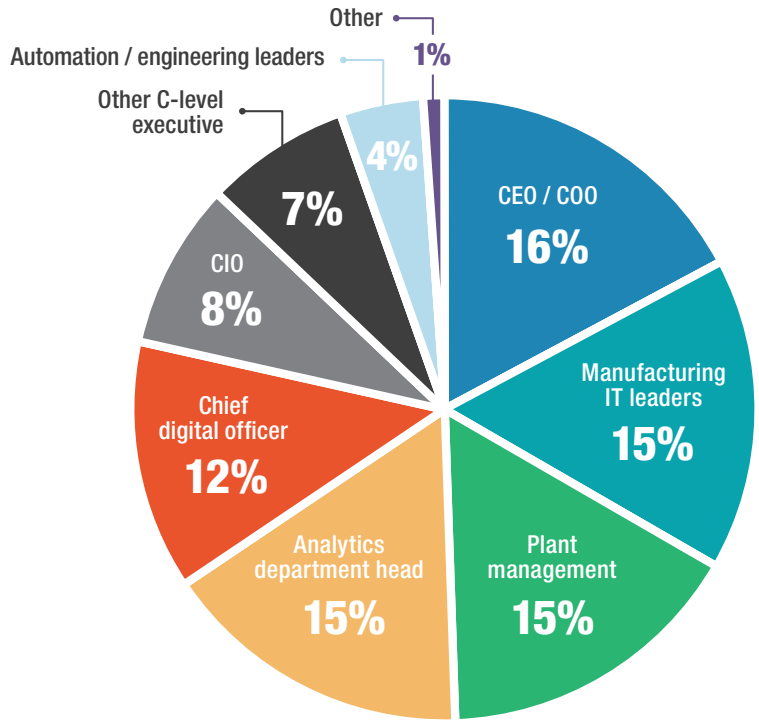
Analytics Today: Who, What, Where?

Let's start with "who is in charge?" We're encouraged to see that corporate and plant analytics programs are for the most part led by senior staff. This structure aligns well with the LNS Research Digital Transformation framework, which strongly encourages C-level executives to own the process and to lead by setting and monitoring Strategic Objectives. Ownership of the analytics program is a great start. However, for success with the analytics program, it needs to be integrated throughout the entire business from sensor to boardroom. More importantly, it must involve all the right people, from those who can benefit to those needed to implement.

Corporate Analytics: Responsible Role



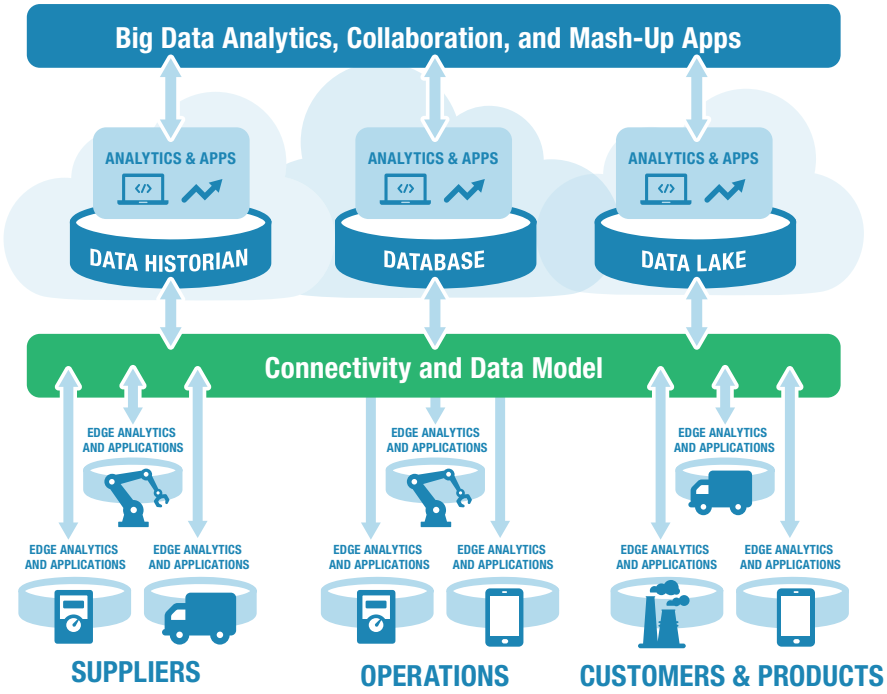
Plant Analytics: Responsible Role



Analytics Today: Who, What, Where? *(Cont.)*

Next, we should consider how the organization uses analytics. Today we see predominantly traditional processes aimed at quality, forecasting, productivity and Operational Excellence. Those that fall under the umbrella of Digital Transformation are as yet less popular – social media, traceability, cross plant comparisons, and the like. That's not surprising since analytics for digital change is absolutely part of the IIoT journey, and it's an essential part of any IIoT platform. Today, many manufacturers are experimenting with IIoT platforms using only analytics as the initial use cases. Asset performance management (APM) has been a long-time low-hanging fruit for IIoT implementation, and in reality, it only uses data collection and analytics to implement current generation APM.

CONNECTIVITY-CENTRIC OPERATIONAL ARCHITECTURE



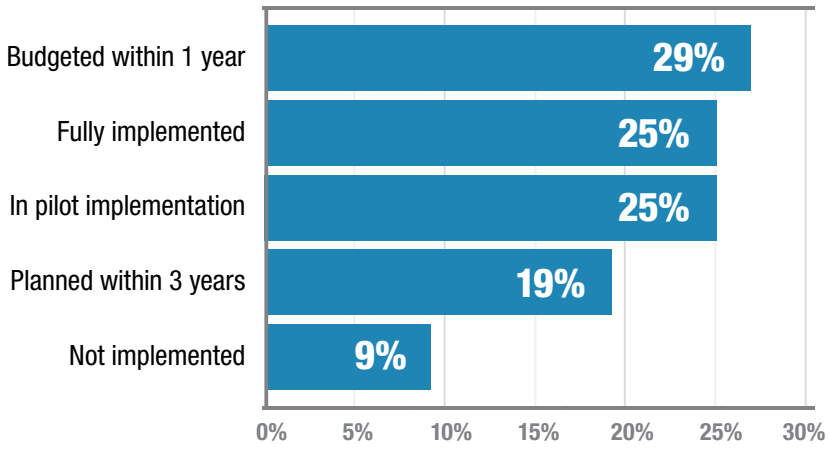
TOP 5 USES OF ANALYTICS IN THE MANUFACTURING ENTERPRISE

IIoT is a Principal Starting Point

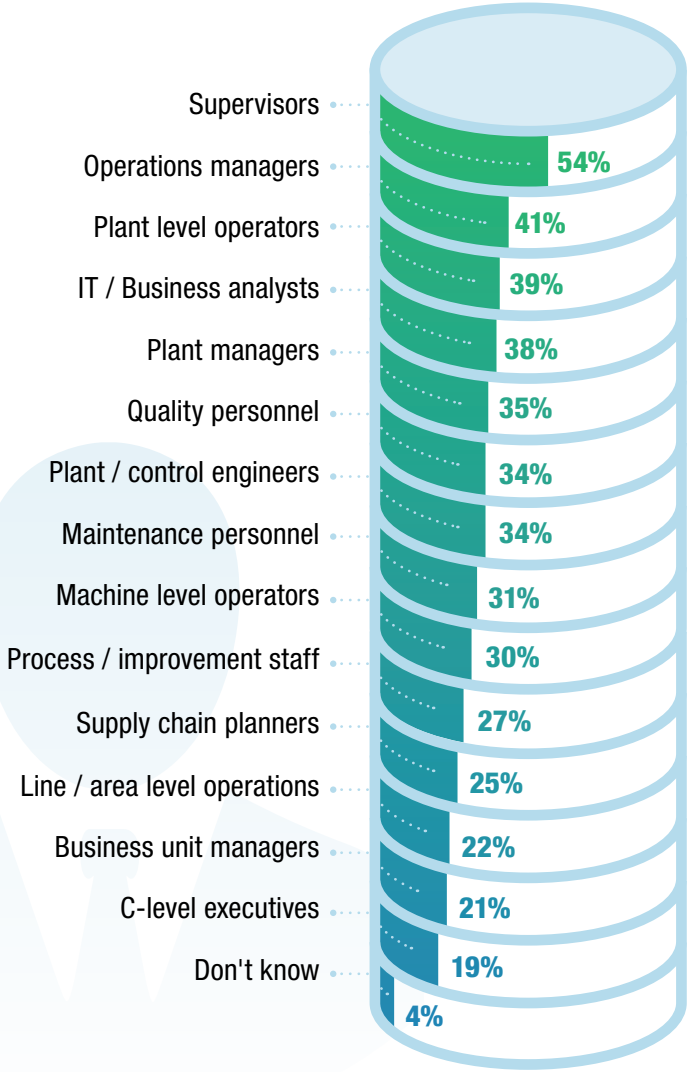
Much has been done inside the plant to collect data (historians, MOM, SCADA, etc.) and, as we have seen, companies have generated lots of metrics to run the manufacturing business better. Some but not all of those who need access to timely information to do their job can access it with existing systems. While that's very encouraging at the plant level, it's less so when we consider the wider world of information sharing. Analytics and the IIoT promise much more, not just in the plant but across the enterprise and beyond.

