RESEARCH REPORT

IoT's Impact on the Business of Engineering

By John Tenore

Introduction

Today's products are more sophisticated than ever and are growing in complexity as embedded software and electronics become integral, especially where IoT-style capabilities are being introduced. These changes are altering the way manufacturing companies deliver value, and in the process are adversely impacting the business of engineering, specifically product development.

In many organizations, product development processes are breaking down, because manufacturers are ill-equipped to handle cross-discipline collaboration. This is especially true when product development processes have been in place for years. They are failing to adapt with business requirements at the speed necessary to win as new technologies and business models disrupt.

The failure to adapt has many companies struggling to keep pace with fast-moving market developments, such as the Internet of Things (IoT), including sensors, ubiquitous connectivity and cloud-based services; new and expanding regulations around complex products; and drastic industry shifts that are driving products to more service-like business models that are updated continuously.

To deal with these dynamics, leaders are embarking on a digital transformation to improve customer experiences, operational processes and strategic business model value propositions. In product development, these digital transformations should drive digital connectedness between the product development disciplines (mechanical, electronic and software development) as well as extended enterprise collaboration in manufacturing, the supply chain and field service.

Most global organizations expected their product lifecycle management (PLM) system to address these issues. Unfortunately, companies have been disappointingly surprised to find PLM severely lacking, for several reasons:

- PLM systems have mainly supported mechanical design and were never intended to manage product development of complete systems with hardware, software and electronics all together.
- PLM products are not easily fit to enable specialized business processes and requirements, making them slow to adapt to fast-changing market conditions.
- Heavily customized PLM implementations are difficult to upgrade, weakening organizations' ability to support evolving strategy and process needs.

This market analysis report investigates the causes and results of varying levels of cross-discipline development for IoT products. The focus is on both front-end product development as well as processes to connect the extended enterprise. Ultimately, the report serves to demonstrate to VP- and C-level executives how fundamental shifts in the way they view and leverage PLM can mean the difference between a successful digital transformation in product development and complete market failure.

Complex IoT Systems Drive Manufacturing Markets

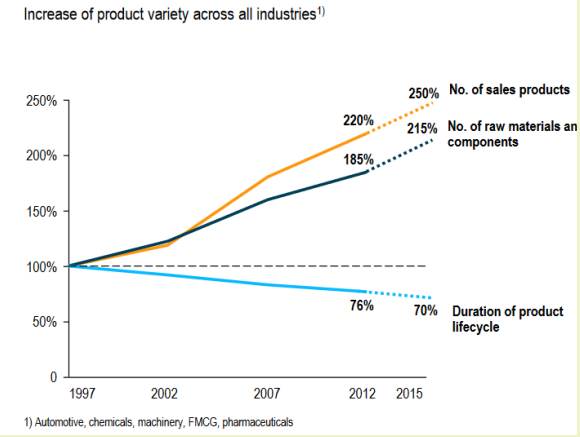
We're all familiar with the expression "IoT," which serves as the umbrella term for today's complex, connected products that incorporate hardware, software and electronics into systems that communicate with other products, services and people via mobile or hard-wired Internet connections. Too often, corporate executives dismiss IoT as consumer product hype, like the Nest home thermostat, and fail to see the ramifications of IoT in their own businesses.

Flavors of IoT are important in every product industry. They include Connected Vehicles, Industrial Internet, Flight Info Feedback in Aerospace, connected wearable technologies, and many more innovations. Consider the definition of IoT as first stated by its inventor, Kevin Ashton, who cofounded the Auto-ID Center at MIT, which created a global standard system for RFID and other sensors. He described IoT as a system where the Internet is connected to the physical world via ubiquitous sensors.[1]

Yet, contend Michael E. Porter and James E. Heppelmann in Harvard Business Review's November 2014 edition, "this phrase is not very helpful in understanding the phenomenon or its implications. The internet, whether involving people or things, is simply a mechanism for transmitting information. What makes smart, connected products fundamentally different is not the internet, but the changing nature of the 'things.'"[2] Embedded sensors, software and processors in products connect via the Internet with product clouds that store and analyze product usage data. This enables companies to make rapid improvements in product functionality, performance and value. According to Porter and Heppelmann, "It is the expanded capabilities of smart, connected products and the data they generate that are ushering in a new era of competition."[3]

Product Complexity Skyrockets

According to Roland Berger's report Mastering Product Complexity, the complexity of products more than doubled during the 15 years ending in 2012 and continues to accelerate. Complexity, Roland Berger said, "manifests itself in the demand for a wider variety of specialized products across multiple manufacturing industries."



