"Innovation without Boundaries" the 2018 Siemens PLM Software Industry Analyst Conference

CIMdata Commentary

Key takeaways:

- *Siemens PLM Software (Siemens) is building a comprehensive set of increasingly integrated solutions, creating a ubiquitous innovation platform that customers can leverage to develop new products, systems, and business models.*

- *Siemens has expanded the view of generative design to include mechanical/geometry, electronics systems, and generative architecture-level view. in what they're calling Generative Engineering.*

- *Siemens closed loop digital twin strategy is the broadest and deepest in supporting their customers' digital transformation. Their approach to autonomous mobility expands their digital twin strategy, from the virtual and physical product to the driving experience. Thus, companies can pursue digital twin initiatives as part of the environment that a product operates in.*

- *Siemens sent a clear message that they see additive manufacturing (AM) as a fundamental technology for digital transformation. They are accelerating, transforming, and scaling the global adoption of AM by aggregating digital and physical access to equipment, materials, and service providers through the Siemens Additive Manufacturing Network.*

- *Siemens is rapidly delivering broad-based offerings for the Industrial Internet of Things (IIoT), including an extensive ecosystem of top notch partners, a growing base of apps, and, with the Mendix acquisition, the ability for both Siemens and their customers to develop purpose-built applications to support their digital transformation objectives.*

- *Siemens continues to expand on their support for PaaS and IaaS to support delivery of their digital innovation platform using the cloud.*

CIMdata recently attended Siemens PLM Software's 11th annual analyst conference in Boston, Massachusetts August 27 through 30, 2018. This event continues to expand as Siemens' solution portfolio grows, with over 100 industry analysts and journalists in attendance.

Keynotes

In the opening keynote, "How Continuous Innovation Accelerates Digital Transformation," Dr. Jan Mrosik, CEO Digital Factory, described Siemens AG's evolution into a digital enterprise both developing solutions for its customers and using its own technology, like from their PLM business unit to drive its business. He claimed that Siemens AG is a top ten software company with more than 24,500 software engineers and over 250 digital offerings including digital services and industrial applications. He noted that by 2020 Siemens AG will be organized in three strategic companies and three operating companies. One of the planned operating companies, Digital Industries, will focus on driving the digital transformation of process and discrete industries. CIMdata thinks this Digital Industries focus could provide significant capabilities for Siemens customers across their business units.

Dr. Mrosik described how Siemens AG has worked for the past eleven years to bring together the worlds of software and automation, and integrate the virtual world with the digital world

through a combination in-house development and strategic acquisitions (of $10+ billion). He also announced a systematic expansion of Siemens software portfolio with Bentley's software tools for the design and simulation of infrastructure. Siemens now owns 9% of Bentley and the two companies have doubled their joint investment funding to $100 million. Plant Data Management and design (i.e., Bentley ProjectWise, COMOS, and 3rd party offerings) will be more tightly integrated with enterprise data using Teamcenter as the collaboration platform. Based on the iModel offering from Bentley, integrating the two technologies will cover large and complex products in a holistic way. With the on-going application of manufacturing approaches to the architecture, engineering, and construction (AEC) industry CIMdata expects that Siemens can bring some real value to their joint customers.

