BRIDGING THE GAP BETWEEN PRODUCT DEVELOPMENT AND OPERATIONS

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Report Highlights

Based on the experiences of 125 respondents, this report identifies best practices for product developers and operations to design and manufacture more successful products.

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Given the repercussions of many recent events surrounding new product introductions and product quality, manufacturers are facing pressures today that in many cases didn't exist even five years ago.

Many companies today are struggling to quickly deliver new products to market on time, on cost, and on quality. This struggle is further compounded with the fact that every company is being asked to do more with less. Aberdeen research has consistently shown that a large portion of these hardships come from internal silos between business groups. The New Product Introduction (NPI) process is a perfect area that can be targeted for improvement. The product lifecycle involves practically every business group in a company - from designers, to the shop floor, to service technicians. However, this enterprise-wide involvement can, in turn, breed inefficiencies and failure because of knowledge silos.

This report will focus on why it is important for companies to break down the silos between product development and operations, and how this holistic approach will help a company tackle change and increase design for manufacturability potential (DFM). The Best-in-Class also take this approach a step further by integrating their PLM and MOM systems to connect their business processes, provide necessary visibility, and make decisions swiftly.

Business Context

Given the repercussions of many recent events surrounding new product introductions and product quality, manufacturers are facing pressures today that in many cases didn't exist even five years ago. The complexity of both products and the overall value chain has greatly increased. Cost is still king when it comes to manufacturing operations, but as Figure 1 shows, other factors are starting to assert themselves more. Product release cycles are being compressed and customer demands for higher quality are increasing.

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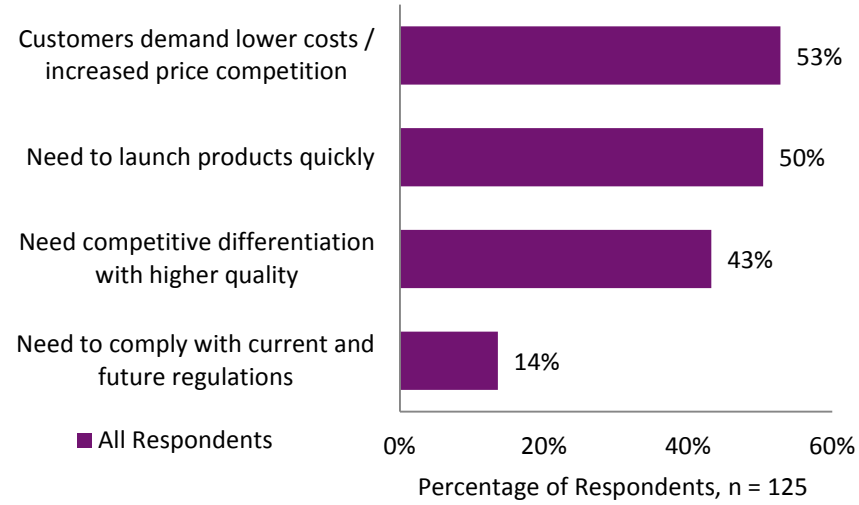
Figure 1: Cost and Time Driving Focus on Operations



Source: Aberdeen Group, January 2014

Compounding the issue are the many internal challenges companies face on a day-to-day basis (see sidebar). It is no surprise to see the top two internal challenges match with the top two external pressures, but cost and time concerns are symptoms of another overlying issue, inefficiencies in the process. And unfortunately, a siloed design or manufacturing approach isn't likely to address this problem.

Maturity Class Breakdown

To identify best practices for managing the complex interactions between product development and production, Aberdeen benchmarked the performance of study participants according to metrics indicating design and production success, as well as revenue generation. Aberdeen categorized participants as Best-in-Class (top 20% of performers), Industry Average (mid 50%), or Laggard (bottom 30%). The Best-in-Class are seeing 92% of their new products hit the targets they set, while at the same time running at 93% OEE…clearly the Best-in-Class are doing something right (Table 1).

