Informed Manufacturing: Reaching for New Horizons

Although still in its infancy, informed manufacturing – making the right data available in the right format at the right time – is progressing across industry sectors. Nonetheless, our primary study confirms that conflicting priorities prevent many companies from fully embracing this transformative model.
Executive Summary

Earlier this year, Cognizant published a white paper outlining the concepts of informed product, informed process, informed people and informed infrastructure – providing specific examples of how informed manufacturing can transform each of these areas.

As a follow-up, we conducted primary research to explore these themes in greater detail, and gain deeper insight into how different companies view informed manufacturing. The study involved in-depth interviews with CXOs at manufacturing companies, engineering firms and service providers across geographies; technology providers (those that serve manufacturing companies); academia (engaged in active research on manufacturing) and industry analysts (see Appendix 1, page 18).

The study revealed that most companies recognize the significance of informed manufacturing and have already begun the journey. However, the adoption of informed manufacturing remains nascent, and the focus – even where implementation has begun – is on furthering research to gain a better understanding of the requirements for chalking out a roadmap.

While acknowledging the importance of informed manufacturing, many companies are yet to feel a burning need for such capabilities, and are proceeding cautiously. A key challenge is balancing the conflicting priorities of managing ongoing business while keeping a sharp eye on innovation and breakthrough initiatives. Concerns over information security and regulatory ambiguity also inhibit the investigation of informed manufacturing technologies. External support – be it from technology providers/consultants, collaborative workgroups and forums, or seminars and training sessions – is seen as critical in speeding the adoption of informed manufacturing.
Key Findings

Our study revealed some key considerations that companies should keep in mind when planning, developing and implementing initiatives for informed manufacturing:

- **Informed products are well established; informed processes are still nascent.** Nearly 79% of our study respondents said they had started implementing informed products in one form or another; 37% said that 50% or more of their products fall into this category.

  Informed product data is used for one or a combination of three of the following: product identification, track and trace, and product-condition monitoring. Track and trace initiatives are fairly well established, thanks to the prevalence of barcoding, RFID, etc.; in fact, 82% of study respondents said they are using these technologies to enhance supply chain visibility. Automation of product-condition monitoring is not as prevalent, but is garnering acceptance; roughly 53% of respondents said they had at least partially automated this functional area. While most companies use product data internally, there is a growing recognition that sharing relevant data with external stakeholders can yield significant benefits.

  For example, access to product-tracking data can help dealers and distributors improve supply planning and make more informed customer commitments. Sharing product-performance data from the field with concerned suppliers can help in developing better products and controlling warranty costs.

  Many companies apply analytics to product data to make more informed decisions and improve overall quality and productivity. Some use analytics in conjunction with process data to enhance process control, although process changes and adjustments are still handled manually. The integration of product and process information to enable process automation is still in the early stages, but gaining ground.

- **Informed people are seen as a critical pillar for informed manufacturing.** Most organizations we studied are putting infrastructure and solutions in place to enhance collaboration among employees. In fact, 48% of study respondents said they allocated more than 5% of their IT budgets to these efforts, mostly for building knowledge platforms to be shared across geographies.

  Social networking is seen as an important enabler for collaboration. However, most of today’s manufacturers use social tools primarily to foster internal collaboration and share information from other stakeholders across the extended value chain. Active collaboration with external stakeholders and customers on conventional social media platforms is not a focus area.

  Despite the existence of collaboration tools, study respondents noted that their adoption of these technologies – even for internal purposes – is not widespread. Indeed, 68% of respondents said that employees in their organization preferred to use personal networks to find expertise, rather than utilize knowledge-sharing platforms or tools. While there are several reasons for this, what emerges is the criticality of training and change management to enable employees to transition to new technologies and platforms.
One thing is clear: The path to informed manufacturing excellence is unlikely to be sequential in nature – i.e., it is not necessary for a company to achieve the same level of maturity across three pillars – product, process and people – before moving to the next level. Based on individual focus areas, capabilities and priorities, manufacturers can choose to progress further in one area than in others. However, achieving excellence in one will not be possible if it is isolated from the other two.

