

2016  
EDITION

# MANUFACTURING METRICS IN AN IoT WORLD

## Measuring the Progress of the Industrial Internet of Things



**MESA**  
INTERNATIONAL

MANUFACTURING  
ENTERPRISE  
SOLUTIONS  
ASSOCIATION  
MESA.ORG



2016 EDITION

# MANUFACTURING METRICS IN AN IoT WORLD

## Measuring the Progress of the Industrial Internet of Things

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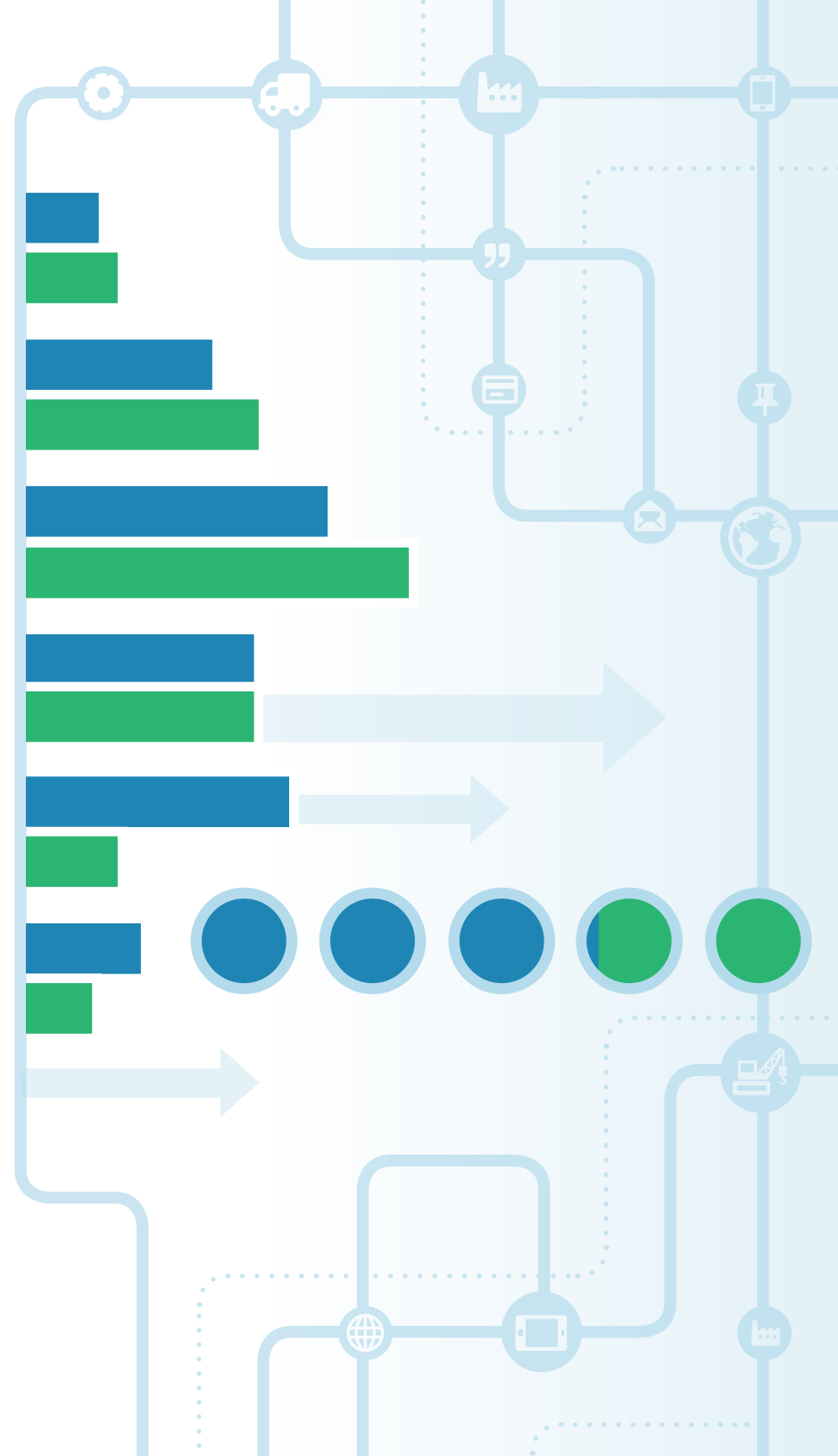
# Introduction

## Research Objectives & Overview

Welcome to the 2016 edition of the MESA International and LNS Research survey on Metrics that Matter in the manufacturing world.

Manufacturing is changing. The traditional view of manufacturing plants as islands of automation, expertise, and control no longer stands up in an ever more connected world. With that, manufacturing is becoming of much more interest to executives and Information Technology staff than was typical in the past. This has led to a substantial change in the demographics of people that LNS Research attracts to its surveys and the general interest in plant technology in manufacturing companies. This has undoubtedly been accelerated by interest in the Internet of Things (IoT) and, in particular, the *Industrial* Internet of Things (IIoT). This year's survey reflects that change by focusing more on the "soft" metrics that define how businesses are changing rather than on those that are purely numerical, financial, and operational.

This eBook will examine in detail some of the key findings of the Metrics that Matter survey. The starting point is the demographics as it is vital to understand from whom results are being collected to clearly see how the manufacturing landscape is changing due to the advent of the IIoT. This eBook will demonstrate how Manufacturing Operations Management (MOM) is still at the center of data collection, information handling, and operations management in most enterprises. The impact that IT trends are having on the MOM space will be investigated, and suggestions will be given as to where things will go in the coming years.



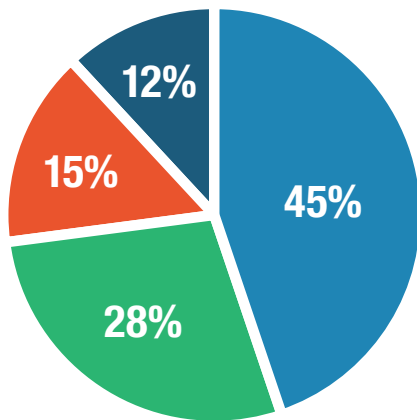
## SECTION 1

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# Demographics: Changing People

## Demographics: Changing People

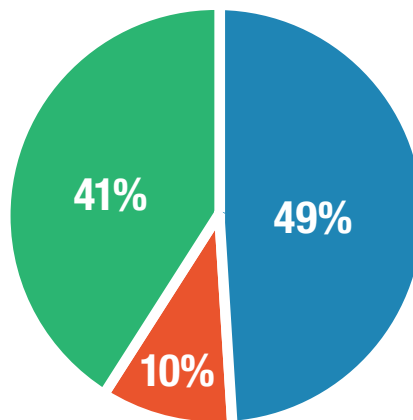
Looking at the standard demographics data for the Metrics that Matter survey, there were few surprises; they hardly warranted a second glance. They are very similar to the LNS Research demographic responses from 4,000+ respondents over the last two to three years. It was only later in the study of the survey responses that one or two unexpected results arose that prompted a deeper look at who, from where, and from what role, took the survey. One of these results was the answer to the question, “Which manufacturing software does your company currently possess?” Fifty-nine percent did not know.



**2016 Metrics That Matter Survey  
GEOGRAPHY**

COLOR BY HQ LOCATION

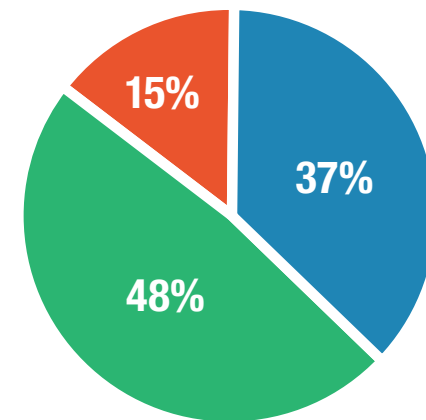
- North America
- Europe
- Asia/Pacific
- Rest of World



**2016 Metrics That Matter Survey  
REVENUE**

COLOR BY COMPANY REVENUE

- Small: Less than \$250 Million
- Medium: \$250 Million - \$1 Billion
- Large: More than \$1 Billion



**2016 Metrics That Matter Survey  
INDUSTRY**

COLOR BY INDUSTRY

- Process Manufacturing
- Discrete Manufacturing
- Batch Manufacturing

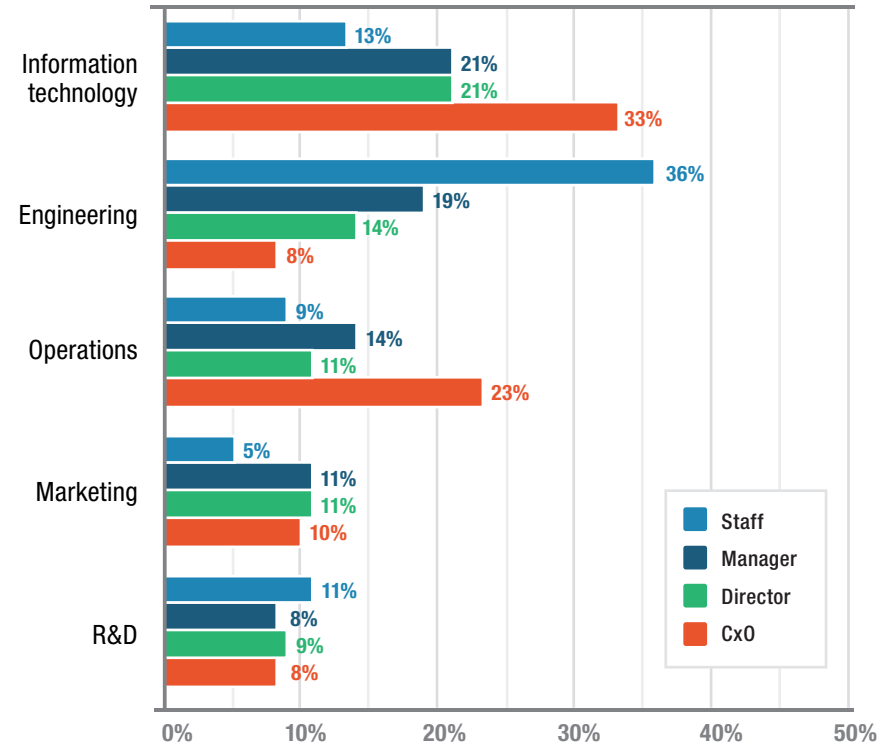
## Demographics: Changing People (Cont.)