Dr. Mrosik then disused how Siemens has created a holistic Digital Twin that spans the value chain including product, production, and performance twins (Figure 1). He stated that Siemens, with its Digital Enterprise Suite, can provide the digital twin across the mechanical, electronics, and software domains. He noted that one of Siemens strengths is that it is gaining insights as it applies its digital solutions and PLM suite within its 250+ factories world-wide. As an example, he noted that the Siemens Electronics Manufacturing plant in Amberg, Germany has had a 13x production increase since 1990, and maintains a 99.9999% quality level across over 120 product variations built per day with approximately 350 changeovers per day to handle 1,200 different products. All these gains were made with about the same number of employees since 1990.
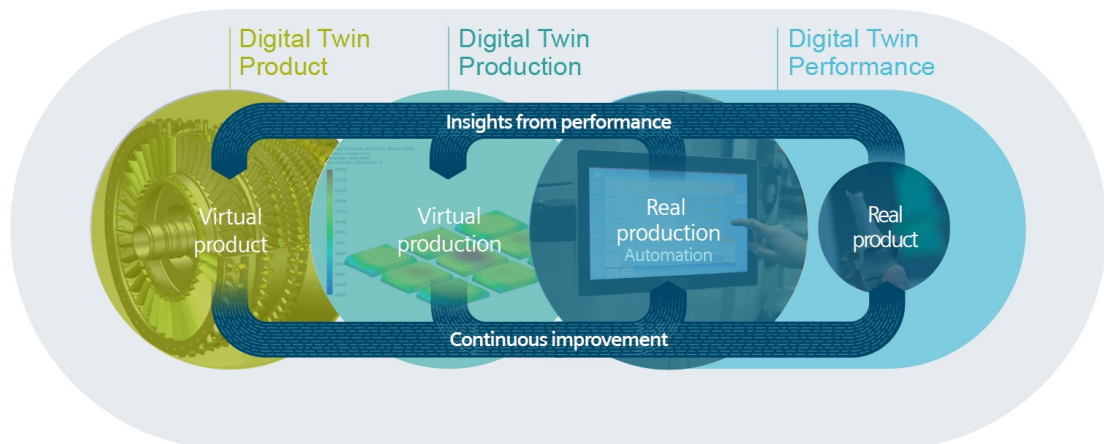

Figure 1—Digital Twins of Product, Production, and Performance
(Courtesy of Siemens PLM Software)

After Dr. Mrosik, Mr. Tony Hemmelgarn, President and CEO of Siemens PLM Software, took the stage to discuss how Siemens is helping enable "Innovation Without Boundaries." He quoted Mark Weiser, Chief Scientist, Xerox and the father of ubiquitous computing, who stated that "the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." Mr. Hemmelgarn claimed that Siemens is doing just that in the PLM space—creating an innovation platform that disappears and is transparent and seamless to the user. However, he noted that achieving ubiquitous innovation will require deep integration and understanding of processes, while eliminating the boundaries between ideation, realization, and utilization. CIMdata agrees with this strategy— users don't care about "how" the environment works, they just want to be able to do their tasks without having to think about "what application must I use" or "where is the data and how do I get it." Mr. Hemmelgarn stated that Siemens is focusing on integrated solutions that have the greatest transformational business value:

- Closed-Loop Digital Twin—use real-world performance insights to change the way a company does business
- Generative Engineering—automate engineering exploration to find optimal designs and systems orders of magnitude faster
- IIoT/EDGE—leverage IoT insights to increase productivity, optimize products, and discover new business models
- Digital Factory—build intelligently automated digital factories to achieve configurable, flexible, and personalized production
- Additive Manufacturing—industrialize additive manufacturing to design and produce useful parts at scale
- Autonomous/Electrification—realize autonomous mobility faster by integrating design and validation of the entire system in one environment
- E/E Systems Integration—optimize design and manufacturing of complex electrical, electronic, and mechanical systems of systems
- Electronics Manufacturing—accelerate NPI by "left-shifting" engineering and planning to achieve right-first-time manufacturing
- PaaS/SaaS/Cloud—Bring continuous innovation to market faster with flexible cloud solutions and rapid application development

CIMdata believes that Siemens' strategic direction will help their customers better leverage Siemens' very broad technological solution suite and create new, innovative products, systems, and services.

Mr. Hemmelgarn's session, entitled "Innovation Without Boundaries," provided an update on Siemens PLM Software's view of industry trends and how they continue to evolve to address them. As part of his business update, Mr. Hemmelgarn claimed the Siemens PLM Software business is enjoying over 10% organic growth and reaching over €3.4 billion in revenue. He stated that they doubled their cloud revenue during the past year and now have thousands of Teamcenter users running in the cloud. Additionally, they are certified on both Microsoft Azure and Amazon Web Services (AWS) and are the only PLM solution provider in AWS' Industrial Software Competency Program. He noted that while Siemens is offering cloud-ready applications and developing cloud-native solutions, and they do not intend to push their customers to the cloud. Siemens will let each customer decide if, when, and how they will use cloud infrastructure and solutions. CIMdata thinks this is a very pragmatic approach that customers will appreciate.