As we move into the IIoT world, analytics will be a part of the toolkit available to those running a digital business. However, it will not be everything. When we look at analytics offerings from a multitude of vendors today, the one common trait is that they rarely use analytics to genuinely control plants and the business. Metrics are great for diagnostic and descriptive analytics, but the enterprise can only realize rich value when it moves to predictive and prescriptive forms.

Current state of Industrial Analytics Program



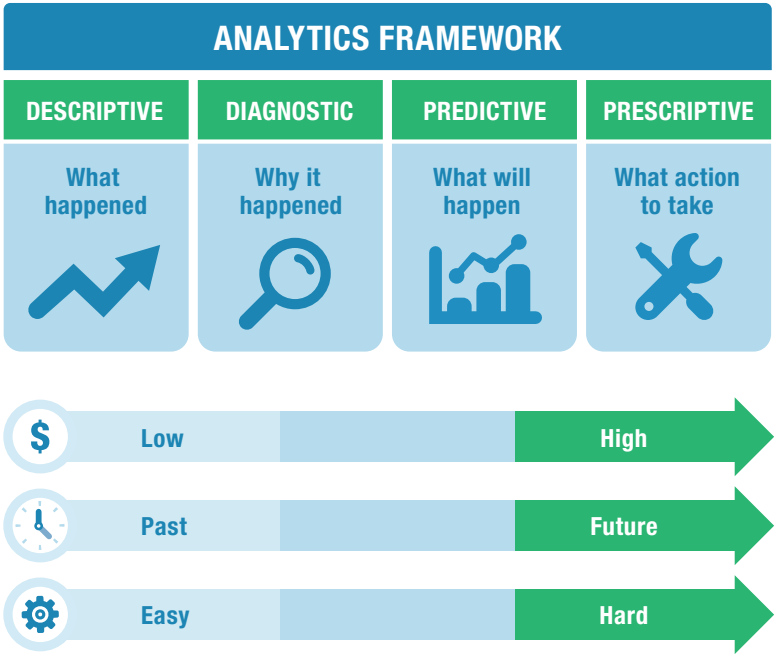
Which roles have access to analyzed info from plant within timeframe required to make appropriate decisions?



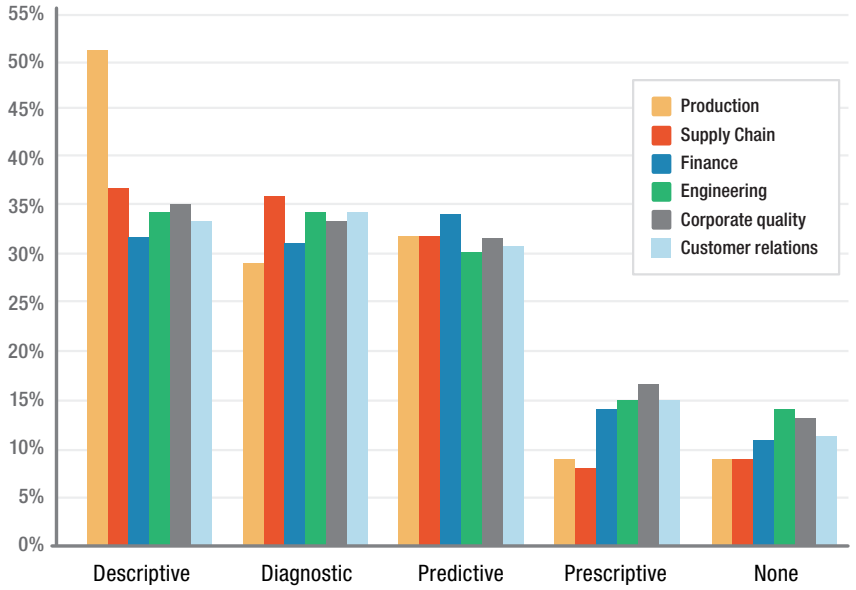
IIoT is a Principal Starting Point *(Cont.)*

The use of descriptive and diagnostic analytics is much as we would expect; about one-third of manufacturers use these analytics (in reality, old-fashioned business intelligence (BI) and enterprise manufacturing intelligence (EMI) across the enterprises. The surprise comes with predictive analytics, with a level of deployment very close to the first two. That degree of adoption means that companies are trying hard to increase their analytics skills and, in some ways, it correlates with another interesting finding: nearly 40% of companies claim that they have sufficient data scientists to manage analytics needs.

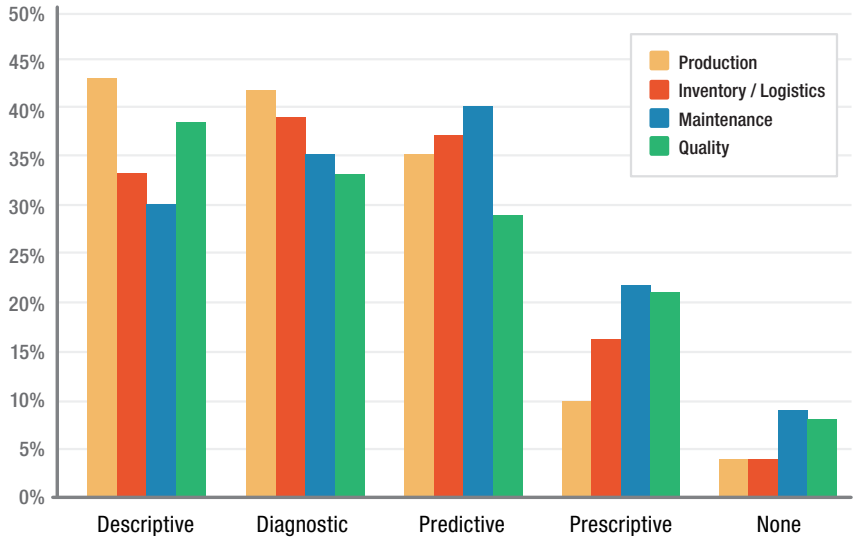
TRADITIONAL VIEW OF ANALYTICS



Business Analytics Sophistication



Industrial Analytics Sophistication: Plant Operations and Related



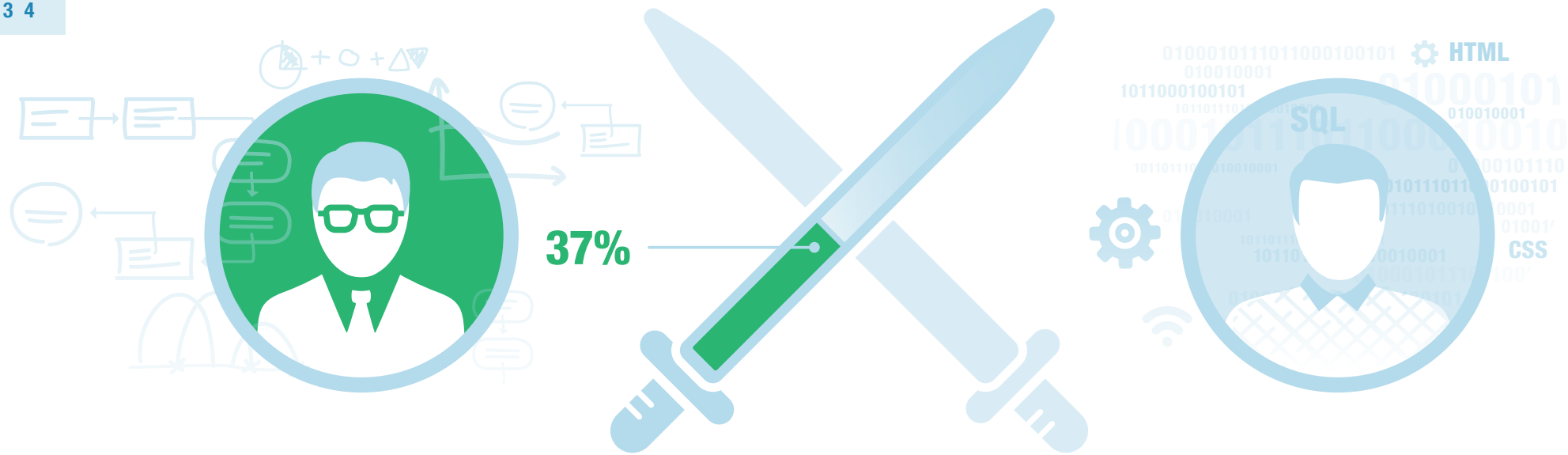
IIoT is a Principal Starting Point *(Cont.)*

We suspect that these two data points come from the use of BI and EMI applications in relatively sophisticated ways and have little correlation with Big Data analytics that are a fundamental part of Digital Transformation and the IIoT.