From our analysis of the responses and input from our subject matter experts, we developed a maturity framework that represents the stages through which a company can progress – from a base-level understanding to excellence – along the three pillars of informed product, process and people. In this way, organizations can quickly ascend the learning curve and master the disciplines necessary for excelling in informed manufacturing.

Finally, we synthesized the collective insights from all respondents into five key insights that companies striving to master informed manufacturing can embrace and apply to their businesses.

**Informed Manufacturing: A Journey Just Begun**

The concept of informed manufacturing is not new to most companies. While increasing competition compels manufacturers to continuously innovate to reduce costs, improve quality and accelerate delivery, emerging technologies such as the SMAC Stack™ (social, mobile, analytics, and cloud) have made it possible to meet these challenges and take manufacturing to the next level.

Nearly all study respondents told us they have plans to adopt informed manufacturing (see Figure 1); more than half (52%) revealed they have already embarked on the journey. Approximately 60% of respondents were still gathering information, while 40% said they were involved in R&D.

Interestingly, even among those that were in the “information-gathering” stage, a few had actually begun implementation in select areas.

What is clear is that in executing informed manufacturing, companies have not limited their scope to the shop floor or even internal processes. Many have broken boundaries by focusing externally on areas such as sales or service, based on their strategic direction and their priorities.
For example, a UK-based engineering company has enhanced its sales forecasting by combining RSS feeds on product information from registered users with the data from previous RFP responses. In APAC, a commercial vehicle manufacturer told us that its informed manufacturing initiative is customer-centric and focused on services. The company tracks product performance data from the field and uses it to improve customer service.

Other options that organizations are pursuing include:
- Investment in RFID
- Automated warehouses
- Collaboration tools
- Manufacturing execution systems
- Big Data analytics
- Barcode synchronization

**Informed Manufacturing: Changing the Game**

Given the pace of change and competitive pressure facing today’s businesses, all respondents made clear that they cannot remain indifferent or non-committal for long when it comes to adopting informed manufacturing (see Figure 2). While 33% of respondents said that informed manufacturing is critical to their business today, the percentage rises to 80% when we view the outlook over the next three to five years.

Several respondents noted that their companies have identified informed manufacturing as a focus area, and thus have a clear idea of the capabilities needed. However, these organizations face a significant hurdle when it comes to dedicating resources and funds for such long-term, capability-building initiatives, given the more urgent priorities of managing day-to-day business concerns.

**Building a Strong Business Case Amid Conflicting Priorities**

While most companies acknowledge the criticality of informed manufacturing over time, they do not feel a pressing need today, and are proceeding cautiously. (Figure 3 on the following page points to the obstacles).
Supporting this prudent approach is the fact that investment decisions are largely driven by ROI considerations; it is typically difficult to find a quantified business case for fundamentally new concepts like informed manufacturing. Other priorities also compete for investment, including projects that are likely to yield immediate benefits.

Another challenge is the significant publicity and media noise surrounding new technologies, which makes it difficult for senior management to make informed choices on investment directions and decisions. As one study respondent from a major engineering company noted: “Currently, there is a lot of talk, but very little action on the ground for concepts like ‘Internet of Things’.” Concerns about data security and (lack of) comprehensive regulations in areas such as data transparency also dampen the motivation to invest in these technologies.

Clearly, managing conflicting priorities is an imperative. Yet it also presents a dilemma. To help deal with this conflict, manufacturers should look at developing a distinct information-management strategy and business plan for long-term capability-building, backed by a separate budget and performance measures. This will help ensure that short-term priorities and issues do not mask areas that are critical to survival and growth.

One area where most respondents indicated the need for additional knowledge and external support is digital initiatives – efforts designed to spur innovation and drive differentiating opportunities. Respondents also sought guidance, or “hand-holding,” during implementation.

