



FACTORY OF THE FUTURE:

It's Time to Get it Going

“Factory of the future” is just one name for the sweeping change going on throughout manufacturing. We use this phrase specifically because our research focuses primarily on operational technology (OT), that which drives factories and plants, and communicates with the rest of the enterprise and beyond. Industrial Transformation (IX), Industrie 4.0, and Smart Manufacturing are other terms we frequently hear, but they are not all synonymous. They do all however focus on the transformation of the industrial landscape driven by people, process, and technology.

This report explores how data and people can work together to drive unimagined value with the staggering array of new technologies that enable factory of the future. As we consider any one of the technologies individually, whether it is machine learning or fast wireless networks, no single change could ever make a huge difference to plant performance. However, we haven't seen just one, but a multitude of new technologies introduced over the last ten years or so. Many have been adopted by consumer-facing technology companies, and our world has completely changed as a result.

To think I used to be proud of my map reading and navigation skills — the new generation (my daughter right along with them) can do it better and faster with their smartphones. Every aspect of our daily lives has been taken over by data and technology, used primarily to connect people. The data isn't just collected and stored; tech companies are constantly scouring it to see how they can monetize it and influence the way we behave (for better or worse). Industrial companies need to think the same way about technology — to use it to change how the plant and industrial organization runs.

Where It All Begins: The IX Leader

LNS Research recently conducted a [study on industrial transformation readiness](#), and the results of this research are highly relevant to factory of the future. Specifically, let's zero in on the 28% of companies that emerge as IX leaders – the 8% of companies describe the IX program as a “real success,” plus the 20% that report the company is “making progress and the corporation is seeing value” with it. These leaders display many characteristics in their businesses that help them benefit more

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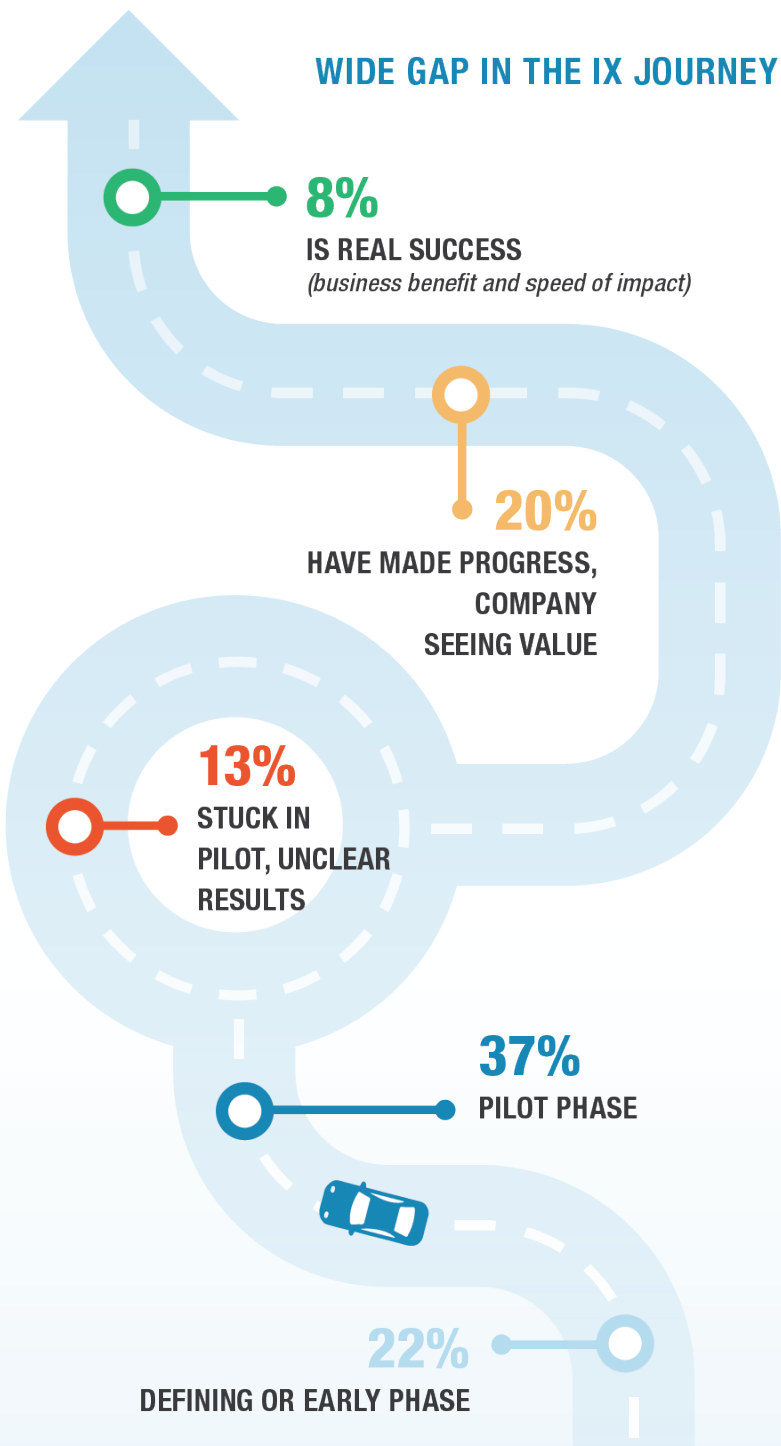
—ANDREW HUGHES