The extensive dialogue about the value of data scientists and analytics that takes place in the heady heights of the data intelligence industry does not seem to have reached the calms of manufacturing enterprise IT departments. Manufacturers should closely examine the skills they will need throughout the Digital Transformation process and then honestly and objectively evaluate existing capabilities.

Manufacturers should closely examine the skills they will need throughout the Digital Transformation process and then HONESTLY AND OBJECTIVELY EVALUATE EXISTING CAPABILITIES.

We have a STRONG TEAM OF DATA SCIENTISTS that will not require much help



SECTION 2

Closer Look at Operational Architecture Elements

Cloud and Edge: What, Where, Why

One of the trends over the last few years has been the advent of cloud computing, first to the enterprise and now gradually to the plant. While the LNS IIoT platform shows Cloud as the main data block, in reality the world has evolved to "Cloud and Edge." When we examine where a company runs various types of analytics, we can determine its highest level architecture.

Finance is the most conservative department with little Cloud and predominantly corporate data center use. Most manufacturers we have spoken with find it fascinating that production leads the way into the Cloud. Where plant analytics is concerned little changes, but it's encouraging that 25% of companies have some analytics running on public Cloud.

Corporate Analytics: Location

	PRODUCTION	SUPPLY CHAIN	FINANCE	ENGINEERING	CORPORATE QUALITY	CUSTOMER RELATIONS
Public cloud	23%	12%	8%	9%	12%	13%
Private cloud	23%	32%	21%	22%	20%	24%
Corporate data center	40%	42%	56%	42%	45%	41%
Plant data center	14%	13%	11%	18%	15%	13%
Edge device / asset	5%	6%	5%	5%	12%	8%
None	6%	6%	6%	9%	7%	12%

Industrial Analytics: Location

	PRODUCTION	INVENTORY / LOGISTICS	MAINTENANCE	QUALITY
Public cloud	24%	15%	10%	13%
Private cloud	22%	30%	25%	22%
Corporate data center	38%	44%	48%	37%
Plant data center	28%	31%	32%	38%
Edge device / asset	8%	10%	8%	7%
None	4%	3%	4%	5%

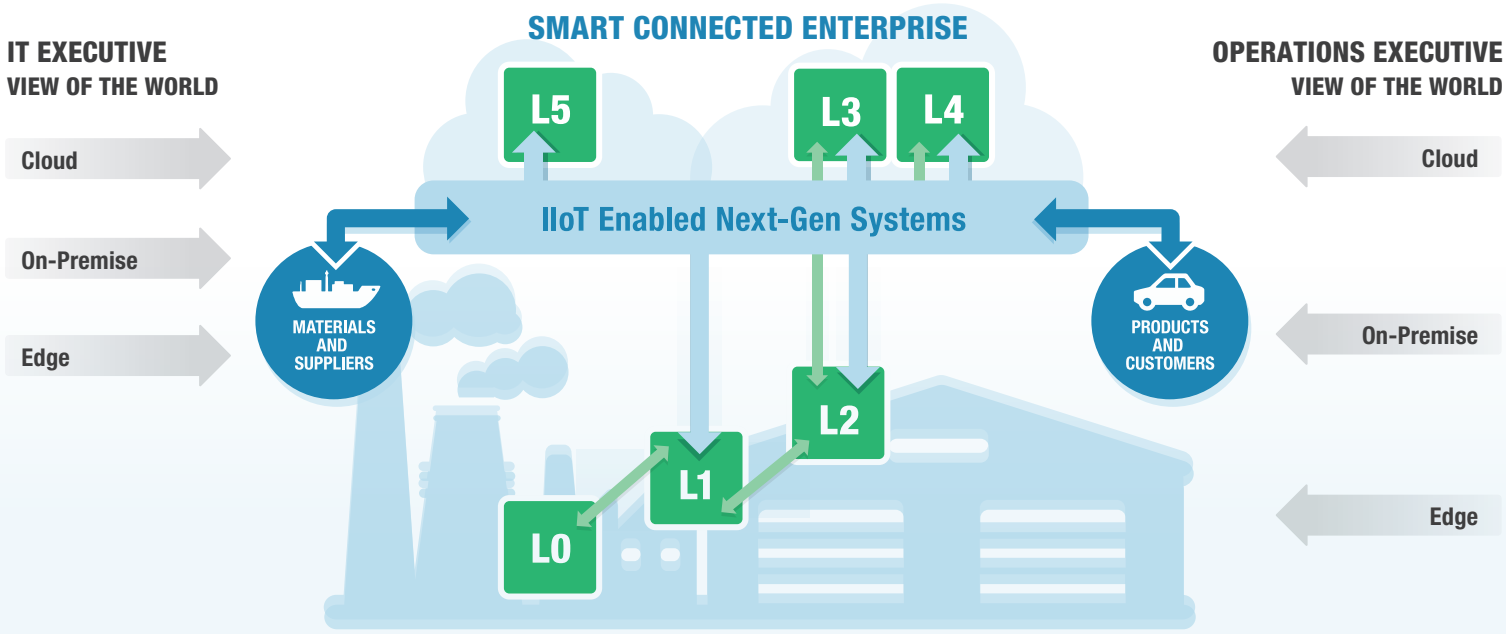
Cloud and Edge: What, Where, Why *(Cont.)*

It's hard to decide where to run what in an unchanging operational state but going through Digital Transformation makes life much more complex. As a company builds out a new Operational Architecture there are enterprise architecture changes required for Digital Transformation. Furthermore, the organization must make a series of data location choices. This is especially true to support analytics, but some infrastructure choice must happen early on. The company should consider a basic data architecture to make these choices. For many organizations, a new way of thinking about IIoT data management has undoubtedly helped. We now see the discussion moving away from "everything in the Cloud" to the much more flexible "from Cloud to Edge." Of course, it's important to remember that between Cloud and Edge there are other places where data can reside, but we can't discuss them until we first find the Edge!

Defining the Edge is difficult because it depends heavily on the company's initial viewpoint. A company that makes computers for corporate data centers will view computers and systems that sit in the plant as Edge systems. They would include systems like manufacturing operations management (MOM), data historians, SCADA, HMI, PLCs and so on. On the other hand, a pump manufacturer would perceive the pump's controllers as Edge systems and everything higher up the control hierarchy and beyond is "on-premise" or "I don't care."

Either of these perspectives is an excellent starting point to manage data placement if the architecture is to remain somewhat faithful to the ISA-95 standard that has served operational technology leaders and technologists well over the last few decades. In other words, everything that sits below the MOM layer (Level 3 in ISA-95) consider Edge, and MOM systems as on-premise, Cloud or wherever they happen to reside.