What Barriers Do You See Impeding the Adoption of Informed Manufacturing?

![Figure 3](image-url)
Given the lack of experience and/or knowledge in informed manufacturing, most respondents look to external support for help in various ways (see Figure 4). As one respondent put it, “We need to learn to walk before we can run.” “Big bang” adoption of informed manufacturing was discounted by all respondents. At the same time, companies that are able to manage conflicting priorities and quickly conquer the learning curve by leveraging external support are likely to emerge as leaders over the next three to five years. The imperatives are clear.

The nature of support a company seeks for informed manufacturing depends on how far the effort has progressed. We observed that companies that have already started implementation in some form typically look for support from external technology providers or professional services / consulting firms. Those in the “information-gathering” stage look at options like collaborating across workgroups for knowledge-sharing, and attending training programs or seminars to gain awareness.

For most companies, product information is key to monitoring business performance and making better decisions. This is particularly relevant for businesses that manufacture or handle discrete products. As a result, a majority of study respondents felt they are already implementing key aspects of informed products in their businesses (see Figure 5, next page).

The concept of informed product pertains to a scenario where advanced sensors, controls and software applications work together to obtain and share real-time information about products. Informed products enable machines to take autonomous actions on the shop floor, provide visibility and traceability across the supply chain, and support remote diagnostics and condition-monitoring while in use.
For some companies, this takes the form of sensors or RFID tags to facilitate the tracking of a product across the supply chain. For others – such as automotive OEMs – efforts can be around embedded systems to track and monitor product performance.

Irrespective of the current level of adoption, there is a unanimous sense of focus on making products more informed. Organizations that are already implementing initiatives in this regard are looking to widen their scope, and make the majority of their products informed and connected. For example, an auto OEM from North America mentioned that while “all product lines have embedded intelligence,” investments are also being made in areas such as “connected car” and smarter vehicle systems. A major European engineering firm said it is looking to “embed intelligence everywhere.”

Informed Products: Key Applications

Product information typically serves to answer any or all of the following three questions: What is the product? Where is the product? How is the product performing?

The answer to the first question centers on capturing basic product data – product code, name, material, size, etc. – and is generally handled through physical tags or barcoding. The second question pertains to tracking and tracing the product; for example, how far it has progressed in the manufacturing process, or its physical location – information typically captured using sensors or RFID tags. The third question relates to product performance or condition-monitoring – information that is generally captured through embedded sensors.

Supply Chain Tracking

Most companies we studied have implemented solutions for product tracking, as evidenced by the fact that 82% of respondents told us their supply-chain tracking processes were either fully or partially automated. While supply chain track-and-trace technology has been used for a long time, considering the popularity and reduction in cost of sensors and RFID tags, companies see this as a critical enabler for the informed product (see Figure 6). Also, for most organizations, barcoding represents a relatively easy entry point for starting the informed manufacturing journey.
In terms of condition-monitoring, 29% of respondents noted that their company handled this task manually, while 57% said that they employed partially automated systems (see Figure 7). Apart from a company’s own technological maturity, leveraging informed products for condition monitoring also depends on the type of product and the criticality of the information. For example, automotive and construction equipment manufacturers use sensors to monitor product usage and condition, and use this information to enable better product diagnostics and service.

**Product Information: Focused on Internal, Upstream Functions**

Product information is used in a variety of ways within an organization. While product data related to manufacturing can be useful for plant operations and planning, performance data – associated with usage, wear and tear, etc. – is used by other functions, such as engineering, quality control and service.

When asked what functions within their organization will benefit most from informed products, respondents gave almost equal relevance to all key functions – product development, manufacturing and sales, and marketing (see Figure 8). Some respondents told us that the relevance related to a product’s lifecycle stage. For new products, data from informed products would be of greater interest to functions such as product development and marketing; for mature products, functions such as manufacturing, quality and service would find more relevance for such data.