Principal Analyst



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from IX and factory of the future. For example, many IX leaders have a higher level of control over transformation budgets; this means project choices are strategic rather than plant by plant. However, this can lead to evaluating projects at too high a level in the organization, and when it comes to implementation, problems arise.



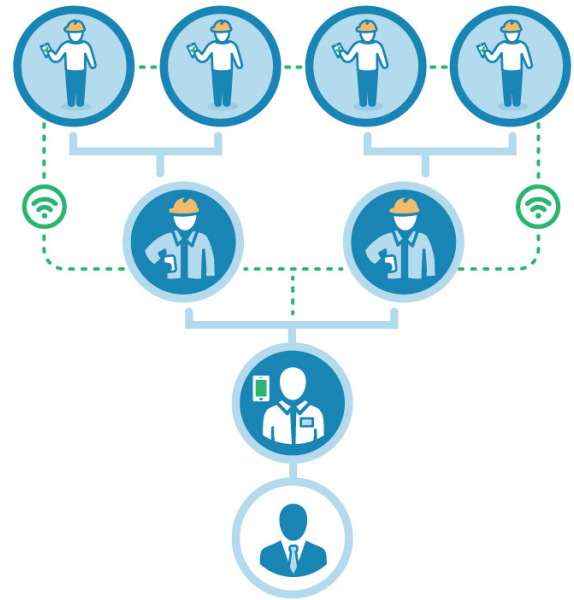
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We don't deny that transformation-ready companies clearly need great leadership. However, even more important in many ways is the commitment and quality of people far beyond senior executives. IX leaders often appoint a chief digital officer and almost always have a program in place to drive IT/OT convergence, both technically and organizationally. Even today, it's still the case that many early factory of the future programs are equally challenged by technology integration as they derive organizational benefits.

When looking at ways to drive factory and business improvement, companies should not address technology first. We consistently see that any company without the necessary people and processes in place has a much harder time making IX technology work.

A good example of this is the CPG company where top management was fully aware of the need for better technology to drive target improvements. Integration between plants, more flexible manufacturing, and reducing time to market were some of the main project goals. Rather than design a solution for each issue, the company defined a new architecture from the bottom up to include integration with equipment, new controls, and corporate-wide batch management and data historian. Although this was a tough decision and, surely, a demanding technology deployment, the immediate benefits were substantial — 10-15% extra production — and the new infrastructure further addresses other potential benefits in the transformation journey. For example:

- Closer supplier and customer relations; share information for closer just-in-time and customer satisfaction
- Flexible manufacturing; shorter runs, less work-in-progress, product mix
- Remote operations; keep people away from danger and harsh working conditions
- Better forecasts of production across plant(s)
- Higher manufacturing quality



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Principal Analyst

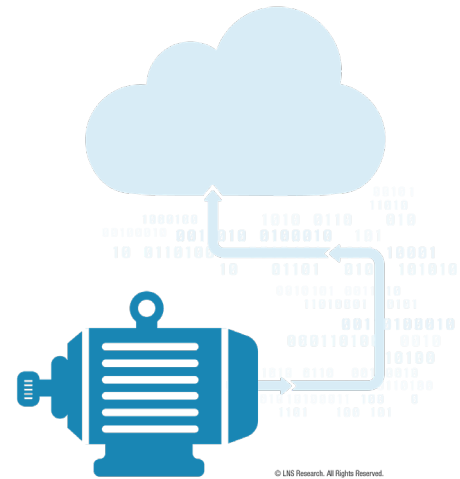
Build Capability Using Plant Data

Data is a core driving force of Industrial Transformation (IX), even though each sector has a vastly different experience in collecting it. In large scale process industries, it's common to collect large amounts of time series data in historians and apply it for process optimization, maintenance, and quality. In that scenario, connections to plant equipment through distributed control systems (DCS) and supervisory control and data acquisition (SCADA) has been the norm for decades. In contrast, discrete manufacturing plants still often rely on paper and spreadsheets as the main sources of information. In either case, we call this operational technology (OT) data or simply operational data.

