PRODUCT DEVELOPMENT IN THE ERA OF IOT: TYING THE DIGITAL THREAD

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Best-in-Class firms are 2.4x more likely to develop a digital thread that ties together all phases of a product's lifecycle.

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Applying systems engineering rigor to achieve continuous verification and validation, Best-in-Class firms are 2.4x more likely to use simulation to verify interactions between subsystems, before building physical prototypes.

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Agile methodologies allow Best-in-Class software developers to adapt to changing requirements, hit market targets, and design products with 10% higher profit margins.

This report looks at the importance of the Internet of Things (IoT) and how Best-in-Class firms maximize product development in a complex manufacturing environment. Specifically, this is examined through the innovative use of tools and processes to create a digital twin / digital thread that is maintained throughout the product development lifecycle.

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Manufacturer commitment to digital transformation is strong. Preliminary Aberdeen Group analysis found that 35% of manufacturers plan to achieve digital transformation (IIoT, Industry 4.0, smart manufacturing).

Today's smart, connected products have changed the rules for product development. The IoT is coming, and the products you develop are more innovative, more data-centric, and involve more software than ever. At the same time, the product development process itself is based on continuous engineering and connected manufacturing operations. This report looks at how Best-in-Class firms maximize product development in a complex manufacturing environment through the innovative use of tools and processes to create a digital thread maintained throughout the product development lifecycle. Their tool kit for success includes systems engineering, asset performance management, product lifecycle management, and streamlined software development through agile methods.

Product Development in the Era of Industry 4.0

We live in a new manufacturing era that has been called the fourth Industrial Revolution. This period is characterized by the digitalization of manufacturing (a.k.a. Industry 4.0.) and the fourth major transformation of modern manufacturing. The new industrial stage follows the lean revolution of the 1970s, the outsourcing trend of the 1990s, and the automation that took place in the 2000s.

Manufacturer commitment to digital transformation is strong. Aberdeen Group analysis finds that already 27% of manufacturers plan to achieve it (industrial IoT, Industry 4.0, smart manufacturing). A key part of digital transformation is the Internet of Things, which is positioned to revolutionize the entire product development value chain by providing an unprecedented level of connectedness and functionality. For consumers, this change comes in the form of small, highly-connected devices (e.g., smart phones, tables, GPS devices) and sophisticated electronics embedded into our means of transport, living spaces, and work places. For companies, this change empowers them with new

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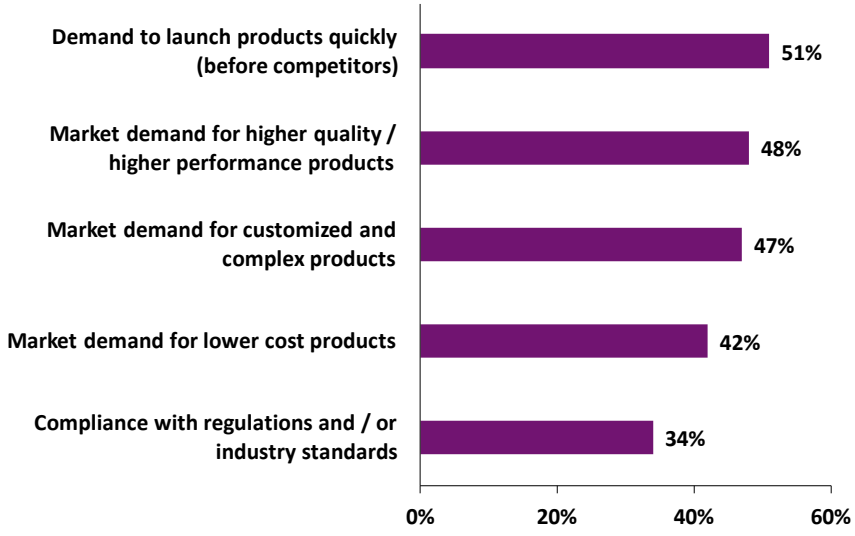
ways to develop, innovate, and manufacture, due to the endless connections available. This is known as the industrial IoT (IIoT), a subset of the IoT, that links manufacturing operations to develop connected products and services.