Top Challenges Reinforce the Pressures

Top challenges to manage operations (All Respondents):

- **Operating costs are too high:** *40%*
- **Too many new product introduction targets missed:** *33%*
- **Managing multiple datasets:** *30%*
- **Reduced budgets (operational or capital)**: *30%*
- **Rising cost of raw materials**: *25%*

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Table 1: Top Performers Earn Best-in-Class Status

Definition of Maturity Class	Mean Class Performance
Best-in-Class: Top 20% of aggregate performance scorers	93% Overall Equipment Effectiveness (OEE) +15% Operating Margin vs. Corporate Plan 92% Successful New Product Introduction (NPI) Rate 14% **Decrease** in average number of Engineering Change Orders (ECOs) after release to manufacturing
Industry Average: Middle 50% of aggregate performance scorers	82% Overall Equipment Effectiveness (OEE) +7% Operating Margin vs. Corporate Plan 73% Successful New Product Introduction (NPI) Rate 13% **Increase** in average number of Engineering Change Orders (ECOs) after release to manufacturing
Laggard: Bottom 30% of aggregate performance scorers	71% Overall Equipment Effectiveness (OEE) -11% Operating Margin vs. Corporate Plan 58% Successful New Product Introduction (NPI) Rate 14% **Increase** in average number of Engineering Change Orders (ECOs) after release to manufacturing

Source: Aberdeen Group, January 2014

"Successes we have seen are higher machine utilization and less wrongly produced parts. Failures we have experienced are allowing parallel paper stream, leading to not updating the MES/ERP layer in time and not taking timely action on feedback from the floor (e.g. corrections on drawings, routing and timing)."

~ IT Manager, Medium Industrial Equipment Manufacturer

ECOs are the scourge of new product introductions; they are the primary drivers of product delays and increased cost due to rework. A huge reason why you see the Best-in-Class have such a higher NPI success rate is because they design the product right the first time; a 14% decrease in ECOs over the past year is a huge advantage.

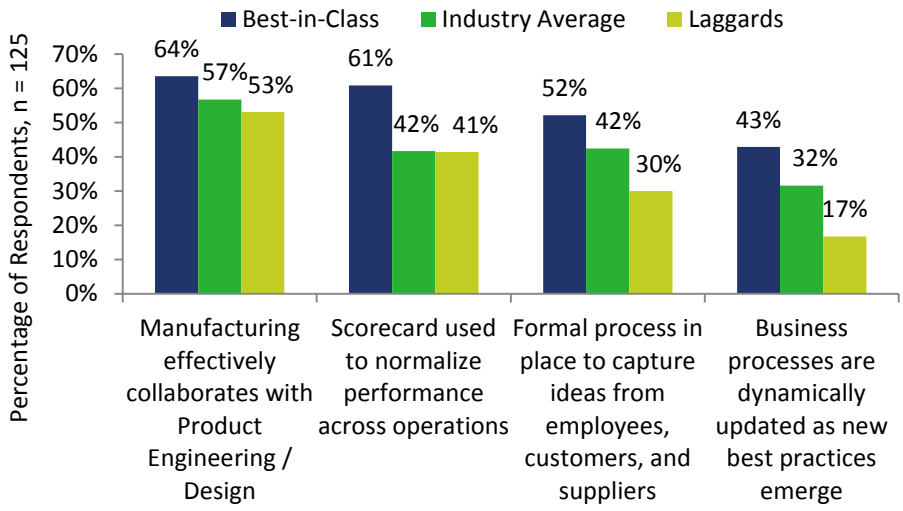
Building the Foundation for Collaboration and Ideation

Product development and manufacturing are two groups within a company that are generally stand-alone, and in some cases, make every effort to avoid each other whenever possible. I have seen first-hand the tension that can develop between the two groups because of the stakes that both hold in product introductions. If a problem arises after release to manufacturing, the blame gets passed around like the plague. Engineering designed the product with "X" material that has known quality

issues with "Y" process. Manufacturing decided to tweak the machine run settings and never notified product development of the change.

These are the types of comments and excuses that are thrown around constantly and result from organizational friction generated by a "silo mentality". To be successful you have to break down the barriers between these groups and make them realize it takes organizational commitment from all groups to succeed, and that the only way to make it work is by working across organizational boundaries. The Best-in-Class realize this and strive for collaboration and ideation among their employees (Figure 2).