This led to a deeper look at the demographics in a bit more from “people” to “detail” and when we studied the numbers, there were two things that stood out—more managers and above took the survey than was typical in the past and the roles of engineering and operations people have declined. Of course, this does not mean that the demography is unrepresentative, rather that LNS Research and MESA are addressing an audience that has become much more diverse than in the past.

Looking at the chart on the right, we see a clear pattern that readers should take into account throughout their consideration of the results: respondents are biased towards management in IT and operations while staff dominate in engineering roles. Looking back at the 59%, perhaps engineers and managers do not have detailed information about the specific applications running inside a plant.

In studying other demographic correlations, there was little out of the ordinary except one very clear trend: In North America the proportion of respondents with R&D roles was much lower than in the rest of the world. For example, only 21% out of a 44% of the total of North American respondents are R&D while 41% of European respondents were R&D out of a total of 30%. This is interesting but probably not significant.

Who took the survey



**Respondents are biased towards management in IT and operations while staff dominate in engineering roles**

## SECTION 2

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# The Industrial Internet of Things: Metrics that Really Matter



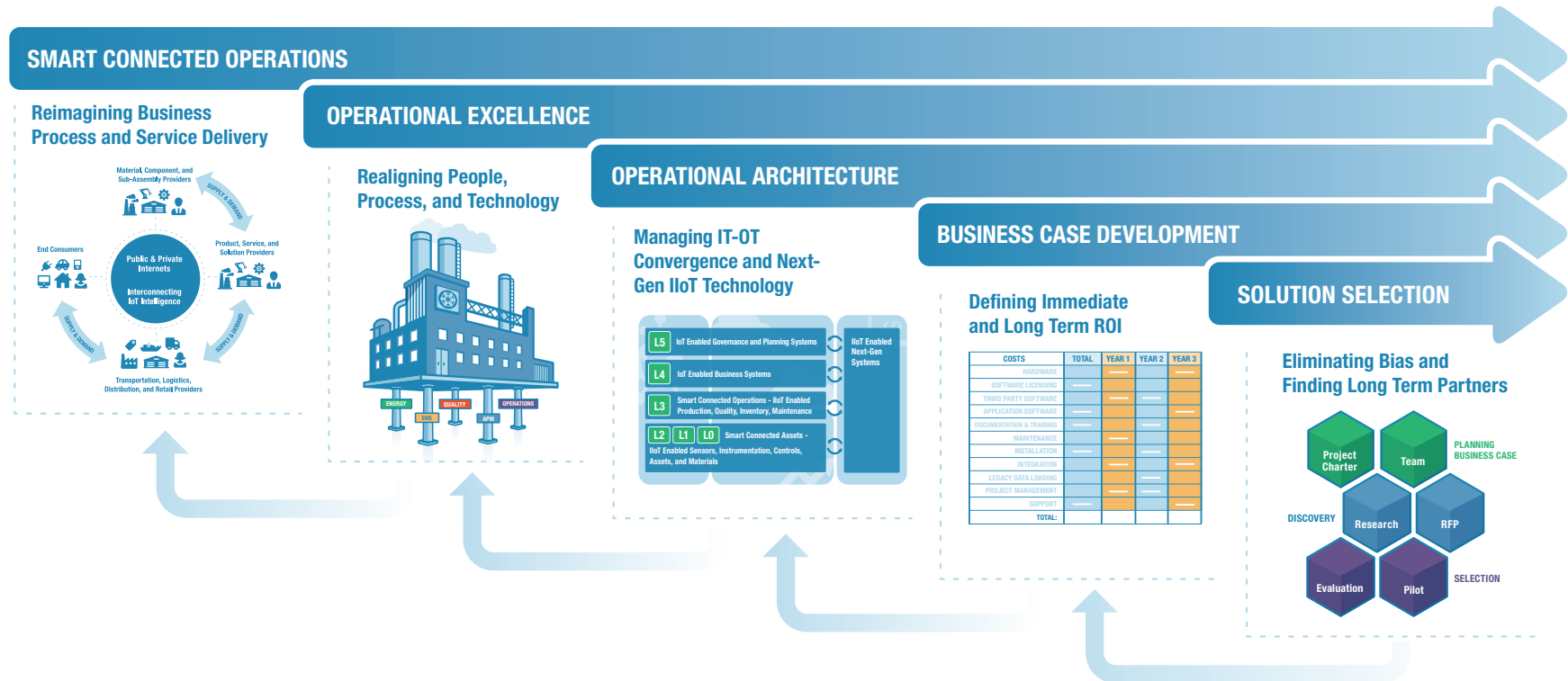
# Metrics that Really Matter

The IoT is the most hyped technology of today. However, the IIoT is rapidly becoming real and relevant to many manufacturers. As seen in the LNS Research Digital Transformation Framework, the move from an old manufacturing technology landscape to an IIoT-driven business is a journey of multiple steps, some of which will help to build infrastructure while others ensure that the journey is well organized and executed as software solutions and intelligent hardware are implemented to deliver the benefits the IIoT promises. LNS

Research is publishing much on the Digital Transformation and will not use this eBook to dive into the details. Rather, this report looks at the metrics affecting the uptake and uses of IIoT technology in manufacturing companies.

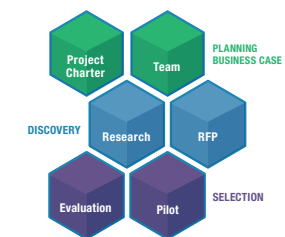
LNS Research has been carrying out surveys of manufacturing companies for over three years. Having closed out all of our surveys last year, we can now compare the state of play over the last few years with an up-to-date set of surveys, all taken in 2016.

## DIGITAL TRANSFORMATION FRAMEWORK



**Defining Immediate and Long Term ROI**

COSTS	TOTAL	YEAR 1	YEAR 2	YEAR 3
HARDWARE				
SOFTWARE LICENSING				
THIRD PARTY SOFTWARE				
APPLICATIONS SOFTWARE				
IMPLEMENTATION & TRAINING				
MAINTENANCE				
INSTALLATION				
INTEGRATION				
LEGACY DATA LOADING				
PROJECT MANAGEMENT				
SUPPORT				
<b>TOTAL:</b>				



## Metrics that Really Matter (Cont.)

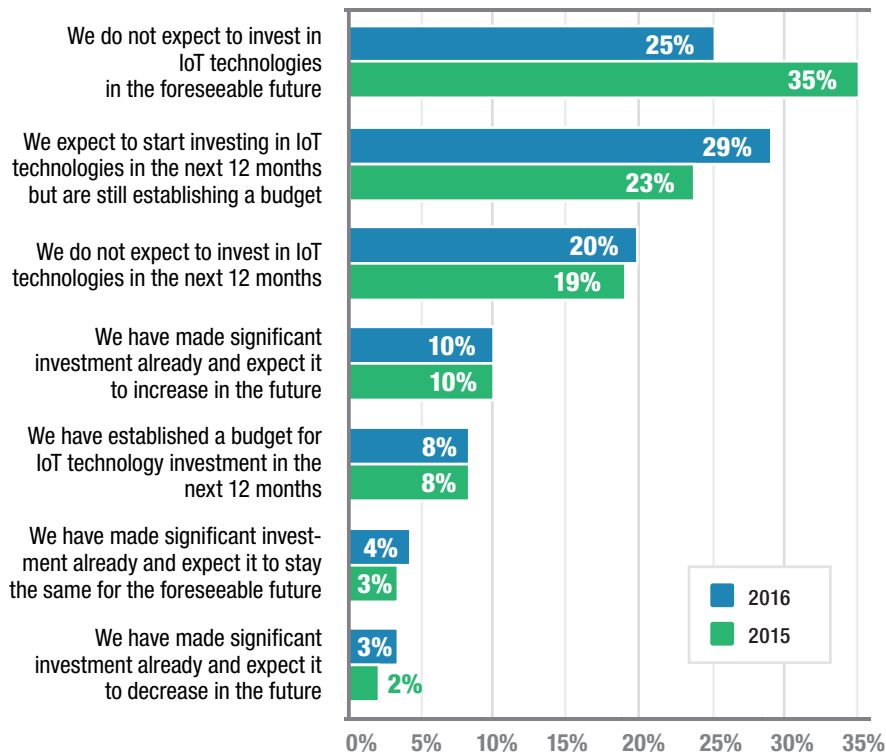
The first question on IIoT was, “Please indicate how the IoT is impacting your business today” with some very positive results showing dramatic improvement in IoT awareness. Although the number of companies that have already seen significant impact is still very small, trends are in the right direction and, similarly, the number of manufacturers who are being driven by their customers to investigate the IoT is also rising.

Looking at actual plans for deployment of IoT technologies the trend is still encouraging if not quite so dramatic. The number of companies intending to do something in IoT in the next 12 months is, for the first time, above half. The most encouraging sign is that

the number of laggards who expect to do nothing in the foreseeable future is trending down fast.

Slicing by company size reveals other trends that need to be addressed by mid-size manufacturing companies. Only 46% of companies with revenue between \$250 million and \$1 billion intend to invest in the next 12 months. This difference does not exist in the 2015 survey results where all company sizes trended similarly.

