SYSTEMS ENGINEERING RESEARCH CENTER

Systems Engineering Research Center

RT-152: ePDM MPTs
SERC Sponsor Research Review

Principal Investigator:
Dr. Mitchell Kerman, Stevens Institute of Technology

Research Team:
Mr. Jeff McDonald, Stevens Institute of Technology

November 17, 2016

Agenda / Discussion Topics

- Executive Summary
- Background
- Current Status of CERDEC Product Data Management
- Future View of CERDEC Electronic Product Data Management
- Identification and Analysis of Industry Best Practices
- Lessons Learned
- Conclusions & Recommendations

Executive Summary

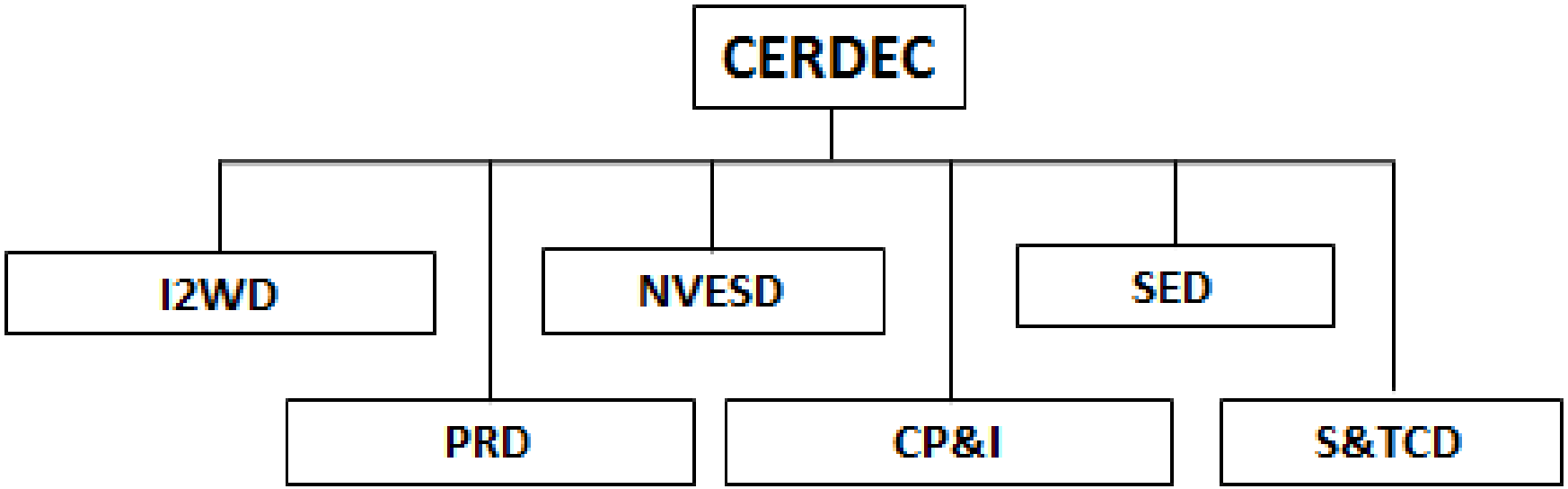
- Year long research task
- Kickoff meeting shifted focus from ePDM tool search to focus on PTC Windchill implementation
- CERDEC ePDM tool use survey
- Industry and DoD interviews
- Interim Project Report
- Data compilation and analysis
- Lessons Learned
- Conclusions and Recommendations

Background

- Background
  - —CERDEC Organization
  - —Product Lifecycle Management
  - —Digital Thread
- Terms and Abbreviations
  - —Electronic Product Data Management (ePDM)
    - o PTC Windchill: a specific ePDM software tool
  - —Product Lifecycle Management (PLM)
  - —US Army
    - o Communications-Electronics Research, Development and Engineering Center (CERDEC)
  - —Stevens Institute of Technology
    - o Systems Engineering Research Center (SERC)

Background – CERDEC Organization

- CERDEC Organization



- Technical Data Packages Minimum Requirements
  - Technical Product Data
  - Technical Product Definition Information
  - Technical Product Operational Information
  - Technical Product Associated Information

