More Than Technology Is Driving the Factory of the Future

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To develop a roadmap for the factory of the future, manufacturing line of business leaders must navigate numerous political and industry frameworks, balance technology infatuation with business strategy, and synchronize with manufacturing excellence initiatives.

Impacts

■ In manufacturing, the explosion of factory of the future initiatives from government, industry trade associations and consortiums has reached a tipping point and is creating confusion for companies seeking to develop a holistic strategy.

■ The technology-heavy allure of the factory of the future is overshadowing the need for manufacturing leadership to construct and integrate new process capabilities with the supply chain.

■ Not considering how key projects, new performance measures and processes for innovating manufacturing will integrate across various supply chain functions is creating unmanageable constraints and driving operational excellence in isolation.

Recommendations

■ Drive top- and bottom-line impact by dissecting factory of the future initiatives into their individual components and facets with an underlying focus on "industrial productivity beyond national and consortium borders."

■ Map the factory of the future from the outside-in versus relying on capability development and technology acquisition in granular silos. The mutual reinforcement of technology and process capabilities in line with business outcomes will enable differentiated levels of quality, velocity or flexibility in production.

■ Align factory-level operating strategies with the supply chain to synchronize manufacturing excellence with the fundamental requirements of metrics, change management and technology enablement.
Analysis

The factory of the future (see "Factory of the Future Strategies Innovate How Production Delivers Value") is evolving at a blistering pace. Manufacturing line of business leaders are being forced to rethink, redesign and innovate manufacturing’s strategies and invest in new process capabilities (see Figure 1).

In the past 36 months, an abundance of industrial productivity frameworks, policies and initiatives under the banners of Industrie 4.0, smart manufacturing, or smart or digital factory have materialized. These initiatives all promote the use and leverage of enablers only available in the digital world, such as the Internet of Things (IoT), smart machines, operational intelligence and cloud computing. The resulting vignettes of the factory of the future are alluring, and aligning modernized and innovative factory capabilities with the supply chain is no easy ask.

The factory of the future impacts plan, source, make and deliver functions. Misalignment of modernized and innovative production capabilities with other supply chain functions will result in local optimization versus value stream optimization, and will not deliver on the outcomes and returns intended. Consider the scenario of capitalizing on the affordability of sensors and cloud-based analytics to develop models to depict the ideal performance of a packaging line or other critical plant asset. This can certainly improve the efficiency or flexibility of the factory. But, will that performance improvement opportunity be connected with other supply chain processes? Or will production only create constraints and issues for other supply chain functions like warehouses shouldering inventory carrying costs or other unwanted complexities to manage?

This current episode of digitally led modernization of manufacturing’s capabilities is moving fast — and it is a speed that manufacturing operations are not used to. Several Gartner clients report there is uncertainty as to which framework, facets, technologies or combinations thereof to adopt, resulting in more confusion than defined strategies and roadmaps.
Impacts and Recommendations

In manufacturing, the explosion of factory of the future initiatives from government, industry trade associations and consortia has reached a tipping point and is creating confusion for companies seeking to develop a holistic strategy.

Corporate operating strategies will create differentiated ways to leverage — or drive — the initiatives in Figure 1, and it is wrong to consider any one initiative better than another.
Figure 2. Heritage of Initiatives Impacting the Factory of the Future

Legend
- Government
- Consortium
- Trade Association

MESA: Manufacturing Enterprise Solutions Association International
VDMA: Association of German Engineering Federation
BITKOM: Federal Association for Information Technology

Source: Gartner (September 2015)
The heritage of the various consortiums, trade associations and nationally driven programs in Figure 2 might differ, but their core concepts differ minimally and are borrowed from one another in an effort to portray a unique view of what the factory of the future can look like. The differentiation is blurred by:

- Promoting industrialization and innovation of factory models and setups through advanced technologies. These objectives are anchored by increasing integration, digitalization and automation. Integration, while cliché, is apropos in these discussions.

- Developing a sustainable pipeline of engineering, math, analytical and science skills that are transferrable across sector.