ROLE AFFECTS PERCEPTION OF EDGE



Data and Analytics Architecture in a Digital World

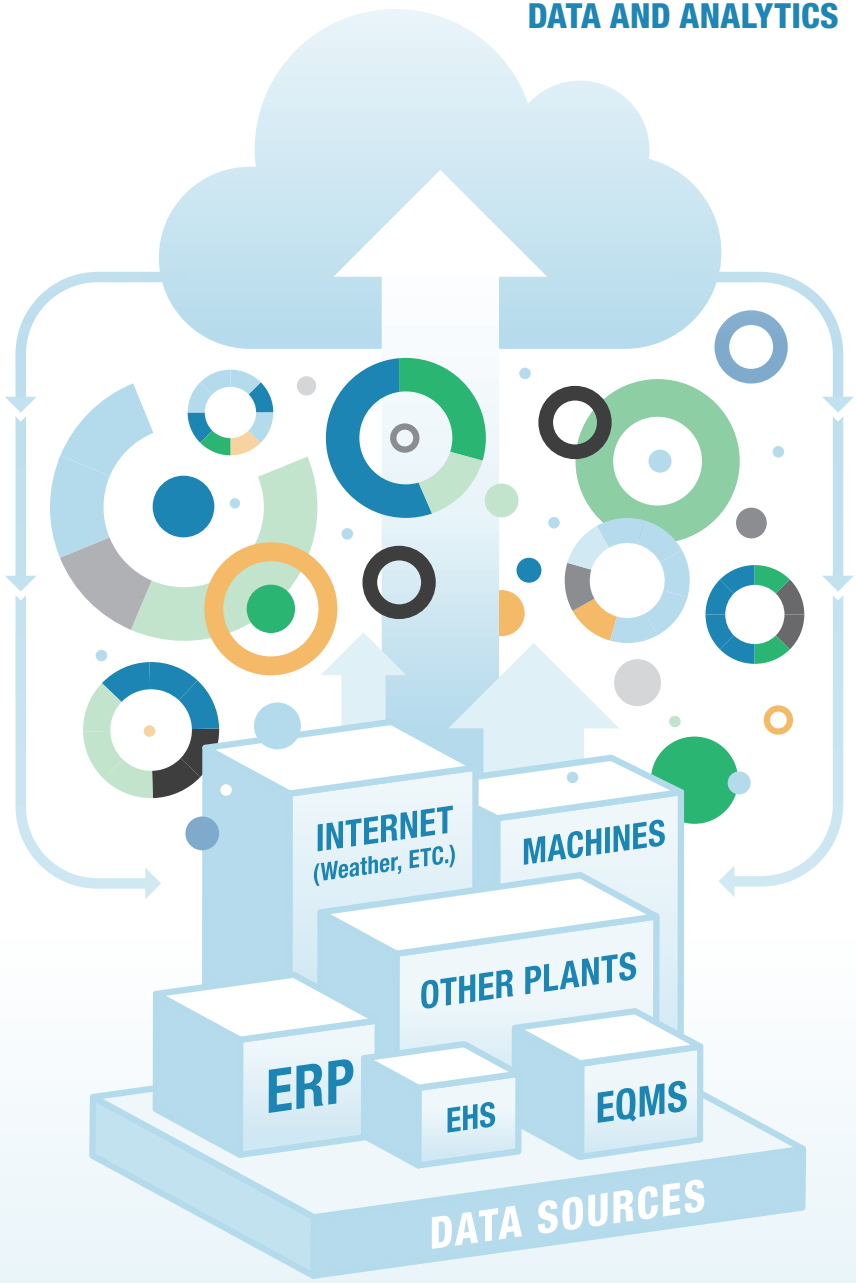
While Edge to Cloud is important for the highest level Operational Architecture, there is much more to be done than just deciding where data will sit. All data must be useful and accessible to applications that need it. Rather than a deep-dive on application and data architecture, let's explore just a few data requirements for analytics. This is simply a cursory view and any Digital Transformation program requires a detailed study of data architecture.

First consider how the company wants to use the data; for analytics several dimensions are important:

- **Data location:** Edge (device/asset), on-premise (plant data center, enterprise data center), Cloud
- **Data speed:** decision time and bandwidth constraints, streaming and protocols, historical (pointers or replicated)
- **Data type:** structured, semi-structured, unstructured
- **Analytics model:** statistical, first principles, artificial intelligence (AI), machine learning (ML)
- **Purpose:** display, long-term improvement, direct feedback to control system, improve people processes

TYPES OF DATA	SPEED AND QUALITY OF DATA	TYPES OF ANALYTICS
Structured	Fast	Descriptive
Semi-structured	Latent	Diagnostic
Unstructured	Precise	Predictive
	Ambiguous	Prescriptive
		Visualization

DIMENSIONS OF DATA AND ANALYTICS

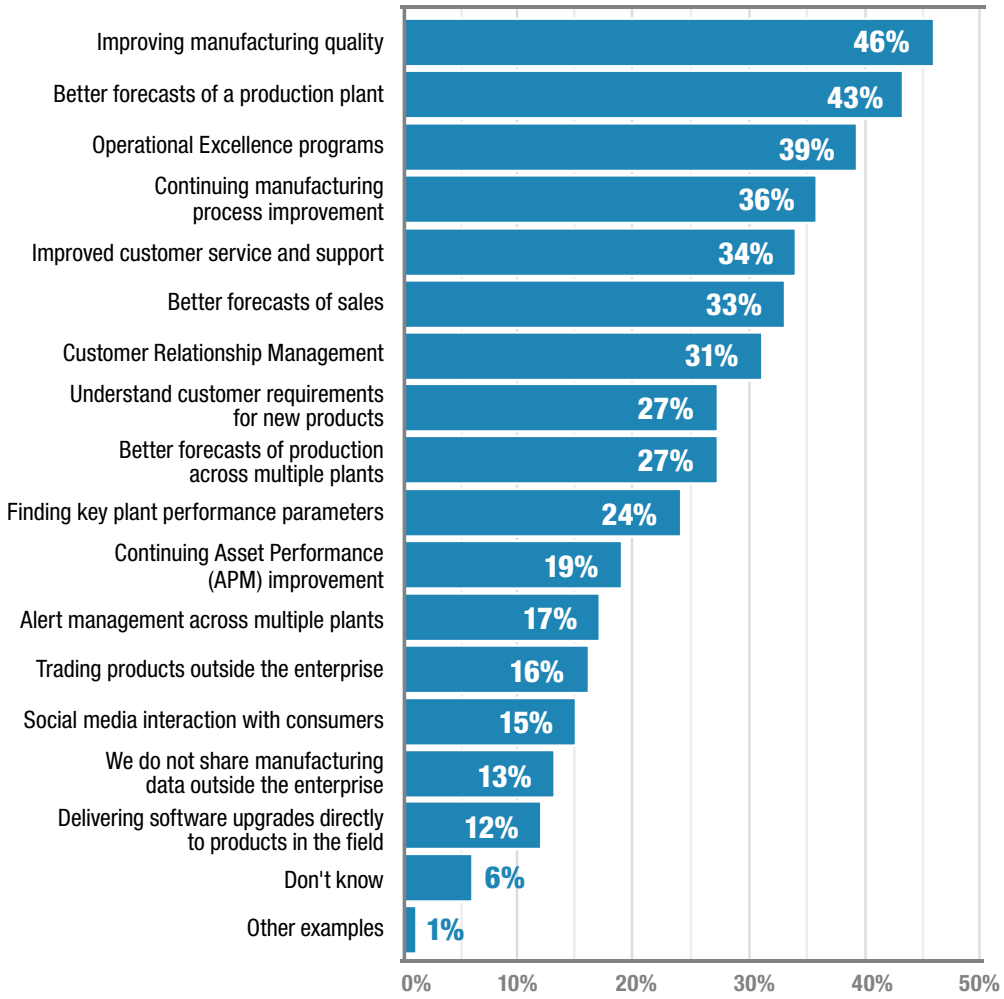


Data and Analytics Architecture in a Digital World *(Cont.)*

When we examine uses none specifically say "analytics," but many such as energy efficiency and asset reliability are the low hanging fruit in the industrial analytics industry. Most of the top IIoT use cases today aren't to provide instantaneous feedback to the plant or process. Indeed, when we discuss industrial use with analytics vendors, we rarely see feedback loops. Why? There is a strong fear of analytics applications setting automatic control. That's why we see a low uptake of prescriptive analytics. However, an industrial organization will only achieve real value when new analytics methods provide new insights on processes, then feed that information back into the process itself. Companies can use many applications with human intervention (such as planned maintenance improvements), but others can directly affect equipment, design information, product flow or production speed; the possibilities are endless.

