Connected Products
How IoT is Transforming PLM
Connected Product Journey

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Product Life Cycle Transformation

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Implications for Product Lifecycle Management

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Products that comprised mechanical and electrical parts, have become complex systems that combine hardware, sensors, connectivity, data, and software
Product Life Cycle Transformation

- Smart Design and Development
- Design and Development
- Reuse, Recycle, Retire
- End of life
- Manufacturing
- Operations
- Service
- Integrated Manufacturing
- Connected Operations
- Servitization

Connected Product Ecosystem
How the design process will change ...

- **Product**
  - Standalone
  - Ecosystem

- **Design Principles**
  - Traditional
  - Connected, Interdisciplinary

- **Design Cycle**
  - Long
  - Short, Connected

- **Functionalities**
  - In the Product
  - Distributed in the Ecosystem

- **Connectivity**
  - Unconnected, Wired
  - Ubiquitous, Wireless

- **Data**
  - Not a core consideration
  - Core to the Value proposition

- **Security**
  - Physical, Restricted to the Product
  - Security for the complete system
Open / Closed ecosystem
Interoperability
Co-Development with partners

Securing the whole ecosystem
Physical, Data center, Firewalls, Network, Embedded product, Encryption
System modeling, Threat modeling, Attack trees, Risk index, Identifying business impact, Prioritization, Mitigations

Modeling and Simulation, Model based product design
Advanced algorithms, Rule engines, Edge analytics, Data lakes

Choosing right from a range of connectivity technologies (3G, LTE, WiFi, BLE, Modbus ...)
Low cost of data transfer by edge computing
Standardizing and modularizing hardware
Designing and building frugal gateway devices for older products already available in the market

Interdisciplinary design - Mechanical, Electrical, Electronics, IT, Data, Analytics, Communication
Designing for long product life enabled by software, software driven product variants
Connected Business model design (Product as a Service, Outcome based models)

Agile, Short Design – Prototype – Build cycles
Requires product focused, cross functional “DevOps” teams
Product redesign based on field data from connected products
Rapid prototyping with additive manufacturing technologies

Designing for distributed functionalities across the ecosystem
Edge analytics in the product hardware
Advanced analytics in the Cloud
Over the air feature upgrades
Implications for PLM

- Open / Closed ecosystem
  - PLM to become an Extended Enterprise solution with collaboration from Suppliers and customers
  - Design collaboration to enable feeds from customer voice, product voices and supplier voices
  - Securing the whole ecosystem
  - System modeling, Threat modeling, Attack trees, Risk index, Protocol Protection
  - Access management for User authorization and authentication for secure collaboration with extended enterprise
  - Regulation and Compliance management
  - Scalable data model data from downstream data sources like simulation, testing and product performance
  - Visual BOM and Model based design
  - Advanced algorithms, Rule engines, Edge analytics, Data lakes

- Security
  - PLM to manage robust product data at lower cost – PLM on cloud a viable option
  - PLM data management to accommodate unstructured data. Crowd-sourced adding to the unstructured data deluge

- Connectivity
  - PLM to Integrate design domains (mech, electric, electronic ...) and support ALM- SLIM integration for faster changes, updates and upgrades
  - DfM, DfA, DfS becomes default design principles
  - Modularization: Redefining the way product must be built, assembled and serviced impacts configuration and BOM management

- Design Considerations
  - Shorter design cycle to be managed within PLM product development process
  - Better integration of product field data and design data with right feedback loops
  - AS – MAINTAINED view of BOM to be maintained

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Integrated Manufacturing

- Collaborative, Social product/process development
- Concurrent engineering and collaboration across supply chain entities
- Production & Design feedback loop
- Digital Product Memory for the entire product lifecycle

Digital Threads

- Digital product memory
- Connected work pieces and Machines
- Highly integrated shop floor and business systems
- Real time production optimization
- Decentralized operations
- Virtualization and Simulation
- Proactive quality management
- Predictive maintenance

Flexible Manufacturing

- End to End plant visibility
- Condition monitoring
- Digital Plant operations – Workflows, Guided plant operations, Schedule modifications, Rule based alerts and insights