- Driving innovation incubation and co-development by combining industry, technology and service providers, machine builders and OEMs, academia, and government organizations. Nationally driven initiatives focus on localization of these initiatives while consortia are more cross-border in their designs.

While some stakeholders gravitate toward national initiatives because of the economic opportunities that promote local production — caveat emptor. Many initiatives carry risk, especially if there's political instability. Moreover, government alone will not drive the factory of the future, which is why several companies are compelled to move faster than consortia to achieve market advantage. Most consortiums are spawned from national programs. Industrie 4.0 started as a German government initiative, but its reference architecture and programs that are being carried have influenced several consortiums. Additionally, the U.S.-based Digital Manufacturing Design and Innovation Institute (DMDII) has directly benefited from both government (under the Advanced Manufacturing Partnership) and corporate financing.

As a whole, consortiums offer the most immediate access to co-innovation opportunities to develop new industry standards and processes with supply chain potential. Even if competitors are involved, the overall cost reduction and time savings that can trickle into the supply base (in turn, stimulating small to midsize companies) are beneficial enough to justify participation and industry revitalization. There is still caution as test projects and standards take time to develop.

Regardless of the initiative and the body leading it, the ideals are broad-sweeping, which helps them gain momentum. In tactical strategy development and best practices for strategy and roadmap development, however, they are lacking. Additionally, several of them eye manufacturing excellence in isolation. As an example, several factory-centric initiatives acknowledge inbound/outbound logistics versus the supply chain function itself as an integrated component.

**Recommendations:**

- Drive top- and bottom-line impact by dissecting factory of the future initiatives into their individual components and facets with an underlying focus on "industrial productivity beyond national and consortium borders."

- Make consortium participation a strategy with dedicated resources. Find the right projects and initiatives to align with that can address customer requirements and the supply chain strategies
for your target markets. Protect your product IP and focus efforts on co-developing common processes and standards that benefit your supply chain.

The technology-heavy allure of the factory of the future is overshadowing the need for manufacturing leadership to construct and integrate new process capabilities with the supply chain.

As scalable deployment models (e.g., cloud) and the entry costs for many technologies continue to drop, manufacturers are more easily enticed to buy in haste. A reactive approach to technology investment is risky and counterintuitive to expectations of sustained excellence and process innovation.

The framework in Figure 3 provides manufacturing strategists a continuum to deliberately identify opportunities and focus investments based on business outcomes.
Figure 3. Continuum for an Outcome-Based Approach to the Factory of the Future

<table>
<thead>
<tr>
<th>Supply Chain and Business Outcomes</th>
<th>Performance Teams and Level Within Manufacturing for Capability Development</th>
<th>Impact on Manufacturing Strategy and Systems</th>
<th>Technology and Systems Enablement/Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand and Cash Visibility</td>
<td>End-to-End Supply Network</td>
<td>Production Systems Deployment</td>
<td></td>
</tr>
<tr>
<td>New Market/Segment Expansion</td>
<td>Region/Market</td>
<td>Digitalized Processes</td>
<td></td>
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<tr>
<td>Agility Within Existing Markets</td>
<td>Site-Level</td>
<td>Flexibility</td>
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<tr>
<td>End-to-End Supply Chain Visibility</td>
<td></td>
<td>Process Automation</td>
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<tr>
<td>Align Supply Cycles With Demand Patterns</td>
<td></td>
<td>IT/OT Skills and Talent</td>
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<tr>
<td>Design and Manufacture Anywhere</td>
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<tr>
<td>Continuous Improvement and Lean Supply Chain</td>
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<td>Access to Data and Information</td>
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<td>Sustainability</td>
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<td>Smart Machines and Advanced Analytics</td>
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<td>Manage Portfolio Complexity</td>
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<tr>
<td>Traceability and Compliance</td>
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<td>Security</td>
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What is the business goal and how will manufacturing support it? Where does the focus need to be? Where do capabilities need to be built/improved? What are the supporting technology investments and deployment models?