Background – Product Lifecycle Management

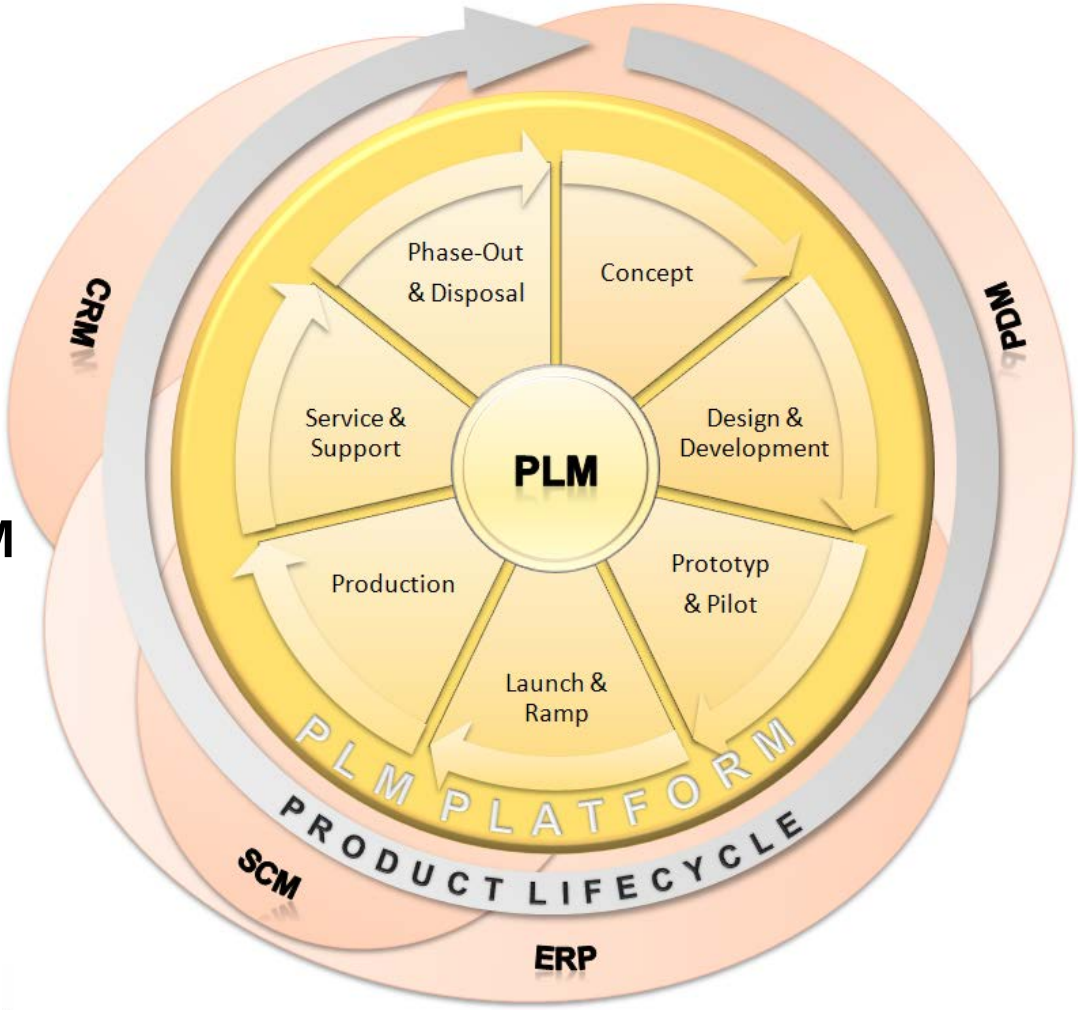
- Product Lifecycle Management (PLM)
  - The process of managing the entire lifecycle of a product from inception, through engineering design and manufacture, to service and disposal of manufactured products.
  - PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise.
  - The backbone of PLM is the concept of a “digital thread.”
  - System engineers, senior analysts and engineering managers are the driving forces for PLM.
  - Engineers, engineering/technical management, and executive management are the primary stakeholders in PLM.
  - A technical background is essential to accomplish PLM.