The sections that follow provide more information about many of the strategic themes used to organize the meeting content.

Generative Engineering

Siemens has introduced the concept of Generative Engineering to enable next generation product engineering. It supports innovative design, development, and manufacturing of complex cyber-physical systems requiring cross-domain synthesis and optimization (e.g., mechanical, electrical/electronics, embedded software, and controls). While industry embraces the concept of Generative Design to take advantage of new technologies in 3D design, simulation and topology optimization, and manufacturing (both additive and subtractive), the focus has been primarily at the sub-system and component levels. Generative Engineering expands this to an overall systems-level view of product design where functional requirements and design exploration to identify optimal architectural design alternatives that are then iterated

in a closed loop, managed across all of the engineering domains at the systems, sub-systems, and component design levels. Cross-domain best practices and team knowledge and learning are captured and enable collaboration across the global organization and supply chain. CIMdata believes the Siemens approach greatly expands the value of generative design compared to geometry-focused generative design by including other domains like electrical/electronics, software, IC design, and others.

The key elements of Siemens' Generative Engineering approach are:

1. A common product innovation platform foundation (Teamcenter) that enables systems level design automation with process and knowledge capture, multi-dimensional analytics, and closed loop feedback across engineering and manufacturing domains.
2. Advanced capabilities for multi-disciplinary, multi-physics, and multi-scale modeling and simulation, robust design and optimization, and machine-in-the-loop/Hardware-in-the-Loop/Software-in-the-Loop/Human-in-the-Loop (MiL/HiL/SiL/HuiL).
3. Conceptual systems and component level design tools with capabilities for model verification and validation via physical prototype testing.
4. Open cross-domain platform based on industry standards for data interoperability and widely used systems architecture modeling languages supporting requirements, functional, logical and physical domains.
5. In-service data can be combined with digital models throughout the product lifecycle via Teamcenter connections to IIoT platforms such as Siemens MindSphere.

Closed Loop Digital Twin

Throughout the event both Siemens and its customers described the importance and use of the holistic digital twin in closed loop processes. Presenters stated that to achieve the full fidelity of the digital twin it must include product, production, and performance, and that developing a functional twin is a systems integration task. It is not just about the geometry but it must include software, electronics, networks, and other factors. Siemens described the foundation for the closed loop digital twin as including the following characteristics:

- Multi-domain—develop the whole product
- Deep—provide unified configuration across domains with visualization and VR
- Multi-discipline—support more business processes for more people
- Traceable—virtually validate and test every step of the way
- Connected—inform the whole process; capture knowledge, real-world feedback to design, simulation, and manufacturing information
- Modern—built on an architecture that is scalable, open, and low cost

Siemens is using this full definition to provide actionable intelligence via bi-directional active feedback loops between the real world and the virtual world. CIMdata supports Siemens' holistic digital twin concept and believes that the closed loop twin is what companies need to achieve maximum benefit from the use of digital twin technologies.

Autonomous Mobility

Dr. Jan Leuridan, SVP of Simulation and Testing Solutions, cited a McKinsey estimate that there will be more than 200 electrical vehicle startups by 2021, an IHS projection of 21 million autonomous vehicle sales by 2035, and a ReThinkX forecast of 6 billion ride-share passenger

miles at 1/3 the cost by 2030, to focus his presentation on the design, verification, and validation challenges of autonomous and electric vehicles. Over the past 4 or 5 years, Siemens has strategically acquired businesses such as LMS, CD-adapco, Polarion, Mentor Graphics, TASS International, Infolytica, and Sarakol, to help accelerate the development of electric and autonomous vehicles. CIMdata agrees that investing in broad multi-physics capabilities is essential to meeting Siemens vision for autonomous mobility.

Siemens offerings are intended to help model and simulate at the micro and the macro levels for design, verification, and validation every step of the way for silicon, system-on-chip (SoC), IC boards, ECUs, subsystems, and the entire vehicle within its operating environment. Essentially, Siemens offerings enable the development of the digital twin of the vehicle, as well as the digital twin of its operating environment. These twins will be essential for assessing all of the possible scenarios facing autonomous vehicles.

