

Integrating PLM with MES Connecting the Digital Thread from Design through Manufacturing

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Mixed Maturity and Room for Improvement

Investing in PLM-MES Integration

Today's manufacturers need to rapidly bring high-quality products to market despite rising product complexity. One way they can do this is by improving the quality and timeliness of their digital thread data and enabling better collaboration between engineering and manufacturing. The challenges and impacts of a disconnected product digital thread caused by poor PLM – MES integration hampers that ability.

Mixed Messages on the Status Quo

Our survey of over 200 complex, discrete manufacturers with revenues greater than \$500 million that have implemented both Product Lifecycle Management (PLM) and Manufacturing Execution Systems (MES) systems shows relatively low integration maturity. Only about one in five companies in our study demonstrates truly mature PLM-MES integration across the areas assessed. Very few have adopted the advanced practices needed to fully connect the digital thread from engineering through manufacturing.

The results, however, suggest that "average" respondents have adopted more advanced processes than one might expect. We believe this is because the survey participants reflect larger, more advanced companies based on the targeted industries, company size, and level of system adoption. Based on our experience, this audience is more likely to have adopted advanced practices than the average manufacturer.

Clear Opportunity for Improvement

Despite the somewhat optimistic state of the average respondents, the survey points to clear room for improvement. Manufacturers that have integrated MES are achieving the product quality and time-to-market advantages they seek, among other valuable benefits. PLM – MES integration yields benefits even when companies don't achieve the highest level of maturity. But manufacturers still have a long way to go to create a closed-loop, model-based digital thread between engineering and manufacturing.



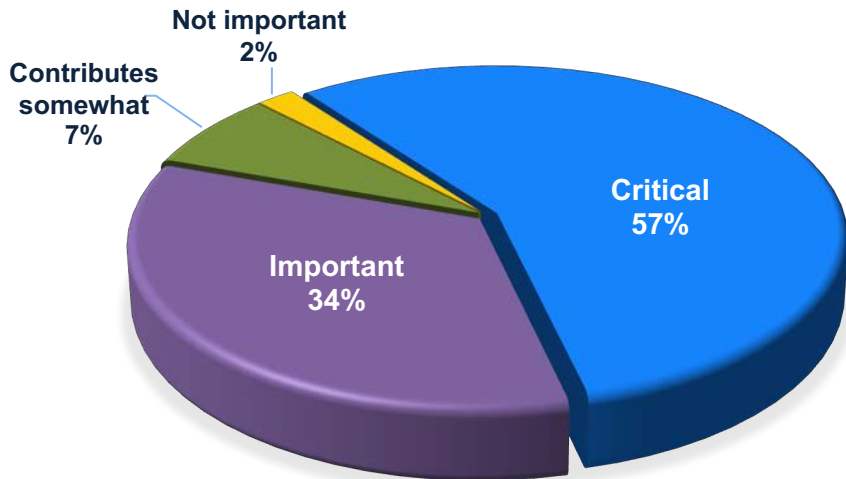
This survey of **over 200 complex, discrete manufacturers** with revenues over \$500 million that have implemented both PLM and MES systems shows relatively low PLM-MES integration maturity, but more advanced processes than expected for average companies. Manufacturers still have a long way to go to create a closed-loop, model-based digital thread between engineering and manufacturing.

Integrating Product Lifecycle Data is Critical

The Promise of Engineering–Manufacturing Integration

The manufacturing industry is under significant time, cost, and quality pressure and turning to digital transformation to help. Many manufacturers in the industrial equipment / machinery, automotive / transportation, electronics / high tech, medtech / life sciences, and aerospace / defense sectors targeted for this study are pursuing model-based enterprise (MBE) management approaches to streamline delivery of model-based design (MBD) data to the plant. They're also looking to close the loop from manufacturing back to design.

PLM AND MES DATA INTEGRATION IMPORTANCE TO ACHIEVING MANUFACTURING PERFORMANCE OBJECTIVES

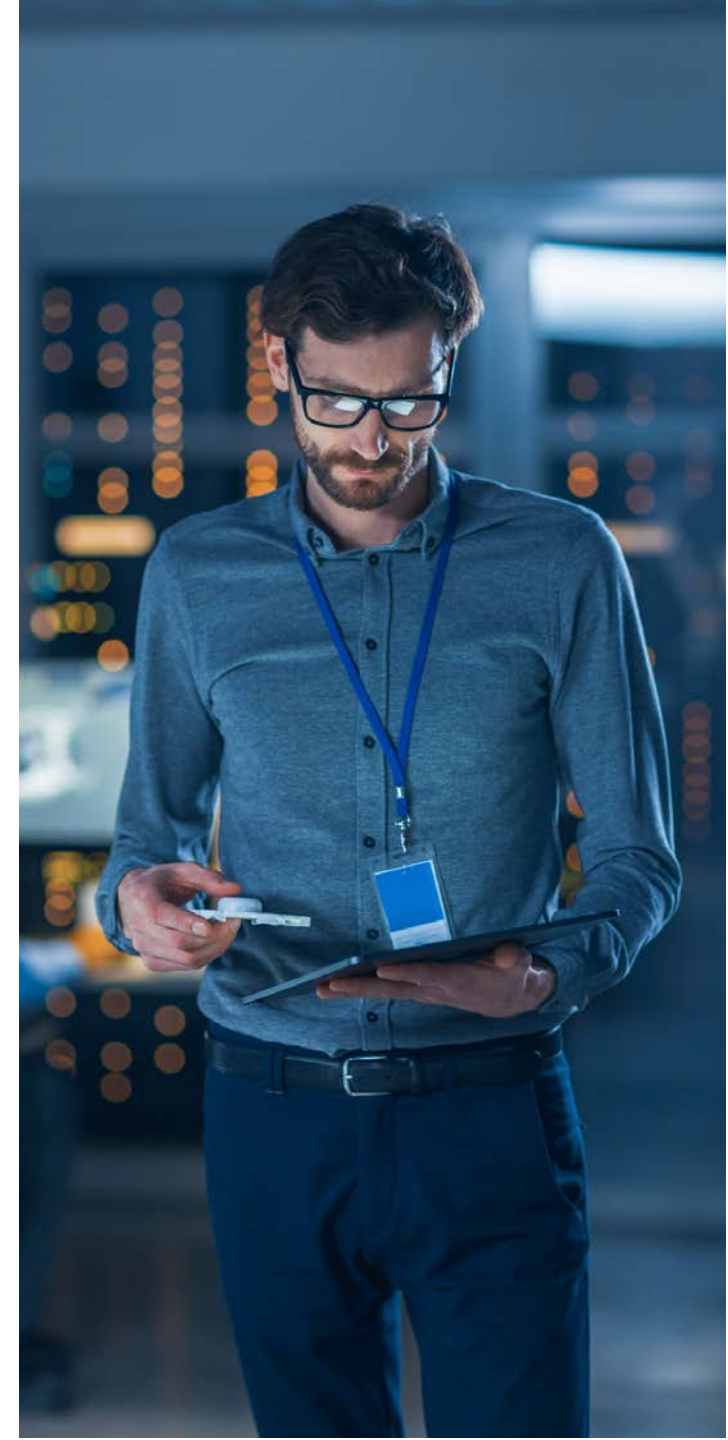


The Need for PLM–MES Integration

To create a closed loop, model-based digital thread, manufacturers need to integrate data stored in the two primary systems supporting engineering and manufacturing, PLM and MES, also known as Manufacturing Operations Management (MOM). This integration is not just a straight data transfer, as manufacturing details like process plans and work instructions need to be developed using a Manufacturing Process Management (MPM) and/or ERP system.

The Value of PLM–MES Integration

Researchers asked participants how important PLM – MES data integration is to achieve their manufacturing performance objectives. The majority of companies, a full 57%, say PLM to MES data integration is critical to achieve their manufacturing performance objectives. Perhaps most telling is that while 91% of participants say that it is at least important, only a small fraction (2%) say it is not important to achieving performance objectives. With that in mind, analysts investigated the objectives, challenges, approaches, maturity, and successes in PLM – MES integration.





Why Integrate PLM and MES Data?

Improve Data

Researchers asked participants about their objectives for PLM – MES integration. The top reasons primarily reflect the value of data. About two-thirds say they target higher quality data. In addition to data quality, over one-half are seeking more timely information. Better, more timely data leads to better decisions and better performance in the plant. It also improves efficiency, because people who have access to trusted information don't have to spend time gathering and validating information from others.