Background – Product Lifecycle Management

- PLM is realized through the use of tools to link:
  - Engineering data (technical, development, and manufacture specifications)
  - Cost and procurement information
  - Operational feedback and failure reports
- Systems engineers use the PLM system to better inform management and assist in making better decisions.
- The goal of PLM is to maximize producibility, reliability, sustainability, maintainability, and availability

Background – Product Lifecycle Management

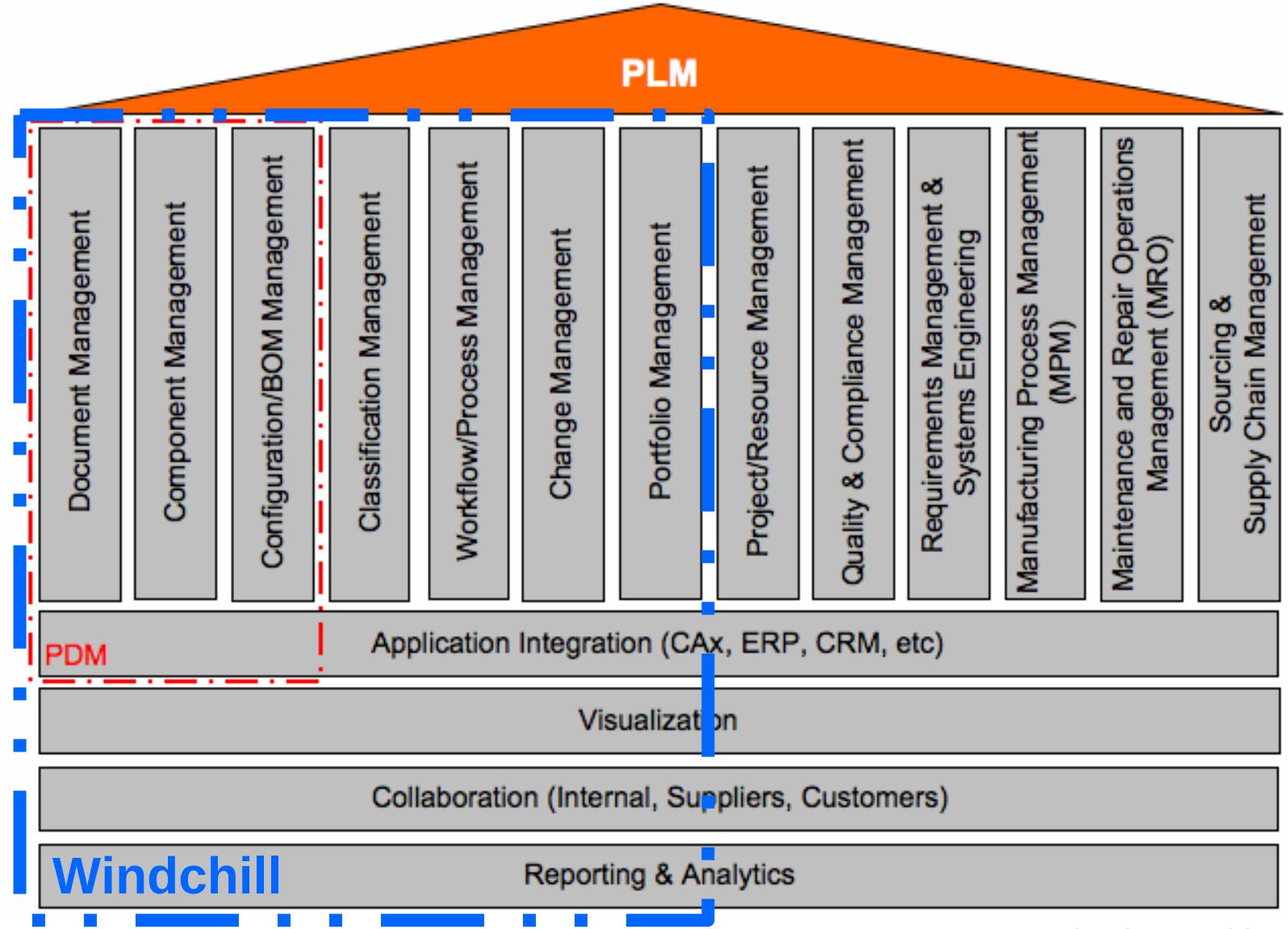
Engineering Phases of PLM



- Product Data Management (PDM)
- Supply Chain Management (SCM)
- Enterprise Resource Planning (ERP)
- Customer Relationship Management (CRM)