Overall, Siemens provides a suite of solutions that can enable reliable digital twins for autonomous and electrical vehicles, as well as the digital twins of their operating environments to accelerate the economic design, verification, validation, and certification of such vehicles.

Additive Manufacturing

Siemens has made significant progress since the last analyst briefing by repositioning AM from a discrete operation to make single components or prototypes, into an end-to-end vision for producing useful final quality parts at scale, anywhere in the world.

Although there were a number of presentations focused on Siemens' AM solutions, it is significant that AM was also a theme throughout many other presentations during the event. From Dr. Jan Mrosik's presentation about Siemens AG combining the real world with the virtual world, since 2007, as well as during presentations on Generative Design, Digital Factory, Digital Twin, and MindSphere (their cloud operating system), AM was present as a consistent theme throughout.

Mr. Robert Meshel, Director, Siemens Additive Manufacturing Network, outlined how the Siemens AM Network helps customers innovate their designs by drawing upon global expertise of AM design consultancies, AM materials suppliers, specialized print shops, and software tool providers, as well harness global production capacity to scale production and manufacture close or at the location of final part usage. He also explained how using the Network can help engineers create many more design alternatives and retain proven designs in their personal "My Workspace," creating an ever-expanding corporate AM repository of intellectual property (IP). Enhancing learning opportunities and capturing knowledge is essential to taking AM from an art to production readiness. Sharing that learning will help broaden its commercial applications and revenue potential.

Mr. Aaron Frankel, Senior Director Marketing, and Siemens PLM Software's primary spokesperson about their AM strategy, lamented that despite enormous advances in the AM industry toward making final end-use production parts, most people still think AM is for prototypes. Mr. Frankel continued to highlight how this is changing and went on to elucidate Siemens digital twin concept for AM—how Siemens is repositioning AM from prototype use to end-use production, and how the concept expands into digital twins of the product, production, and performance (see Figure 1). This end-to-end digital twin concept allows customers to use insights gained from production and product performance to make improvements to all aspects of a product throughout its entire lifecycle. These approaches are commonplace in traditional manufacturing, leveraging a knowledge base of materials and processes built over many decades. For AM to succeed commercially, companies like Siemens and their customers must

be able to learn faster and apply that knowledge to rapidly develop the same maturity for using AM in production.

Electronics Manufacturing

Mr. Fram Akiki, Vice President, Electronics Industry, commented that increasingly, the competition in the electronics industry is driven by personalization, miniaturization, customer experience, and application in mature industries. In CIMdata's opinion, these elements should be considered in light of constraints of: (1) cost due to remote low-cost manufacturing competition, (2) time-to-market and dynamic inventory due to direct shipping from factory and Internet shopping, and (3) large numbers of variants and configurations due to mass-customization. Essentially, electronics manufacturing must undergo digital transformation to cope with ever increasing product mix, demand volatility, and the need to maintain operational performance of automated processes.

Mr. Oren Manor, Director of Business Development for Siemens' Valor Division, presented the integrated capabilities offered by Siemens to help the digital transformation of electronics manufacturing, based on machine-to-machine closed-loop feedback and closed-loop feedback from manufacturing to design via design-for-manufacturing (DFM) analysis. He described three focus areas, namely, integration for enabling full flow coverage from design-through-manufacturing, improving manufacturing performance and flexibility, and finally, maintaining consistent and coherent data across the flow to drive improvement.

The centerpiece of electronics smart manufacturing is the Valor IoT Manufacturing Analytics platform, which is supported by Siemens MindSphere for monitoring and managing global electronics manufacturing operations for precise, real-time manufacturing utilization and overall equipment effectiveness (OEE). It collects and manages data sources from Valor shop-floor modules, thus providing visibility into materials management, shop floor equipment, traceability, supply-chain operations, and product quality, globally to support supply-chain performance. Valor IoT Manufacturing Analytics offers a comprehensive suite of IoT services and solutions that fulfil customer requirements and provide several opportunities to develop and operate digital offerings by facilitating a smooth connection between the electronic and mechanical flows, with real-time updates between each domain. The analytics-based feedback loop bridges Teamcenter manufacturing for electronics, Valor NPI DFM, and Valor process preparation, and the Camstar electronics suite, which is consists of Camstar Scheduling, Valor MSS Materials Management, Valor IoT Manufacturing Analytics, and MindConnect Valor.