In most cases — process manufacturing and discrete alike — data collected in the plant is used in the plant, period. Information technology (IT) departments traditionally have limited access to OT data except for that which is passed on to the business system to record production. IX changes all that. Why? We already know that Industrie 4.0 and other programs modernize manufacturing. It turns out that the breadth of exciting new tech provides new capabilities in digital environments. These include high-performance computing, massive data storage (Cloud), artificial intelligence, and fast communication. These basic technologies allow us to do things with data that were previously beyond the capabilities of existing systems; today we shift to new analytics, asset performance management, digital twins, IIoT platforms and others.

The [need for data to feed our new toys is clear](#) and as we look around, we discover vast amounts of data in the plant, especially in process industries. However, reality is somewhat less complete than at first glance. Even in process industries, applications use only about 10% of all data collected. Although it's tough to estimate, it wouldn't surprise us if companies harvest only 10% of potentially useful data in most plants, and far less in others. Yes, the opportunity for growth in this area is enormous.

We know about many real-world examples, but a particularly memorable one is about a mining company with remote operations. The organization centralized control and runs a data historian and workflow management to automate business processes and launch alerts to remote engineers. As a result, the mining company improved throughput by 11%. There was no need for expensive hardware investments; it achieved real benefit by intelligently using lots of data.



Everything Must Change: People in the Plant and Beyond

The plant is the throne of process engineers and all the data they survey (or at least collect), especially in process industries. For decades, work life in the plant has improved gradually with ever more sophisticated process control and optimization. Control rooms have changed out of all recognition and the technology already in place can be re-purposed (actually just reused) to ensure better data access for everyone, not just operators.

However, there is much more happening with people in the factory of the future. Two key changes are required or will happen: IT/OT convergence is well documented, and, the changing workforce. Most manufacturers must address both as they roll out new technologies. Ultimately, it's this crossroad that technology and process come together in the people that run the business. And, just as we drive change with technology, we must ensure that people aren't left behind.

So, what is IT/OT convergence? First, it is better communication between the people that run IT systems and those that manage OT systems. Of course, it also includes bringing the information and applications together. However, without people talking to each other, it will never work. To [achieve IT/OT convergence, companies must take an important first step: build trust](#). That means find people that are open-minded, enjoy a new challenge, and are capable of handling new technology from a new perspective. That's the easy part. Following that, there are many steps that advance the merger of ideas, technology, and people. These include:

FOSTER BETTER INTERACTION BETWEEN PEOPLE IN IT AND OT

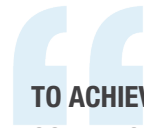
- Move people between departments
- Create cross purpose teams

HELP OT TO USE IT TECHNOLOGY

- Inside and outside the plant
- Essential tech such as security, cloud, communications

MAKE DATA AVAILABLE TO ALL

- A key success factor for IX is the ability to use information any way you want; make it available
- Manage data properly, so it's not onerous (e.g., data cleansing, architecture, data model)



TO ACHIEVE IT/OT

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Yes, there are many reasons why a company embarks on a path to smart manufacturing. One directly related to people is shifting demographics among the workforce, both retiring baby boomers and today's younger workers entering the manufacturing world. Although the retiring workforce is often considered the bigger problem, the reality is it is only an issue in the developed world; IX should address future issues, not so much the past. However, it is important to capture retirees' knowledge and understanding of processes. Modern artificial intelligence and machine learning systems are a potential starting point.