Source: Karlsruhe Institute of Technology

Background – PLM: Windchill versus Historical PDM



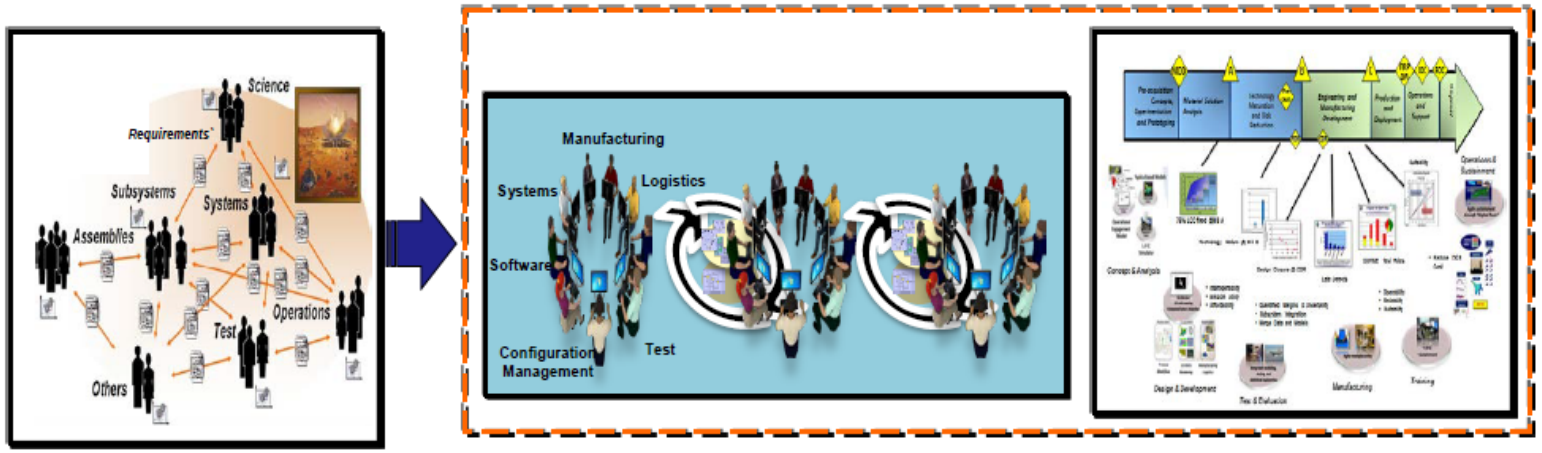
Source: PLM Technology Guide

Background – Digital Thread

- Digital System Model
  - A digital representation of a defense system, generated by all stakeholders that integrates the authoritative technical data and associated artifacts which define all aspects of the system for the specific activities throughout the system lifecycle.
- Digital Thread
  - An extensible, configurable and component enterprise-level analytical framework that seamlessly expedites the controlled interplay of authoritative technical data, software, information, and knowledge in the enterprise data-information-knowledge systems, based on the Digital System Model template, to inform decision makers throughout a system's life cycle by providing the capability to access, integrate and transform disparate data into actionable information.
- Digital Twin
  - An integrated multiphysics, multiscale, probabilistic simulation of an as-built system, enabled by Digital Thread, that uses the best available models, sensor information, and input data to mirror and predict activities/performance over the life of its corresponding physical twin.