Improve Collaboration

Manufacturers are also turning to PLM – MES integration to enable better collaboration. The third most commonly reported goal is better collaboration and DFX (design for excellence). DFX helps engineers design for manufacturing, cost, quality, reliability, and other product performance metrics by working better together across disciplines to get products right up front.

Another 41% say they want to be able to work in parallel or adopt concurrent design. This allows manufacturers to develop and collaborate on manufacturing processes based on early product design data. This can help improve speed, with the added benefit of allowing engineering to receive early, collaborative feedback on the downstream impacts of their decisions.

Fuel Analytics and AI

Another way better data supports improved performance and decision-making is by enabling better product and production intelligence. About one-half of respondents are pursuing this, reporting they aim to support their analytics and AI initiatives through PLM – MES integration. This value is highly strategic given the current high priority of AI initiatives.

OPERATIONAL OBJECTIVES FOR PLM-MES INTEGRATION



The Business Value of PLM–MES Integration

Operational Benefits Enable Business Benefits

Better data, decisions, and collaboration are valuable, but companies turn to PLM – MES integration for more than operational efficiency. Manufacturers connect the digital thread from design to manufacturing to drive business benefits. In fact, companies report targeting between four and five business goals each, on average. The wide range of goals, acknowledging there is complementary value across objectives, shows the broad business benefits available from an integrated digital thread of data.

Accelerate Time to Market

One of the key themes the study uncovered is the need for speed and agility. The market rewards companies that get products to market quickly, and today's volatile markets require manufacturers to rapidly adapt to market changes. Several findings show companies look to a comprehensive digital thread to support speed and agility. First, about two-thirds of responding companies reported that they look to PLM-MES integration to accelerate

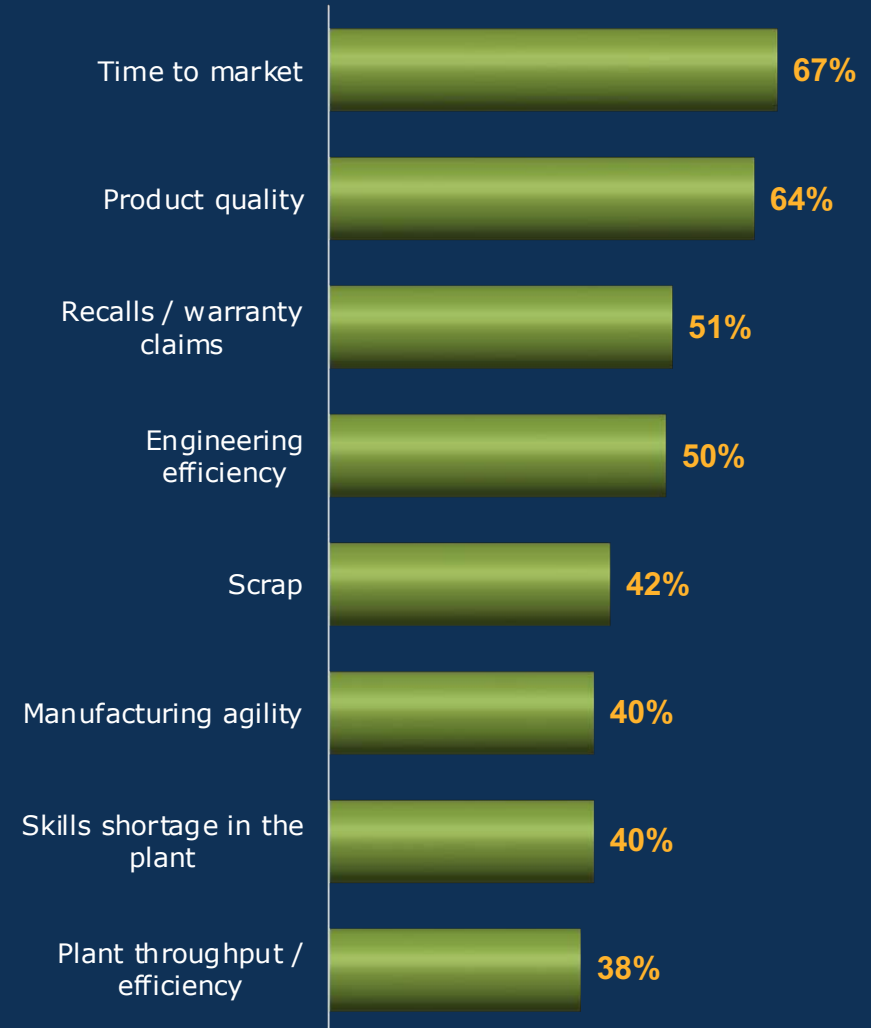
time-to-market. The operational objectives reported earlier clearly support the ability to shorten the timeline between design and full production.

In addition, 40% turn to PLM – MES integration to improve manufacturing agility, allowing them to rapidly introduce new market features, operational enhancements, and quality improvements. Further, about one-half turn to PLM – MES integration for engineering efficiency. Engineering efficiency supports time to market and agility goals, helps companies respond to disruption, and frees up engineers to innovate.

Increase Product Quality

About two-thirds reported that they are also looking to PLM-MES integration to improve product quality. Increasing quality helps create a competitive advantage and enhance the company's reputation. Along those lines, about one-half say they want to reduce recalls and warranty claims, and 42% look to reduce scrap. These improvements have top-line benefits while simultaneously driving bottom-line value by reducing the cost of quality.

BUSINESS OBJECTIVES FOR PLM-MES INTEGRATION



Business Value Achieved

Most Achieve their Goals

Manufacturers not only target a wide variety of benefits from PLM-MES integration, they also reach them with significant rates of success. When asked about the status of their primary objectives, over 90% said they achieved their goals or still expect to. In fact, less than 5% that hadn't yet achieved one of their goals said they didn't expect to. Some may just take longer to achieve than others.

Achieving the Top Goals

Almost two-thirds of the companies that turned to PLM – MES integration to increase product quality were able to do so. Three out of five manufacturers that targeted faster time to market through integration achieved the faster product development speed they sought. Connecting the product digital thread across design and manufacturing has a clear positive impact on the top two goals reported for integration, quality, and time to market.