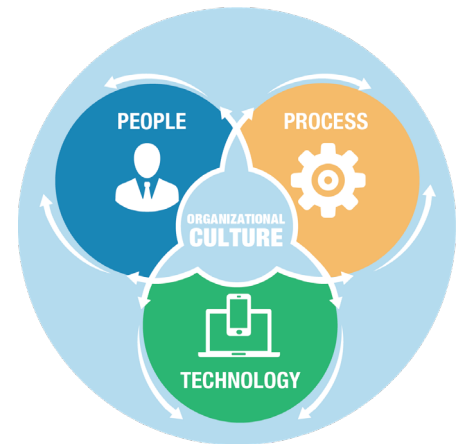
However, companies must focus more on the new workforce required and attract those people to the wonderful world of OT and IX. The user experience a company offers to newcomers must live up to daily expectations and experience and meet their desire to use modern equipment in a modern environment (the millennial effect). To achieve goals, we need to address the challenges with all three IX triumvirate: people, process, and technology. Yes, the most obvious is people, but the most critical is process. Training younger workers so they understand "the old way" is wasted energy. Bringing together new technology to implement new processes promises more success.

In the mining example above, workflow management would make this kind of change straightforward: define what people do and build it into real systems or computer-based training. This approach allows a company to quickly to demystify "the old guys' wisdom." Many issues around retaining knowledge in manufacturing boil down to small but complex processes used wisely. With defined processes in place, they can augment with up-to-date expertise of well-trained incoming engineers. Furthermore, modern user interfaces and mobile tools that younger engineers already use in their daily lives eases the transition from old to new.

Companies must also support the shift with appropriate technology and business process. However, all of this this is truly just a starting point for the factory of the future — the necessary infrastructure and tools that will support industrial transformation.

OT and Change

One of the most significant barriers to change in the world of manufacturing control is perceived ownership of data. Plant engineers spend a lot of time as guardians of nearly all plant-centric information. Traditionally, plant management has had purchasing power, and they have protected their environment by ensuring tools worked with the data and improved the lives of engineers. One way of achieving this has been



proclaiming, “My system is unique, and every industry is different;” — a relentless myth of industrial systems.

If we consider DCS and PLC-based systems, the IT/OT barrier is more pronounced in process industries partly because the DCS is the domain of the process engineer and requires process and chemical specialist knowledge to understand what's really going on. When we take a step back however, and examine the computing technology in use, the differences are small and dwindle moving up the software hierarchy.

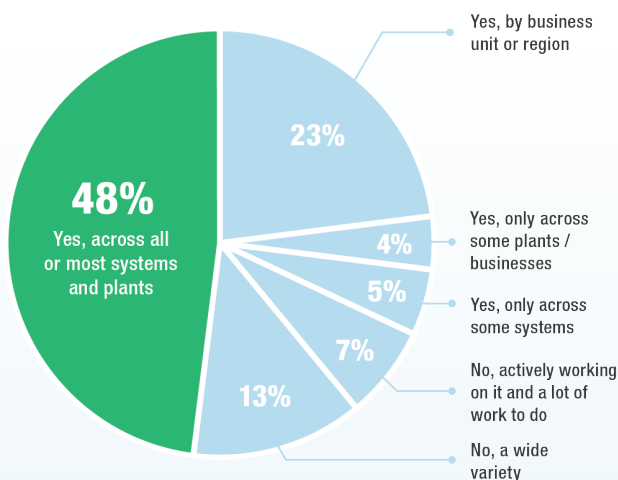
Another sticking point for IT/OT convergence is that process engineers, particularly those further along in their career, are often less comfortable in an IT environment. They tend to guard their job with that posture of “we’re different” rather than embracing the opportunities change presents. Finally, OT people don’t generally trust IT, partly because in the past they had little need for IT skills. With Industrial Transformation, all that has changed.

Certainly, we see [more successful IT/OT convergence in batch and discrete industries](#) where specialized knowledge for a different technology is not so prevalent. It is probably also the case that a greater percentage of discrete manufacturers were early adopters of consumer technology in the plant (although to be fair, it has been slow everywhere). However, we now see smartphones, tablets, and wearables deployed everywhere from banking to social media, and from pharmaceuticals to mining. These barriers will disappear in half a decade, once old and young alike make it clear that these changes are compulsory.