Source: Gartner (September 2015)
The framework lessens the technology-first predisposition of the factory of the future by:

- Identifying what levels of manufacturing require focus (down to individual work processes), what new capabilities should be developed or improved, and where technology investments are needed to meet specific outcomes.
- Surfacing opportunities for experimentation and specific pilot programs to ensure feasibility of new technologies and processes so that companies can either fail fast with minimal risk or determine, based on successful projects, how to drive scale. Experimentation is necessary, and some companies report managing over 20 different pilots based on differing business needs.

Once outcomes and capabilities are determined, the technology investments can be pinpointed. In some cases, core infrastructure investments (like wireless LAN) are needed to track materials and support either gateway devices or mobile content access for quality inspectors or maintenance rounds. In other instances, cloud models for scale and collaboration could be necessitated. In some cases, the framework can identify more complex opportunities with strong returns.

For example, an automaker improved the quality and traceability of the bolt-tightening process in its transmission production by codifying expert knowledge into an automated system. It worked with Bosch Software Innovations to develop an IoT-based application to provide early warning and fault detection in the bolt-tightening process. Each tightening tool was provided an IP address and integrated into a rule-based application that monitored over 400 different tightening points at one time (including torque value and bolt angle). The program is active at one site responsible for 40% of the transmission production volume. By automatically detecting nonconformances, process disruptions have been reduced by 50%.

Recommendations:

- Map the factory of the future from the outside-in versus relying on capability development and technology acquisition in granular silos. The mutual reinforcement of technology and process capabilities in line with business outcomes will enable differentiated levels of quality, velocity or flexibility in production.
- Understand the intended outcomes and their impacts on total and operating cost structures in order to make trade-offs against specific structural costs that are identified. Use value stream mapping to ensure that process capabilities and technology investments are aligned with other functions (e.g., logistics) and the desired outcomes of the business versus improving localized processes.
- Focus on the art of possible and create capabilities otherwise unachievable before. Using desired outcomes to justify "rip and replace" strategies is costly and narrow.

Not considering how key projects, new performance measures and processes for innovating manufacturing will integrate across various supply chain functions is creating unmanageable constraints and driving operational excellence in isolation.
execution, and develop shared risk-and-reward models (see "Overcome Misalignment of Objectives Between Plant and Business to Execute the Factory of the Future Strategy"). Factory of the future requirements need continuous design and modification — or, at a minimum, assessments on a yearly or semiannual basis — to ensure alignment and optimum performance but ensuring the following:

- Manufacturing processes align with the supply chain strategy by focusing on the relationship of plan, source, make and deliver in the role of inventory (form and function) to deliver against the business strategy.

- The manufacturing network is designed for both outsourcing and in-house production by planning on a global basis how supply response will be executed locally. It's at this level that demand-driven processes must be designed to support integrated manufacturing capabilities.

- The core strategies for manufacturing excellence and the related supply network for local execution at each site are executed without overlooking improvements in quality, cost, cycle times, decision making, and information availability/usage.

- A technology strategy is centered on operational intelligence for improving decision making and the transparency/reliability of operations versus investing in siloed applications. The latter only increases latency and extends decision-making cycles. This doesn’t overrule investments in functional applications like manufacturing execution systems (MES) or quality management systems (QMS) might require investments or redeployment.

Misalignment between factory and business operating strategies will result in offsetting capabilities and incentives. This will drive divergence not convergence, alignment and scale.

**Recommendations:**

- Align factory-level operating strategies with the supply chain to synchronize manufacturing excellence with the fundamental requirements of metrics, change management and technology enablement.

- Use the factory of the future and associated smart manufacturing concepts as a platform to engage plant-level and business-unit leadership in dialogue to understand their differentiation and jointly define opportunities.

- Develop shared financial risk and incentives for factory-level technology adoption that lessens the burden of success on individual factories and production units.

**Gartner Recommended Reading**

*Some documents may not be available as part of your current Gartner subscription.*

"Hype Cycle for Leaders of Manufacturing Strategies, 2015"

"Factory of the Future Strategies Innovate How Production Delivers Value"
"The Five Things Chief Supply Chain Officers Need to Know About Industrie 4.0"
"Design and Align the Supply Chain Strategy Primer for 2015"
"Supply Chain and Operations Trends and Innovation Primer for 2015"
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