CIMdata observes that Siemens has provided a comprehensive solution for electronics manufacturing that enables all the necessary feedback loops between design and manufacturing to help businesses compete in the ever changing electronics industry, by providing required integrations between PLM, MES, IoT platform, edge devices, and manufacturing BI analytics.

EDGE & IIoT

A core differentiator of Siemens' digital innovation platform is support for a holistic digital twin. The IoT and the IIoT are critical enablers to achieve this vision. Companies are leveraging inexpensive sensors and communication technology to make both their manufacturing processes and their products smart and connected. Companies can instrument their manufacturing processes and their products to track their performance vis-à-vis what the product and production twins say it should be. One major question in IIoT implementations is where do you manage the vast amounts of data these strategies can generate? MindSphere,

Siemens "cloud-based, open IoT operating system" allows you to stream data directly to the cloud or you can process it locally, referred to as on the edge, using edge computing resources. Having local, connected computing hardware in the field can reduce communications cost and time. Many analyses can be readily conducted and consumed locally. In April 2018, Siemens announced their offering to meet this IIoT need, Siemens Industrial Edge[1], a product line that includes: an Edge Management System, Edge Devices, and Edge Apps.

In his opening remarks Dr. Mrosik described Siemens' growing IIoT ecosystem: over 1 million connected devices (up from 800,000 last year), over 600 new tenants on MindSphere in the last six months, all supported by Siemens, and over 160 MindSphere partners. In January 2018, Siemens AG announced the MindSphere World Association, an alliance focused on developing an IIoT ecosystem around MindSphere[2]. CIMdata is impressed with the rapid expansion of the MindSphere ecosystem and the progress shown by the customer presentations at this event. A central tenet of Siemens' strategy is openness, which requires working with a wide range of market stakeholders. But in CIMdata's opinion their digital innovation platform and holistic digital twin strategy is taking enabling (and empowering) heterogeneity to a new level.

Just as in our everyday world, for Siemens to be successful, it's all about the apps. Of course, their core PLM portfolio includes a wide range of robust applications. They and their partners are building MindApps that can leverage other enterprise knowledge to power reporting and advanced analytics. The results can be delivered to a wide range of users as clearly and quickly as possible in a way they can best consume. Active Workspace helps deliver on this promise. But Siemens and their ecosystem partners can only build so many apps. Users know better about what they want and need than their solution providers. Why not put the tools in users' hands to help them get it? With their acquisition of Mendix, discussed at the meeting but not yet closed, Siemens will get a leader in the "low code" development platform space.

Mendix can cite some gaudy efficiency gains like developing apps 10x faster using 70% less resource. In the PLM space, this is one of the benefits that PTC received from their ThingWorx acquisition: the ability to rapidly develop IoT apps with little or no code, that can readily leverage other enterprise data sources. In Mendix, Siemens gains a market leader in the low code space with over 650 customers in 29 countries and a huge ecosystem of over 60,000 developers, and over 135 partners, including both SAP and IBM, which deployed Mendix on their cloud platforms. Mr. Derek Roos, Mendix's CEO, stated that their approach lets people with domain knowledge easily develop the apps they need. Mendix describes their offering as "any existing database, any legacy system, any event, any service, any file, any cloud." If this is indeed true, and their success suggests that it might be, they could support extremely heterogeneous environments. In his opening session, Mr. Hemmelgarn stated that he loved the Mendix quote and the event made clear that the whole Siemens product line is looking forward to leveraging Mendix to deliver better solutions across their digital innovation platform. In his remarks, Mr. Hemmelgarn also envisioned that their customers will use Mendix to more rapidly digitize processes to build their own digital responses to the market. Having tools that make it easy for subject matter experts to develop their own applications, or more directly contribute to their development than in the past, will help ensure that those new applications meet their needs and can be delivered at the pace needed to support digital transformation initiatives.