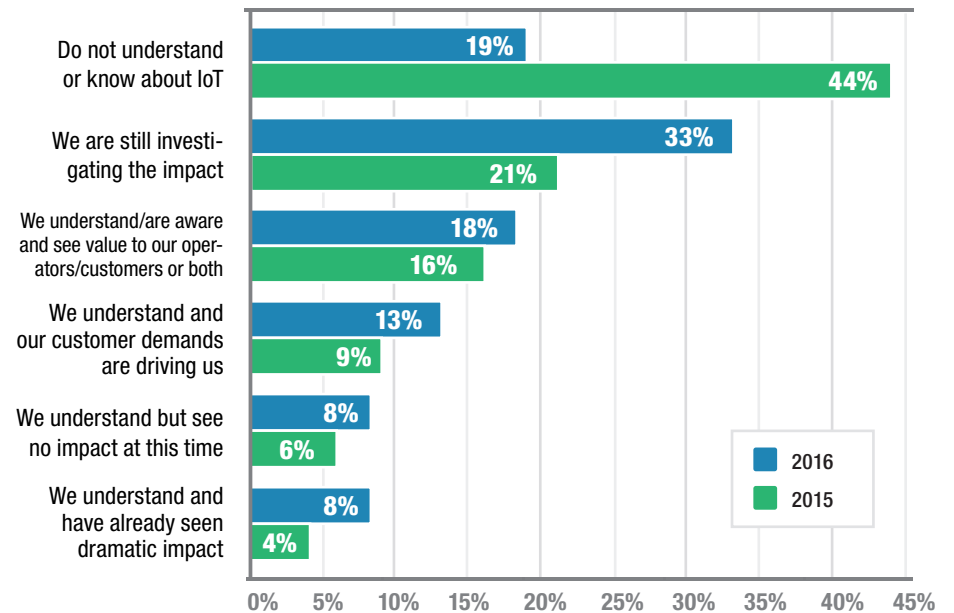
### Deployment



### Do not understand IoT:



### Please indicate how the IoT is impacting your business today



## SECTION 3

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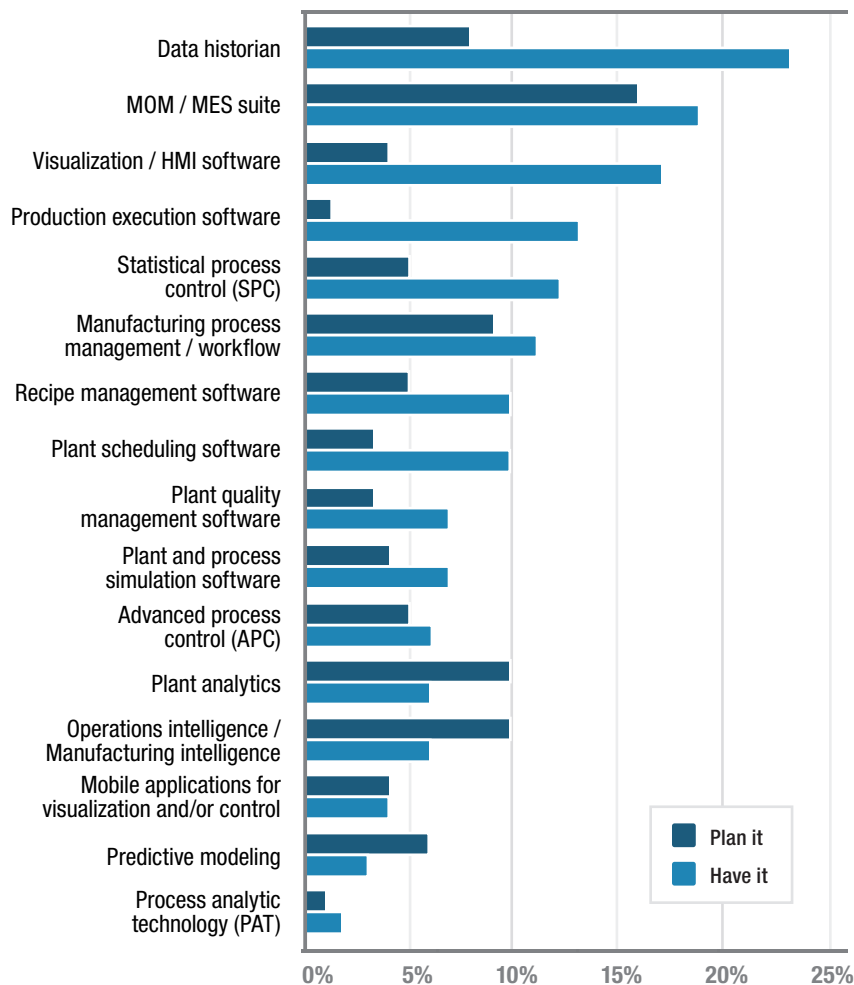


# Manufacturing Software in Use

# Manufacturing Software in Use

Before looking in a little more depth about MOM deployment, this chart gives a brief view at what has been implemented in manufacturing software. Here we see an overview of current and planned manufacturing software implementations, and it is clear that things are changing. While MOM remains a popular choice

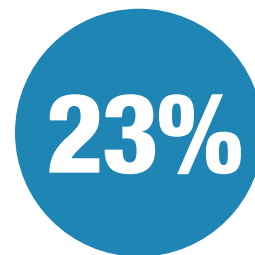
## Actual and planned software implementation



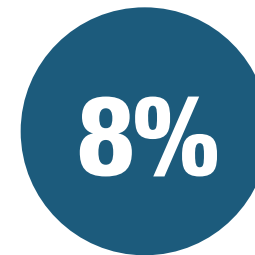
for manufacturing software, the previous dominance of data historians is not going to continue. Other lower level software such as SCADA and production execution software are rather mature and, when manufacturers are looking at their future manufacturing software architectures, they are tending towards integration and not point solutions. Three areas that are on the increase are predictive modeling, plant analytics, and manufacturing intelligence. Indeed, all those categories where more plan it than have it are focused on metrics and analytics. These are good signs that manufacturers are starting to look beyond the plant and consider advanced analytics technologies. We will take a closer look at analytics later in the eBook.

Another category that stands out is MOM/MES; it has the highest planned adoption rate of any category, but will adoption be real? Adoption rates have been hovering around 20% for years.

### Data Historians:



23% have it

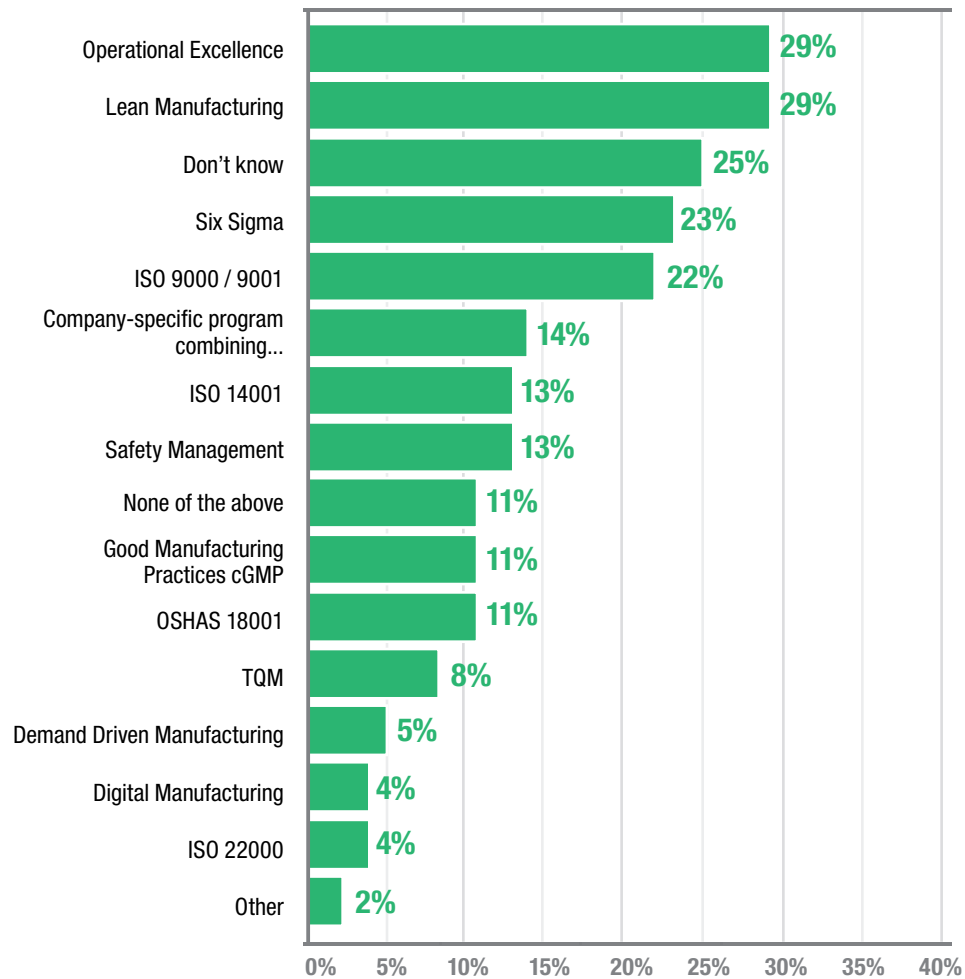


only 8% plan for it

## Manufacturing Software in Use (Cont.)

LNS also looked at improvement programs implemented or planned. A simple takeaway is that standards are popular and managed improvement programs, such as Operational Excellence, are even more popular. This is a good thing.

### Actual and planned software implementation



## SECTION 4

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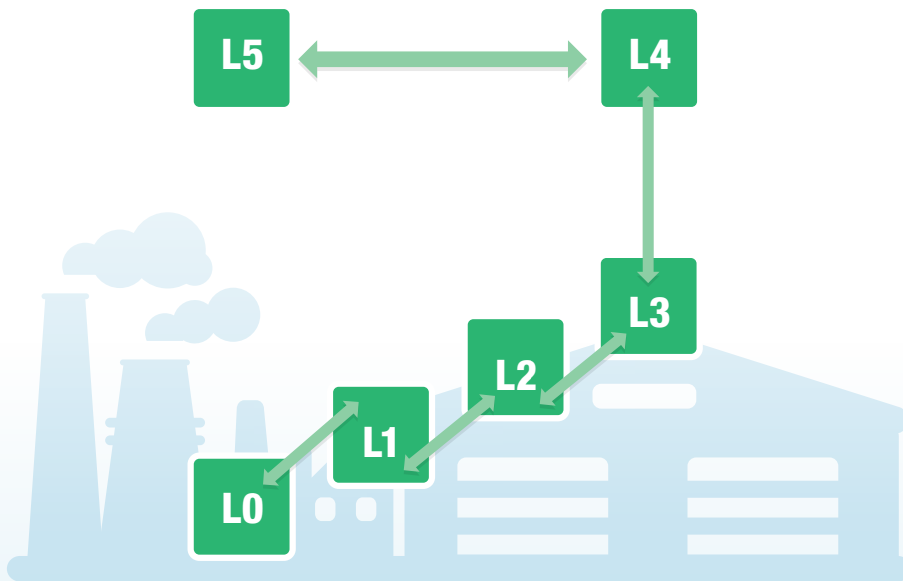
# What Is Happening in MOM?

