RESEARCH SPOTLIGHT

MOM AND PLM IN THE IIoT AGE:

A Cross-Discipline Approach to Digital Transformation

Executive Summary

From glorious hype to essential talking point in less than two years — that's where the Industrial Internet of things (IIoT) is today. Every manufacturing executive should now have Digital Transformation near the top of his/her strategic to-do list. The ones who achieve success with it are those that turn Strategic Objectives into a series of projects to transform and align enterprise processes, technologies, and people into those required for Smart Manufacturing. Discrete manufacturers that invest in the opportunities presented by Digital Transformation will achieve the promise of transformational value only by aligning the processes, technology and especially the people involved in information technology (IT) and operational technology (OT); they will achieve IT/OT convergence.

This spotlight report examines how manufacturing operations management (MOM) or the manufacturing execution system (MES) are key enablers of data management and Digital Transformation. Companies can combine many other opportunities with manufacturing operations in a digital journey. This spotlight also explores product lifecycle management (PLM) as a high-value discipline to pair with MOM in discrete manufacturing, and the value of digital continuity across engineering, manufacturing operations, and supply chain.

Finally, we will probe a robust integration of MOM and PLM technologies and the advent of the Digital Twin (a virtual copy of the product and how it's made) to demonstrate maturity in Smart Manufacturing and the ability to make smart products in smart factories.

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>
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> *Principal Analyst*

Level-Setting MOM

Manufacturing execution systems (MES) have been around in various forms for 30 years. It has satisfied, often well and occasionally inadequately, a specific goal: provide a solid reporting and execution system for plant floor operations. More recently, some options have evolved to provide a much broader solution set beyond the production process, to include supporting functions such as warehousing, quality, maintenance, plant scheduling, planning, and analytics. Many define this broader solution set as manufacturing operations management (MOM),

but LNS Research prefers to not differentiate too much between MES and MOM. Instead, we recognize that the variety of solutions provide a wide range of functionality and we use MOM to express that variety.

ISA-95 Not Left Behind

Our industry is fortunate to have an excellent standard, ISA-95, that is a universally accepted definition of the functions that a MOM system should be capable of, and how it should communicate with other systems. Although the standard covers detailed communication and data structures, it is the higher-level interfaces and the communication between layers that is most useful to those who are working on Digital Transformation in the manufacturing enterprise.

Timeliness is Relative and Contextual

The LNS interpretation of the ISA-95 standard shows the functional layers and highlights other important aspects of a manufacturing operations architecture: timeliness and integration maturity.

Timeliness is a critical concept in a traditional architecture and Digital Transformation alike. Many people claim that their systems work in "real time," but that is an almost meaningless statement unless it's

heavily qualified. For a high-speed canning line filling hundreds of cans per minute, the control system reaction time must be milliseconds, while an operator managing such a machine would only react to changes in status or an alarm in a matter of seconds (if you're lucky). Meanwhile, the plant manager would need to know the impact of a line stoppage within minutes or perhaps close to an hour. What each person or machine needs is information (not just data) in a timely manner: timeliness is contextual.

When used properly, the traditional ISA-95 hierarchy from physical assets at level 0 through control, supervision, business management, and planning, helps manage timeliness effectively. It makes no sense to require an alarm on an operator's screen within ten milliseconds when his typical reaction time is two to three seconds.

"It Integrates" Doesn't Necessarily Mean "To Your System"

Integration maturity is a key issue illustrated in the LNS take on ISA-95. Most MOM solutions claim to have standard out-of-the-box integration with business systems (especially ERP). However, our manufacturing clients almost always view integration as one of the highest risk elements of any implementation. For every manufacturing company, a key criterion in choosing a MOM solution is that the vendor has a proven record of integrating with their specific business systems. The interface between plant and business serves many functions. Information sent to the plant from the ERP might include recipes, orders, schedules, and work instructions. Reporting back from MOM to ERP, and other business systems such as supply chain may include completed jobs and quality information.

As you integrate downwards from MOM into the plant, standard protocols and networking have evolved enormously over the last decades; few today have connectivity difficulties, at least for the control hierarchy. The majority of new devices use the OPC UA standard, and many older ones support it as well. Most MOM suppliers have also amassed a substantial set of native interfaces for older equipment, so connectivity is a non-issue. However, when starting a project, it's important to understand downstream and upstream data communication requirements thoroughly. This detail ensures you avoid disruption caused by the need to change existing systems, especially connections upwards to business systems.