Another insight: Most companies we studied use product information internally; for example, to help internal functions enhance their performance and decision making. Yet in several cases, this kind of information would be of use to external stake-
holders. For instance, car-usage data can be used by insurance companies to tailor their products, and by customers to improve their driving habits. Many companies recognize the potential of external collaboration and are working on reaching out with informed products.

Product information, specifically with regard to track and trace, is one of the easiest entry points for a company seeking to implement informed manufacturing solutions. As processes are firmly established and reliable data becomes consistently available, the company gains confidence that it can then expand the scope of informed manufacturing to include end-to-end supply chain visibility or product-condition monitoring. Further down the road, the company can look to build process automation by integrating product and process data.

**Product/Process Integration: Nascent for Now**

Most companies we studied noted that while they capture and use product data in one form or another, they grapple with how to put this data to the most effective use. Many companies are looking to apply analytics to product data to make more timely and informed decisions on operational improvements or design changes. An executive from a global technology services firm puts it this way: “Inside the four walls – apply analytics in top three areas of safety, productivity, and quality. Use data from products in the field and leverage that data for enhancing design and production.”

In other cases, product data is largely used in conjunction with and to enhance manual processes. For example, while embedded sensors identify a product issue and throw an alert, these actions still require manual intervention to assess the priority and urgency of the alert and take the required corrective action. This is evidence that informed processes are at an earlier stage of evolution compared with informed products. An advanced level of maturity in informed manufacturing would be reflected by the ability to integrate product and process data, and automate process adjustments or shutdowns based on information provided by the product.

**Informed Processes**

Emphasizing bi-directional information-sharing across the global manufacturing value chain – from supplier to customer – “informed processes” lead to a flexible and adaptable supply chain.
While approximately 39% of our study respondents said that informed processes are a lower priority, most expect these initiatives to become significantly important or business-critical in the next three years (see Figure 9).

Most organizations have yet to bridge the gap between informed products and automated processes, although some have taken the lead and made significant progress in this regard. Key initiatives that our research unearthed include:

- A UK-based engineering company is focusing on “standardization of processes and IT systems across multiple locations and plants.”

- A respondent from the process industry said his company is looking to build elements of informed processes into its new plants; for existing facilities, the focus is on incremental improvements with minimal investment and risk.

- Approximately 25% of respondents said that for their companies, the focus of informed processes is on improving supply chain visibility and better integrating demand, procurement and product development data with manufacturing execution systems (MES).

- Roughly 20% of respondents are planning to invest in plant automation systems and MES.

The responses indicate that most players are looking to set in place foundational capabilities, like data standardization and visibility, before moving further. This is a prudent approach, since implementing a full-fledged automated process often requires significant capital investment.

**Focus on Informed People by Increasing Knowledge-Sharing, Collaboration**

Most businesses are aware of the tremendous wealth of knowledge that resides within their pool of employees, and focus on harnessing those assets to benefit the entire organization. Informed people are key – not just for informed manufacturing, but for the overall good of the business.

In our study, 100% of respondents agreed that informed people are important for the organization, varying only in the respondents’ degree of conviction. More than 50% said that informed people have a significant influence in driving improvements within the organization. In most cases, value stems from informed decision

**Informed People**

By connecting people across all business functions and geographies, and providing them with relevant information in real time, “informed people“ can provide intelligent design, operations and maintenance, as well as higher-quality service and safety.
making, rapid response, better collabora-
tion across divisions/geographies, and
developing closer ties with customers.

Innovation in products, processes and
business models is critical for thriving in a
highly competitive business environment;
likewise, collaboration and knowledge
management are key to driving innovation.
Every respondent we spoke with mentioned
that their company has earmarked specific
budgets to build collaboration tools to
enhance knowledge-sharing. For roughly
20% of respondents, more than 20% of
their IT budget was allocated for collabora-
tion tools (see Figure 10). Different options
are being explored to gain and share
knowledge; areas where investments are being made vary – from standard knowledge-
management platforms, to social media, to crowdsourcing (see Figure 11).