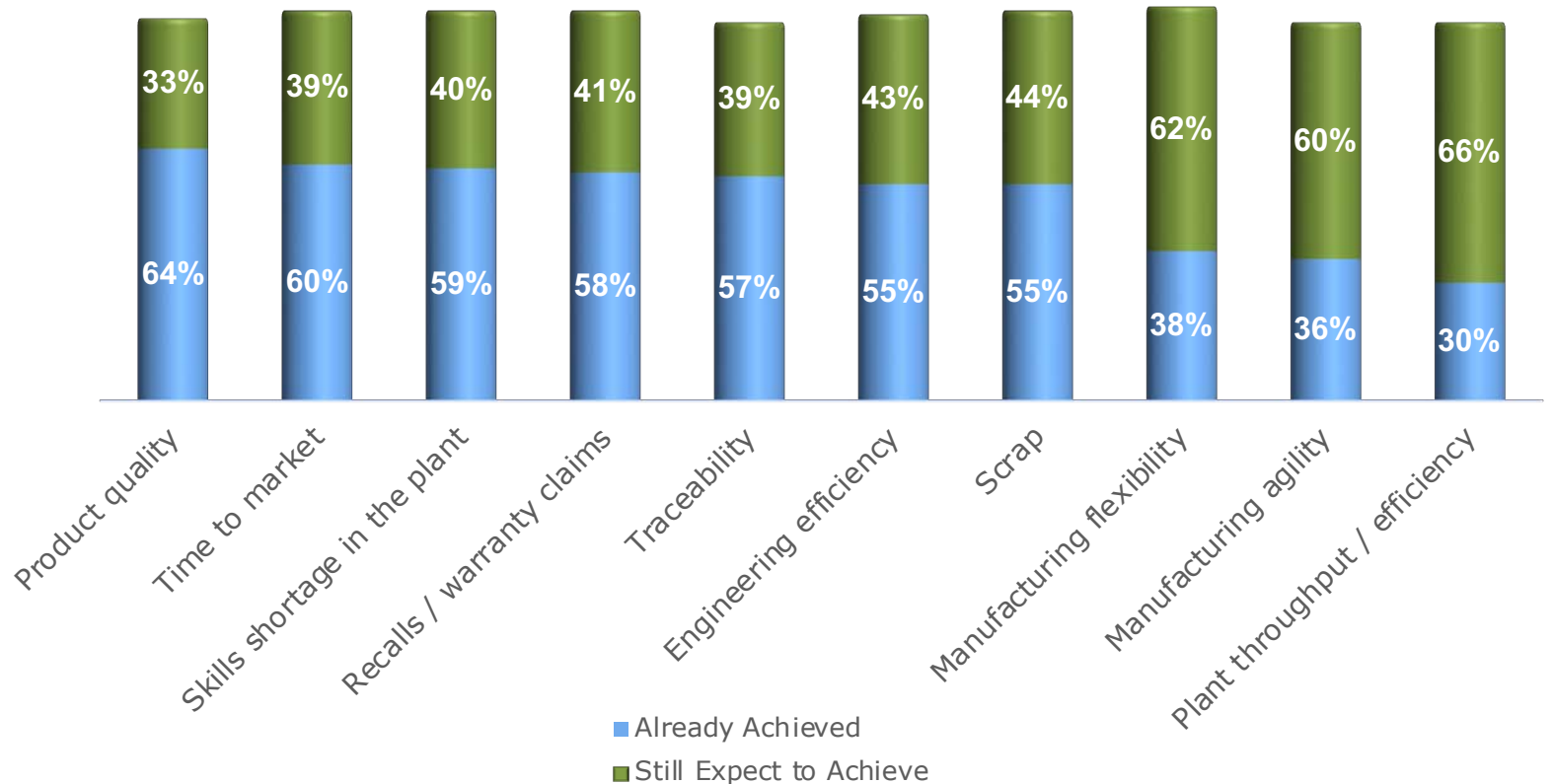
Achieving More Differentiated Goals

Each company's situation is unique, and not all companies reported the same goals for integration. The most common goals may not be the most important or highest goals for any given company.

Fortunately, manufacturers report reaching the less typical goals with significant success. For example, while addressing skills shortages in the plant was only reported by 40% of companies, 59% of those companies achieved that goal. In a similar way, traceability was not as commonly

sought after from PLM – MES integration, but it was well achieved by those pursuing it. The goals are varied and likely depend on specific company needs. Perhaps most importantly, the data shows that the goals are achievable.

ACHIEVEMENT OF TARGETED PLM – MES INTEGRATION BUSINESS OBJECTIVES



Poor Integration Impacts Operations

Challenges of Poor PLM-MES Integration

We've discussed why PLM-MES integration is important and the goals companies have for integrating the product digital thread. Let's step back to further understand why companies selected the goals they did. Manufacturers have faced significant challenges due to poor integration between design and manufacturing data.

Poor Data Quality and Usability

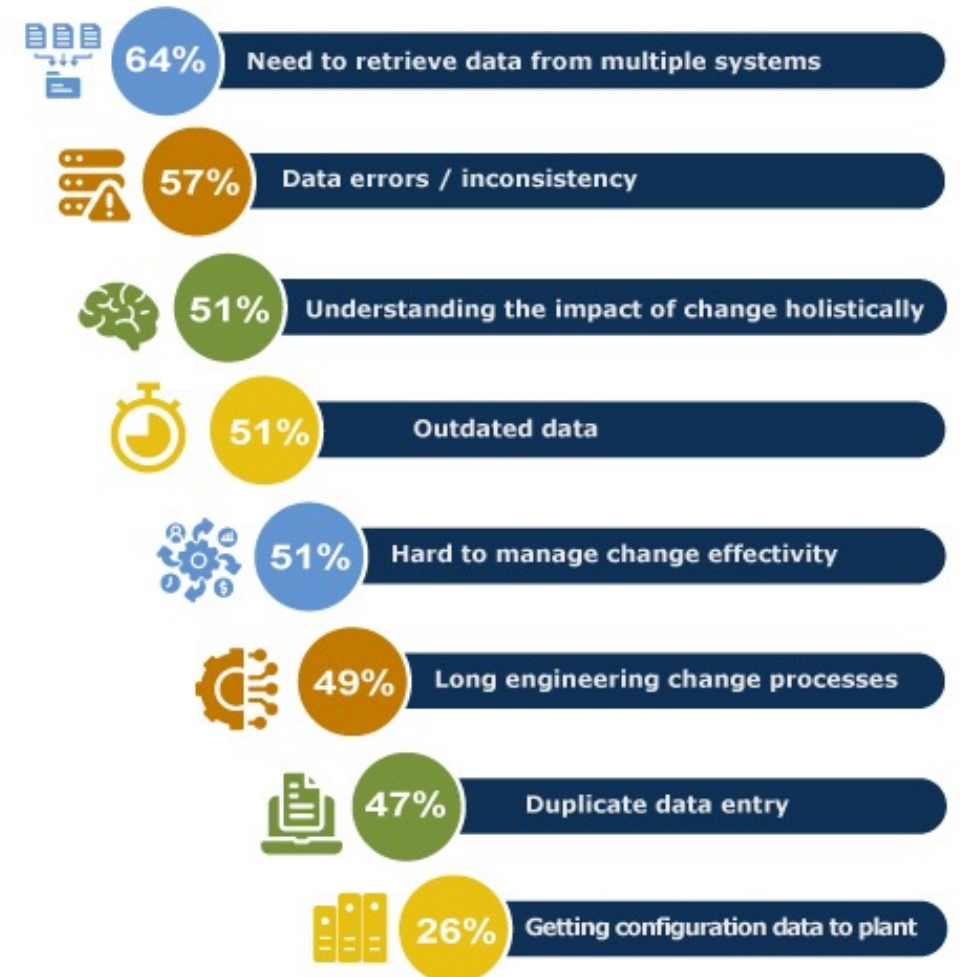
Poor integration causes data problems. For example, two-thirds of respondents say they have to look for data in different systems. This creates inefficiency and can slow decision-making or create blind spots. Similarly, almost one-half say they have to enter data into multiple systems. Again, this is inefficient but also leads to more severe issues. These issues include data quality issues such as data errors, inconsistency, and outdated data, reported by over one-half of companies. These errors can lead to poor decision-making and costly mistakes.

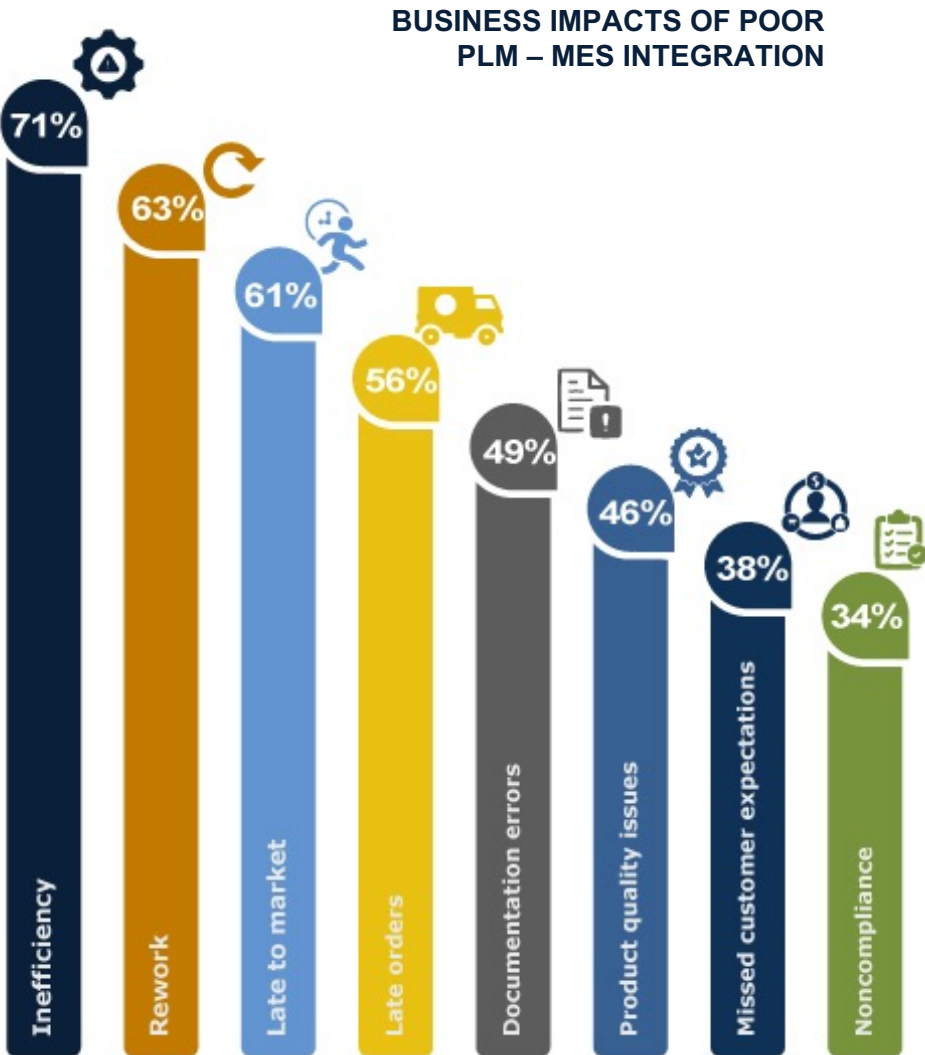
Poor Integration Impacts Change Management

One of the most important and most challenging processes in manufacturing is managing engineering change. Effective change management is essential to product quality, time to market, and agility. The process inherently relies on data that spans engineering and manufacturing. Not surprisingly, then, about one-half of manufacturers surveyed report that it is hard to holistically understand the impact of change. The same percentage directly report that it's hard to manage change effectively, and almost that percentage say they suffer from long engineering change cycles.