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How has MOM's role changed?

The IIoT is changing the role of MOM in manufacturing companies. That doesn't mean we think anyone should toss out the ISA-95 control hierarchy, but the breadth of data and some data flows will grow by applying IIoT.

One of the IIoT trends LNS predicted last year was the rapid growth of smart connected devices in the plant. These devices provide access to information about equipment that was not previously available. They are simple Internet connected devices with inputs that were not available (or not used) in the control system. Today they are very often used for asset performance management (APM) and are connected directly to an IIoT application through the Internet connection. This approach avoids conflict with the control hierarchy, and the expense and risk of modifying control systems.

The connection between control and business systems serves many more purposes in a connected world than was the norm in the past. IIoT platforms can help to provide consistent interfaces with the control hierarchy plus make connections to smart devices. However, this is not as big a driver in future architectures as the need to deliver business processes that add value to the new data being generated and shared.

Thinking Broader Integration?

As systems, including ERP, MOM, quality, design, and APM expand with IIoT connectivity or connect to an IIoT platform, the breadth of data captured will become available to all other systems; there will no longer be a rigid control hierarchy. However, implementing that hierarchy for control purposes will provide the same ISA-95 functions when required. The key to bring data together to deliver value is the ability to create business processes and the data structures they need when required. It is vital to ensure the Operational Architecture can handle the business processes as much as the data.

Even when starting out, manufacturers will want the ability to define and build business processes to drive better use of data across the enterprise. A well-selected MOM solution is a great place to begin, since you can build business processes to demonstrate the usefulness of manufacturing data to other apps plus address integration issues with business systems. Perhaps the best reason for implementing early in a Digital Transformation program is to bring people together.

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IT and OT Work Together

As MOM matured over the last three decades, it grew to fill a big gap between business and control systems. This gap is also partially filled by people from Information Technology (IT) and partially by people from operations. In many companies, the separation of skills and disciplines has caused difficulties in getting the best results from the integrated whole. Rather than dwell on the past, fast forward to when IT and OT convergence happens, not just technically but also between teams.

As we move to a fresh Operational Architecture that involves new connectivity standards such as OPC UA for IIoT, other IIoT devices, connections between controls, the plant and business (and indeed beyond the enterprise walls), it will require both IT and OT skills. For example, a new connection of a smart sensor will require a physical connection in the plant, connection to and configuration of the Internet network, definition or configuration of the data model and security certificates, and then use of the data in whatever apps that have access to it. The people involved in such a simple addition range from plant engineers to IT systems people, security, and perhaps all the way to data scientists if the new information is integrated into analytics solutions. Success of such projects, and, of course, much larger ones, will require organization, teamwork and excellent cooperation. The most important people for future success are, of course, day-to-day users.

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So Much Data, Untold Uses

Perhaps the biggest change that will occur on the Digital Transformation journey is an explosion of uses for data. The control hierarchy that many plants have used for data management will become just one part of the data flow in and beyond the enterprise.

Instead of passing data between PLM, MOM, ERP and IIoT/IoT apps and enabled devices, data will be published on an enterprise data platform, providing access to anyone or any application with proper authority, regardless of the data source. This changes everything — publishers of data have historically defined the use before deciding exactly what data to provide. In a digital world, data is ubiquitous, and use will be wholly or partially unknown when it's published. Indeed, novel uses of data will be created by individual users as they learn about the flexibility of apps and availability of information. It's an environment that allows everyone to do their job better.