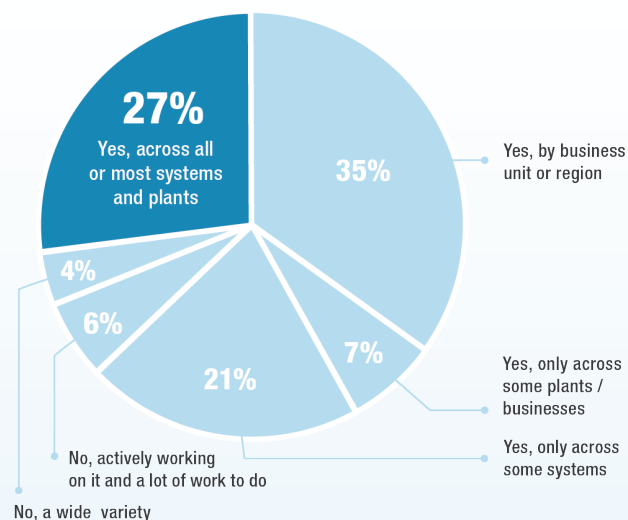


Common OT Systems in Plants

STATUS AND PORTION OF IX LEADERS



STATUS AND PORTION OF FOLLOWERS



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From the IT perspective, that domain has shifted with much of the local load now in the Cloud. As a result, IT is looking for new opportunities to influence and improve the business. The plant is a tremendous opportunity, but the welcome might not be warm. Getting over the barriers to joint success is vital to all IX activities since [using all data, wherever it can provide value, is a critical step to drive change](#). The debate about what to share and whether plant data should be available to enterprise-level systems and beyond is pretty much over. The only challenge that remains is to define how IT and OT will work together to drive value through factory of the future.

IX leaders are much more likely to have common OT systems than other companies, and with that knowledge we suspect that their IT and OT people are set up to collaborate. Executives that lead IX must define teams and shared responsibilities that will drive IX initiatives forward. That doesn't mean just one or two "pilot" plants, but throughout the enterprise. Their long-term plans, projects, and goals must encompass the entire enterprise from design to manufacturing. Thinking big leads to overarching organizational support, which then fosters local change. This is a critical element for sub-teams, such as local IT/OT convergence leaders. It's a cultural model that allows small gains to snowball into big results rather than get lost in the mire of everyday factory life.

The factory of the future delivers essential technologies, architectures, and, of course, people to enterprise industrial transformation. Every company must start where it is today, but then continually manage the changes that can deliver the target value.

Improving the Process: Making the Move to Factory of the Future

Yes, the manufacturing organization must be aware of underlying issues it will likely face on the journey to factory of the future. Everything will change, but a sound infrastructure and people committed to the benefits of change are just the starting point.

Even the IX leaders must ensure the organization is fully engaged and that it has executive sponsors in place. This provides a launchpad to incorporate increasingly advanced technology with quick ROI and lower incremental costs. A big bang infrastructure is often needed — consider the earlier mining and CPG examples — however, big bang functionality might not be the way to go. First, [address the critical technologies for infrastructure and solutions; look to the LNS Research IX Reference Architecture](#) to determine which those are for your organization.



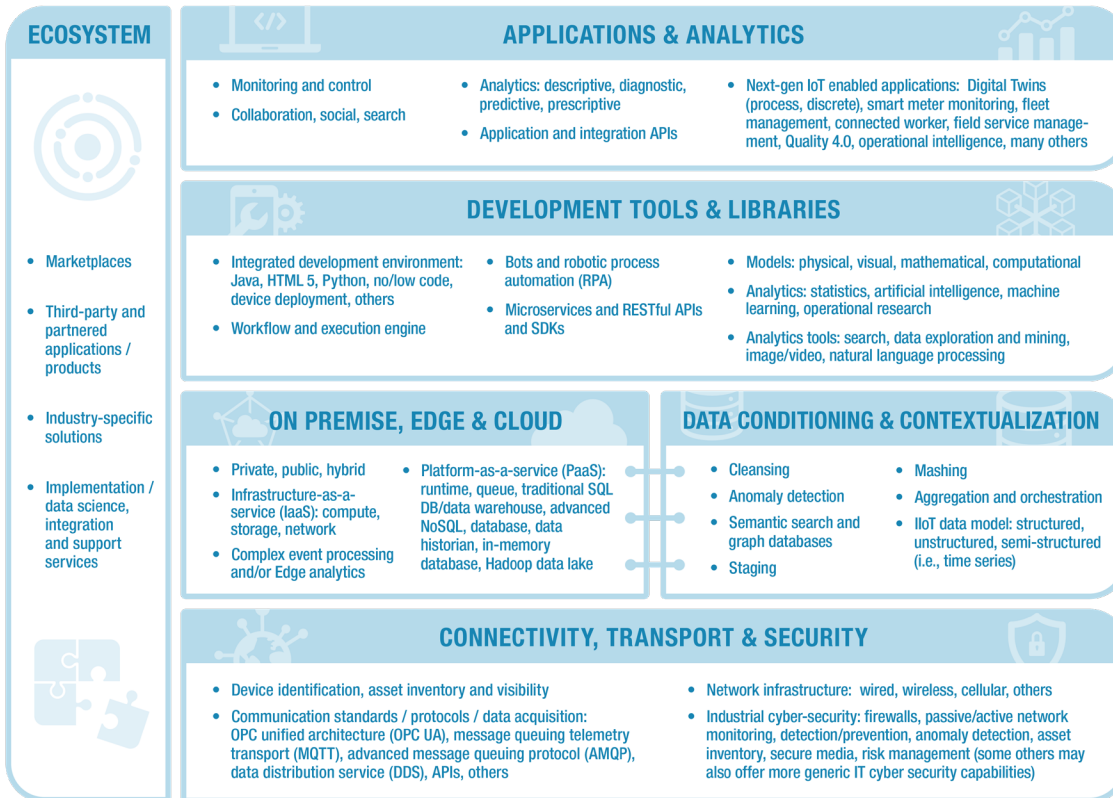
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Principal Analyst