Figure 2: Fostering a Collaborative Enterprise



Source: Aberdeen Group, January 2014

Collaboration between these groups is key; the Best-in-Class already have the advantage, but looking at the top strategic actions, you can see they want to improve it even more (see sidebar). This further illustrates the importance of collaboration,

Top Strategic Actions

Top actions to deal with pressures:

- **Promote collaboration between product design and manufacturing:**
  Best-in-Class: *58%*
  All Others: *41%*
- **Promote visibility between manufacturing operations and the enterprise:**
  Best-in-Class: *20%*
  All Others: *12%*
- **Build compliance and traceability into production processes:**
  Best-in-Class: *17%*
  All Others: *9%*

and identifies an area where the Industry Average and Laggards need to start focusing immediately.

Once you have your employees working towards the same goal - successful product introduction - the ideas on how to improve the process are guaranteed to follow. Getting different viewpoints thinking critically about the same problem will move your employees from doing things “as they've always been done” to the most effective way possible. A formal process needs to be put in place to capture these ideas and reap the benefits. The Best-in-Class lead the way in this aspect, being 73% more likely than Laggards to possess this capability. The Best-in-Class also take it a step further by dynamically updating their processes once these ideas are analyzed and deemed a best practice. This ensures a smooth transition and allows for the process to be continually improved.

Finally, there are a lot of different ways to measure metrics like OEE, on time and complete shipments, or new product introductions.

- ➔ Are specified or optimal machine speeds used?
- ➔ Are promise or re-promise dates used?
- ➔ Does time to quality matter for achieving new product targets?

All of these questions should be answered, and answered uniformly, across the enterprise. The Best-in-Class are 28% more likely than their peers to have already standardized these metrics across the organizations (see sidebar). They also then extend this capability by being more likely to utilize scorecards for these metrics, which normalizes and compares performance across their operations. This also furthers collaboration efforts

Fast Fact

KPIs (Key Performance Indicators) are standardized and implemented across enterprise:

- Best-in-Class: *77%*
- All Others: *60%*

because every group will be working from the same set of measurements.

Change Management

The very nature of NPI process makes it susceptible to change. There is almost no way to avoid it. Even if a designer produces a completely sound product, change can be needed for reasons out of a company's control. New regulations could force a change in material, process, or function. A cheaper, more effective process or machine could be introduced, and change in the product is needed to take advantage of the benefits. The Best-in-Class know how important change management is to not only a new product, but also the business (Table 2).

Table 2: Managing Change

Change Management Capability	Best-in-Class	All Others
Standardized process to formally request a change to operations	83%	72%
Formal process to review and approve proposed changes in operations	83%	63%
Formal process to manage and communicate changes in operations	70%	55%
Closed loop processes for change related tasks	55%	35%
mBOM (manufacturing bill of material) or BOP (bill of process) created from the eBOM (engineering bill of material)	60%	43%
eBOM and mBOM remain “linked” so changes in either are reflected in the other	43%	34%

Source: Aberdeen Group, January 2014

The Best-in-Class have a standardized process to formally request a change in operations, whether it occurs in equipment, manufacturing process, or materials. Following that, they have a formal process to review and approve changes in operations. In doing so, they go through the proper channels to ensure that if

the change is made, it won't have an unknown impact on the business. Once a change has been approved, the Best-in-Class are also more likely to make sure that it is communicated across the organization, followed by having a formalized closed loop process. In doing so, the Best-in-Class ensure that change is not only communicated but also implemented and adhered to.

However, what truly separates the Best-in-Class when it comes to managing change in the business is in the transfer and management of the eBOM and mBOM. First, 60% of the Best-in-Class generate the manufacturing BOM directly from the eBOM, ensuring there are no hand-off errors between developers and operations. The next step, where every group can improve but the Best-in-Class still lead the way, is in the linking of their Bills of Material. With the frequent ECOs/ECNs that occur in companies, ensuring the accuracy of the BOM management can be a real challenge. Linking the BOMs is essential for those companies aiming to improve the interactions between engineers and manufacturing.