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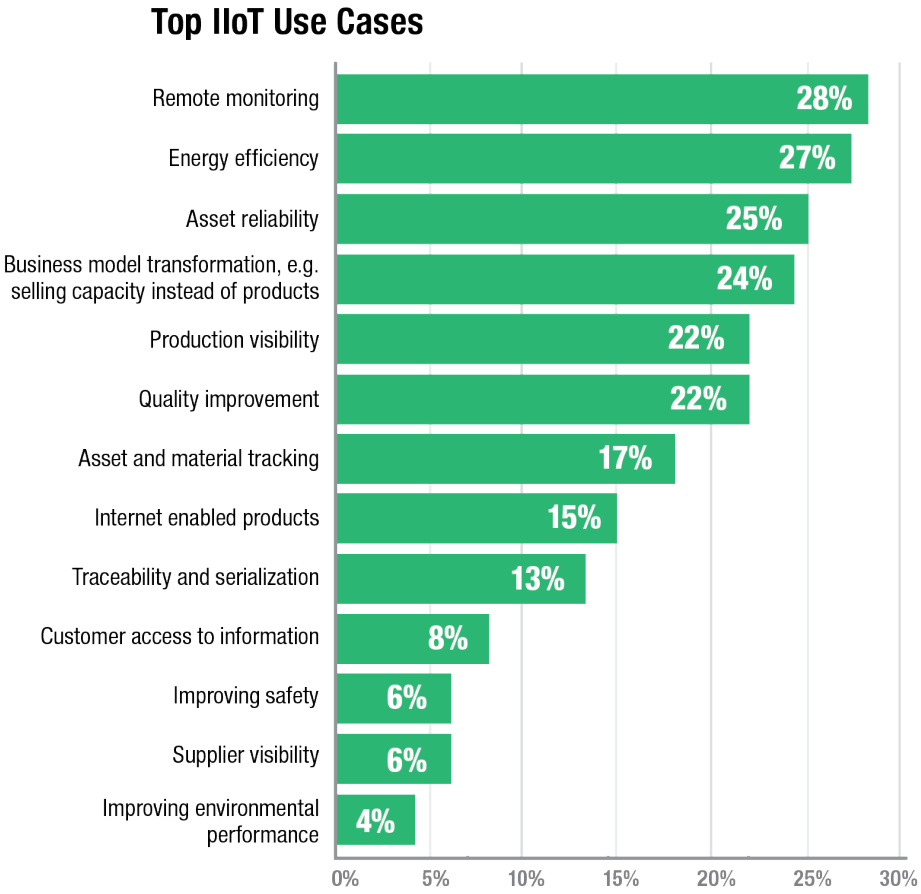


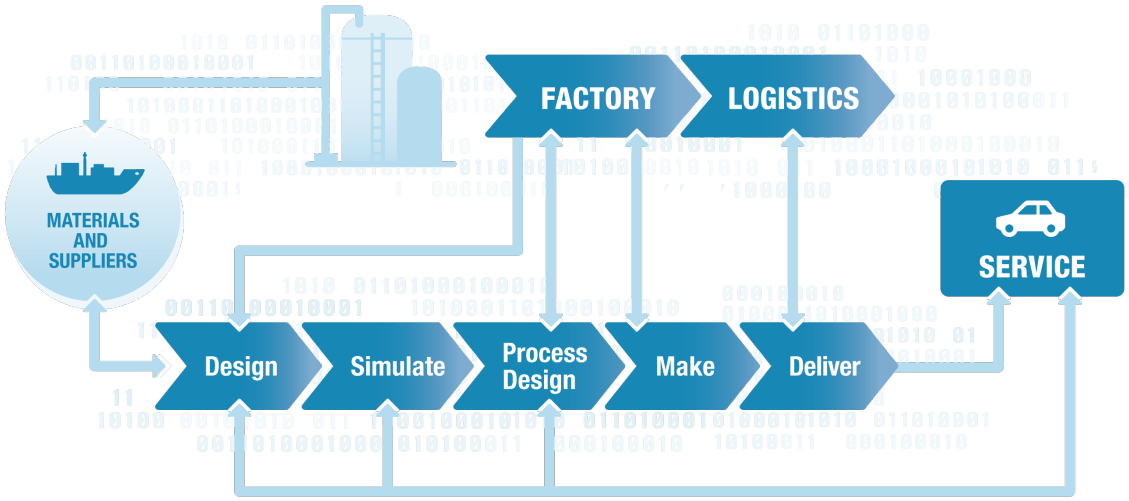
In many plants, data flow is currently restricted or non-existent because it's not needed for control; even the data needed for control might be handled manually. LNS believes that MOM information is a great starting point for Digital Transformation. However, there are many other sources of data that can publish to a business platform and equally used for new business processes. These include asset performance management (APM), a favorite of IIoT vendors but beyond the scope of this spotlight, new product introduction (NPI), customer interface and product lifecycle management (PLM).