# What Is Happening in MOM?

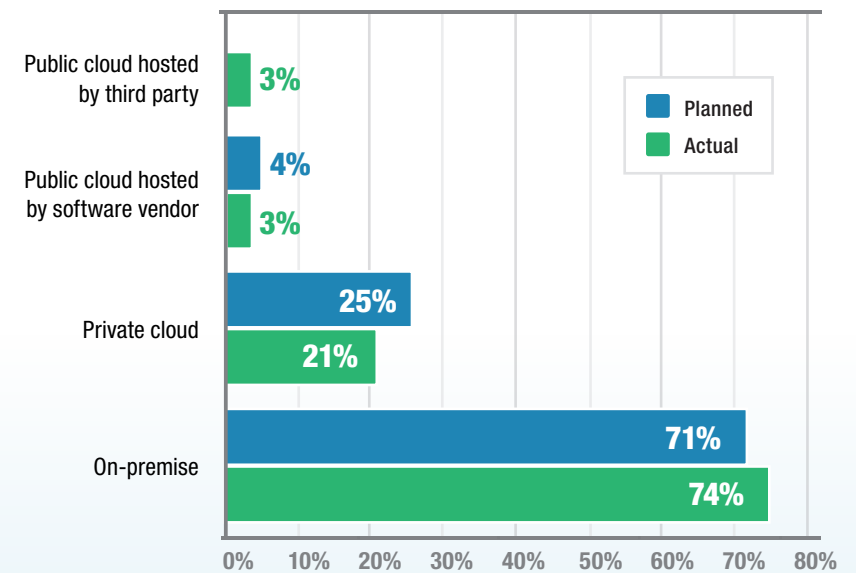
As almost everyone who has worked in the field over the last 30 years or so knows (or at least thinks), MOM has never been a boom business. Deployments have tended to be steady and corporate roll outs over many plants have not been the norm. However, the market seems strong today and the advent of the IoT has highlighted the need for manufacturing data beyond the plant. The traditional ISA-95

model, shown in super simplified form here, is still much used and will be for the foreseeable future. This model also leads to a traditional approach to purchase and deployment of MOM systems. Perpetual licensing models (70%) outnumber periodic (19%) and SaaS (11%) by a wide margin. Similarly, the actual and planned deployment leans heavily toward on-premise systems.

## TRADITIONAL ENTERPRISE



## Actual and Planned MOM Deployment



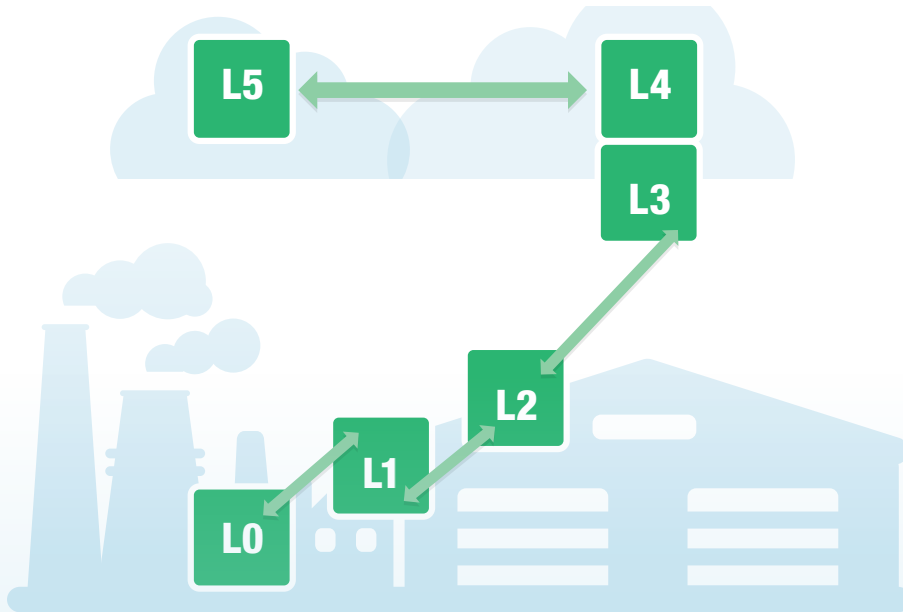
## What Is Happening in MOM? (Cont.)

Although MOM purchasing appears to be very conservative in terms of keeping everything close to the plant, evidence from the business software world would suggest that the MOM environment might change in the future. Looking at ERP deployment in 2016, the actual installed base is still heavily leaning toward on-premise, but the future plans are quite different. This fits well with what we see

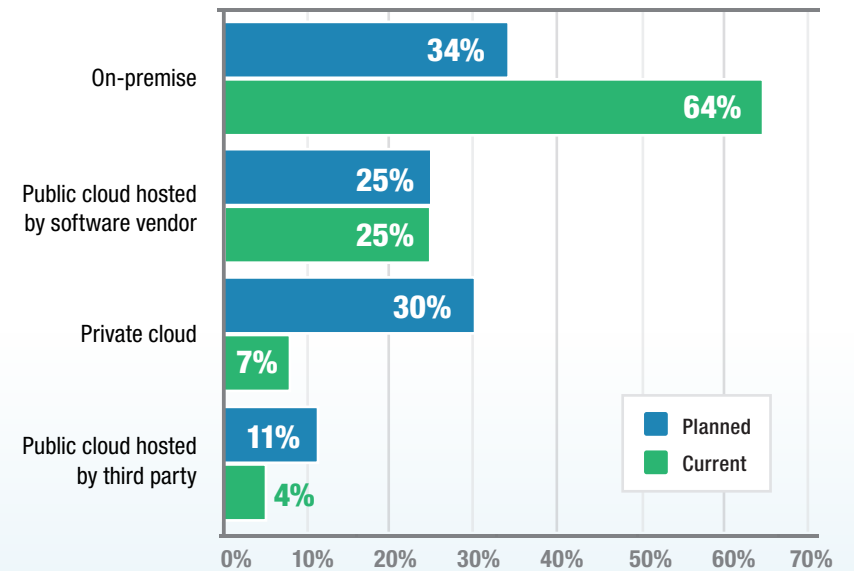
in almost all ERP vendors—a strong drive to move everything into the cloud.

The perceived cloud benefits survey respondents highlighted are led by lowered cost and increased speed to implement solutions. It is sure that these benefits will also filter down to MOM solutions as we move toward cloud-based MOM.

### INTEGRATED ERP AND MOM IN THE CLOUD



### Which best describes your current and planned ERP deployment model?





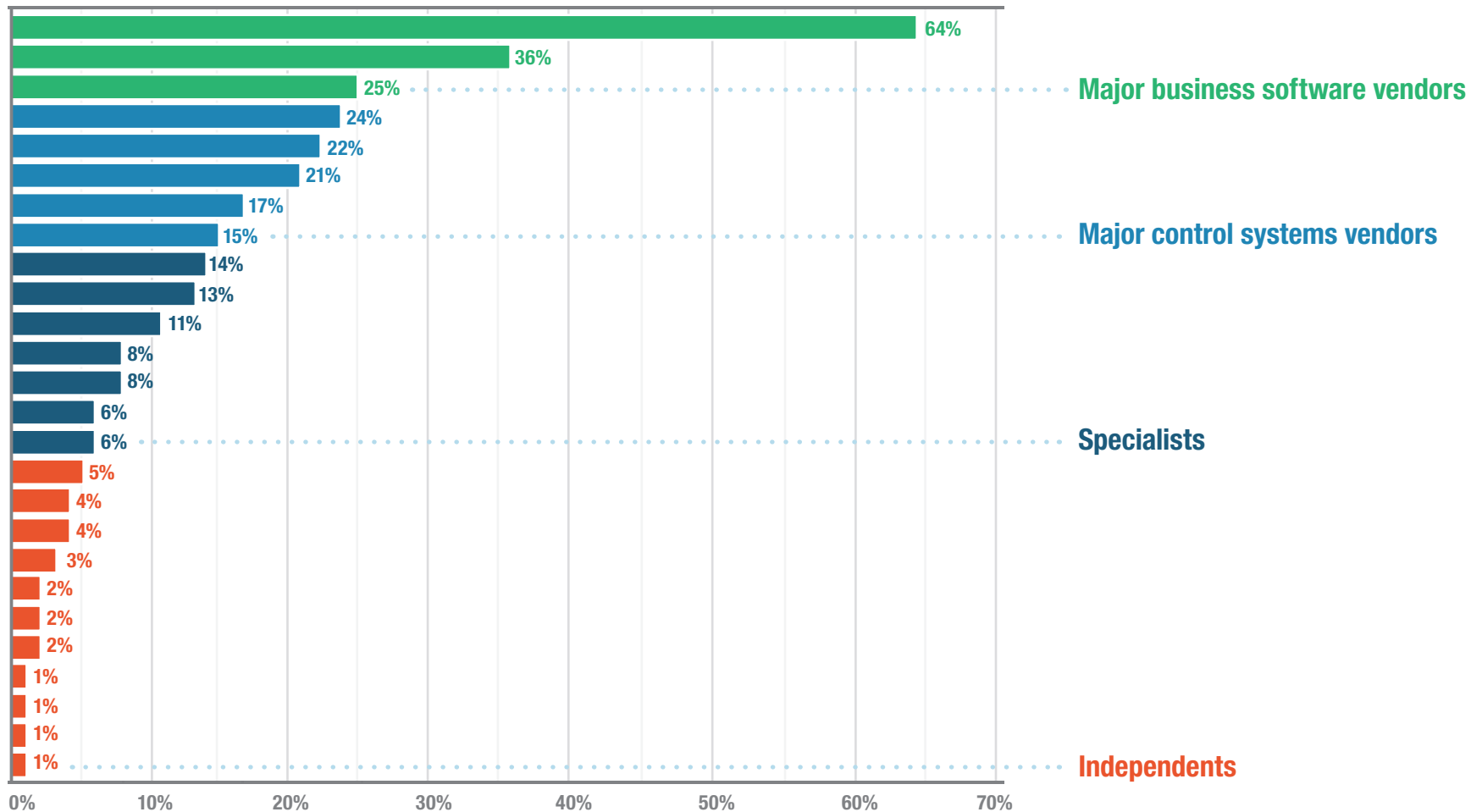
## What Is Happening in MOM? (Cont.)