IaaS/SaaS

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[1] https://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2018/digitalfactory/pr2018040239dfen.htm

[2] https://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2018/corporate/pr2018010136coen.htm

Mr. Ray Krok, Vice President of Innovation, Architecture and Embedded Systems, discussed Siemens' cloud strategy. Siemens demonstrated their strong commitment to providing cloud-based solutions across their Digital Innovation Platform, offering both Integration as a Service (IaaS) and Software as a Service (SaaS) solutions. Teamcenter (PLM), MindSphere, and the TIA Portal (Manufacturing Operations Management) are offered as cloud platform services, with the full set of applications offered as SaaS. This shown in Figure 2.
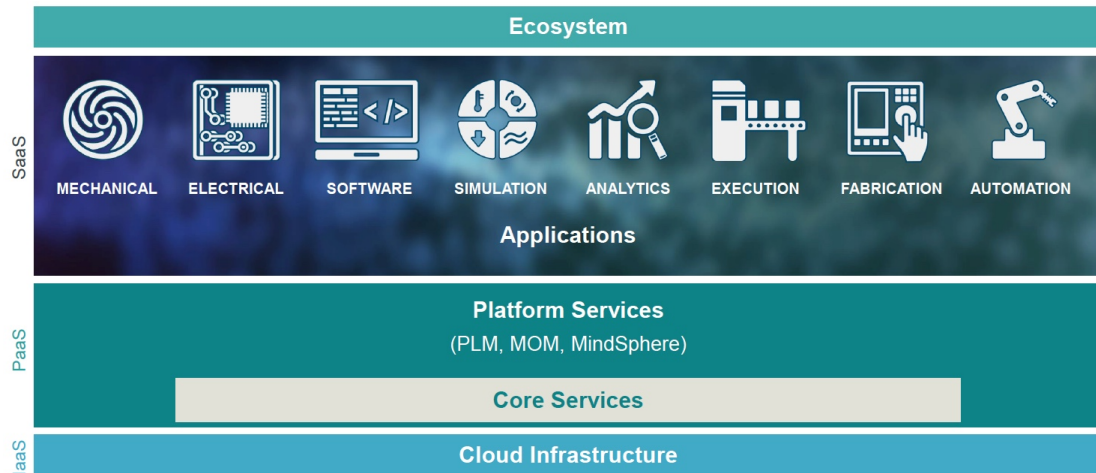

Figure 2—SaaS Solution Landscape
(Courtesy of Siemens PLM Software)

CIMdata research on cloud PLM deployments indicates that PLM prospects are now "cloud ready," with 94% of surveyed respondents deploying cloud PLM solutions within the next two years, and 37% planning cloud-only PLM deployments.

Mr. Krok announced that Teamcenter now supports a number of global cloud providers, having recently been certified for use with both Microsoft Azure and Amazon Web Services (AWS). Support for other global cloud service providers is planned in the near future.

Overall, CIMdata is impressed with the progress Siemens has made in supporting cloud-ready offerings the market, with support across their broad product line and using MindSphere as a managed, secure platform for all cloud and IIoT transactions.

Conclusion

While this commentary is longer than usual, in some ways it is only scratching the surface of the information provided at this 2.5-day analyst event. Siemens' PLM solution portfolio has become so broad that one such event is really not large enough to contain it. Organizing the event around strategic themes did help show how different parts of the Siemens portfolio can be used in combination to address those themes. As long has been true of Siemens, their efforts are both broad and deep. Time and again being part of one of the world's largest manufacturers has proven to be a strategic advantage that its PLM competitors and others competing around those strategic themes find tough to beat. With all of these tools, and the work done to create optimized process flows, Siemens will be challenged to deliver all of these benefits in a heterogeneous solution environment that is typically found in most industrial organizations. Many of their processes and workflows seem to work best using combinations of Siemens offerings. But their efforts at ecosystem building for MindSphere, the cloud, additive manufacturing, and with the acquisition of Mendix, Siemens remains committed to meeting their customers where they are and helping them reach their vision for PLM, digitalization, and Industry 4.0.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM). CIMdata provides world-class knowledge, expertise, and best-practice methods on PLM. CIMdata also offers research, subscription services, publications, and education through international conferences. To learn more about CIMdata's services, visit our website at http://www.CIMdata.com or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 734.668.9922. Fax: +1 734.668.1957; or at Oogststraat 20, 6004 CV Weert, The Netherlands. Tel: +31 (0) 495.533.666.