On a related note, about one-quarter report that poor integration makes it difficult to get configuration data to the plant. This tech transfer challenge negatively impacts quality and time to market.

CHALLENGES FROM POOR PLM – MES INTEGRATION





Poor Integration Erodes Business Value

Data Quality and Usability Hurt the Business

When we asked about the impact these challenges create, the responses were plentiful. The challenges are tightly aligned with the goals companies reported most frequently - speed and quality.

Poor Integration Impacts Speed

Poor integration leads to inefficiency, as reported by over two-thirds of participants. This inefficiency has both direct and indirect impacts. One of the indirect impacts is another common issue, being late to market, which significantly impacts market share and profitability. Similarly, 56% report late orders, likely for configured items that are designed to order.

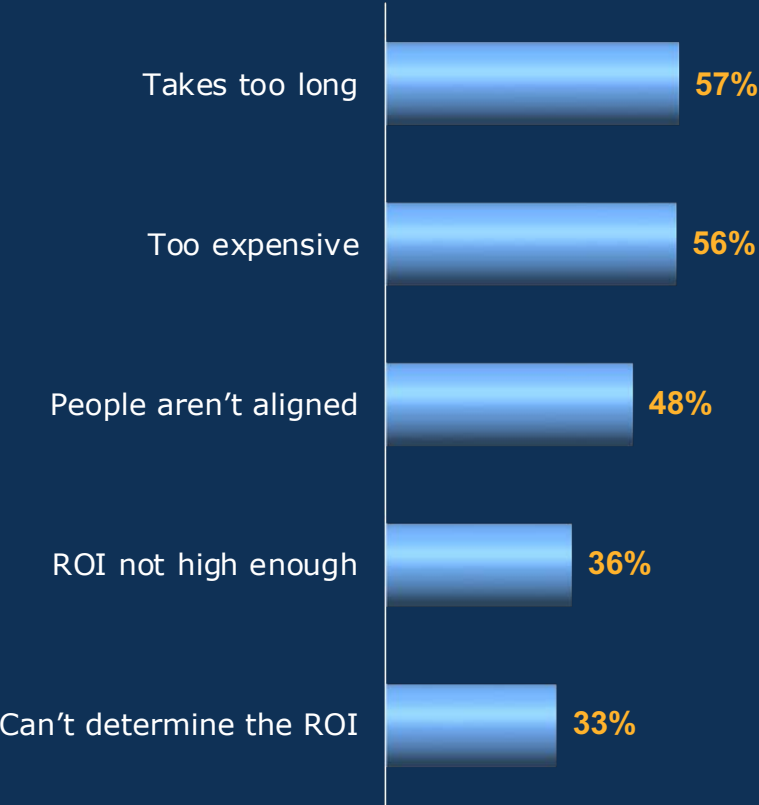
Poor Integration Damages Quality

Poor PLM – MES integration also leads to quality problems. Almost one-half of respondents report that poor integration leads to documentation issues. This creates risk and liability, especially in regulated industries, and can further slow new product introduction. Further, 46% report that poor integration of engineering data with manufacturing data creates product quality problems.

It's also important to note that almost two-thirds of companies report that inadequate integration leads to rework issues. The survey didn't specify whether this was design rework or product rework, but either is a problem that points to the major themes of product quality and speed.

Integrating PLM and MES is Challenging

BUSINESS CHALLENGES INTEGRATING PLM DATA WITH MES DATA



Integration Challenges

If the challenges of poor integration are so high-impact and the benefits of integration are so valuable, why hasn't every manufacturer integrated PLM with MES? Researchers investigated the challenges manufacturers face when integrating the digital thread from engineering to production from a business perspective. While the scope of this survey didn't cover technical challenges, without solving business challenges, they aren't relevant. Of course, it's possible that some of the business challenges may be a result of lacking or poor technology.

Scope and Maturity

First, although not addressed by this survey, not every manufacturer has implemented both PLM and MES solutions. While the larger, discrete

manufacturers polled for this report are more mature than others, and these solutions are now pretty much standard in IT strategies, many manufacturers lack effective PLM and/or MES systems. Beyond that, integration is often delayed for a later phase of adoption.

Level of Effort

Over one-half of respondents report that integrating PLM with MES takes too long. PLM and MES have many potential touch points, and often, data must not only be transferred, but it must also be transformed. In these cases, a Manufacturing Process Management (MPM) solution can help bridge the gap. Further, over one-half report that integration is too expensive.

Organizational Issues

Beyond time and effort, many companies report that people aren't aligned. This may be the underlying cause for other issues as well, including time and expense. Integrating PLM with MES requires organizational, process, and data alignment.

Lack of ROI Clarity

The final issues relate to the business value of integration: either the ROI isn't high enough, or it can't be determined. On the other hand, there is clear business value in solving the problems highlighted in earlier sections. But without alignment and process redesign, ROI can be difficult to pin down. The benefits reported by companies that have integrated PLM with MES, however, are compelling.