The final key question we asked about MOM deployment was, “Which of these vendor(s) does your company currently use for manufacturing software?”

While LNS does not generally publish such research results it is interesting to look at the chart with names removed. What we see is a clear delineation between a number of different types of vendor. The top three are all major (very major) business software vendors.

It is no surprise that they dominate manufacturing software as well. The next small group are the major control systems vendors who also have large MOM software departments. Below 15% are mostly the specialists (data historians, DCS vendors, smaller integrated ERP/MOM vendors...), and finally the smaller independents of which there are many. The chart shows some of these!

### Manufacturing vendors currently implemented



# SECTION 5

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# Industry Trends

# Industry Trends

In all surveys LNS Research asks some general questions about trends in specific industries. Here we show a few of these:

In Aerospace & Defense (A&D), two main trends outstripped others by far:

- Collaboration with increasingly complex supply chains (51%)
- Integration of business, engineering, and operations (49%)

While the A&D market is in pretty good shape, other markets such as Oil & Gas and Mining are impacted by the market volatility (66% for O&G) more than anything else. In the current market, investments are low and cost cutting is high.

One trend that LNS sees in many industries is related to regulation and the impact that has on the manufacturing environment. In Life Sciences two top trends are:

- Regulatory requirements for quality management (67%)
- Labeling, serialization, and traceability requirements (49%)

Similarly, in Automotive traceability and product safety and recall management came at the top, and in Food & Beverage, compliance with the food safety and modernization act came on top (67%). Within the Chemicals industry, the regulatory environment topped the list (57%).



## AEROSPACE & DEFENSE

**51%** Collaboration with increasingly complex supply chains  
**49%** Integration of business, engineering, and operations



## OIL & GAS

**66%** Impacted by the market volatility



## CHEMICALS

**57%** Regulatory environment



## LIFE SCIENCES

**67%** Regulatory requirements for quality management  
**49%** Labeling, serialization, and traceability requirements



## FOOD & BEVERAGE

**67%** Compliance with food safety and modernization act

## SECTION 6

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# Operations and Financial Metrics

## Operations and Financial Metrics

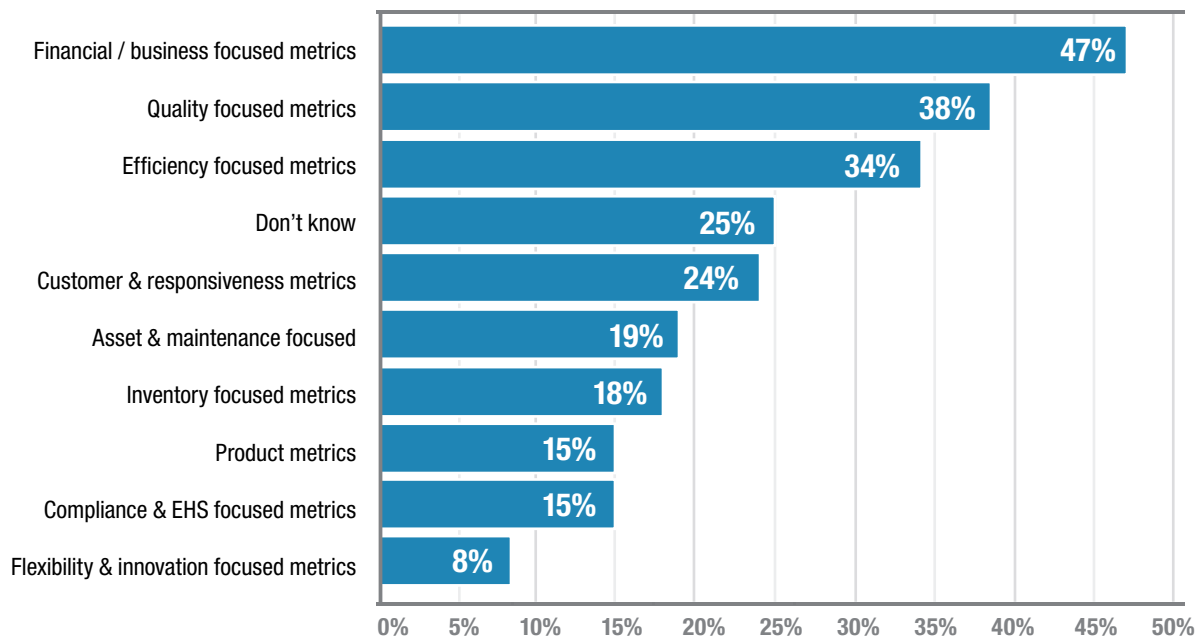
In previous Metrics that Matter surveys strong emphasis has been put on recording many financial metrics. This year we have tried to focus on the changing face of the MOM industry as we move towards an IoT world. This section looks into those financial and operational metrics that remain.

We first asked the following question, “What types of manufacturing metrics does your company rely on for managing your operations?” We then followed up by surveying only those that could actually discuss in detail the particular type of metrics.

It is, of course, no surprise that financial metrics comfortably lead the way. The next two most important are quality and efficiency but the relatively low position of customer focused metrics seems in contradiction with the use of analytics for customer service.

Looking first at the three main financial metrics we have retained this year—all are comfortably in positive territory this year. The manufacturing cost per unit has a first quartile of 6% and a third quartile of 20%. This indicates solid improvement in almost all industry sectors.

### What types of manufacturing metrics does your company rely on for managing your operations?

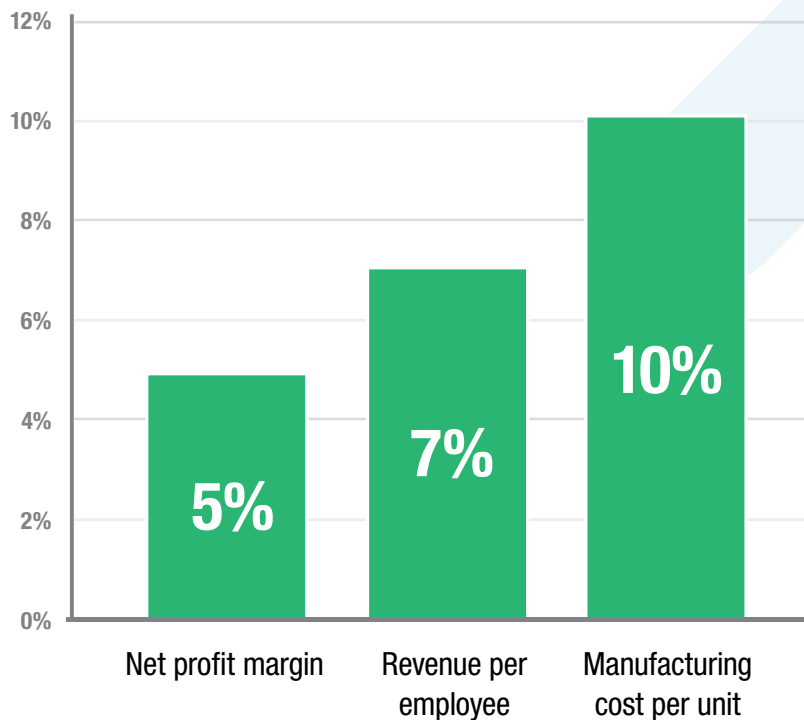


# Operational Improvements

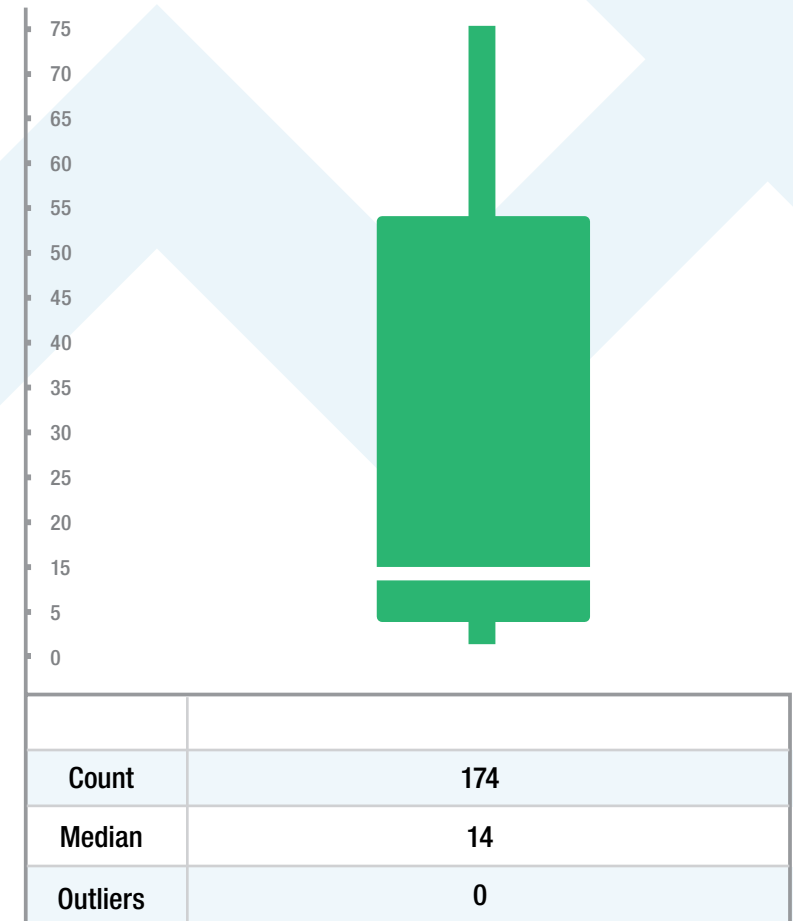
The improvement of 10% in manufacturing cost per unit should imply good improvements in some operational metrics. Indeed we see some fine operational improvements. Almost all replies showed excellent improvement in first pass yield and production output or throughput. First pass yield rose by a median of 14% and output by 15%.