Background – Digital Thread

- Future vision is Digital Model-Centric Engineering
- Shifts away from a linear, document-centric acquisition process towards a dynamic digital model-centric ecosystem
  - Digital Models: Contain Requirements, Specifications, Data, Algorithms, Processes, Vendor-specific information, etc.
  - Low fidelity, implicit representations shift to high fidelity, explicit models which serve as the "single source of technical truth" for all uses
  - Documents shift from the primary role of specification to the secondary role of communication
- Reference: Ms. Philomena Zimmerman, *A Framework for Developing a Digital System Model Taxonomy*, 18th Annual NDIA Systems Engineering Conference, Springfield, VA (October 28, 2015)

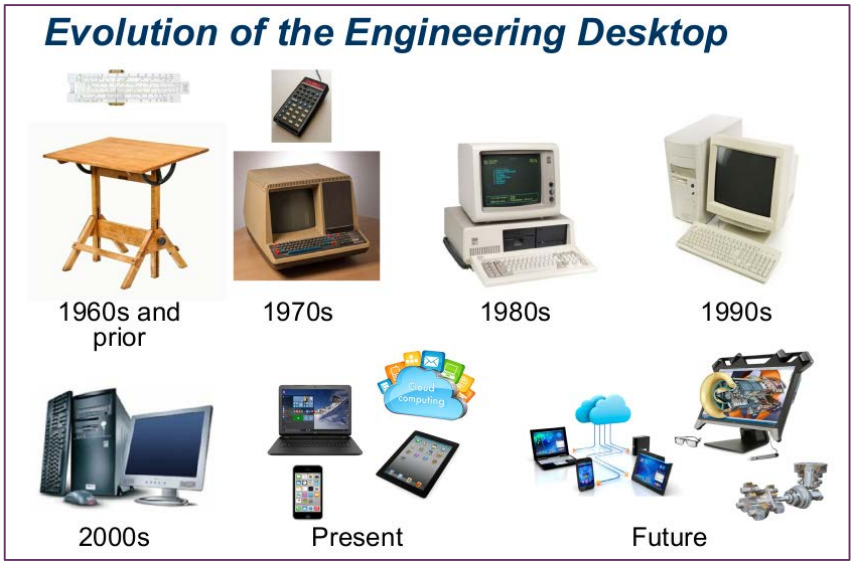


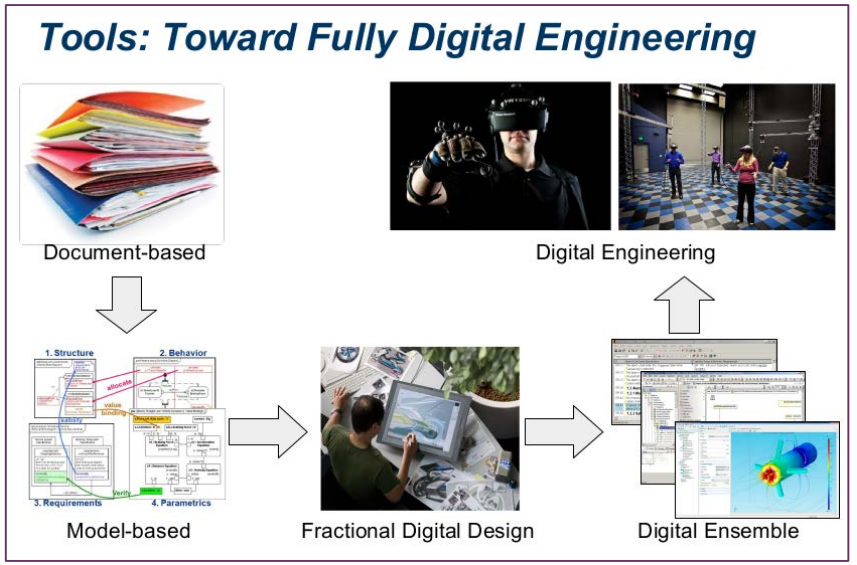
Today: Stove-piped data sources

Future: Dynamic Digital Model-Centric Ecosystem

Background – Digital Thread