The accompanying growth in system complexity, particularly due to increased software usage, is happening across industries. For example, McKinsey found that only 20% of engineers were

[1] https://en.wikipedia.org/wiki/Kevin_Ashton
[2] Michael E. Porter and James E. Heppelmann, "How Smart, Connected Products Are Transforming Competition, Harvard Business Review, November 2014.
[3] Ibid.

engaged in software development and testing in the wireless handset market in 2008.[4] Yet, the number doubled to 40% in 2010 and grew to 60% in 2013. At the same time, PWC reports that the cost of software content in vehicles was less than 20 percent of the total cost a decade ago. Today, software represents more than 35 percent of a car's total cost and is growing rapidly. Reducing software content in cars is not an option, because software systems continue to contribute more than 90 percent of innovations and new features that customers demand.[5]

Consistently delivering innovative new products, profitably, is where manufacturers want to go, and it is clear that some are moving that way faster than others.

When manufacturers get both systems development and business process support right, the payoff can be enormous. On the flip side, when manufacturers "get it wrong" with today's complex products, the costs –in terms of liability, warranty, field repairs, brand damage and public safety –can be astronomical. Consider this recent data from several industries:

- Automakers recalled 74 million cars and trucks in the United States in 2014, more than double the previous single-year high of 30.8 million recalls in 2004.[6]
- Medtronic, a global leader in medical devices and equipment, recalled a hospital ventilator model twice in one year due to software errors that endanger patient lives.[7]
- In Industrial Machinery industry, worldwide warranty claims of US-based materials handling equipment makers totaled $3.1 billion in 2014, an increase of more than 60% over 2004 and a one-year jump of $230 million over 2013 levels.[8]

These data points indicate that many traditional manufacturers are getting it wrong more than they would like, and more importantly, more than consumers and regulators will tolerate.

[4] Harold Bauer and Ondrej Burcacky, "When software meets hardware: Excellence in embedded-software development," McKinsey & Company, Inc., 2013.
[5] PwC, Accessed online March 30, 2016 from the following URL: http://www.strategyand.pwc.com/perspectives/2015-auto-trends
[6] Chris Isidore, "100 million car recalls since the start of 2014," CNN Money, May 22, 2015. Accessed online April 2, 2016 from the following source: http://money.cnn.com/2015/05/22/autos/100-million-recalls/
[7] Joe Carlson, "Medtronic's Puritan Bennett 980 ventilator recalled for second time in a year," Star Tribune, September 2, 2015. Accessed online March 30, 2016 from the following source: http://www.startribune.com/medtronic-s-puritan-bennett-980-ventilator-recalled-for-second-time-in-a-year/324023151/
[8] Warranty Week, "Materials Handling Equipment Warranty Report," June 11, 2015. Accessed online April 2, 2016 from the following source: http://www.warrantyweek.com/archive/ww20150611.html

The Digital Transformation of Product Development

Faced with disruptive competition and the challenge of developing increasingly complex products, many companies have embarked on a "Digital Transformation," defined as the use of technology to radically improve performance or reach of enterprises.[9] The benefits of a digital transformation include:

- Improved customer experiences
- Streamlined operational processes
- New business models and strategic value propositions

To achieve Digital Transformation in product development, digital connectedness between the disciplines (mechanical, electronic, and software development) is essential, as well as, cross-enterprise and extended enterprise processes stretching from manufacturing and the supply chain to maintenance, service and support.

Unfortunately, many global businesses have relied on their existing PLM systems to underpin their product development digital transformation initiatives. However, legacy PLM systems were never designed to flexibly manage hardware, electronics and software engineering together, nor cross-enterprise business processes.