Many companies had better improvement in first pass yield with a third quartile of over 50%. It is interesting to consider a correlation between this and the very high numbers we saw for participation in a variety of improvement programs above.

## Improvements in financial metrics



## First pass yield improvement

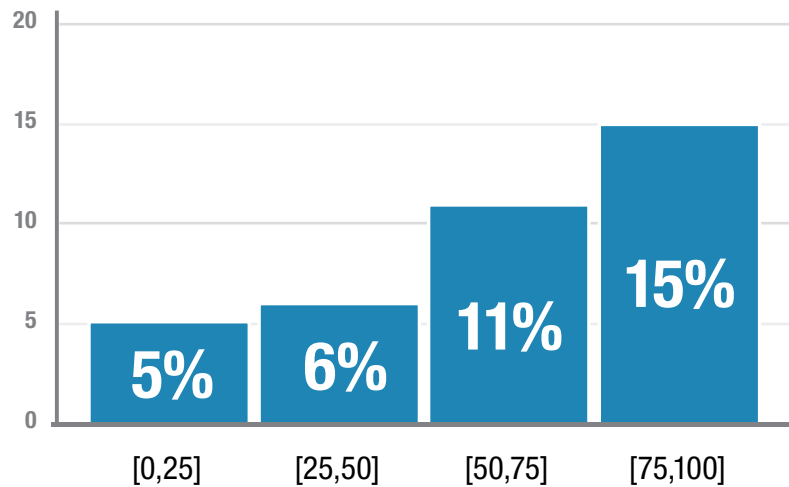


# Capacity

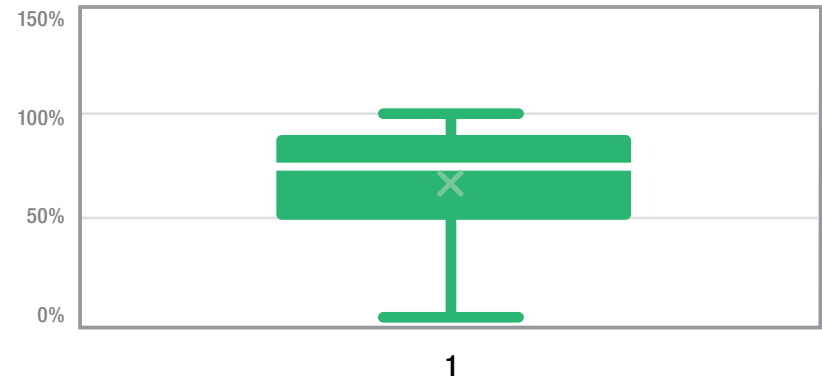
We took a slightly deeper look at capacity since the survey turned up some surprising results. In particular, we see that free capacity is widespread and, as we have seen, production is increasing so we should see free capacity decline.

Indeed, we see a decline in free capacity and an increase in production output over the past year. The continuation of this trend is dependent on macroeconomics but also on manufacturing confidence. We see lots about which to be confident in the coming years in manufacturing.

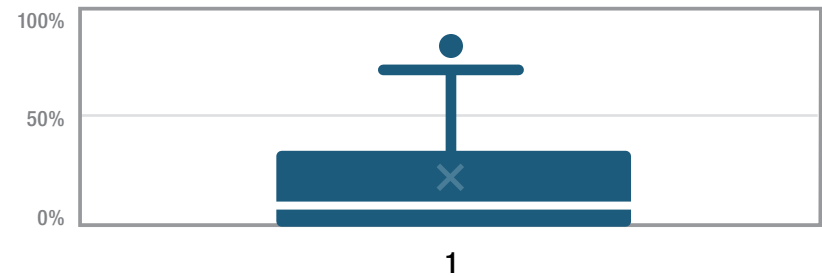
Current capacity utilization %



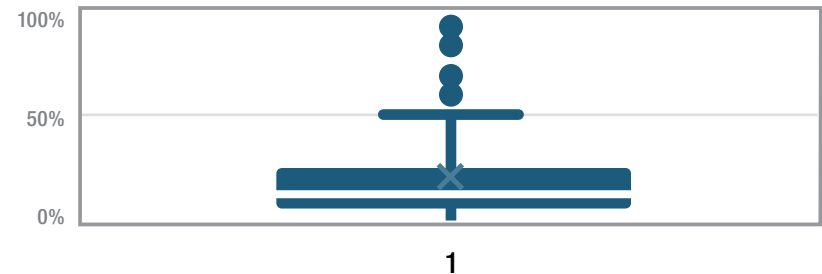
What is your company's current capacity utilization?



What has been your company's improvement in increased capacity utilization over the past year?



What has been your company's improvement in increased Production output / throughput over the past year?



## Other Improvements

### Other Operational Metrics Improvements

<b>Improvement in mfg. cycle time</b>	<b>16%</b>
<b>NPI Improvement</b>	<b>20%</b>
<b>Increase of SKU/products</b>	<b>15%</b>
<b>Planned vs emergency maintenance</b>	<b>20%</b>
<b>Annual WIP/Inventory turns improvement</b>	<b>27%</b>
<b>Improvement in production schedule attainment</b>	<b>10%</b>
<b>Improvement in customer rejects/returns</b>	<b>5%</b>
<b>Improvement in reportable environmental incidences</b>	<b>35%</b>
<b>Improvement in health &amp; safety incidences</b>	<b>37%</b>

It is clear that financial and operational metrics are improving because quality and operational programs are helping to drive real manufacturing productivity and quality gains. As manufacturers drive for ever more Operational Excellence we expect to see these improvements continue.



# SECTION 7

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# Analytics

# Analytics

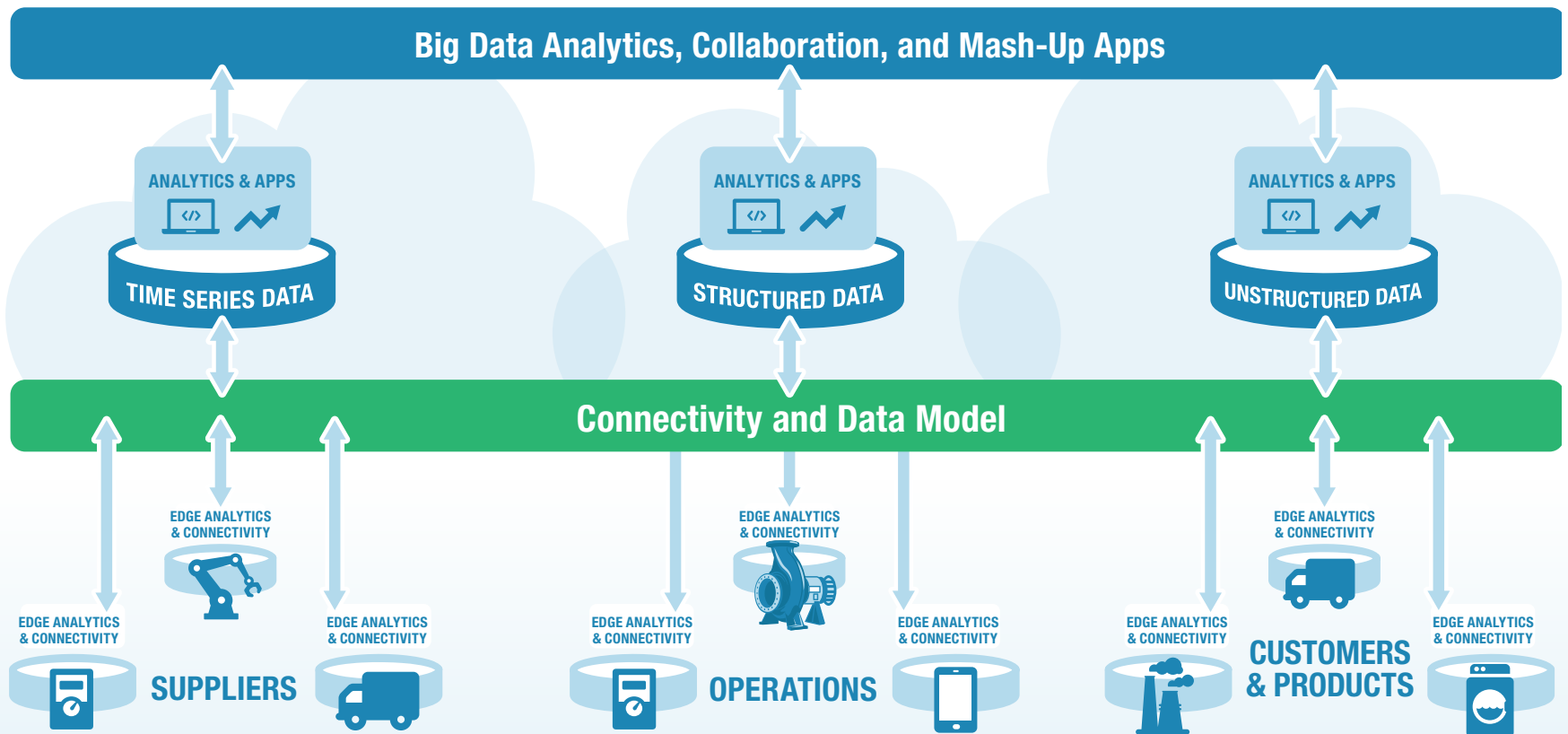
Much of what we have seen in this survey points to a changing world in manufacturing software. At the center of this change is data—Big Data, more data, and different data—and coming with that data is opportunity. The survey asked some specific questions about data and manufacturing. The leading question was, “Do you have a corporate analytics program that uses manufacturing data?”