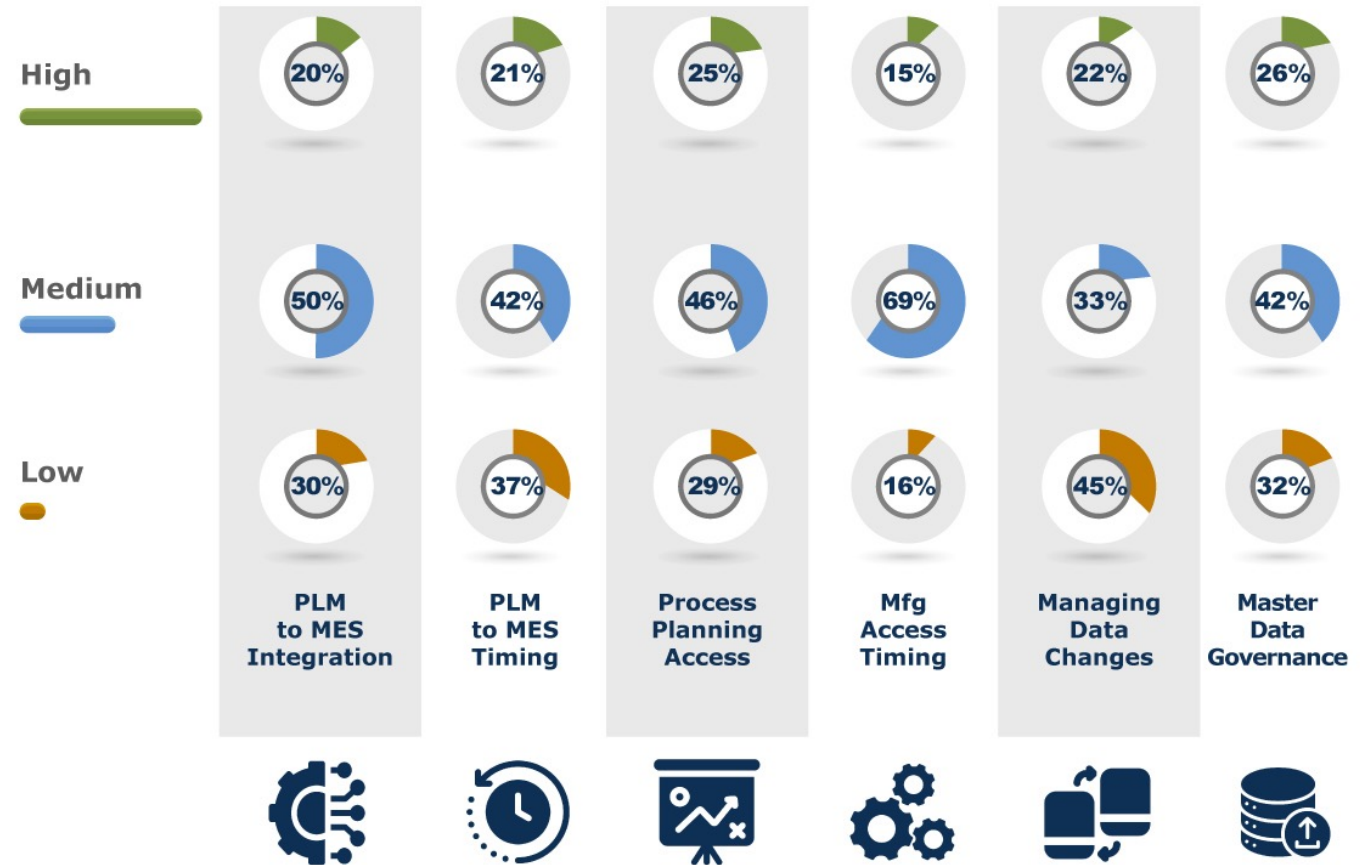
PLM–MES Integration Maturity

The Highest Level of Maturity is Rare

Where do manufacturers stand in integrating their product digital thread from engineering to manufacturing? Researchers investigated multiple facets of PLM – MES data integration and found that only about one in five companies exhibits the highest level of integration maturity. The data points to a large percentage of companies with medium maturity. As mentioned earlier, this is likely due to the size and advanced industries the respondents represent and does not likely represent an average manufacturing sample set, which we expect to skew more toward lower maturity.

The graphic shows the percentage of respondents that exhibit low, medium, and high process maturity. It summarizes the findings across a number of integration maturity measures. More detail on these findings, including the responses categorized into High, Medium, and Low based on our industry experience, follows.

PLM-MES INTEGRATION MATURITY





PLM–MES Integration Approach

Seamless Integration is Uncommon

The first integration capability examined is the process for getting PLM data to the MES system. Only 20% report seamless integration between their PLM and MES systems. Most companies have room to improve.

Average Maturity Shows Integration Progress

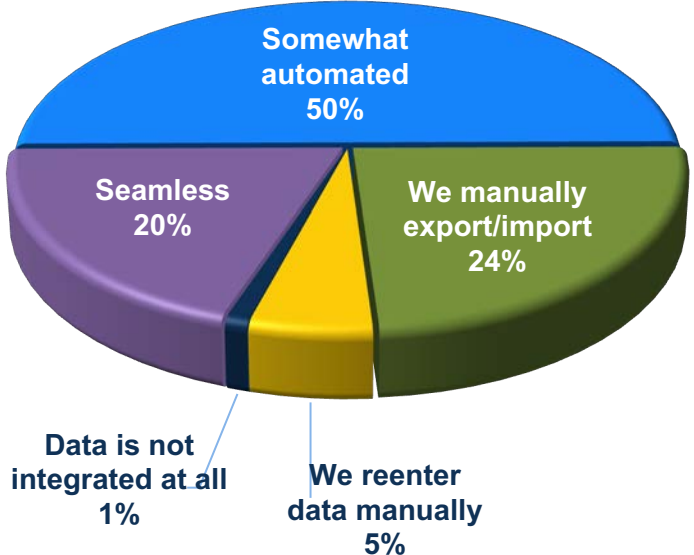
Despite a relatively small percentage of manufacturers showing the highest level of maturity in PLM – MES integration, progress has been made. One-half report that they are somewhat automated. These companies may have only partially integrated the engineering data they need into MES. While most companies have room to improve, the data shows that the majority are gaining valuable operational and business benefits from PLM – MES integration even without reaching the highest levels of maturity.

Many Still Struggle

The first integration capability examined is the process for getting PLM data to the MES system. Only 20% report seamless

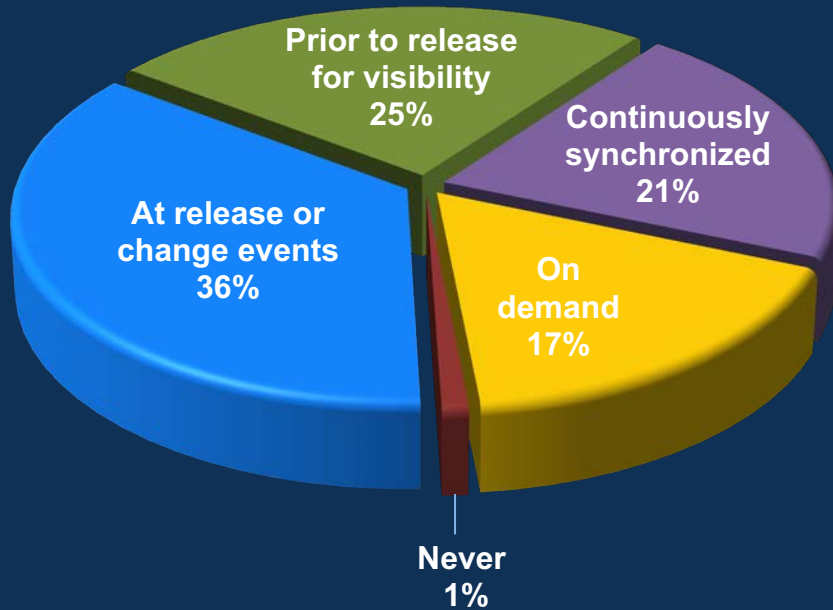
integration between their PLM and MES systems. Most companies have room to improve.

PROCESS GETTING DATA FROM PLM TO MES



PLM–MES Integration Timing

TIMING GETTING DATA FROM PLM TO MES



Integration Timing Maturity is also Rare

How frequently is design data typically transferred downstream to manufacturing from PLM to MES? The highest level of maturity, PLM – MES data synchronization, is relatively rare. Only 21% say that PLM and MES are continuously synchronized. But this capability may not be necessary in all situations. Also, it requires mature capabilities in MES itself to recognize lifecycle states. Lifecycle states are needed to prevent producing based on unreleased information before a product or change is approved.

Early Access is Somewhat Common

Concurrent and collaborative design processes require downstream functions to have early visibility to design data. About one-quarter of manufacturers integrate PLM data prior to design release to give downstream functions visibility. This helps by allowing people who leverage and extend engineering data for manufacturing to get started on their work.

Again, this requires additional maturity in MES to prevent products or changes in an unreleased state from being accidentally used for production.

Traditional Release Timing is Typical

Historically, engineering has maintained tight control over design data prior to release to prevent manufacturing from inadvertently using it before it is approved and ready for production. The most common approach is to transfer data at design release or change events (ECOs). About one-third of responding companies transfer data at the time the data becomes official and is ready to be utilized in production. Others release PLM data on demand.

It's possible for companies to have multiple releases. For example, they may have one for downstream visibility, one for downstream validation, and a final release to authorize production. Frequently, these releases may have an increasing amount of rigor.

Time for Manufacturing to Access PLM Data

The Highest Maturity is Rare

As with the integration approach and timing, the highest level of maturity investigated is rare. Only 15% of companies provide access to PLM data close to real time, within a few minutes. However, a total of 43% say that the average time for manufacturing to gain access to PLM data is within an hour two, and this may be sufficient in many cases.

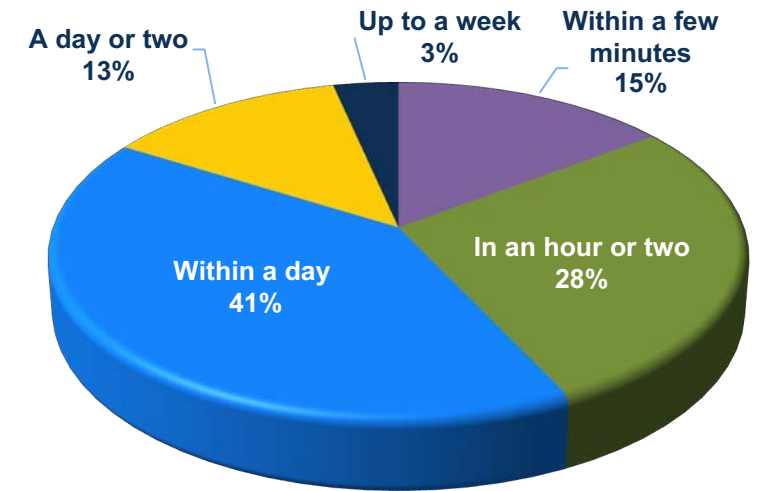
It's important to note that giving access to data doesn't necessarily mean through integration. As we'll see later, companies take a variety of approaches to provide information downstream.