The transformative potential of the IoT in manufacturing is huge. Findings from Aberdeen's *MOM-MES and Manufacturing Operations Benchmark Study* found that 89% of respondents see the manufacturing benefits of the IIoT, and manufacturers are eager to "operationalize" them. While they most certainly see the cost effectiveness of the IIoT, the bigger benefit is perhaps the IIoT's ability to enable connected operations, allowing manufacturers to improve operational equipment uptime and availability.

Figure 1: Top Pressures to Improve Product Development



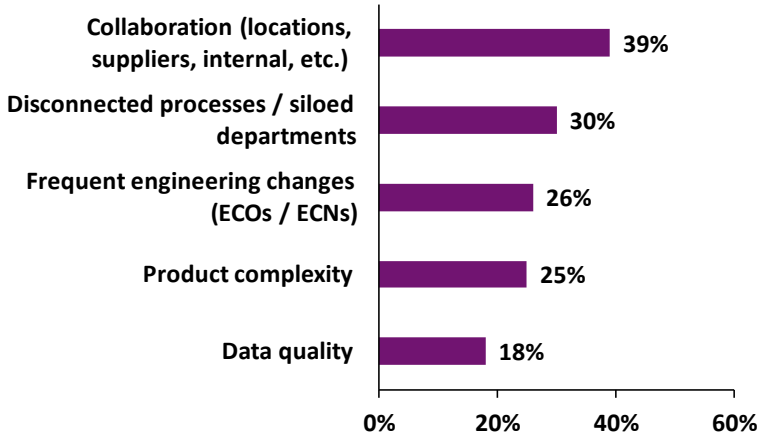
Source: Aberdeen Group, April 2017

Demands to launch products quickly (before the competition), the need for continuous product innovation, and expanding market

opportunities leave companies no choice but to stay on the cutting-edge of the development process. Forty-eight percent of manufacturers cited market demand for higher quality, and higher performance products, as their top pressure when it comes to improving product development. Not far behind, 47% of manufacturers said market demand for complex yet highly customized products drove their desire to improve in this area.

These pressures to improve product development (see Figure 1) take on new meaning when designing objects for the Internet of Things. By their nature, IoT-based products are more complex. Thus, the development process must accommodate more product functionality and higher reliability, without compromising power, form, factor, or overall performance.

Figure 2: Top Product Development Challenges



Percentage of Respondents, n=196

Source: Aberdeen Group, April 2017

Thirty-nine percent of all survey respondents said collaboration was one of their top two challenges in the development process. Closely following collaboration, 30% of respondents said disconnected processes / siloed departments was at the top of their list of product development challenges.

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Best-in-Class firms are

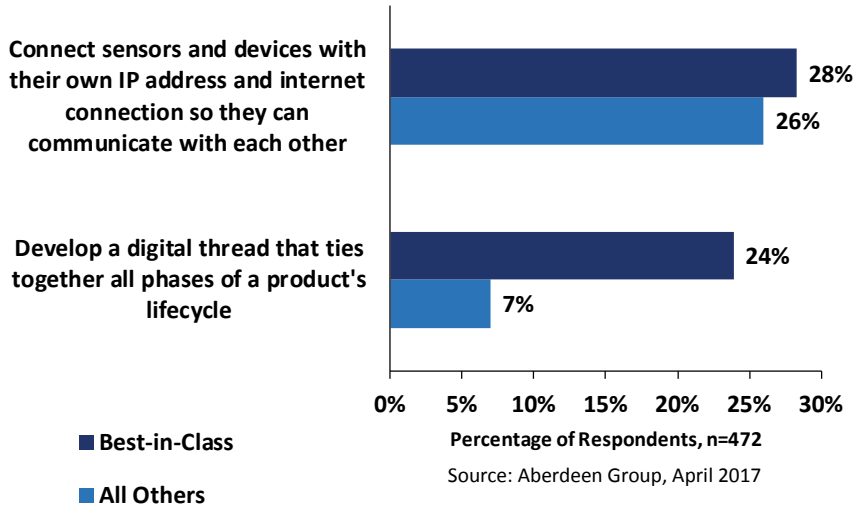
2.4x

more likely to develop a digital thread that ties all phases of a product's lifecycle together.