Paperless Plant

- Living replica of the real plant in the Virtual world
- Detailed Product, Plant, and Process modeling, Scenario building and What If analysis, Virtual manufacturing before real manufacturing
- Advanced analytics, Prediction and Prognosis
- Real plant synchronizes with Virtual plant to align and optimize operations

Digital Twin

- Integrated Manufacturing
Collaborative, Social product development
Concurrent engineering and collaboration across supply chain entities
Production & Design feedback loop
Digital Product Memory for the entire product lifecycle

Manufacturing Considerations

- Digital Threads
- Paperless Plant
- Flexible Manufacturing

- Real-time Integration of PLM, MES, MOM and ERP
- PLM to enable Design anywhere, build anywhere and service anywhere

- Integration of AS-DESIGNED and AS-BUILD configuration views to maintained to support flexible manufacturing
- Modular approach to design of component, sub-assemblies to be incorporated within PLM

- Embedded RFID to track and monitor the parts and subassembly
- Enabling workflows and notification triggers
- Product cost management for Total cost of ownership

- BOM Synchronization to ensure the various BOM product information are real-time updated
- Knowledge management processes to be enabled within PLM for enhance decision making
- Integrated Process Information to enable simulation

- Embedded RFID
- Knowledge management
- Real-time Synchronization
- Product Cost Management
Connected Operations and Servitization

Innovative Business Models
- Product as a Service
- Outcome based business models
- Availability as a Service

Contracts, Planning
- Data driven contract management
- Data driven parts planning

Service Management
- Real time condition monitoring
- Rule based Alerts and Insights
- Predictive analytics
- Proactive maintenance management
- Real time field force scheduling

Connected Operations
- Remote operational visibility, Condition monitoring, Operational data, Historical data, Near real time, knowledge management
- Centralized visibility across installations
- Advanced analytics, Alerts and Insights
- Benchmarking
- Performance optimization
Innovative Business Models

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- Availability as a Service
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  - Condition monitoring,
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  - Benchmarking
  - Performance optimization
  - Real time condition monitoring
  - Rule based Alerts and Insights
  - Predictive analytics
  - Proactive maintenance management
  - Real time field force scheduling
  - Data driven contract management
  - Data driven parts planning

Contracts, Planning

- Master data management to enable parts traceability and planning
- Maintain In-Service BOM and operating data
- Data driven contract management
- Data driven parts planning

Connected Operations

- New Service Introduction leveraging product as a platform
- Product usage based feeds for Idea management, Knowledge management and Product planning
- Social product development and Crowdsourcing

Service Management

- On field data provides inputs to product design, product planning and product usage information
- Parts End of life knowledge management for proactive service management

Implications for PLM

- Tight PLM-MES-ERP Integration
- Embedded systems to know specific resources and locations used for every step performed on the product
- Incorporate tags to synch real-time behavior with factory simulation
Impact to Enterprise IT

Product Software
*Embedded & Control Software*

IoT Components
*Communication, Big Data, Analytics, Security…*

Enterprise Systems
*PLM, ERP, CRM, Finance etc*

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**Future Direction for IT**
- Part of the Product Development Pipeline and on the critical path
- Increased Collaboration with Business

**Reporting & Roles**
- Changing relationships between Prod Dev, CIO and CSO
- New Roles will be added – Data Scientists, System Integrators...

**Competency**
- Competency in IoT Components – Develop or Acquire?
- IT skilled employees with a Customer Focus and Mindset
- Embedded software development
Transformed PLM: Closed-loop Value Chain

- Social Product Development
- Crowdsourced ideas for Product planning and product improvements
Re-imagining PLM Components

Enhanced Existing Capabilities
- Systems Engineering
- Requirements Management
- Portfolio Management
- Knowledge Management
- Services Management
- Supplier Collaboration

New Capabilities
- Software Lifecycle Management
- IP Management
- Security Management
- Data Analytics
- Program Management

Others
- Enhanced Industry Specific Solutions
- Standards Definition
- External Data Integration Capabilities
- Integration with ERP, MES, CRM

Note: Representative, not Exhaustive
Thank You