INDUSTRIAL TRANSFORMATION (IX) REFERENCE ARCHITECTURE



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Your company doesn't need to implement all this in an early factory of the future — it's an endpoint. Certain foundational elements are required:

- Communication standards
- Industrial cyber-security
- Data model
- Support for analytics and applications

Immediately we see something novel: IT has a lot of skill with these technologies, and OT people will suddenly have a strong need for support. If OT resists collaboration, the organization will have to take a step back to get alignment. We often hear roadblock statements like, "IT can't do OT security because we can't patch our systems all the time;" don't get caught by clever negativity.

Although an organization can define an infrastructure today, the technologies are a moving target. There is a great deal of discussion and competition among industrial software vendors and the bigger purveyors of cloud services. **Industrial cyber security is in early stages of**

[standardization](#) (which our analysts will follow closely), while plant-to-cloud communication starts with the assumption of the fully mature Internet protocol (IP). Other interfaces and programming tools are starting to emerge (RESTful Web services (RWS) for example), and there are innumerable analytics tools from many vendors.

Assuming everything is in place, the company can define some apps and analytics that will turn the infrastructure into the factory of the future.

Factories of the Future (Yes, >1 Iteration)

Most industrial companies spend a lot of time on analytics for process improvement and talk only vaguely about ML and AI. Instead, it should work on small steps toward the FIRST factory of the future. Why the emphasis on first? Factory of the future isn't one giant end goal — it's gradual evolution of the manufacturing business into something fundamentally more agile, profitable, and flexible by applying people, technology, and data differently. It will provide tools to allow existing process-focused experts to expand their expertise and become more business- and change-focused.

The first steps should apply technologies that already exist today: walk before you run. For example, analytics is a vast category that can deliver significant short-term benefits. Many think of analytics as going from nothing to [Big Data analytics, a much-abused term](#). In reality Big Data analytics answers questions we didn't know to ask. No one can do this using only existing process data; instead it requires information from multiple sources so smart algorithms can find answers to (nearly) anything. This immediately excludes existing plant systems for such analytics — not enough space and not enough processing power. However, Cloud-based data lakes and large computing centers can handle Big Data analytics with ease.

We must first consider the possibilities before making infrastructure choices. If we only want to do simple plant (or multi-plant) analytics today, then we do not necessarily need cloud connectivity, but it would be sensible to approach today's factory of the future with a thought for tomorrow. Being prepared for handling new data through better plant connectivity and IoT devices direct sharing data through cloud-based storage would seem to be a good idea.

Certainly, the organization shouldn't lose sight of the singular goal: improve the business. Process data alone won't cut it; the organization intent on factory



of the future must introduce financial, market, customer, and general social data to make the machine operator a more valuable asset. While automation has reduced the need for low-end operators, but that hasn't automatically led to higher value factory staff. However, if we give the shop floor operator time to be creative and the ability to run analytics and other "what if" tools, business performance will improve immediately and dramatically. This isn't IT/OT convergence; it's leadership to shop floor convergence (or vice versa), a fundamental shift for IX and factories of the factories.