We did not expect a majority of respondents to reply in the affirmative but were somewhat surprised that only 14% said yes.

This gap in the use of manufacturing data can be addressed by incorporating analytics into ongoing Operational Excellence and other programs. Manufacturers should build a common framework to include both, much as Lean and Six Sigma were combined some years ago.

**14%** ONLY USE MANUFACTURING DATA IN ANALYTICS

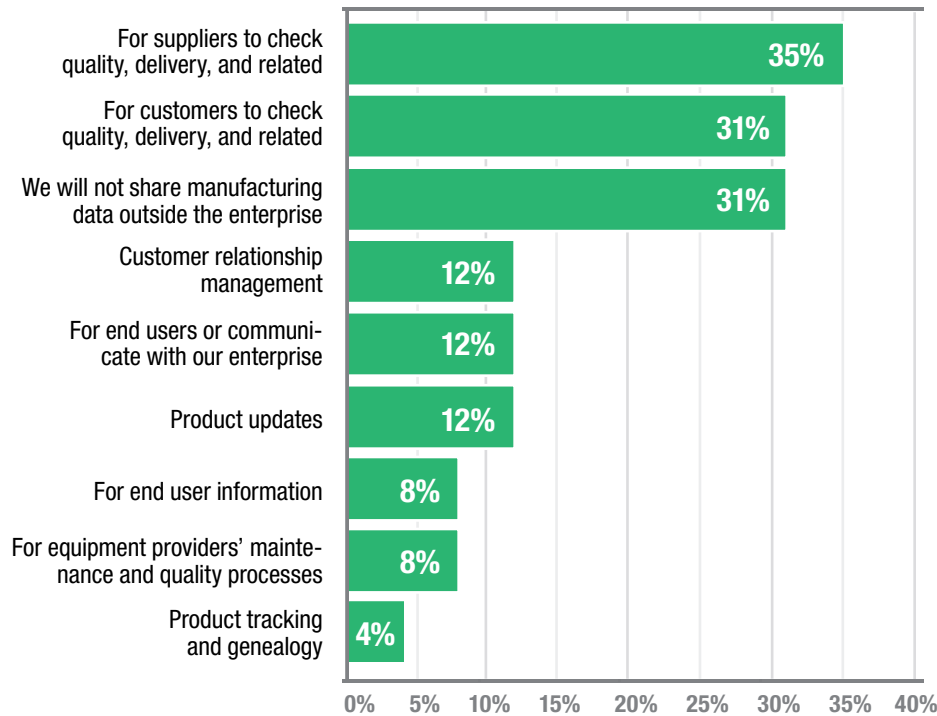
## OPERATIONAL ARCHITECTURE



# Using Analytics in and Beyond the Enterprise

The use cases of the analytics are getting interesting. We were particularly interested in manufacturers who were sharing their data outside the enterprise because this is something that the Internet of Things is going to enable on a much larger scale than is practical today.

## How data is shared outside the enterprise



It is good to see suppliers and customers both at the top of the list of cloud usage outside the enterprise. We also asked about internal use of Big Data Analytics to improve manufacturing and business performance. Realizing that there are innumerable possibilities, we gave a long list of options. Here are the complete responses:

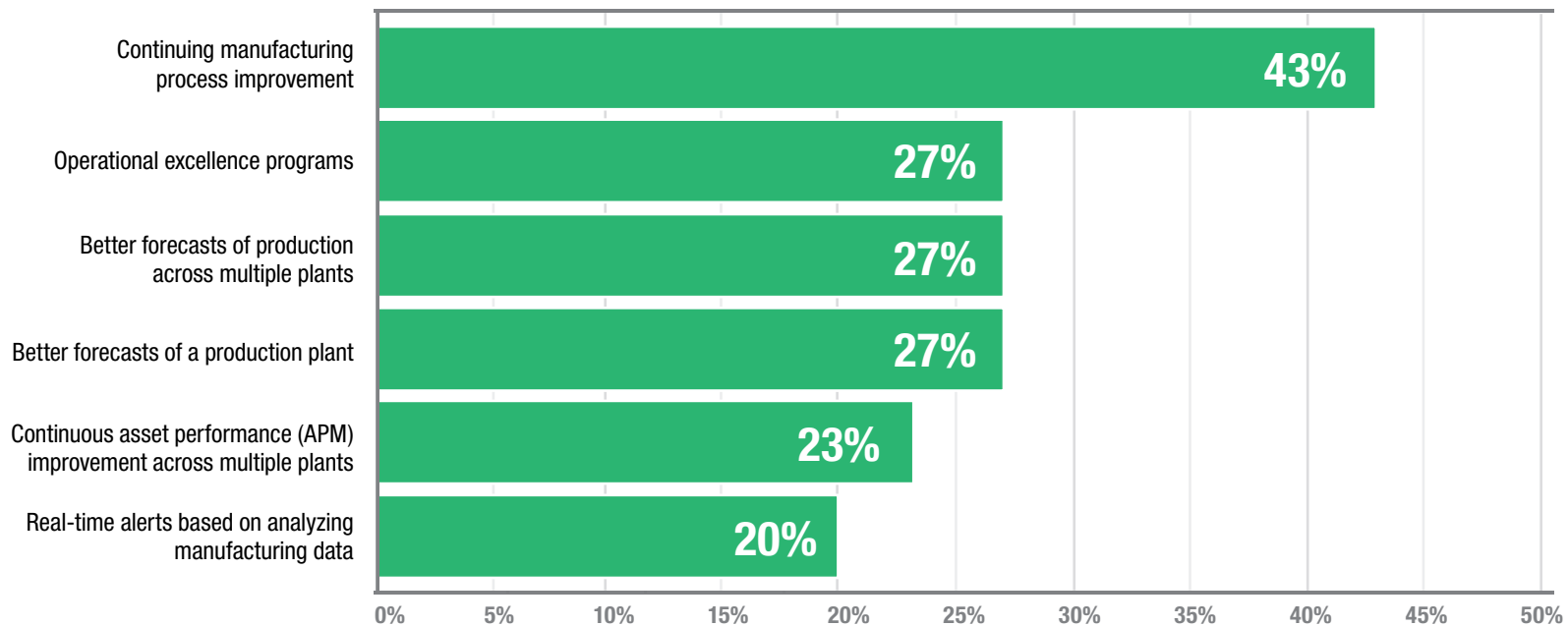
## Uses for Big Data analytics in the enterprise

Continuing manufacturing process improvement	43%
Better forecasts of a production plant	27%
Better forecasts of production across multiple plants	27%
Operational Excellence programs	27%
Continuous asset performance (APM) improvement across multiple plants	23%
Real-time alerts based on analyzing manufacturing data	20%
Improved customer service and support	17%
Understand customer requirements for new products	17%
Finding key plant performance parameters through correlation	17%
Better forecasts of sales	13%
Reduce recalls	13%
Correlate manufacturing and business performance information together	13%
Mine combinations of manufacturing and other enterprise data	13%
Alert management across multiple plants	13%
I don't think we use Enterprise Big Data	13%
Improve relationships with suppliers	10%
Correlate performance across multiple plants	10%
I don't think we use Plant Big Data	10%
Perform predictive modeling of manufacturing data	7%
Tracing products outside the enterprise	7%
Don't know	7%
Delivering software upgrades directly to sold devices	0%
Other ways	0%

## Using Analytics in and Beyond the Enterprise (Cont.)

If we look at those with a score of more than one fifth of replies, we see that Big Data Analytics is still focused on traditional operational metrics that probably do not need Big Data Analytics to help improve; traditional Enterprise Manufacturing Intelligence (EMI) will suffice.

### Most popular analytics uses



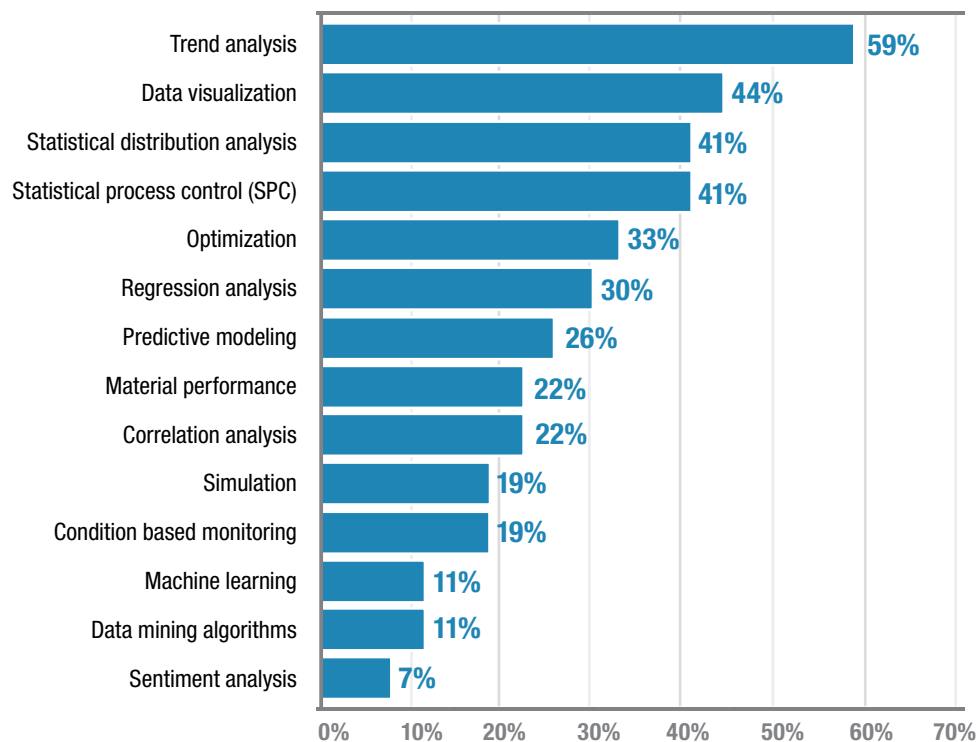
## Getting More from Analytics, People, and Algorithms

Thinking outside the box when it comes to data usage is probably not high on the agenda of those focused on production improvement and better process management. Having looked at usage, we were interested in the “how” of Big Data Analytics. We asked, “From where does your company get or plan to get its analytics experience?” To our astonishment, 40% said that they have a strong analytics team that will not require much expansion. This goes directly in the face of perceived wisdom on the subject; most pundits claim that the lack of data science skills will hold back some companies in their pursuit of IoT

and Big Data Analytics. However, when considering the results of the above question in the context of this one, it starts to come into focus that Big Data claims in manufacturing companies might be slightly ahead of the reality. Manufacturers already have advanced analytics in Enterprise Manufacturing Intelligence (EMI) and Business Intelligence (BI), for which they probably have sufficient skills. When it comes to Big Data, with unstructured information like video, climate, and image information, and when companies want to delve much deeper into their manufacturing and business data across supply chains, we suspect they will need new skills—about which they know little today. Indeed, these new systems will hopefully answer questions about the business that we do not yet even know to ask.