Bigger Horizons with Digital Transformation and PLM

MOM has traditionally focused on manufacturing, but recent advancements allow for the integration of the entire product lifecycle. This will improve NPI and manufacturing quality, plus help change the way we design products and improve productivity across engineering and manufacturing. Starting from 3D design, we go through many types of product simulation, to the design and simulation of the manufacturing

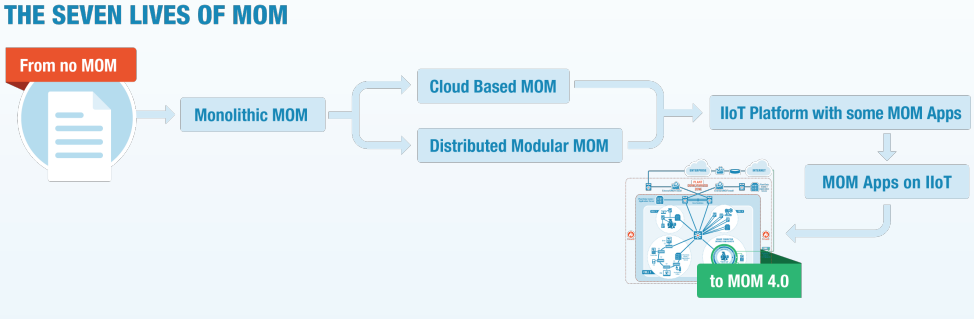
process itself. We call this manufacturing process management (MPM); it's where the worlds of MOM and PLM come together.

The PLM marketplace has long been an advanced digital world. However, most PLM deployment is across the early stages of product development; PLM came from 3D design, so this is no surprise.



Feeding data from MOM, APM, customer feedback and others will undoubtedly unlock PLM information to much more of the product lifecycle than just design. Being able to design, simulate, make and service all from the same data set is a very attractive prospect; it will improve and speed innovation as it extends to the field, and will especially aid rapid detection of quality problems at ever earlier stages of the lifecycle.

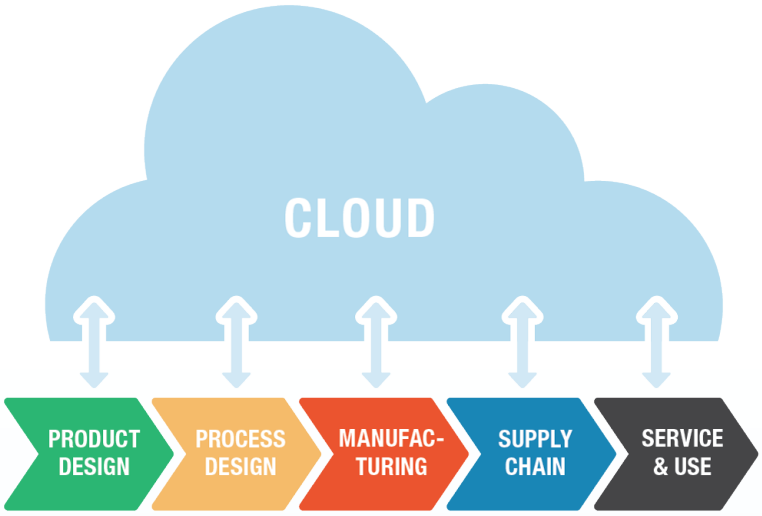
The potential for feedback loops is everywhere as data is consumed, analyzed and shared among processes. What becomes clear is that an MES with a separate, private database for internal information is not going to be the way forward for data management in this complex intercommunicating world. Certainly, architectural choices are important; learn more by reading the introductory article, The Seven Lives of MOM.



Bigger, Better Data Sharing

Product lifecycle management is becoming a major platform for data sharing across nearly every aspect of the product lifecycle. Traditionally, PLM systems tended to focus on the early stages of product development and introduction; more recently they have evolved into holistic business platforms for innovation. This is the platform concept that leads us to consider the role of PLM and IIoT as discrete manufacturing companies mature their digital landscapes.

Today, innovation-based business platforms certainly seem like a good place to start sharing information across many more business processes. For example, supply chain models could use parts of the innovation platform for managing their specific needs for complex planning and scheduling. Building models for design, MOM, supply chain and customer experience on such an innovation-based business platform could provide some unique opportunities for manufacturers.