Proving the value with just infrastructure is hard, but our examples show just that — a modern infrastructure and control system can do a lot to deliver value. Add in a selection of analytics at the plant level so the workforce can make better use of process data to solve the same quality, maintenance, and optimization problems as in the past, more quickly and with better results. Similarly, measuring performance with a well-executed overall equipment effectiveness (OEE) program and excellent connectivity of people through HTML5 or similar UI infrastructure can deliver fast ROI.

The bottom line on factory of the future: the manufacturing organization must collect new data, share and analyze it, deliver the results to all those that can benefit, and do it all again. But why?

IX Requires “Good Data;” Only Factory of the Future Can Deliver

No company will want to be late to the IX movement, or worse, refrain from it. To gear up, executives should consider:

- What constitutes an IX leader, and what capabilities are necessary?
- Why should the organization strive to be an IX leader?
- How does factory of the future fit in?

Recall that an IX leader is among the 28% of companies that describe the IX program as a “real success” or report the company is “making progress and the corporation is seeing value” with it. While we examine IX readiness in detail in separate research, it's clear that IX programs are becoming mainstream. In 2018, there was a 10% increase in the percentage of companies with an IX program; we expect well over half of companies to be fully involved by 2020. To remain competitive, a manufacturer must be in the top half over the coming few years of accelerated growth.



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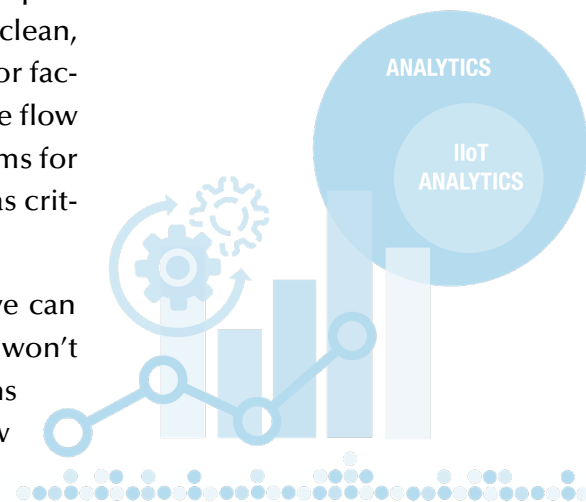
Principal Analyst

IX leaders certainly behave differently than all others. In many ways, including leadership and the extended organization, everyone focuses on business performance rather than technology. There's also a strong emphasis on people at all levels throughout the organization. It's interesting that IX leaders have a stronger focus on manufacturing operations and quality than others involved in IX, which is a key driver for factory of the future.

Of course, the opportunities with new factory-focused technologies is a big influence and driver for Industrial Transformation. And, it's natural that much of the IX focus has been on analytics, particularly analytics across the enterprise and beyond. For success with Big Data analytics, they need access to reliable, clean, consistent data. Big Data is data with high volume, tremendous variety, high velocity, and veracity. Big Data gets its high quality "stuff" from lots of sources — the factory of the future is one among many.

IX is nearly impossible without factory of the future ... because it provides "good data" to the enterprise and beyond. Good data means clean, consistent, and current. As the company connects more devices for factory of the future, the role of Edge and plant systems to manage the flow of potentially unmanageable data will grow inexorably. New systems for consuming data locally and sharing that data widely will become as critical as the output of analytics.

Looking ahead, some say that we already have more data than we can comfortably handle and that passing terabytes of data to the Cloud won't help. The fact is, factory of the future and operational applications in it ensure that good and Big Data can live together in the new world of flexible and digitally managed manufacturing.



Recommendations: Gear Up Now, Pave the Way for Factory of the Future 2.0

"Factory of the future 2.0" (and beyond) will deliver ever-expanding opportunities with new technology in the plant, the enterprise, and the world at large. As manufacturers take advantage of the low hanging fruit of basic analytics early on, they open the door to the many operational and advanced analytics applications available now and in the future. This report only touches on a couple of possibilities; every company will discover new opportunities through its people and ongoing IX programs. Organizations with an IX program, or eager to get one started should engage functional leaders and senior executives to put these recommendations into action.

FACTORY OF THE FUTURE: It's Time to Get it Going

STRIVE FOR IX LEADER STATUS and get there quickly, which translates to making the IX program a “real success” or “making progress so the corporation sees value.” Only factory of the future technologies in the plant and beyond will allow the organization to achieve the full benefit of IX efforts.