Top Challenges to Manage Bill of Materials

From Aberdeen's most recent Product Lifecycle Management survey (All Respondents):

Maintaining accuracy of BOMs - 41%
Visibility / control over BOMs in service lifecycle - 32%
Managing multiple views of BOMs (as built, as planned) - 27%
Maintaining revision control and implementation timing with outside partners and suppliers - 26%
Maintaining completeness of BOMs - 25%
Integrating BOMs across engineering disciplines - 17%

Design for Manufacturability (DFM)

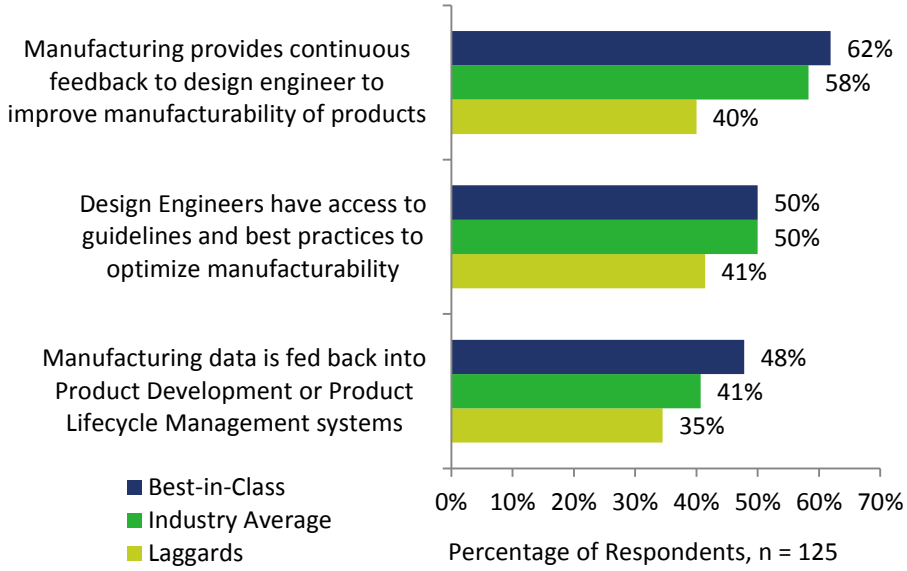
A successful product is not just based on good design - manufacturability is a critical aspect of all design endeavors. Often an otherwise good design is difficult or impossible to produce. Design for Manufacturing ability is the practice of designing products in such a way that they are easy to manufacture. Implementation of this concept differs widely by industry or organizational maturity, but the overall idea of DFM is very similar to Lean or Six Sigma - eliminating as much "waste" as possible.

Take as an example CNC machining; areas that can be focused on to improve manufacturability are material type (steel vs. aluminum), material form (bar stock vs. plate), the shape or

design (optimizing the length to diameter ratio), or tolerances (loosest tolerance while stull functional). If these DFM guidelines are not followed, companies will fall into iterative design process, lose manufacturing time and increase costs due to rework, and ultimately, increase time to market. The higher new product target rates for the Best-in-Class prove the importance of DFM (see sidebar); there is a direct correlation between DFM and being Best-in-Class.

For certain industries or products (steel structure components, Printed Circuit Boards (PCB), Integrated circuits (IC), etc.) there are set guidelines and best practices already out there on how to maximize manufacturability. Both the Best-in-Class and Industry Average take advantage of these best practices and provide them to their engineers, which keeps DFM at the top of the design engineers mind when developing a product (Figure 3).

Figure 3: Tying Back the Data



Source: Aberdeen Group, January 2014

Additional Product Metric Performance

Product Launch Dates:
- Best-in-Class - 77%
- Industry Average - 69%
- Laggards- 62%

Product Cost Targets:
- Best-in-Class - 82%
- Industry Average - 70%
- Laggards- 67%

Quality Targets at Release:
- Best-in-Class - 84%
- Industry Average - 75%
- Laggards- 67%

Product Revenue Targets:
- Best-in-Class - 84%
- Industry Average - 72%
- Laggards- 64%

Interoperable Enterprise Systems

The Best-in-Class are leading the way when it comes to utilizing enterprise systems to manage the complexities of product development and manufacturing:

- **Enterprise Resource Planning (ERP):**
  Best-in-Class: *80%*
  All Others: *75%*
- **Product Lifecycle Management (PLM):**
  Best-in-Class: *52%*
  All Others: *42%*
- **Manufacturing Operations Management / Manufacturing Execution System (MOM / MES):**
  Best-in-Class: *50%*
  All Others: *36%*

Where the real advantage comes in is the interoperability that the Best-in-Class provide between these systems:

- **MOM and PLM:**
  Best-in-Class: *42%*
  All Others: *18%*
- **MOM and ERP:**
  Best-in-Class: *48%*
  All Others: *30%*
- **ERP and PLM:**
  Best-in-Class: *49%*
  All Others: *20%*

The next step to ensure an easily manufactured product is in the design review. A proper design review involves a design engineer creating a model or design and sending it to manufacturing for review and feedback. If this process is not followed diligently, you run the risk of the product failing at the manufacturing stage. That is why you see almost two-thirds of the Best-in-Class leading the way when it comes to continuous feedback from manufacturing.