The Vast Majority of Companies Have Timely Access

A full 84% have information available within a day. For most scenarios, this timing is acceptable, particularly if manufacturing has early visibility to upcoming changes and releases.

This timing, however, must be taken into consideration with the release timing mentioned earlier. The timing is likely from the time the information is released to manufacturing to when it's available, not from when the data is created in PLM.

TIME FOR MANUFACTURING TO ACCESS PLM DATA



Providing Access to PLM Data

Access Doesn't Always Mean Integration

As mentioned earlier, just because design data isn't in MES doesn't necessarily mean manufacturing planners and manufacturing operations personnel don't have access to it. There are multiple ways that downstream people can gain access to data they need prior to formal data release downstream to manufacturing.

Production Access is One Step Removed

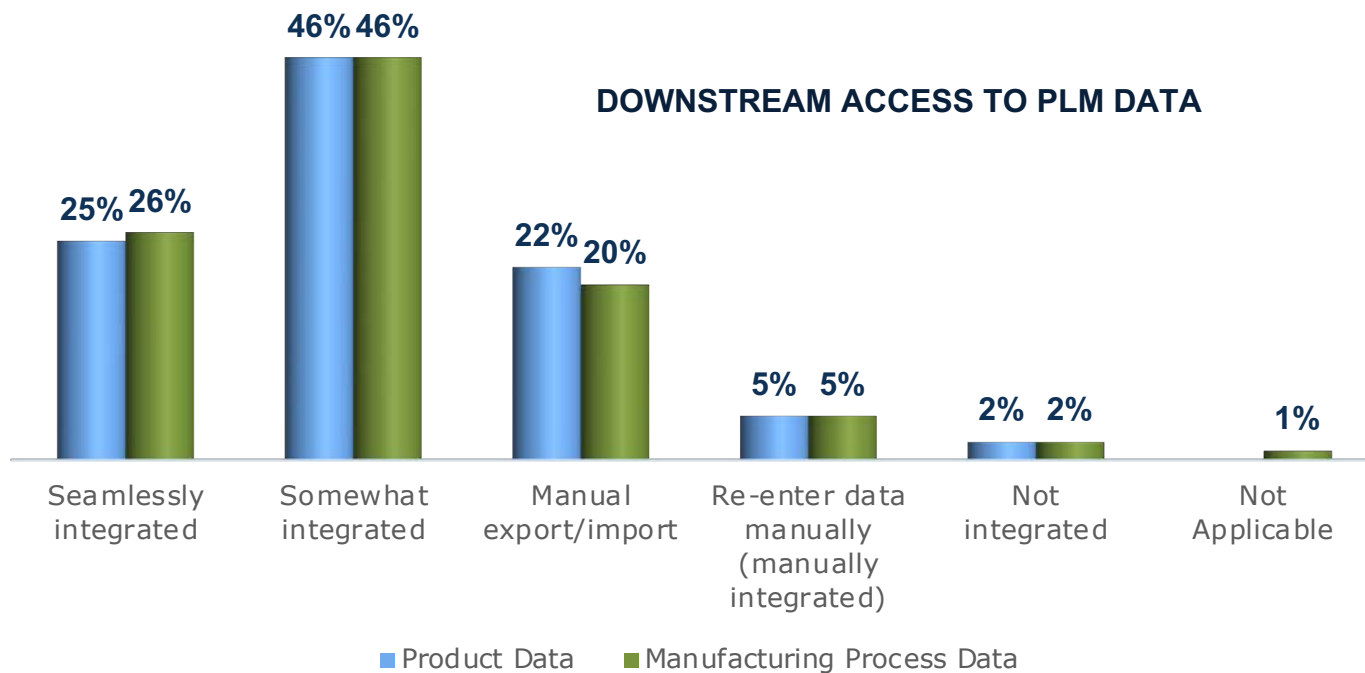
Not everybody that needs access to design data is supported in the same way. Manufacturing personnel are most likely to access the PLM data they need in MES, through integration. Access through integration ensured a level of control and discipline to what data is available and how it is used. However, one-quarter log

into PLM and 15% access it via a portal. In these cases, the PLM system or portal likely has filters and security to reduce the potential for errors from unreleased information. It's important to note that while spreadsheets were reported very infrequently as the way people access data, our experience shows that this is likely happening at higher rates than indicated here, potentially in parallel with the methods mentioned above.

Process Planners have Direct Access

Process planners and manufacturing engineers are more likely than production personnel to go directly to PLM for the data they need. Process planners are likely better trained and more cognizant of the lifecycle state of the product and can be trusted with greater access to data. In some cases, they have MPM capabilities directly in PLM that allow them to do their work in a single platform, inherently integrating and associating the data.

DOWNSTREAM ACCESS TO PLM DATA



Process Planning Access to Product and Process Data

Access Doesn't Mean Integration Maturity

Although the earlier chart shows that production planners and manufacturing engineers commonly have access to PLM data, it's important to recognize that having access to information doesn't necessarily equate to the ability to directly utilize it. Poor integration may still lead to the inefficiency and data quality issues discussed earlier.

Integration Maturity is Rare

Researchers asked how process planners get the PLM data they need to develop detailed manufacturing processes and process data. In the most mature scenario, engineering data would be directly used downstream and associated with the source data to create a cohesive digital thread of data, ensuring change impacts are readily understood. Only one-quarter of

manufacturing planners have information seamlessly integrated to support manufacturing processes and work instructions.

Most Companies Show Progress

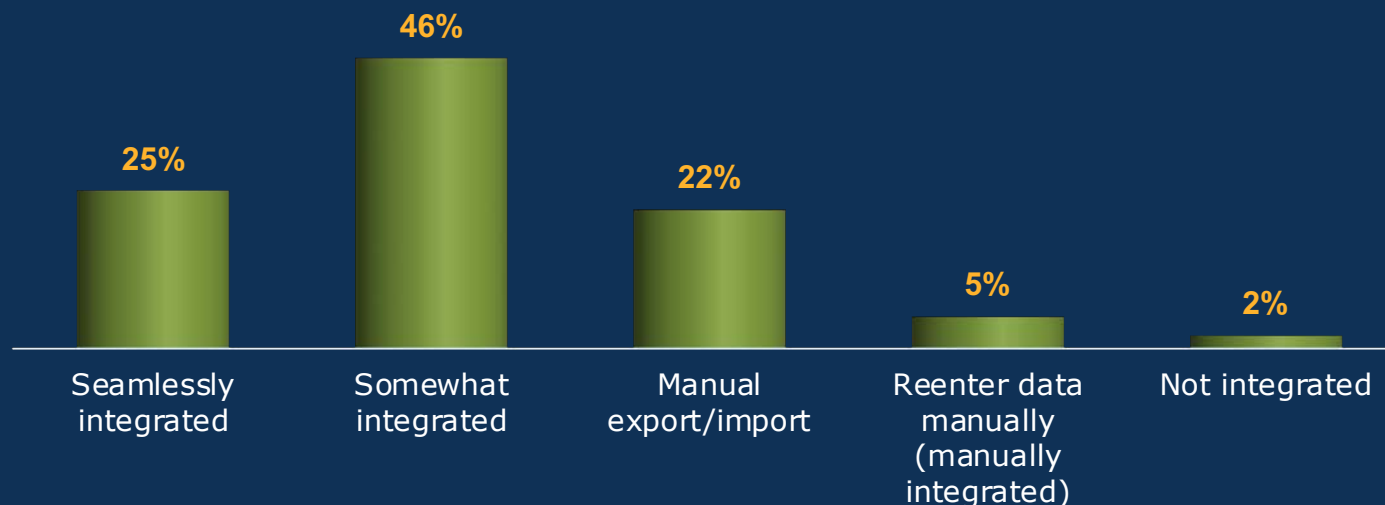
As with integration as a whole, most manufacturers have made some effort to integrate PLM data into process planning. About one-half have some level of integration.

These companies have the potential to leverage those investments and improve over time.

Manual Effort is Still Common

Despite integration progress, about one-quarter of process planners must manually export and import product data. This precludes the ability to associate the data and achieve the highest levels of maturity.