By looking at the type of data being used in analytics systems we can start to understand some of these issues. Most Big Data algorithms such as machine learning and sentiment analysis are still little used. This shows us that here is probably a gap of skills not necessarily recognized yet. Engineers and data scientists have different views of what predictive analytics are; one is very model- and simulation-centric, while the other is data- and correlation-centric. Like the historical lack of trust between plant and IT technicians, today there is distrust between the groups. A key to success in Big Data Analytics is to bring them together from a mathematical as well as cultural perspective.

### Algorithms used in analytics system



**40%** HAVE SUFFICIENT ANALYTICS SKILLS

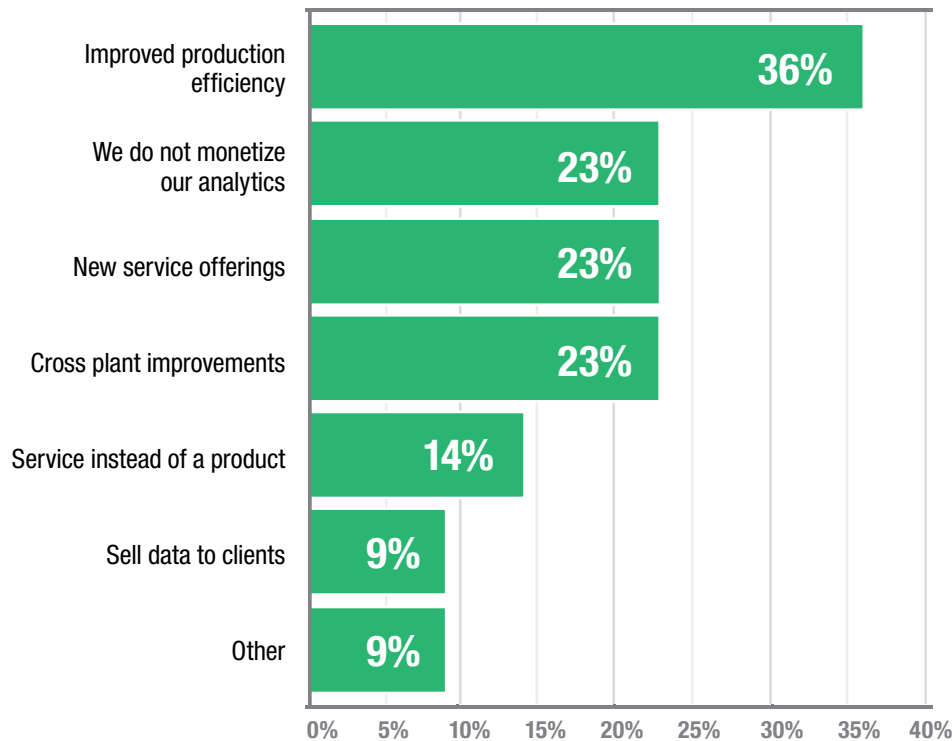
# Getting More from Analytics, People, and Algorithms (Cont.)

This thought is reinforced when we look at our last couple of data related questions: “How are data analytics being monetized?”

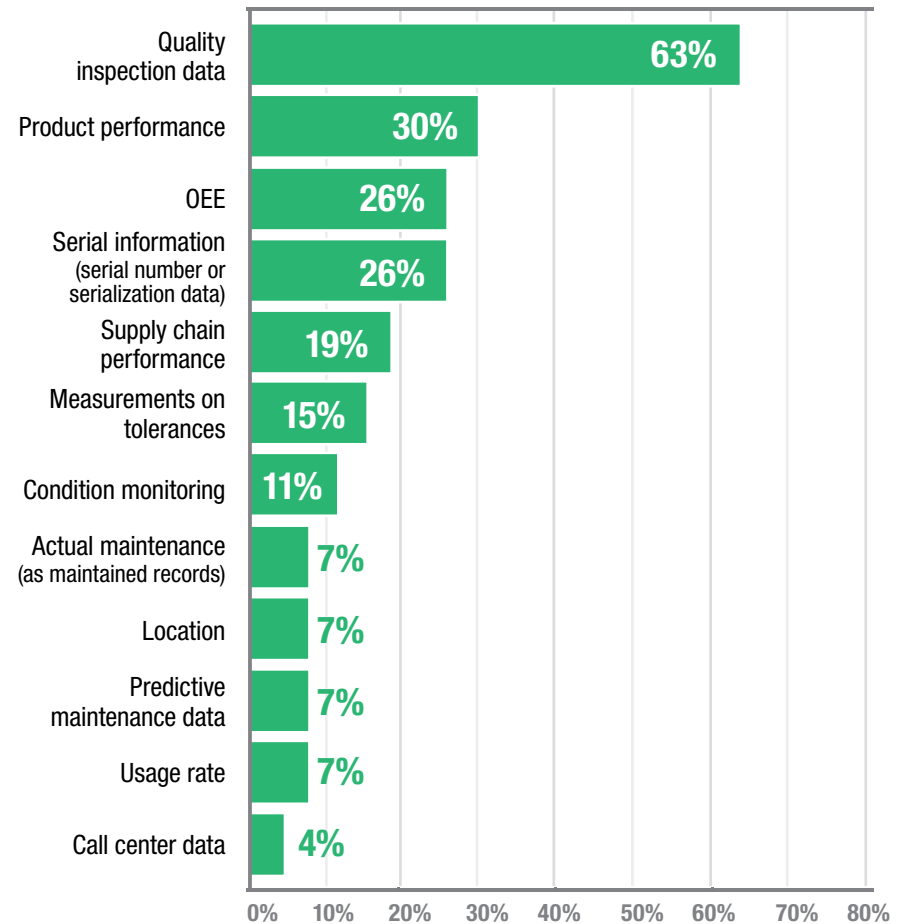
Again we see domination of internal improvements while, encouragingly, new service offerings are being considered by a few.

To complete this glance at analytics now and in the future, respondents were asked what data is being gathered about their products and how that data is used after sale. The signs are encouraging.

## Monetizing analytics



## Gathering product data



## SECTION 8

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# Summary & Recommendations

## Summary and Recommendations

The world of manufacturing systems has been in constant growth over the last 30 years or so. In 2016 we find ourselves caught up in change at a speed that we have never witnessed before. The IoT, and in particular its industrial cousin, the IIoT, has brought much attention to what happens inside a manufacturing enterprise. In the past most of the data from sensor to business system has been used internally for a multitude of tasks from control through process improvement to quality and business improvement. Now all that data will become part of the IIoT.

Our survey results show that a small proportion of manufacturers are starting to make serious efforts at implementing IIoT technologies and expanding their use of analytics across and slowly beyond the enterprise. The many different uses of the IoT and analytics in manufacturing companies show us the opportunities that integrated information with advanced analytics on top will bring.

The move toward the IIoT is going to affect almost all manufacturers. Awareness is already shooting up, even from a year ago, and large software (and hardware) vendors and integrators are putting enormous effort into getting IT systems onto the cloud and into the IoT.

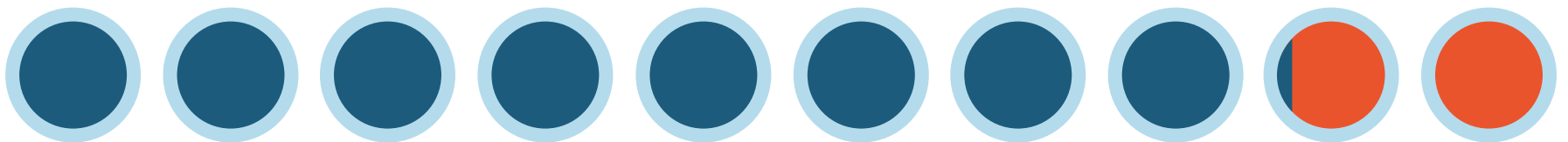
- **Manufacturers who are in the 19% who do not yet understand the IIoT should investigate the impact immediately. Appoint a team from IT, plants, and at least one business area to investigate and come up with potential areas where IIoT trials could be implemented and also devise a budget for the trials.**

- **Try analytics beyond the plant. Many vendors are making it easy for enterprises to try the cloud, IoT, and Big Data tools at low or no cost. Make sure that both engineering and business data experts are involved so the variety of data goes beyond typical shop floor data.**
- **Build commercially viable pilots in which they can investigate more complex analytics and better integration to plant and business through a real IoT platform.**

The real challenge comes in scaling all this. The amount of data involved and the complexity of networking and applications that arise through a complete Digital Transformation cannot be undertaken alone. Seek support from chosen vendors and partners, as well as involvement from suppliers and customers to be able to gradually integrate your extended supply chain into the Internet of Things.

Throughout 2016 and 2017, until the next Metrics that Matter survey, LNS Research will be following the progress of IoT deployment and helping our clients over the daunting Digital Transformation they face.

GET OUT of the **19%**





2016  
EDITION

# MANUFACTURING METRICS IN AN IoT WORLD

Measuring the Progress  
of the Industrial Internet of Things

Presented by:



Connect:



[Insresearch.com](http://Insresearch.com)

Author:

Andrew Hughes  
Principal Analyst, LNS Research  
[andrew.hughes@Insresearch.com](mailto:andrew.hughes@Insresearch.com)