Companies not focusing on design for manufacturability initiatives are at great risk for what can be called the hidden change cycle. That is, the process where changes happen in manufacturing and are never reflected back to design. This leads to unofficial documentation in manufacturing, audit problems, rework, yield issues, and even customer satisfaction issues. There are often contractual obligations to notify the customer of any design or process changes that can have penalty implications as well. I have seen this countless times on the shop floor, binders full of scratched out and changed machine settings for products that development is never aware of. That is why you see almost half of the Best-in-Class feed this manufacturing data back into their systems for product development. This is the final step for any DFM initiative; it closes the loop on the process and provides the engine for continuous improvement.

System Integration

There is a connection between the technologies a manufacturer adopts, and achieving Best-in-Class performance (see sidebar). The technologies that associate to Best-in-Class performance span the ISA-95 technology stack; starting at the controls layer, moving up through manufacturing operations management, and ending with enterprise applications focused on the interdependent functional areas of product development, engineering, inventory management, distribution, and

production planning. By adopting such a technology strategy, Best-in-Class manufacturers are able to better address the market pressures they face, including the need to ensure finished product quality, quickly ramping up to demand, and effectively introducing new products.

Companies should invest in these solutions to efficiently manage the massive amounts of complex product data (requirements, configurations, manufacturing specs, suppliers, compliance, etc.) and to provide employees and executives the ability to make connections between the day-to-day tactical operations and the overall strategic business goals. One of the major roadblocks to this process is adoption of technology applications that function independently. That is why the real difference between the Best-in-Class and their peers shows up in providing interoperability between these systems. Best-in-Class manufacturers are more likely to interoperate across their PLM, MOM, and ERP systems. This digitizes the business processes from product design, to manufacturing process planning, and manufacturing execution.

However, detailed questions about the tactical integration of processes, roles, and the use of technology in this context can remain. How does the design process change? With most initiatives falling between engineering and manufacturing groups, will a lack of single ownership and accountability degrade its effectiveness? These two issues, lack of ownership and accountability, tend to paralyze companies, resulting in indecision and inactivity. That is why you see the Best-in-Class focus on the resources available to maximize this (intimidating) integration (Figure 4).

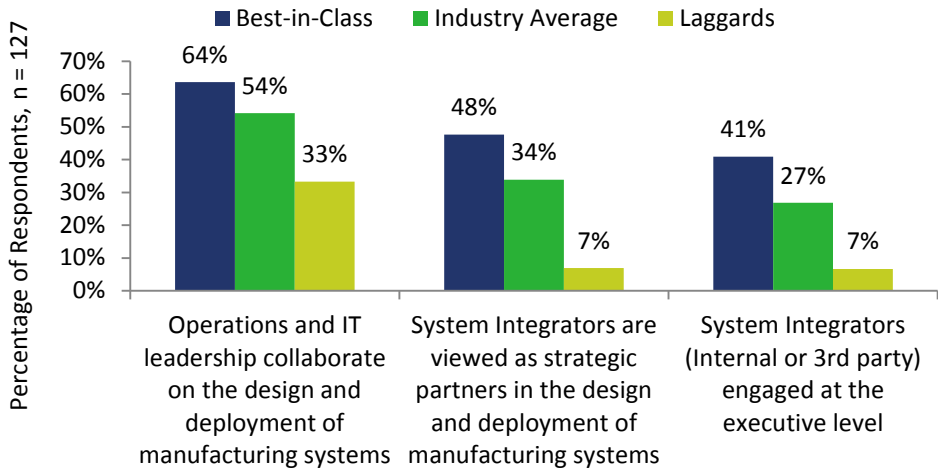
ANSI/ISA-95

ANSI/ISA-95, or ISA-95 as it is more commonly referred to, is an international standard for developing an automated interface between enterprise and control systems. This standard has been developed for global manufacturers. It was developed to be applied in all industries, and in all sorts of processes, like batch processes, continuous and repetitive processes.