ACCESSING PLM DATA FOR PROCESS PLANNING



Data Integrated from PLM to MES

Integration Content is Uneven

Another way to look at PLM – MES integration is to examine which data is integrated between the two systems. The data suggests there is varied maturity here as well.

Core Product Definition

Not surprisingly, the most commonly integrated items comprise core design data. Around three-quarters have integrated the basics of what describes a product, the item and the bill of material (BOM). Manufacturers slightly less commonly integrate CAD data to MES. Almost two-thirds integrate 2D drawings and 43% integrate 3D models. The integration of 3D models could indicate a move toward MBE, a more valuable and mature process that opens up greater opportunities in MES. A more detailed and less commonly integrated element is product specifications, integrated by just under one-half of responding companies. Further, about one-third communicate critical to quality specifications, representing a mature approach to share important product requirements with manufacturing.

Engineering Change

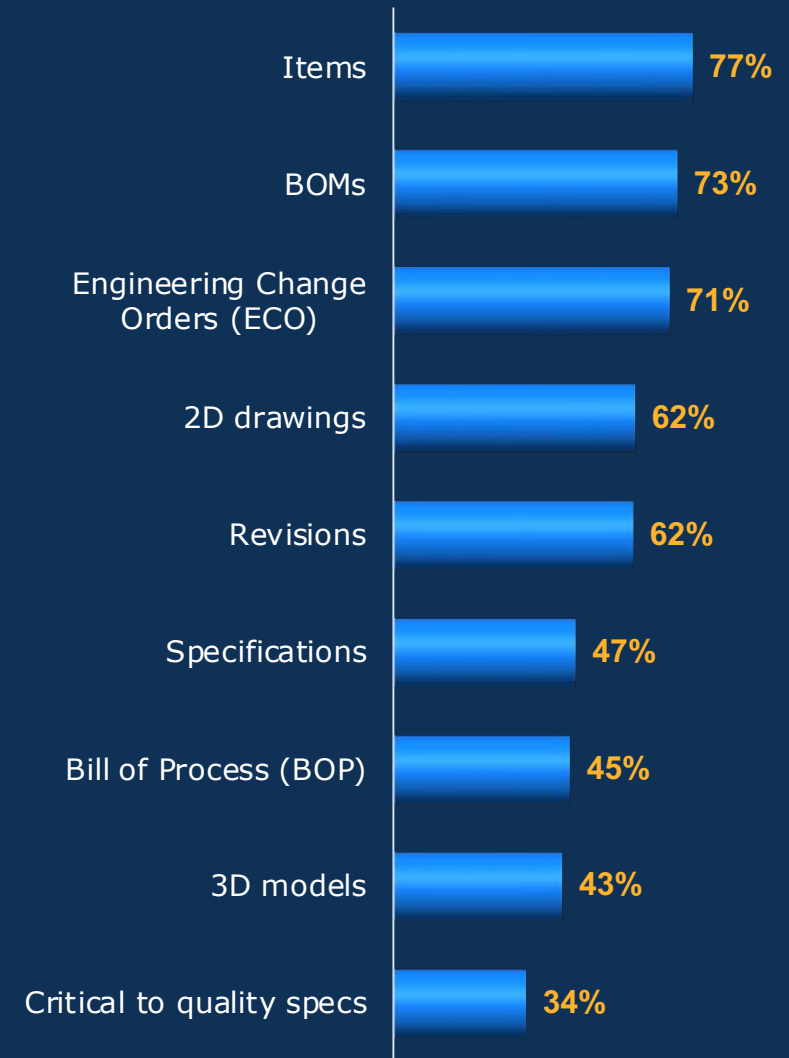
Beyond core product data, some of the most important communication between engineering and manufacturing relates to engineering change data. This is a common area for miscommunication, and poor change management results in costly errors, inefficiency, and difficulty introducing product quality and innovation to the market.

Manufacturers are integrating the product digital thread to streamline engineering change. About two-thirds of respondents share that they have integrated engineering change orders (ECOs), the foundation of the change process, between PLM and MES. In a related way, and overlapping with the core product definition, almost two-thirds of manufacturers integrate revisions from PLM to MES to support product launch and ECOs.

Manufacturing Process Data

Manufacturers less frequently share bills of process (BOPs) from PLM to MES. The survey shows that 45% integrated BOPs from PLM, supporting a more mature, integrated approach to manufacturing process planning.

DATA INTEGRATED FROM PLM TO MES





Data Integrated from MES to PLM

Closing the Loop is Less Common

Integration should be a two-way street to create closed-loop feedback from manufacturing execution. Closing the loop is a more mature approach between engineering and manufacturing and is less common overall. As a result, manufacturing reality is not consistently used to drive continuous improvement and upstream design and requirements validation.

Quality and Nonconformance

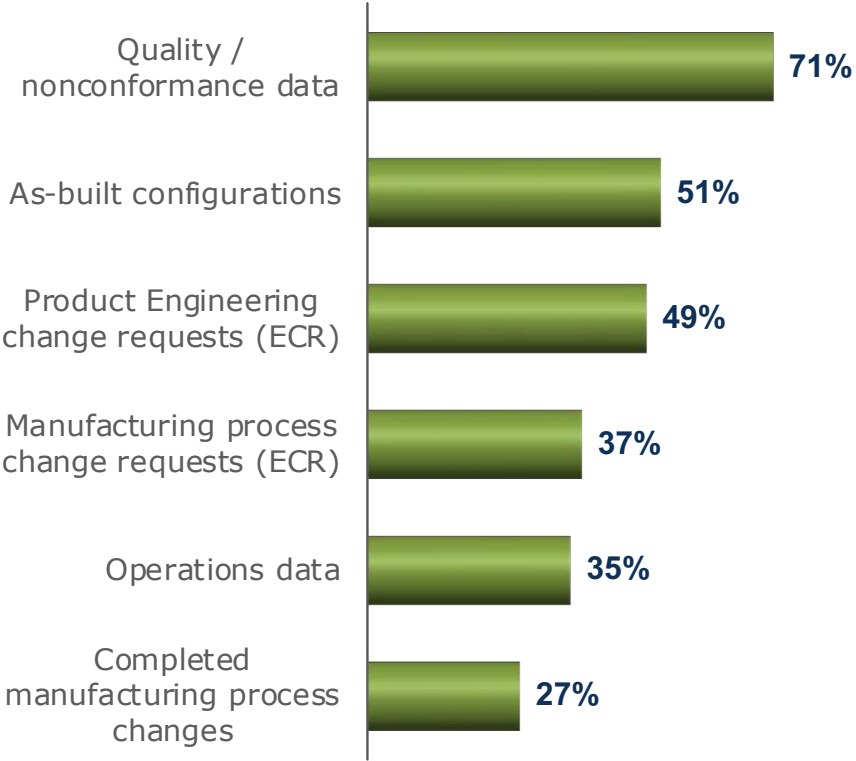
MES captures rich quality feedback from the shop floor. These details can be highly valuable to engineering to close the loop on quality. Almost three-quarters of companies report they share this information back with engineering through PLM – MES integration. But only about one-third share process data back with PLM. More mature companies enable design and process improvement by sharing not only the quality results, but also the processes that created them. This is more mature, but less common.

Closing the Loop on ECOs

In addition to sharing ECO data from PLM to MES, some manufacturers are integrating the change request process from MES to PLM. About one-half integrated engineering change requests (ECRs) and just over one-third share manufacturing process change requests upstream. This direct connection is a mature approach to close the loop from manufacturing back to engineering so they understand what should

change to drive improvements. Only a small percentage, about a quarter, share completed manufacturing requests back with PLM to close the loop on how changes were implemented, however, leaving a potential knowledge gap.

DATA INTEGRATED FROM MES TO PLM



Integration Ground Zero: Change Management

HOW DATA CHANGES CROSSING PLM AND MES ARE MANAGED



ECO Requires Engineering – Manufacturing Coordination

One of the most telling indicators of how well engineering and manufacturing are working together is change management. Changes commonly impact data in both PLM and MES. This study already shows that poor PLM – MES integration makes change impact analysis and overall change management difficult for most companies. So it's important to understand how data changes that cross PLM and MES systems are managed to analyze the impact of change requests and keep data in sync across these systems.

ECO Best Practice Maturity is Rare

Unfortunately, the way companies manage and

analyze data changes across PLM and MES and keep them in sync should be improved. Only 22%, about one in five like earlier, have very mature practices. In the most mature scenario, data across systems is linked, and changes are flagged automatically. This provides a prompt or alert for someone to evaluate potential disconnects and could result in automated changes under certain scenarios. This level of maturity helps ensure changes are implemented holistically and data is kept in sync between systems.