**Social Media is an Important Enabler...**

Social networking is perceived as an important channel that has the potential
to transform internal communications and collaboration. It is estimated that the
social collaboration software market will grow to US$6.4 billion in 2016, from just
US$600 million in 2010.4

Many companies, especially automotive OEMs, actively listen to external stakehold-
ers through social media. In our study, 65% of respondents said they use input
from externally collated social data to aid in their internal planning. At the same
time, it is clear that such interactions are limited to gathering input, and have not
progressed to collaborative dialogues for exchanging ideas or seeking solutions
(see Figure 12). As one respondent succinctly said: “Social media interactions will
be limited for us in the next three to five years. We will not find solutions from
masses; we will sell solutions to masses.”

While companies use social media to listen to their external stakeholders, the focus
for most is on building internal collaboration among employees across functions
and geographies.

**... But Managing Change is Challenging**

**Areas of Investment for Driving Innovation**
One of the key objectives of knowledge management is to enable companies to quickly identify expertise within the organization. The increasing globalization of businesses, inorganic growth through mergers, acquisitions and partnerships, and higher employee churn have enabled most companies to acquire diverse skill sets located across various geographies and business units. At the same time, mapping specific skills and expertise within the organization and identifying resources for specific needs can be a major challenge.

While companies look to build tools and knowledge-sharing platforms to help bridge this gap, most face pushback encouraging and enabling employees to use these channels effectively. In the words of an auto industry executive: “Internal organizational collaboration using social media platforms is still in its infancy.”

It is paradoxical that while networking and communicating through social media is on the rise externally, employees are reluctant to use intranets and social networks to collaborate internally. In our study, 68% of respondents said that using personal networks or referring to internal directories are the preferred ways of finding expertise within their organization (see Figure 12).

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**To What Extent Are Inputs from Social Data Integrated Into Your Planning Systems?**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4%</td>
<td>Don’t know</td>
</tr>
<tr>
<td>17%</td>
<td>A great deal</td>
</tr>
<tr>
<td>17%</td>
<td>Somewhat</td>
</tr>
<tr>
<td>31%</td>
<td>Not at all</td>
</tr>
<tr>
<td>31%</td>
<td>Not very much</td>
</tr>
</tbody>
</table>

**How Do You Find Expertise Within Your Organization?**

<table>
<thead>
<tr>
<th>Method</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use social software to pose a question to an undifferentiated group</td>
<td>16%</td>
</tr>
<tr>
<td>Rely on supervisors/managers to direct me</td>
<td>24%</td>
</tr>
<tr>
<td>Tap into community of interest</td>
<td>40%</td>
</tr>
<tr>
<td>Use internal directory</td>
<td>40%</td>
</tr>
<tr>
<td>Use my personal network</td>
<td>68%</td>
</tr>
</tbody>
</table>

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*Figure 12*

*Figure 13*
One reason could be that in a competitive environment, employees are reluctant to display ignorance or share specific knowledge with unknown peers, and are more comfortable dealing with people they know personally.

In any case, what clearly emerges is the fact that investments in knowledge-management solutions must be supported by specific change-management initiatives and training to enable employees to comfortably transition from traditional channels like phone and e-mail to other platforms.

The Road to Informed Manufacturing

Based on our analysis of developments in informed manufacturing and of the approaches that companies are taking, we have defined a maturity framework for informed manufacturing to help guide companies in assessing their current status and planning ahead.

Informed Manufacturing Maturity Framework

Our framework defines three key pillars: product, process and people (see Figure 14 on the following page). The fourth pillar, infrastructure, while having significant potential to contribute to informed manufacturing, is not expected to gain significance for at least three to five years, or at least until a level of maturity is achieved in the other three pillars.

For each pillar, we have defined five levels of maturity – from a basic stage (unaware of informed manufacturing), to excellence, i.e., a fully mature, informed stage. Based
on our study, we see most of today’s organizations operating between Levels 2 and 3 – competent in some key areas, but largely focused on building awareness of the overall concept.