Enter the Digital Thread

In this new information-centric era, the "digital thread" is a communication framework that connects traditionally siloed elements in manufacturing processes and provides an integrated view of an asset throughout the product manufacturing lifecycle.

Figure 3: Best-in-Class IoT Actions for Creating Connected Operations



Source: Aberdeen Group, April 2017

Best-in-Class firms find the digital thread extremely compelling. These organizations are 2.4 times more likely to be developing a digital thread that ties together all phases of a product's lifecycle. In addition to existing technology, the establishment of a digital thread also requires business processes that help weave data-driven decision management into the manufacturing culture.

To build the digital thread, information "silos" from various processes in the product development lifecycle are slowly being

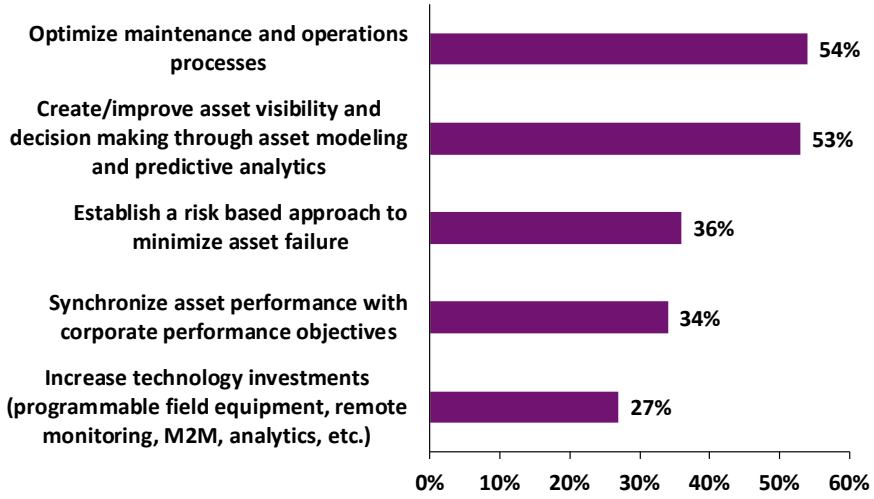
connected to integrate and drive modern design, manufacturing, and product support processes. This complete and rich digital thread enables manufacturers to reduce cycle time and achieve first pass success, and is the only feasible way to deal with the complexity of today's products.

Tying the Digital Thread: The Digital Twin and APM

Central to the idea of the digital thread is the concept of a "digital twin." Quite simply, a digital twin is a virtual model of a process, product, physical asset, or service. One can think of a digital twin as a bridge between the physical and digital world. This pairing of the virtual and physical worlds allows analysis of data and monitoring of systems and assets to head off problems before they even occur, prevent downtime, develop new opportunities and even plan for the future.

Ultimately, the goal of the digital twin is to create, test, build, and monitor equipment and processes in a virtual environment. In doing so, **asset visibility** is created, empowering organizations to shift to an operations-centric view, where proactive and predictive maintenance enables front-line personnel to act before costly failures occur. In this context, asset performance management (APM) enables intelligent asset strategies that balance three traditionally competing priorities — reducing cost, improving availability and reliability, and managing risk — to optimize overall asset and operational performance. Aberdeen Group finds that Best-in-Class firms are 42% more likely to approach risk management through asset management/maintenance (Figure 4).

Figure 4: Asset Performance Management and the Digital Thread



Source: Aberdeen Group, April 2017

It is only thanks to the Internet of Things that the digital thread and digital twin have become cost-effective to implement.

The digital twin makes complex product development attainable. Emerging standards provide 3D geometric models, enhanced with product manufacturing information, that is semantically rich and machine readable. Lessons are learned and opportunities are uncovered within the virtual environment that can be applied to the physical world — ultimately to transform your business.