Top IIoT Use Cases

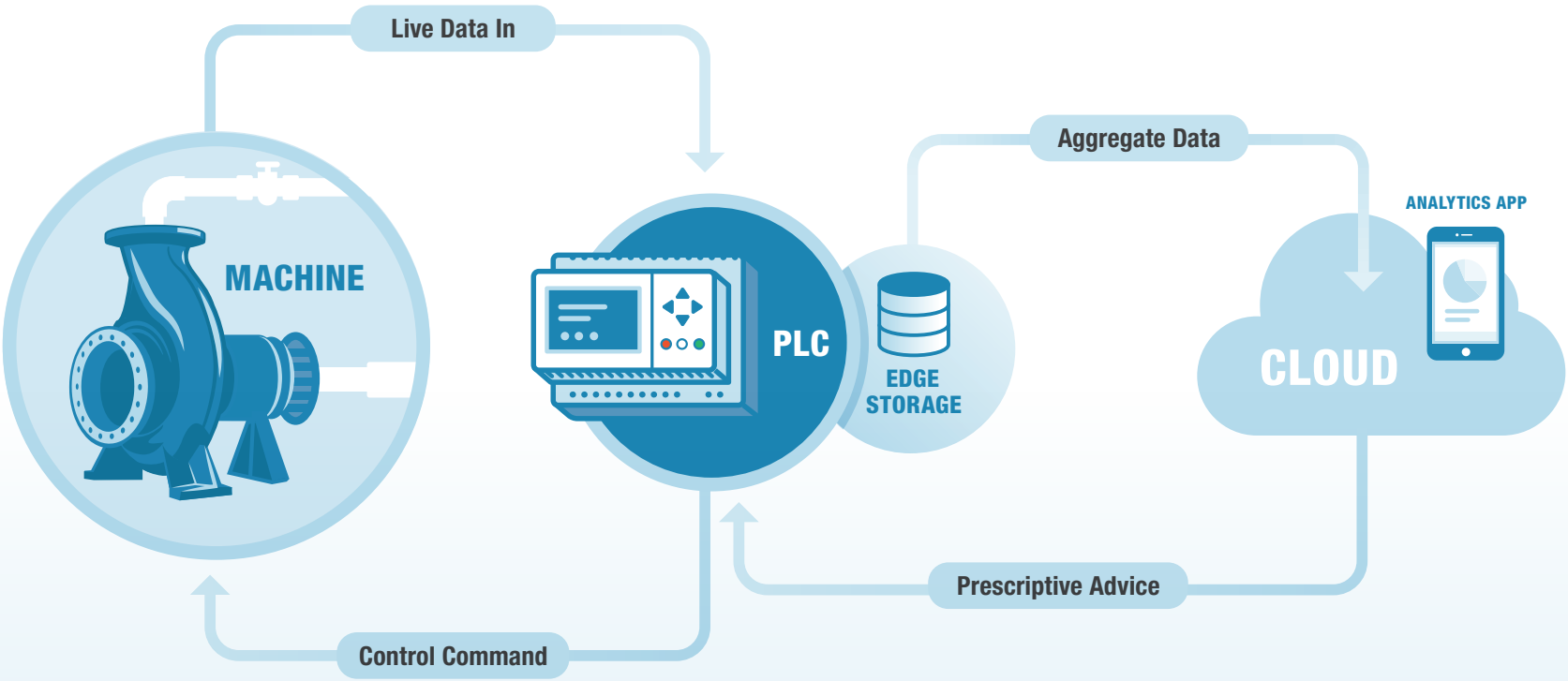
Analytics to Improve Business and Manufacturing Processes



Data and Analytics Architecture in a Digital World *(Cont.)*

As we move into more advanced fields such as Edge analytics and Big Data analytics in the Cloud, data abstraction and cleansing will become ever more important. Managing local analytics at the deep Edge (e.g., on a motor controller) and directly feeding the control system changes the dynamics of data. We often talk about the "four V's" of data – velocity, volume, variety, and veracity. In the deep Edge example, we want to be able to store fast and voluminous data locally for a short time while we conduct local analytics. Longer term decision making will take place at a higher level in the data stack (perhaps in MOM or in the Cloud) and require reduced velocity and volume through consolidation. Similarly, the longer-term feedback loops will not require much speed or volume, but they must deliver the necessary feedback to the system as designed.

EXTENDED PERSPECTIVE OF CONTROL



SECTION 3

Analytics With a Purpose: People

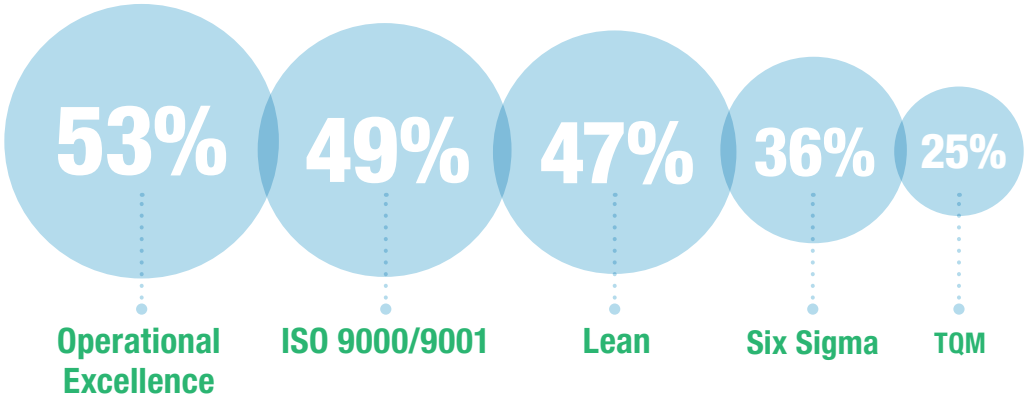
Analytics and People - Continuous Improvement

When talking analytics, data management and Digital Transformation, it's easy to forget about the role of people. To understand this, we examined the use of continuous improvement methods and how organizations apply digital tools to or with them.

When talking analytics, data management and Digital Transformation, IT'S EASY TO FORGET ABOUT THE ROLE OF PEOPLE.

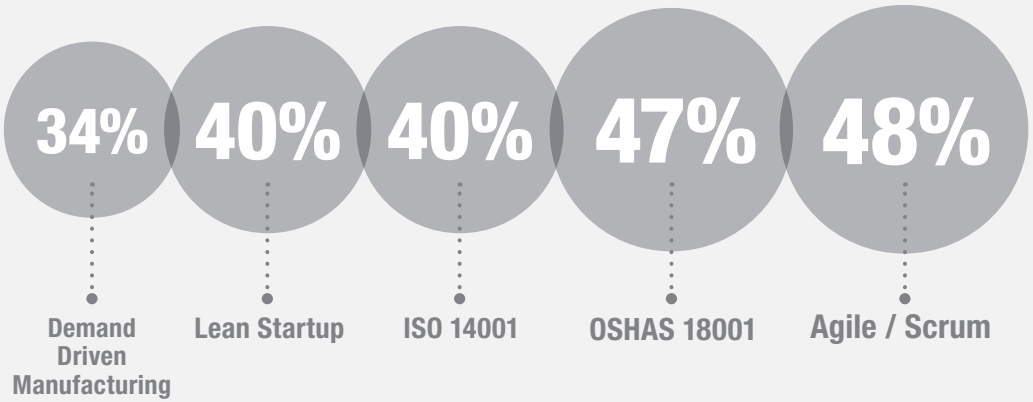
IT'S EITHER "IN AND DONE"...

Percentage of companies that are fully implemented:



... OR "WE DON'T CARE ABOUT IT."

Percentage of companies with no plans:

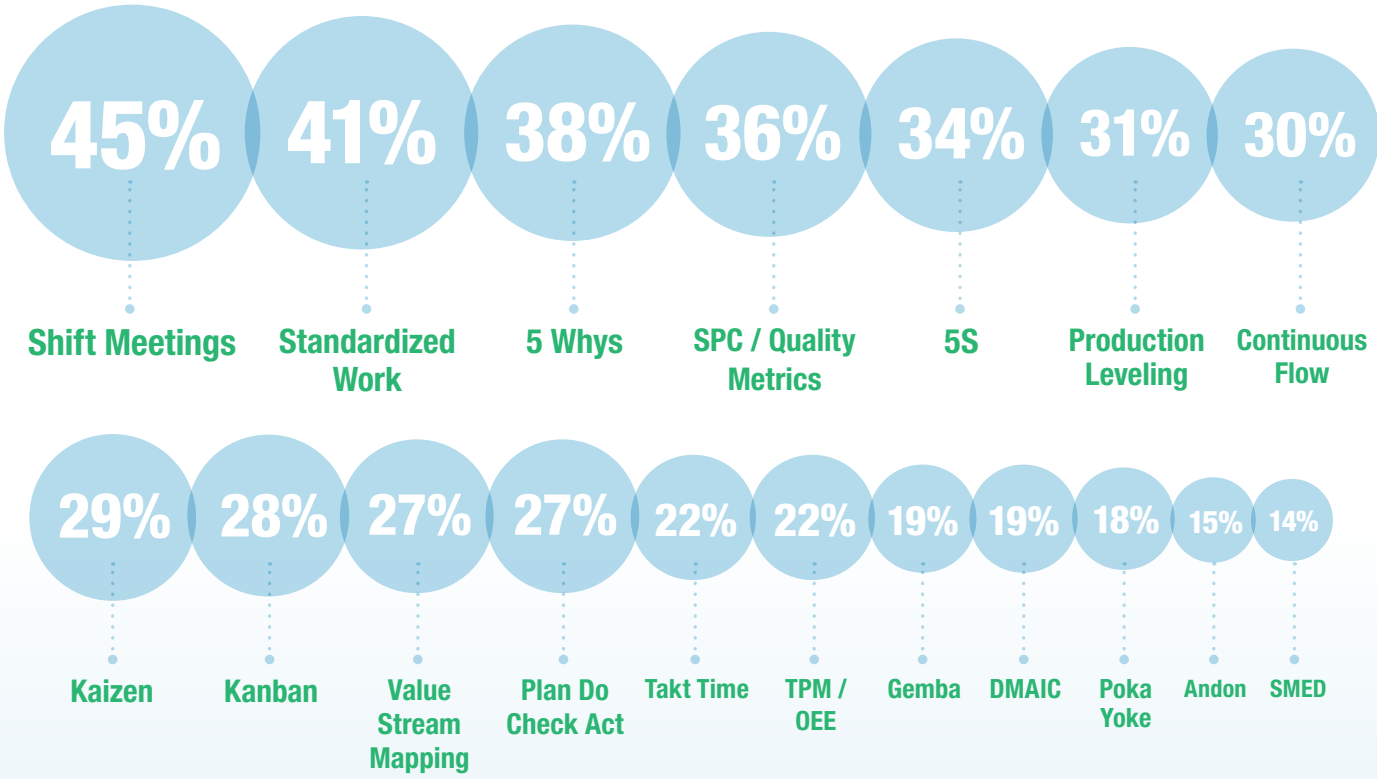


Analytics and People - Continuous Improvement *(Cont.)*

Lean and Six Sigma are very popular traditional methods for continuous improvement. Toyota started the trend, and many have followed the rigorous path these people-centric processes prescribe. Many have achieved truly continuous improvement to the point where incremental improvements are barely detectable, but that is no reason for letting go — the domino effect of these programs is dramatic across companies.

WE CARE ABOUT TRADITIONAL IMPROVEMENT METHODS...

Percentage of companies that are fully implemented:



Analytics and People - Continuous Improvement *(Cont.)*

There is tremendous resistance to change because of how successful these programs have been. Blackbelts and sensei's are highly valued and do, to an extent, maintain a level of self-aggrandizement that hinders change. Encouraging and accepting change is the very thing that has made these programs so successful, yet the leaders resist it. LNS published research on transforming Lean through digital processes, but that approach isn't always welcome. Many companies already have successful continuous improvement (CI) programs but few want to enhance them with digital tools.

Analytics and People - Continuous Improvement *(Cont.)*

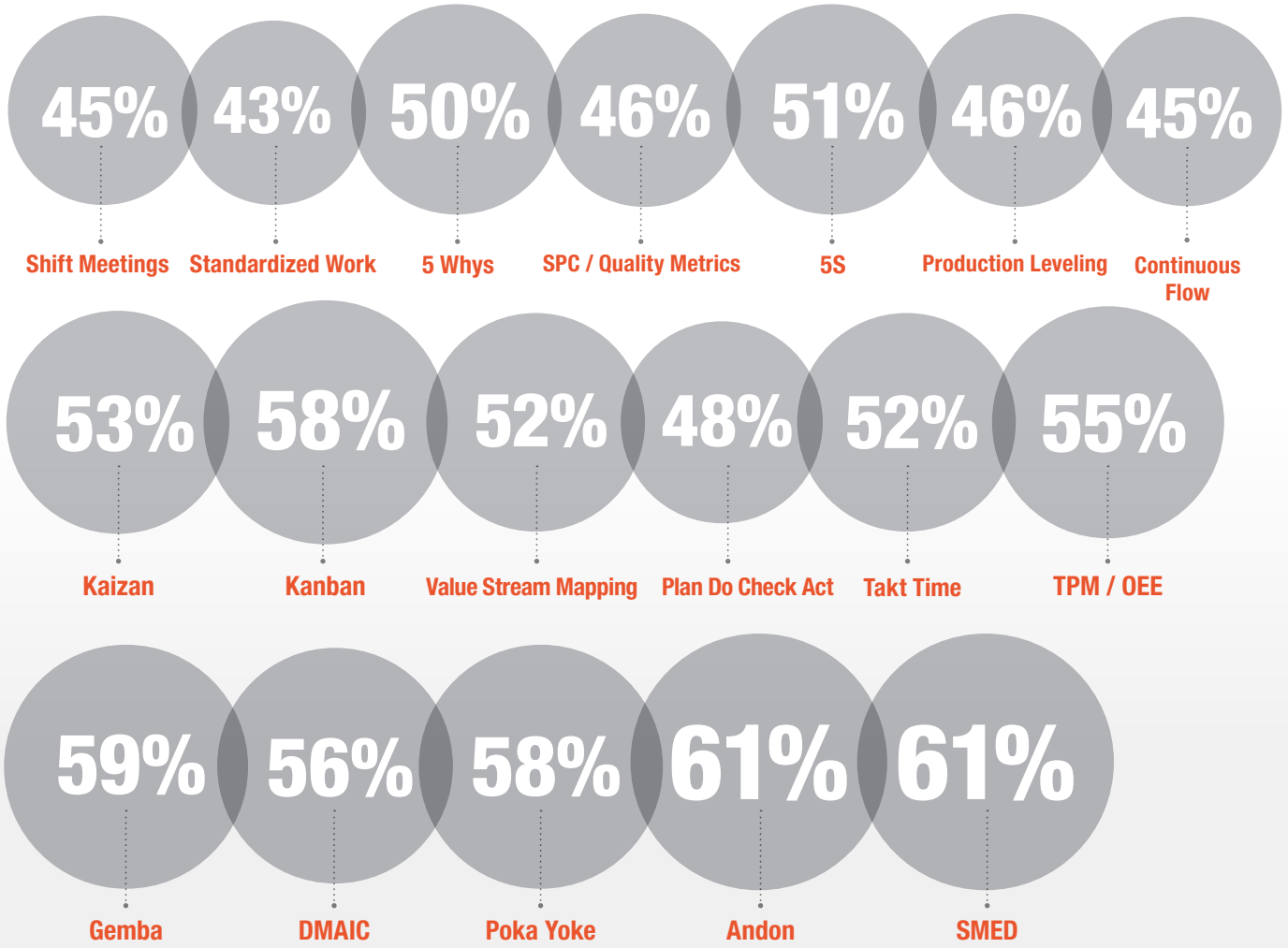
The research results reveal an interesting correlation between CI programs and digital tools; the effect is exactly the opposite of what typical CI leaders believe. In fact, we discovered two closely related correlations about those who digitally transformed their continuous improvement programs compared to traditionalists.

Those that digitally transformed CI are much more likely to be:

- Using advanced analytics such as predictive and prescriptive
- Running analytics in the Cloud and at the Edge

...BUT WE DON'T WANT TO DO IT DIGITALLY.

Percentage of companies with NO PLANS to implement digital tools:



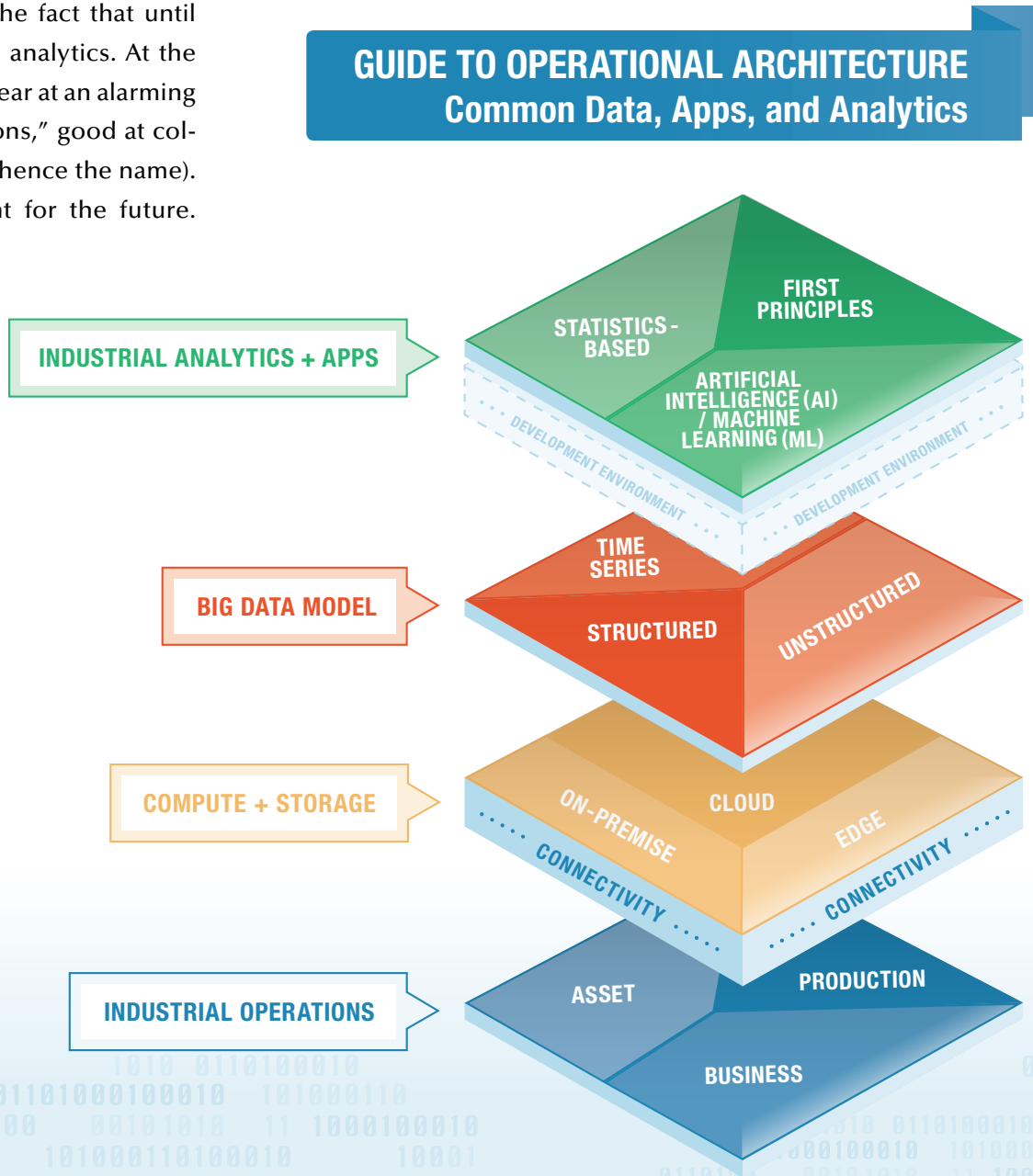
SECTION 4

Recommendations for Analytics and Digital Transformation

Start at the Beginning: Architecture and Edge

Companies have been very successful with the LNS Research Digital Transformation framework to-date, despite the fact that until now it didn't adequately provide for metrics and analytics. At the same time, new analytics vendors continue to appear at an alarming rate. Most are what we used to call "point solutions," good at collecting data from existing sources and analyzing (hence the name). We shoehorned them in without much thought for the future.

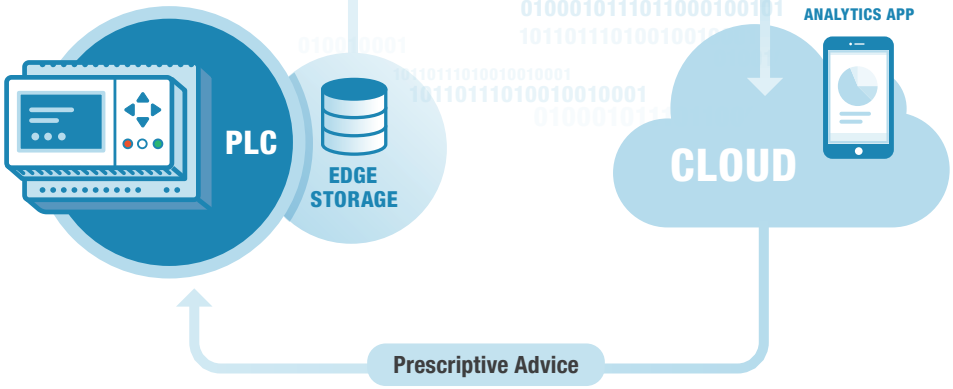
The new LNS Research take on Operational Architecture based on the IIoT platform views analytics in the same context as all other applications. It also supports the concept of Cloud to Edge without implying any difference between them. The definition of Edge leans towards a hardware-centric view of the enterprise – any system that is below a plant data center (or corporate one if no plant data center exists) is considered part of the Edge. That's not a hard and fast rule, but excellent guidance to further the discussion about Operational Architecture with distributed applications.



Start at the Beginning: Architecture and Edge *(Cont.)*

The main point is that we don't differentiate between analytics running at the Edge from those running in the Cloud. Operational Architecture is primarily software-based, and applications and analytics can run anywhere in the corporate architecture that makes sense. This approach means you can build the Operational Architecture without concern for hardware limitations. As an example, a company could decide to provide sufficient processing power in a PLC to run local analytics; that might be cost-effective and fit with the analytics goals, but it doesn't preclude it from running analytics elsewhere as long as there is a logical connection to the architecture without being tied to hardware.

If a company wants to change its world with analytics, it must embrace all stages of Digital Transformation.



STRATEGIC OBJECTIVES AND OPERATIONAL EXCELLENCE

IT'S TEMPTING FOR "operations people" to skip the first two stages of the Digital Transformation framework; doing so makes it difficult to set the right path. Aligning with Strategic Objectives is a fundamental requirement for any enterprise that wants to succeed. When top management sets the direction and translates it into near-term and long-term goals, it sets the stage to drive success with Digital Transformation. They don't simply say, "let's go digital." To the contrary, enterprise leadership is setting transformation goals and demonstrating genuine commitment to industrial transformation.

Commitment must extend to more than just the C-suite: anyone and everyone that's involved in making the company better in any way must buy-in to the journey. Operational Excellence, the focus of continuous improvement for technology, processes, and people (employees and customers), is a critical part of the Digital Transformation journey. Certainly, digitalizing continuous improvement programs can help accelerate improvements from Digital Transformation, and we offer a special word to and about continuous improvement (CI) leaders. Those who lead CI are usually deeply committed to manual processes; these experts must be on-board as key enablers for digital CI, and hence Digital Transformation.

Operational Architecture: Common Data, Apps, and Analytics

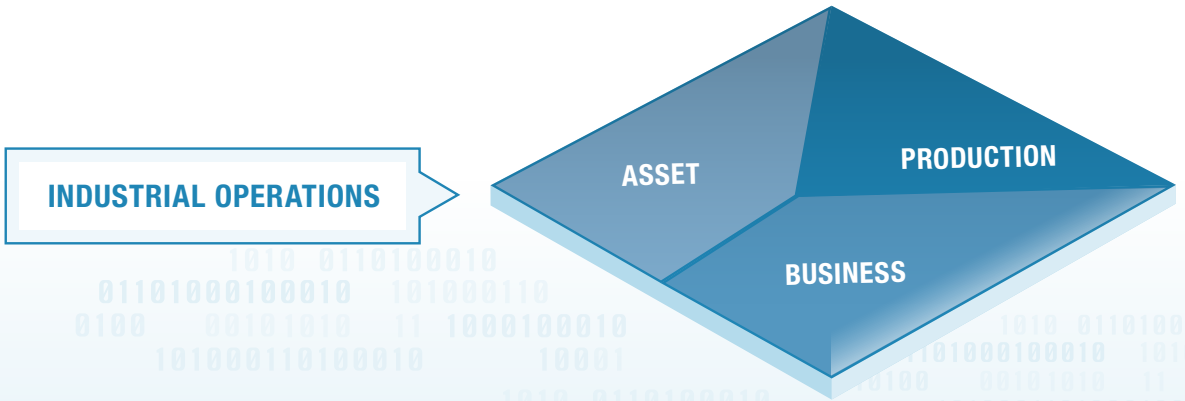
The world of Digital Transformation has moved rapidly in the last two years. Many more LNS Research program members are putting teams in place to look at what Digital Transformation means to their business and what they should do about it. Many quickly realize that they a have a lot of work to do across the enterprise to take advantage of analytics' potential. Although every company starts from a different level of capabilities maturity, it is quite clear that a key element of Digital Transformation is an Operational Architecture that unites and aligns the key components of a digital enterprise.

For that very reason, LNS Research includes Operational Architecture in its Digital Transformation framework (discussed earlier in this ebook). At this juncture, we introduce a guide to Operational Architecture for manufacturers considering the journey. While the final Operational Architecture for every manufacturer is quite distinct, the components and intersections described here are a great starting point to fuel the internal enterprise dialogue for all. In future research we will examine each element in greater detail; for now we offer a brief introduction.

INDUSTRIAL OPERATIONS

Industrial operations is what manufacturing is all about — the actual equipment, processes and people that add value to the business. Quite simply, operations improvement is the main objective of Digital Transformation, including:

- **Improving asset performance** through better maintenance and planning;
- **Increasing production throughput**;
- **Increasing first pass yield**;
- **Faster feedback** and insight to personnel;
- **More and more accurate information** to the business; and
- **Delivering high-quality data** to the digital systems such as analytics.