"We implemented a MES system because we needed to manage all the data in manufacturing. Operationally it has been very successful, but the platform on which the system was built is technically flawed in terms of security and sustainability."

~ IT Manager, Small Chemicals Manufacturer

Figure 4: Maximizing Enterprise Systems



Source: Aberdeen Group, January 2014

There are many benefits that can be seen to interoperating across PLM and MOM.

At the enterprise level:

- ➔ Improved performances in New Product Introductions (i.e. launch or deliver products in less time).
- ➔ Improved performances in Enterprise Quality Management (i.e. increase customer satisfaction, reduce product returns, and reduce in scrap).
- ➔ Improved performance in Operational Efficiency (i.e. reduce production time and costs).

From the perspective of a manufacturing executive:

- ➔ Improved access to critical design, recipe, formulation, packaging, quality, and process data on the shop floor.

"Our system was developed as a corporate wide (all sites) solution. In reality, it is too complex for our own single line operation. We are going to install a new standard system and at the same time migrate order-to-invoice into MES and out of ERP, where it now resides."

~ Manufacturing Managing Director, Medium Lumber / Mill Company

- ➔ Improved communication and collaboration with design and engineering.
- ➔ Improved access to visualization and modeling on the shop floor.

From the perspective of an engineering executive:

- ➔ Less time spent re-engineering products (fewer problems get downstream resulting in fewer Engineering Change Orders (ECOs)).
- ➔ More flexibility in design and cost targets (due to expert manufacturing feedback on how to reduce cost and increase quality).
- ➔ Higher likelihood to comply with development budget constraints (due to higher likelihood to pass prototype and quality tests the first time because of earlier validation with manufacturing experts).

From the perspective of an IT executive:

- ➔ Elimination of organizational silos across manufacturing and engineering IT.
- ➔ Cost reduction for maintaining multiple and disparate systems.
- ➔ Simpler orchestration of business processes that span design, make, and deliver.

Key Takeaways and Recommendations

Given the complexities in today's manufacturing environment, manufacturers are facing many challenges. One of the largest is internal silos between business groups and one of the most detrimental can be between product development and

Fast Fact

Time frame to release ECOs from design to manufacturing:

- Best-in-Class: **27 hours**
- Industry Average: **41 hours**
- Laggard: **50 hours**

operations. However, in this challenging environment there are many opportunities for improvement. To address these pressures and help capture some of this opportunity, the Best-in-Class are creating a collaborative enterprise that strives for operational excellence between development and manufacturing. Those companies looking to bridge the gap between product development and operations should consider the following:

1. **There are many opportunities to foster collaboration and ideation.** Understand the levers in your organization and put together a long term vision. This is the first step all companies need to take to break down silos throughout the company.

2. **Implement a formal change management process with linked BOMs**. Best-in-Class companies understand the importance of having a formalized process to request, approve, and communicate changes across the value chain. Rework, compliance concerns, and product failures often occur when someone within the value chain makes a change without understanding the business impact.

3. **Focus on design for manufacturability to reduce risk in the new product introduction process**. The Best-in-Class lead the way when it comes to utilizing DFM to advance product development. This builds knowledge around the issues that can arise during manufacturing, allows them to be detected earlier, and as a result, avoid rework. This goes a long way to the Best-in-Class having a 92% successful NPI rate and 93% OEE rate.

4. **Connect your enterprise systems (ERP, PLM, MOM) and form strategic relationships between operations, IT, and service providers**. These connections can help shape the vision and execution for business process interoperability, and ensure that critical information is available to all groups for effective decision making.

For more information on this or other research topics, please visit www.aberdeen.com.

Related Research

Managing System Design Complexity: 3 Tips for Saving Time; October 2012

Engineering Change Management: Avoiding Bottlenecks for Competitive Advantage; October 2012

Embedded Software Development: Implementing an Agile Methodology to Improve Time and Quality; September 2012

The Strategic Role of Systems Engineering: Ensure the Future Success of Your Products; August 2012

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