There is now a lot of highly valuable functionality running on PLM platforms, and there's surely competition from new vendors in the IoT and IIoT segment, systems designed to bring together data from across and beyond the enterprise. IIoT platforms compete with the business platforms that have grown out of PLM, MOM, and other manufacturing processes. Manufacturers have to make choices to define the backbone for Digital Transformation and Smart Manufacturing. For example, they must support Cloud to Edge data management, connectivity across the Internet, Big Data analytics and support for business process

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development and management. Software vendors target innovation-based business platforms to handle the design-to-manufacturing process including simulation and software development, often termed application lifecycle management (ALM), and manufacturing process management (MPM).

Innovation-based business platforms and IIoT platforms have similar goals but deliver these goals differently; manufacturers must carefully consider their Operational Architecture to determine how the PLM, MOM, and SCM functionality, the IIoT apps, and the data can work together. One possibility is to go with a single vendor and choose an IIoT platform based on the current PLM, SCM and MOM system; alternatively, you could change PLM, SCM, and MOM supplier to meet your IIoT choice. Given the relative maturity of the domains, we don't recommend the drastic latter action just yet. On the other hand, putting your current PLM, innovation-based business platform supplier's IIoT platform on your short list for initial IIoT projects can do no harm. There is no doubt that PLM functionality is merging with IIoT to drive even more value from the entire product lifecycle.

As we see the approach of PLM to IIoT, it begs the question, "What about MOM?" In discrete manufacturing of complex and mass-produced products (cars, industrial equipment), we already see a move to much more than simple data collection. Defining MOM from PLM and MPM enables a completely integrated view of the design, the product, and how it's made; it's the start of a genuine Digital Twin.

How Does Digital Twin Fit In?

One frustration among industrial companies created by IIoT hype is that most of it is aimed at asset-intensive industries and management of their assets. Those of us that work in design and product-driven industries sometimes feel left out. However, the future is very bright. The advent of high power simulation, manufacturing process design, and intelligent products opens unlimited opportunities, all imagined through the concept of the Digital Twin.

There are as many definitions of Digital Twin as there are manufacturing pundits writing on the subject, and we don't intend to stir the pot in this short offering. Our take on the ultimate Digital Twin is to give it the Turing test: can a person differentiate between interacting with the product versus the twin? The digital twin will, of course, include the product, its environment, how it's made, and how it's maintained.

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Imagine testing changes to a MOM system using the digital twin and then deploying directly to the manufacturing line. The possibilities are endless and will continue to emerge as we bring PLM, MOM, IIoT and the outside world of the Internet of Things itself closer together. It all boils down to one simple goal: we need smart design and smart factories to build smart products. Ultimately though, the promise requires profit too; how do we deliver more than ROI from the IIoT and MOM?

Think Bigger Than ROI

Digital Transformation is a long journey. Initial IIoT investments aren't for making money, they're for proving the concept. We strongly encourage manufacturers to think big and start small; each step should focus on the long-term goals. For example, deploying a MOM system as an initial project and integrating small IIoT projects for some areas can deliver quick value, and highlight gaps in people, processes or technology, or reveal bigger opportunities.

Moreover, leveraging existing MOM investments is one way to explore new areas of IIoT and provide real business value. In some markets things like better genealogy, as-built and as-maintained integrating design, build, and maintain in one record and for the Digital Twin could help deliver early value and demonstrate that Smart Manufacturing is indeed a smart policy.

Small steps pave the way to the compound the benefits of the IIoT and broader integration and usually include faster NPI, higher initial quality, and happy customers.

Recommendations

The time for talking is over; manufacturers must act now or lose ground to their competitors. Platforms to drive Digital Transformation are maturing quickly so forward-looking manufacturers can start to make strategic choices. Take these important first steps immediately:

DEFINE LONG-TERM STRATEGIC OBJECTIVES for IIoT and Smart Manufacturing, not just for manufacturing operations, but for the enterprise.

CARVE OUT INITIAL PROJECTS AND BUILD AN OPERATIONAL ARCHITECTURE that will take you forward to become a digital enterprise. The Operational Architecture provides the definition and structure to bring all the data producers and data consumers together in platforms and storage, to communicate without excessive programming.

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DETERMINE HOW EACH STEP WILL IMPROVE SPECIFIC METRICS such as time to market, cost, delivered quality, customer satisfaction or others.

While the IIoT has opened a world of opportunity for manufacturers, in many ways the world hasn't changed. The key to understanding and capturing business value is how your organization conducts the digital journey.

Presented by:

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