**Getting There: Assess Current Capabilities, Develop an Informed Manufacturing Strategy**

The maturity framework can be used as a guideline for a company looking to assess its current capabilities and decide where it stands on each pillar. It can then chalk out a clear strategy and roadmap for how to get there.

As highlighted earlier, standard ROI considerations may not be appropriate for making investment decisions concerning fundamentally new technologies. Hence, companies need to identify other milestones or measures of success, such as new capabilities built, new processes established, etc., and use those along with more traditional financial metrics.

As a company implements informed manufacturing solutions, the framework can serve as a checkpoint at every stage to confirm if the required level of maturity has been reached, before deciding on further investments along the defined roadmap.

**Informed Manufacturing: Not Necessarily a Sequential Progression**

An important insight revealed by our research is that the informed manufacturing journey is unlikely to progress sequentially. In other words, it is not necessary to achieve the same level of capability across all three pillars before progressing...
to the next level. Based on individual priorities, a company may choose to start off with product, process or people pillars, then expand its scope to include others. As our findings illustrate, many manufacturers have started implementing initiatives around informed product, while others are progressing along the informed people path.

While individual focus points and priorities may differ, companies will need to address all three streams sooner or later; achieving excellence in one would not be possible by ignoring the other two. As a uniformly high level of capability is achieved across pillars, companies can look at integrating the infrastructure pillar to achieve seamlessly integrated informed manufacturing.

An important insight revealed by our research is that the informed manufacturing journey is unlikely to progress sequentially.

Looking Forward

While our interactions with CXOs confirmed our hypothesis that informed manufacturing was high on the agenda of most companies, the study also revealed several interesting new insights and issues. For businesses wishing to progress with informed manufacturing, we recommend the following:

- **Have a specific strategy and plan.** Managing the dual priorities of ongoing business (i.e., problem-solving, immediate/short-term focus) and new innovations (investments for the longer term) requires a well-developed strategy and roadmap.

- **Seek external support as required.** A qualified third party can provide invaluable assistance, not only in developing a strategy and roadmap for informed manufacturing, but also in areas like information-gathering and sharing, and in implementing specific informed manufacturing initiatives.

- **Assess current capabilities and priorities and decide on initial focal points.** Establish basic capabilities in process standardization, data integrity and visibility before expanding further. Fully leverage established technologies such as barcodes, RFID and sensors to reduce risk.

- **Encourage employees to reach out and collaborate internally and externally.** Invest in solutions to enable this level of communication, and facilitate the transition through training and change-management initiatives.

- **Use an informed manufacturing maturity framework.** Such a framework can act as a guideline for charting out your individual roadmap.

Armed with these insights, crystallized from the collective experience and feedback from all of our respondents, we believe that most companies can make a successful transition to informed manufacturing.
Appendix: Study Scope, Methodology

This study was conducted from March to June, 2014, and involved in-depth primary interviews with 32 participants. The interviews were carried out face-to-face whenever possible, and via phone in other cases. The study covered participants from APAC (34% respondents), North America (47%) and Europe (19%). A majority (66%) of respondents were from companies involved in discrete manufacturing.

The companies that participated in the study ranged in size from small (<US$1 billion in turnover), medium (US$1 billion to $10 billion) and large (US$10 billion to US$20 billion) to very large (>US$20 billion). The participant profile ranged across executive-office, IT and functional business heads.

Footnotes


2 An envisioned state of operations in which all relevant and synthesized information is made available when, where and in the form in which it is needed across the manufacturing supply chain, to all stakeholders (people, process, products and infrastructure).

3 The concept of Informed product pertains to a scenario where advanced sensors, controls and software applications work together to obtain and share real-time information about products. Informed products can enable machines to take autonomous actions on the shop floor, provide visibility and traceability across the supply chain, and support remote diagnostics and condition-monitoring while in use.

5 http://mashable.com/2012/09/07/social-collaboration-tools
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