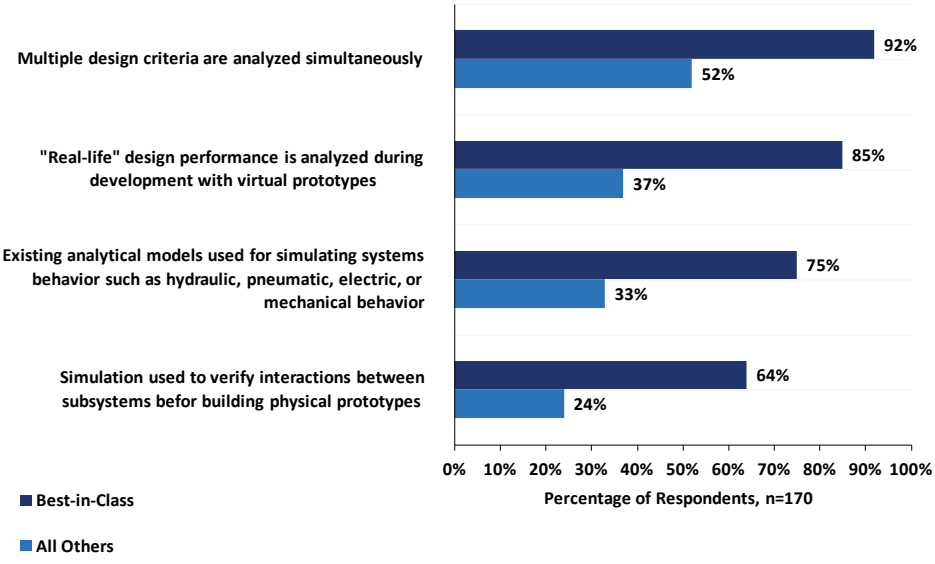
It is only thanks to the IoT that the digital thread and digital twin have become cost-effective to implement. In particular, "IoT platforms" are disrupting product development business models and infusing innovation into the product development process. These IoT platforms allow products, services, and information to be exchanged via predefined streams.

Given this new framework for product development, what tools do Best-in-Class firms use to master their domains? Along with APM (discussed above), the answer includes systems engineering, product lifecycle management (PLM) software as an innovation platform, and agile software development methodologies.

Systems Engineering for Continuous Validation

Best-in-Class companies are at the top, because they understand the value of a standardized systems engineering process. In doing so, they enable faster development, while allowing for completion of more complex products. Best-in-Class companies are clearly leading the way in applying systems engineering practices to complexity in the age of Industry 4.0.

Figure 5: Best-in-Class Firms Employ Systems Engineering



Source: Aberdeen Group, April 2017

Best-in-Class firms apply systems engineering rigor – to avoid the costs of late-stage product development problems – by enabling continuous verification and validation, via virtual prototyping and simulation. These firms analyze multiple design criteria simultaneously, with a bias toward adjusting product design early

in the development cycle. This state of continuous engineering ensures that they will avert costly mistakes in the future. For example, Best-in-Class firms are 2.4 times more likely to use simulation to verify interactions between subsystems before building physical prototypes.

The benefits of systems engineering for early validation are clear. Best-in-Class manufacturers are 47% more likely to meet product launch targets, 42% more likely to meet product cost targets, 41% more likely to meet product revenue targets, and 38% more likely to meet product quality targets.

PLM for Enabling the Digital Thread

While continuous verification and validation are beneficial in designing smart, connected products, the other half of the equation is enabling the digital thread across the product lifecycle PLM software plays this key role.

PLM enables the digital thread across all stages of product lifecycle by representing the product definition across the lifecycle and across product variants, providing traceability. This is critical, as the product definition changes at various lifecycle stages. For example, PLM maintains the relationship between various bills of material (engineering bill of materials, manufacturing bill of materials, etc.) as the product definition progresses through the various lifecycle stages.