To recognize how ill-suited conventional PLM systems are to enabling the digital transformation at manufacturing companies, one needs only review the findings of a recent GatePoint Research study of executives and managers.[10] The results show that most manufacturers are NOT getting what they need from PLM to enable a true digital transformation.

On the front-end product development side, two salient findings from the study underscore the difficulty that traditional PLM systems have with cross-discipline support:

- 84% of global manufacturers surveyed do not use their installed PLM solution for systems engineering involving more than one engineering discipline
- 53% say that their PLM system does not enable collaboration across disciplines

Accenture: Digital Industry 4.0/ Industrial Internet of Things

Connected, intelligent products that communicate with users, new digital business models that harness collected data to offer additional services and as-a-service products, products on the assembly line that tell shop floor machinery how they are to be processed. The core of Digital Industry 4.0 is highly intelligent connected systems that create a fully digital value chain, the 4th industrial revolution enabled by the Industrial Internet of Things. (sourced online March 30, 2016 at: http://prd.accenture.com/microsites/digital-industry/digital.html)

[9] George Westerman, Didier Bonnet and Andrew McAfee, "The Nine Elements of Digital Transformation," January 7, 2014, Sloan Management Review. Accessed online March 20, 2016 from the following source: http://sloanreview.mit.edu/article/the-nine-elements-of-digital-transformation/

[10] GatePoint Research, Q1 2016. Accessed online April 5, 2016 from the following source: http://www.gatepointresearch.com/resources/pulse-reports/

If existing PLM systems were only failing manufacturers in front-end product development, remedying the situation might not be an insurmountable challenge. However, legacy PLM systems, despite marketing claims to the contrary, typically support very few users across the extended enterprise value chain. The following findings from the GatePoint study reflect the limited reach of PLM today and the resulting inability to support tomorrow's fast-shifting business requirements:

- Only 21% of global manufacturers surveyed are supporting more than 1,000 users with their PLM systems.
- 55% of companies reported attempting to implement their PLM system for over 2 years with limited cross-functional results (38% reported trying for over 3 years).
- 75% of enterprises responded that they can't easily modify their existing PLM system to handle changing business requirements.

As a result, most product companies fail to use PLM as a strategic business approach and typically end up with mere CAD file silos managing hardware subsets of their product definition information notes PLM industry analyst CIMdata[11]. Then, they distribute information across different disciplines and with partners via spreadsheets and other documents using email, shared drives and file sharing services — all with no version control and little or no security. This leads to design issues, quality problems and the potential for expensive field failures and liability risk.

An astounding aspect to these findings is their similarity to the ones I reported from the field as a Gartner enterprise management consultant in 1998 and 1999. My team spent a year mapping product data collaboration environments within global Aerospace & Defense manufacturers. Despite all the PLM hype from then to now, it seems the collaboration needle has barely moved, particularly for processes and users outside the mechanical design teams.

The dangers of today's status quo are that global manufacturers get stuck with fragmented processes, with system and data gaps that can undercut the very new product initiatives that represent the future of the company and profitability. Furthermore, as CIMdata points out, using spreadsheets to fill the gaps can lead to unclear master data, a lack of data sharing, unaddressed business processes, and a general lack of [process] scalability.

GE on the Need for Cultural and Digital Transformation

In a recent Harvard Business Review article, GE underscored the complexity of combining digital technology and industrial machines. Both, they said, require sophisticated domain expertise and are experiencing fast-paced innovation. To be successful, GE says, "A digital-industrial company must keep ahead of the curve on both fronts and be able to merge them seamlessly in a way that maximizes value." (sourced online March 30, 2016 at: https://hbr.org/sponsored/2015/06/why-interconnectedness-matters-for-industrial-companies)

[11] CIMdata, "The Business of Engineering (Commentary)," March 15, 2016. Accessed online March 20, 2016 from the following source: http://www.cimdata.com/en/resources/complimentary-reports-research/commentaries/item/5782-the-business-of-engineering-commentary

The GatePoint Research findings provide clues as to why so many manufacturers are struggling with product development digital transformation initiatives. Current PLM solutions, which were supposed to serve as the unified product data system for cross-enterprise collaboration, have proven woefully inadequate. This is likely the reason why 57% of respondents to the GatePoint study state that they currently have "no plans" to do anything with PLM, even though they are struggling with systems engineering and global product development. In other words, management knows they have a problem. Yet, they recognize that their existing PLM solution cannot address the issues and are wary of pouring more money and resources into it.