VIEW FACTORY OF THE FUTURE AS A FUNDAMENTAL ELEMENT OF IX. The enterprise must [have a plan with achievable and measurable steps to make the IX journey real](#). Factory of the future can be a set of manufacturing-focused plant transformations to apply the power and potential of modern technology to access data and make people the real catalyst for change.

TAKE STEPS NOW WITH AN EYE TOWARD FACTORY OF THE FUTURE 2.0. Applying analytics for performance gains shouldn't be the endpoint. Competitors will keep moving forward, to factory of the future 2.0 and beyond, so your organization must continue to evolve its IX program, goals, and strategies too. The plant is a ripe and pragmatic starting point while ever broader data collection and cloud capability will expand opportunities that span quality improvement, faster NPI, digital continuous improvement, and many others.

Ultimately, factory of the future is simply the way people, data, and technology work together to drive unimagined value. Industrial companies that apply factory of the future as a core aspect of Industrial Transformation fundamentally shift how the plant and industrial organization runs and position themselves to achieve IX leader status.



Industrial Transformation Resource Guide

Companies use digital technology to drive transformation across the value chain. Use these resources to learn how to align the people, processes, and technologies required to achieve Operational Excellence in your organization.

INDUSTRIAL TRANSFORMATION

BLOG | Understanding Industrial Transformation: Definition and Framework for Success

[View Blog](#) →

RESEARCH | Industrial Transformation: Architecture and Analytics Just the Beginning

[View Research](#) →

RESEARCH | Industrial Control Systems and Edge Computing: Enabling an Operational Architecture for Applications and Analytics

[View Research](#) →

INDUSTRIAL ANALYTICS

RESEARCH | Build a Flexible Industrial Analytics Strategy for Today and Tomorrow: Why Business Leaders Should Adopt a Use Case Approach

[View Research](#) →

BLOG | How the Right Operational Architecture Powers the Analytics That Matter

[View Blog](#) →

RESEARCH | Analytics Really Do Matter: Driving Digital Transformation and the Smart Manufacturing Enterprise

[View Research](#) →

FACTORY OF THE FUTURE

RESEARCH | Improving Continuous Improvement: Reinvent Lean Today with Digital Technology

[View Research](#) →

RESEARCH | Forging the Digital Twin in Discrete Manufacturing: A Vision for Unity in the Virtual and Real Worlds

[View Research](#) →

RESEARCH | MOM and PLM in the IIoT Age: A Cross-Discipline Approach to Digital Transformation

[View Research](#) →

APM 4.0

SOLUTION SELECTION GUIDE | Asset Performance Management (Platform Vendors), 2018 Edition

[View Solution Selection Guide](#) →

RESEARCH | APM 4.0: Prescription for Better Profitability in Operations

[View Research](#) →

RESEARCH | The Road to Digital Transformation Success: A Methodology to Modernize Operational Excellence

[View Research](#) →

Industrial Transformation Resource Guide (cont.)

QUALITY, COMPLIANCE

RESEARCH | Quality 4.0 Impact and Strategy Handbook

[View Blog](#) →

RESEARCH | Driving Operational Performance with Digital Innovation: Connecting Risk, Quality and Safety for Superior Results

[View Research](#) →

RESEARCH | Roadmap to Supplier Status: Think Risk Performance, Not Compliance

[View Research](#) →

ENVIRONMENT, HEALTH AND SAFETY

WEBCAST | EHS 4.0: Using Technology to Reach New Levels of Safety and Environmental Performance

[Watch Webcast](#) →

RESEARCH | Unify EHS and Quality: Capture Synergies and Turn Policy into Action

[View Research](#) →

RESEARCH | The Connected Worker: Mobilize and Empower People to Reduce Risk and Improve Safety

[View Research](#) →

INDUSTRY FOCUS

AUTOMOTIVE RESEARCH | IATF 16949-2016: A Pivotal Opportunity in Automotive Quality Management

[View Research](#) →

AUTOMOTIVE AND A&D RESEARCH | Manufacturing Performance: Automotive and A&D Gaining Momentum with Analytics

[View Research](#) →

LIFE SCIENCES RESEARCH | Quality 4.0 in Pharmaceutical: Use Cases and Advantage in a Digitally Maturing Market

[View Research](#) →

METALS AND MINING RESEARCH | Data for Balanced Scorecard: Driving Profits in Mining, Metals, and Materials Industries

[View Research](#) →

POWER GENERATION RESEARCH | Driving Better Decision Making with Big Data: A Roadmap for Digital Transformation in the Power Generation Industry

[View Research](#) →

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