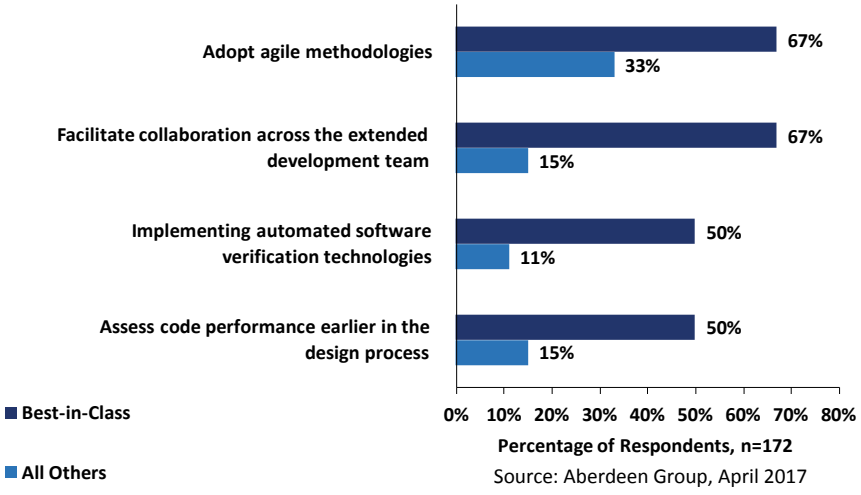
PLM not only tracks data, processes, decisions, and results across the product lifecycle, it provides the ability to trace back in time all inputs, decisions, and data involved in product development.

As digital transformation sweeps over manufacturing, PLM's role in enabling the digital thread and traceability truly positions it as an innovation platform.

Streamline Software Development via Agile Methods

Agile software development methodologies can drastically reduce risk in product development. Aberdeen Group research shows that agile methodologies allow developers to adapt to changing requirements, hit market targets, and design products with 10% higher profit margins. As shown below, top software developers strive for collaboration and ideation.

Figure 6: Best-in-Class Actions for Agile Software Development



Source: Aberdeen Group, April 2017

Best-in-Class firms adapt agile methodologies at twice the rate of All Others and facilitate collaboration across the extended development team. These organizations are 4.5 times more likely to implement software verification technologies, and 3.3 times more likely to assess code performance earlier in the design process, catching errors earlier to save time, money, and wasted effort.

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Best-in-Class firms implementing agile methodologies for software development are richly rewarded. They are three times more likely to meet product launch dates than Laggards, twice as likely to meet product revenue targets, and 2.8 times more likely to meet product quality targets at design release. To top it off, the Best-in-Class enjoy a 9% decrease in development cycle length over the last two years, versus Laggards, who experienced a 14% increase.

Summary

The new product development process is based on connected operations. It uses IoT platforms to streamline manufacturing by creating a digital thread connecting previously siloed elements and manufacturing processes. The digital thread employs digital twins, and greatly enables asset visibility and management.

In this new world, it is vital that your engineering processes don't hold you back. Systems engineering has become a key component in the Best-in-Class tool kit to ensure this doesn't occur. The rigor of systems engineering reinforces the agility of IoT product development and design. This is particularly important for smart, connected products that need to communicate with other products and systems outside the designers' control. Best-in-Class product developers concentrate on applying systems engineering rigor to achieve continuous validation and verification via simulation and virtual prototyping. This continuous engineering bias catches and fixes errors early in the design process.

Catching bugs early, however, is not enough. Best-in-Class manufacturers also use PLM software to enable a digital thread that ties together all phases of the product lifecycle, to achieve digital transformation. Last but not least, PLM enables traceability.

This ensures the ability to trace back in time all inputs, decisions, and data involved in product development.

The final tool kit component is agile methodologies for software development. Applicable in both embedded software and application software environments, these methodologies accelerate time-to-value in software delivery while reducing operational costs and development cycle time.

IoT is not rocket science, but its implications for manufacturing *are* out of this world. Like the rise of network technology in the 1980s and the rise of open source in the late 1990s, IoT platforms will ultimately streamline and standardize data exchange. This time around though, automated data collection and data exchange is between connections among "things" — devices, machines, physical objects, vehicles, buildings — embedded with sensors and actuators.

Just as the Cloud turned computing into a utility, the rise of IoT platforms will ultimately transform into a utility for manufacturing processes. Product developers in the era of connected operations, connected products, the digital thread, and digital twins can look to Best-in-Class firms for ways to excel in this brave new world of product development.

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Related Research

What Does the Digitalization in Manufacturing Mean Now?; January 2017

Maximizing Product Design in a Complex Manufacturing Environment; August 2016

Accelerating Development with Virtual Prototyping; December 2016

Choosing All Three: Fast, Good, and Cheap Using the Digital Twin; September 2016

Simulation in the Internet of Things (IoT); April 2016

Simulation in the Internet of Things (IOT); November 2016

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