Opportunity Exists to Make The Digital Transformation for IoT

The good news is that digital transformation in product development is possible for global manufacturers today. New PLM platform options exist to surpass legacy PLM implementations and move the enterprise forward digitally.

CIMdata proposes in its recent commentary, The Business of Engineering, PLM requires a platform that is capable of filling in data and process gaps to connect system silos into a holistic solution that meets current as well as future business requirements. CIMdata notes that a true cross-discipline platform approach that layers over existing PLM silos is an alternative to the conventional "rip & replace" strategy. This combined with the will to change by bringing together people, processes and systems across the various disciplines and the extended enterprise is necessary to enable the development of future IoT products.

To be a true platform for digital transformation in product development, CIMdata says that a PLM platform needs to provide product data and process frameworks that span the enterprise. In this way, PLM data and enabled processes can underpin complete lifecycles that include cross-discipline product development, field service, warranties as well as fast-changing processes and workflows across the extended enterprise. Note that the extended enterprise includes customers, suppliers, partners, remote employees and other stakeholders.

A true PLM platform can only work when enabled by newer, more modern technologies that fill the large process gaps - left by legacy PLM systems - by managing collaboration, workflows and data while connecting and coordinating existing data silos. In this approach, legacy PLM systems are encapsulated and treated as data sources of the overall PLM platform. This minimizes disruption by keeping the existing PLM system or systems in place and connecting them to the process layer that spans engineering and product definition across the lifecycle to truly enable the seamless design, development and delivery of tomorrow's smart, connected innovations.

Capgemini on the Digital Opportunity

"While conventional complexity management is able to manage product complexity locally quite well, a new approach is necessary to also address the growing complexity and digitalization of the value network. Global organizations could benefit tremendously through an integrated product architecture and platform management in the fields of service, production and engineering. Based on our experience, a world class product architecture and platform management are able to realize significant benefit effects."[1]

Conclusion: Better PLM Brings Digital Transformation for IoT

The growth in product complexity, driven by the IoT, is a permanent trend shaping nearly all product industries. Companies that respond with better integrated product development processes and systems will disrupt and dominate their markets.

Unfortunately, most product companies are seeing their development processes break down, as they are unable to manage cross-discipline collaboration and extended enterprise processes. The problem is exacerbated when trying to respond to new and unforeseen business requirements.

To address the challenges of cross-discipline development and business responsiveness, companies must shift how they view and leverage PLM. PLM must bring automated, digital connectedness between the product development disciplines (mechanical, eletcronic, and software development) as well as cross-enterprise and extended enterprise business disciplines of manufacturing, supply chain, logistics, maintenance, service and support.

New tools and platforms exist to surpass legacy PLM and move the enterprise forward digitally. What's required is a true cross-discipline approach, a PLM platform that layers over legacy systems to provide product data and process frameworks that span the enterprise. Only then can global manufacturing companies achieve the digital transformation required to survive and thrive in this new era.

About Perceptive Analysis

Perceptive Analysis is all about disruptive technologies. We help executives and business managers recognize the ways they can, and should, leverage disruptive technologies to benefit their organizations. We particularly focus on IoT, including enabling infrastructure, software and processes for both technical and business stakeholders.

To find out more, visit us on the web at www.perceptiveanalysis.com

About Aras

Aras® offers the best Product Lifecycle Management (PLM) software for global businesses with complex products and processes. Advanced PLM platform technology makes Aras more scalable, flexible and resilient for the world's largest organizations, and a full set of applications provides complete functionality for companies of all sizes.

By rethinking the way PLM is designed, Aras has taken a fundamentally different approach with a focus on the Business of Engineering. Aras solutions support processes for global product development, systems engineering, multi-site manufacturing, supply chain, quality and more.

Companies running Aras include Airbus, Boeing, Bombardier, GE, Hitachi, Honda, Kawasaki, Magna, Microsoft, Motorola, Nissan, TOSHIBA, Xerox, the U.S. Army and hundreds of others worldwide.