Manual Effort is Very Common

Despite the PLM – MES integration progress most companies report, integration maturity as applied to change management is very low. About four out of five companies require manual

intervention to analyze change impacts and keep data in sync. Specifically, 44% manually look up data, and 33% have to run reports or queries. These approaches result in time-consuming, manual effort and open up the opportunity for costly mistakes. When integration must be applied to one of the most important processes spanning engineering and manufacturing, it is insufficient.

Change Discipline Requires Transformation

The net result is that enterprise change management prevents reported integration progress from translating into business value. This is both a process and technology issue, and a significant opportunity for improvement.

Data Governance Maturity

Effective Integration Requires Governance

One of the organizational issues that can impact integration success and sustainability is master data governance of engineering and manufacturing data, the product digital thread. For the purposes of this survey, we defined master data governance as “the set of policies, processes, and systems that ensure the product definition remains accurate and synchronized as it flows across the product lifecycle from design through manufacturing (and service).” Integration without effective governance leads to many of the common challenges of poor integration mentioned earlier in the report.

Centralized Collaboration is Rare

The most mature approach to data governance is leveraging a committee of impacted individuals from across domains and departments. Each of these participants brings their own unique needs, context, and semantics to the integration effort. Only about one-quarter of survey companies report

that they manage governance through a collaborative approach, a committee of interested parties.

Centralized Governance is Less Common

Another approach, taken by 29% of responding companies, is for one person or organization, typically IT, to manage data governance. While IT may have a broad view of the business, this approach can lead to siloed thinking.

Distributed Governance is More Common

Centralization is the ideal approach, but it can be difficult to achieve for large manufacturers that may have more than one PLM and/or MES system. Although it is not ideal, it's positive to see governance being proactively managed. The most commonly reported approach, shared by 42%, is governance that is distributed across the organization. This has the potential, however, to create conflicts. Fortunately, only 3% say it's not formally managed, the least mature approach.

PRODUCT AND MANUFACTURING MASTER DATA GOVERNANCE RESPONSIBILITY



Key Takeaways

Maturity Varies

PLM – MES integration maturity varies. About one in five has highly mature integration, including:

- Seamless integration
- Synchronizing data
- Flagging changes automatically
- Integration of more advanced design data from PLM
- Integration of manufacturing process data from MES
- Data governance by a committee of interested parties

Beyond these companies, about one-half reported somewhat mature processes. The industry has made progress in integrating the digital thread.

Digital Thread Integration Drives Business Values

Companies report significant business challenges from poor PLM – MES connection and turn to integration for a variety of important business goals. Despite the broad range of integration maturity, success rates for digital thread integration are high. Most businesses are achieving their goals, and almost all those that have not yet achieved them believe they will still achieve them.

Room for Improvement

Despite sharing optimistic levels of maturity and integration across the different aspects of PLM – MES integration, manufacturers reported relatively low maturity in the one process examined in more detail, engineering change management. Although most companies say they have at least somewhat integrated engineering and manufacturing data, over three-quarters still need to run reports or manually look up information for change impact analysis.

This example shows that the vast majority of manufacturers can continue to improve value by adopting more mature practices. PLM – MES data integration should continue to be a high-priority investment for manufacturers.

Further, this report focused on complex, discrete manufacturers with over \$500 million in annual revenue. This sample likely represents an advanced set of manufacturers, and smaller companies likely have less mature practices. These companies can follow the examples and best practices adopted by these larger manufacturers.



Manufacturers report significant benefits from connecting the digital thread from engineering to manufacturing, however the vast majority of manufacturers can continue to **improve value by adopting more mature PLM – MES practices.**

About the Research

Data Gathering

Tech-Clarity gathered and analyzed over 200 responses to a web-based survey. Survey responses were collected by direct e-mail, social media, and online postings by Tech-Clarity.

Industries

The respondents represent companies that serve a broad cross-section of industries. 25% were from Industrial Equipment / Machinery, 20% Automotive /

Transportation, 20% Electronics / High Tech, 18% MedTech / Life Sciences, 18% Aerospace / Defense, and others including Energy and Utilities.*

Company Size

The respondents represent a mix of company sizes, including 45% between \$501 million and \$1 billion, 36% between \$1.1 billion to \$5 billion, and 19% greater than \$5 billion. Sizes were reported in US dollar equivalent.

Geographies

Responding companies report doing business in North America (59%), Western Europe (48%), Eastern Europe (16%), Middle East (10%), Asia (9%), Africa (7%), Latin America (7%), and Australia / Oceania (3%).*

Title

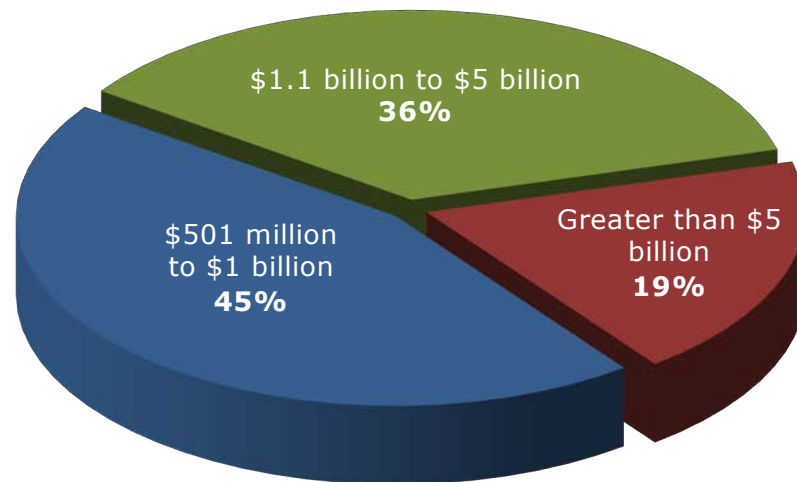
The respondents comprised of 10% Executives / VP Level, 32% Directors, 32% Manager level, and 20% individual contributors.

Organizational Function

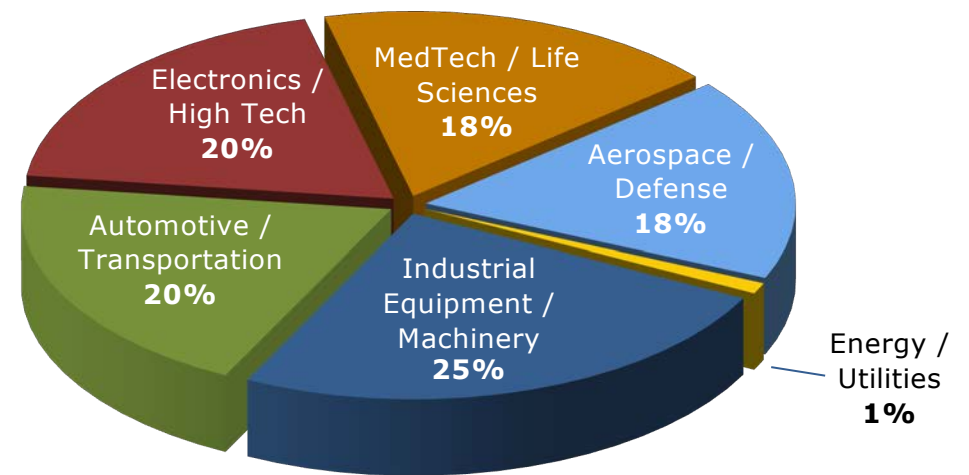
Of the respondents, 31% were in Product Design / Engineering, 15% Manufacturing Engineering, 14% Manufacturing, 13% Information Technology (IT), 12% Manufacturing Planning, 11% Operations, and 3% Plant / Facilities Engineering.

* Note that the values may total greater than 100% because companies reported doing business in multiple industries and geographies.

COMPANY SIZE



INDUSTRIES



Acknowledgements



Jim Brown
President
Tech-Clarity

About the Author

Jim Brown founded Tech-Clarity in 2002 and has over 30 years of experience in the manufacturing and software industries. Jim is an experienced researcher, author, and speaker and enjoys engaging with people with a passion to improve business performance through digital enterprise strategies and supporting software technology.

Jim is actively researching the impact of digital transformation and technology convergence in the manufacturing industries.

Tech-Clarity is an independent research firm dedicated to making the business value of technology clear. We analyze how companies improve innovation, product development, design, engineering, manufacturing, and service performance through the use of digital transformation, best practices, software technology, industrial automation, and IT services.



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