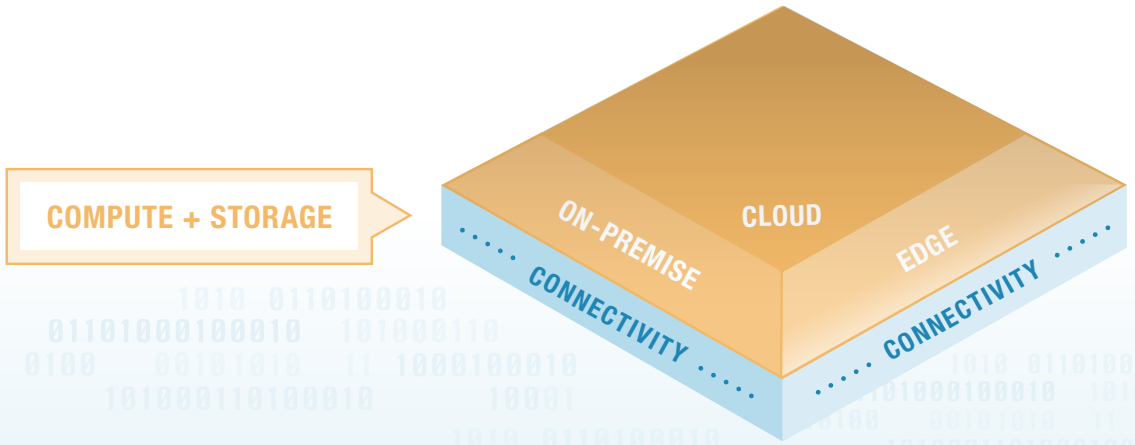
Operational Architecture: Common Data, Apps, and Analytics *(Cont.)*

COMPUTE AND STORAGE

Many manufacturers have production and business processes that produce enormous amounts of data. Most of the time, the vast majority of that data isn't used for profit. Traditionally, the only data collected from, and sent to equipment is for control purposes; the digital world requires much more. Connectivity will be enabled through smart devices with IP (Ethernet) capability, and more performance data will be stored. Additionally, the whole world outside the plant will become a source of data, and a place to which data needs to be sent.

To achieve capability maturity with Big Data the Operational Architecture must support data everywhere in the enterprise and beyond. Some of that data needs to be close to the process, while some should reside in the Cloud and accessible globally. In designing the data and connectivity architecture, the enterprise should consider current and future needs. For general perspective and discussion, we define three layers of data: Cloud, on-premise, and Edge. Cloud could be split between public and private, on-premise could be split multiple ways (for example by site or in enterprise and plant levels), and Edge should be defined according to the manufacturer's needs. Often Edge will be a plant-level data and compute server, but some companies will want to define Edge as close to control equipment. Future research on the topic will refine the definition and details of the storage architecture.

In addition to data, the hardware computing architecture must match execution requirements. There's no point in having lots of storage yet insufficient power to run sophisticated analytics and other applications. Indeed, access to public Cloud computing power can be quite beneficial for things like simulation which usually requires enormous numbers of computer cores to deliver sufficiently fast simulation.



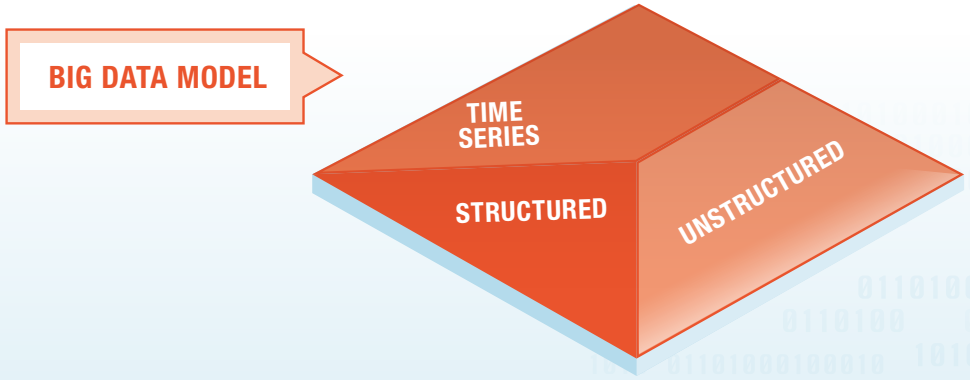
Operational Architecture: Common Data, Apps, and Analytics *(Cont.)*

BIG DATA MODEL

Once the organization provides for "compute and storage" capabilities, it can move on to delivery of capabilities. The Big Data model must be able to handle all types of data used in a digital enterprise. We categorize data three ways:

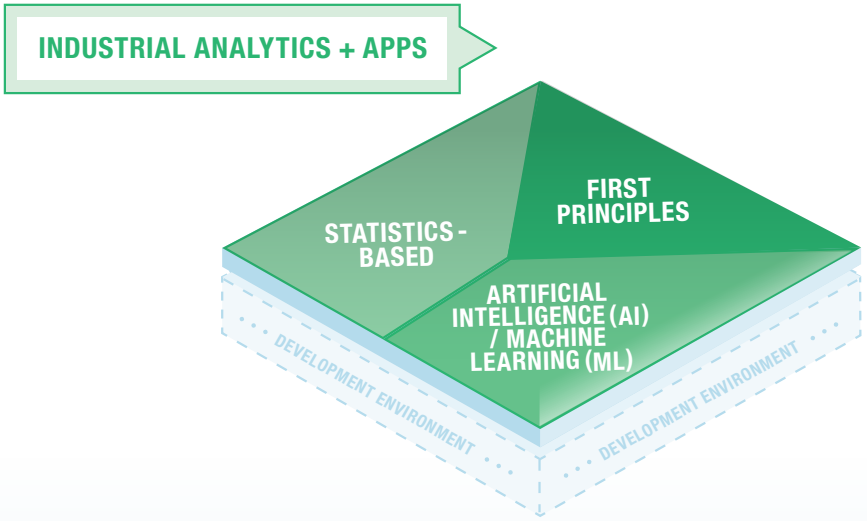
- **Structured**, which comes from traditional databases and equipment;
- **Time series**, which is very specific to manufacturing and includes continuously changing and event-based data in speciality databases (often data historians); and
- **Unstructured data**, such as video, weather and all sorts of information that has not typically been used in manufacturing but will enhance analytics and application development as Digital Transformation continues into the future.

As companies continue to define their Operational Architecture in greater detail, it will be interesting to see how they use new types of data in the different levels of the storage hierarchy. For example, using augmented reality (AR) / virtual reality (AR) in the plant is already becoming a reality, but the infrastructure to handle it efficiently still needs work.



INDUSTRIAL ANALYTICS AND APPS

Finally, at the summit of the Operational Architecture is where new things get done. In this ebook, we have examined how manufacturers can benefit from analytics, and now we define what they must do to design a hardware and software architecture to support the promise of analytics. Many types of analytics run on multiple levels of the Operational Architecture. We see a variety of technologies like those shown here, plus it supports the levels of analytic sophistication from diagnostic (simply looking at what is happening), to prescriptive (controlling the process and business), and most importantly, supporting the people who run the business from top to bottom (or operator to CEO).



Recommendations

We keep saying it and have no intention of stopping — Digital Transformation is a "must" for industrial organizations to survive and succeed today and into the future. Analytics capabilities are growing quickly, and the number of vendors selling IIoT platforms and the apps and analytics to go with them is rapidly accelerating. One clear outcome of our analytics that matter study is that there are gains to be had just by using analytics. Applying analytics within a digital framework means the benefits will continue to multiply.

Manufacturers that want to take a deeper dive and compare their own capabilities should contact LNS Research. Each organization's specific capabilities and objectives lend a unique perspective to the research. Doing nothing now will in most cases leave the manufacturer behind the competition. Take the following steps to do more than just stay in the game:

1. **Set ambitious objectives for the company**, or for a division of a large company; it is not necessary to jump in with both feet, but you do have to get your feet wet.

2. **Choose a Digital Transformation team**, headed by a top operational executive and sponsored by the C-suite or board.

3. **Ensure that CI and Operational Excellence is well represented**; this isn't an exercise to replace Operational Excellence with Digital Transformation. Aligning these major transformational processes is how companies will achieve the fastest gains.

4. **Try an IIoT platform — don't commit, but do try**. Focus on applications and analytics that drive true improvements in plant processes. This is an opportunity to test the connectivity and ensure that plant-level data is available.

5. **Plan for the long-term**; for example, set a goal to achieve specific targets by the start of the next fiscal year, or by the next annual general meeting, and for a digital enterprise that delivers long-term strategic value within the next three to five years.

ANALYTICS REALLY DO MATTER

Driving Digital Transformation and the Smart Manufacturing Enterprise

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