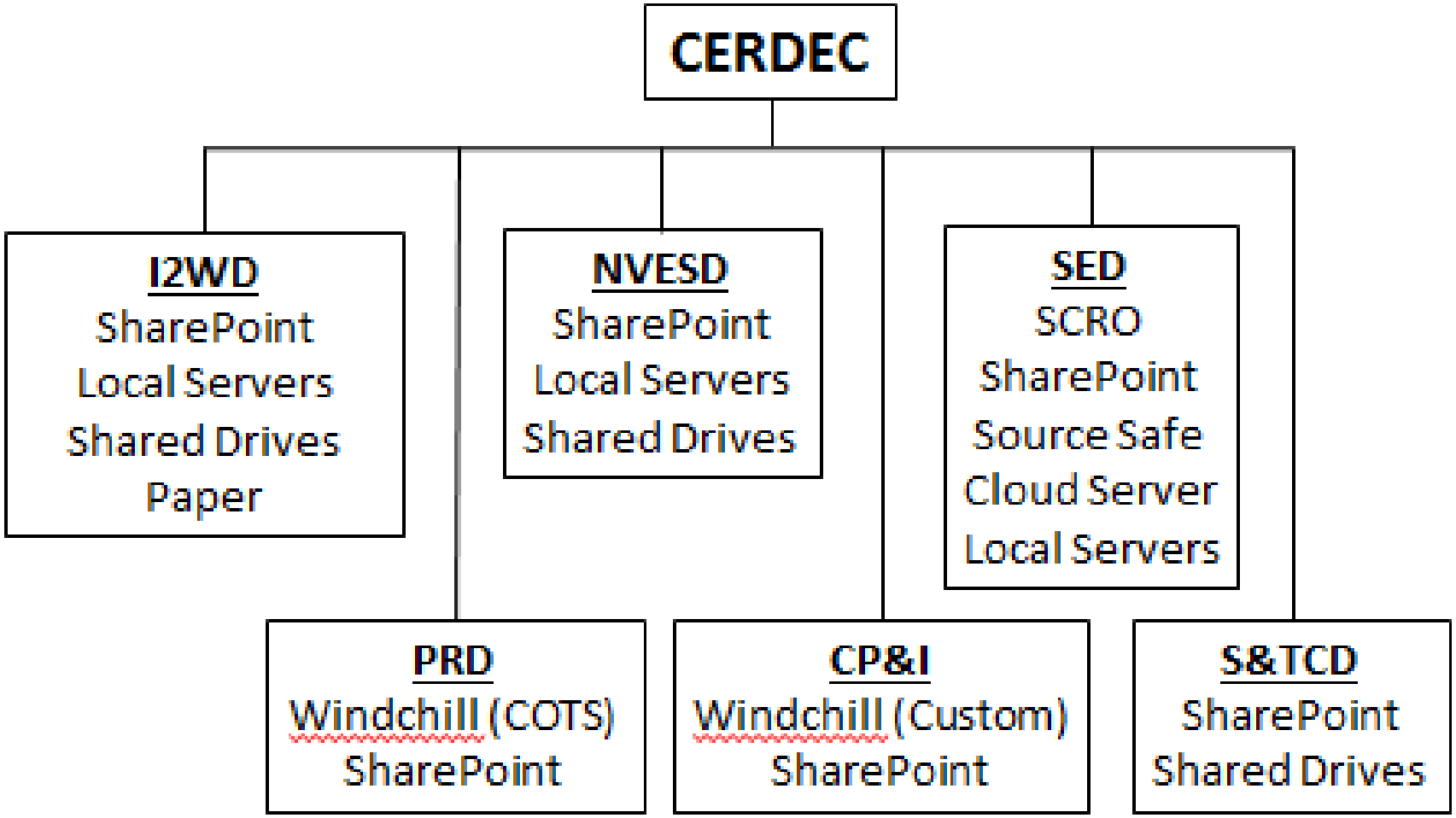
- DoD Initiatives: The Digital Engineering Working Group (DEWG)
  - Explore transitioning traditional acquisition processes to a digital model-centric environment by shifting towards a dynamic ecosystem that would supplant documents/models.
  - Develop the Digital Engineering concept that will be implemented across engineering functions and subsequently within the Defense Acquisition System.





Current Status of CERDEC ePDM

- Electronic Product Data Management (ePDM) Tools in Use



Current Status of CERDEC ePDM

- Comparison of ePDM Tools in Use at CERDEC

	Team Collaboration	Digital Thread	Source Library	Search Functions	Workflow Support	Analysis Support
MS SharePoint	Excellent	Poor	Excellent	Good	Excellent	Good
PTC Windchill	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Shared Drives & Local Servers	Good	Poor	Good	Fair	Good	Fair
SCRO	Good	Poor	Good	Fair	Good	Poor
Paper	Poor	Poor	Poor	Poor	Poor	Poor

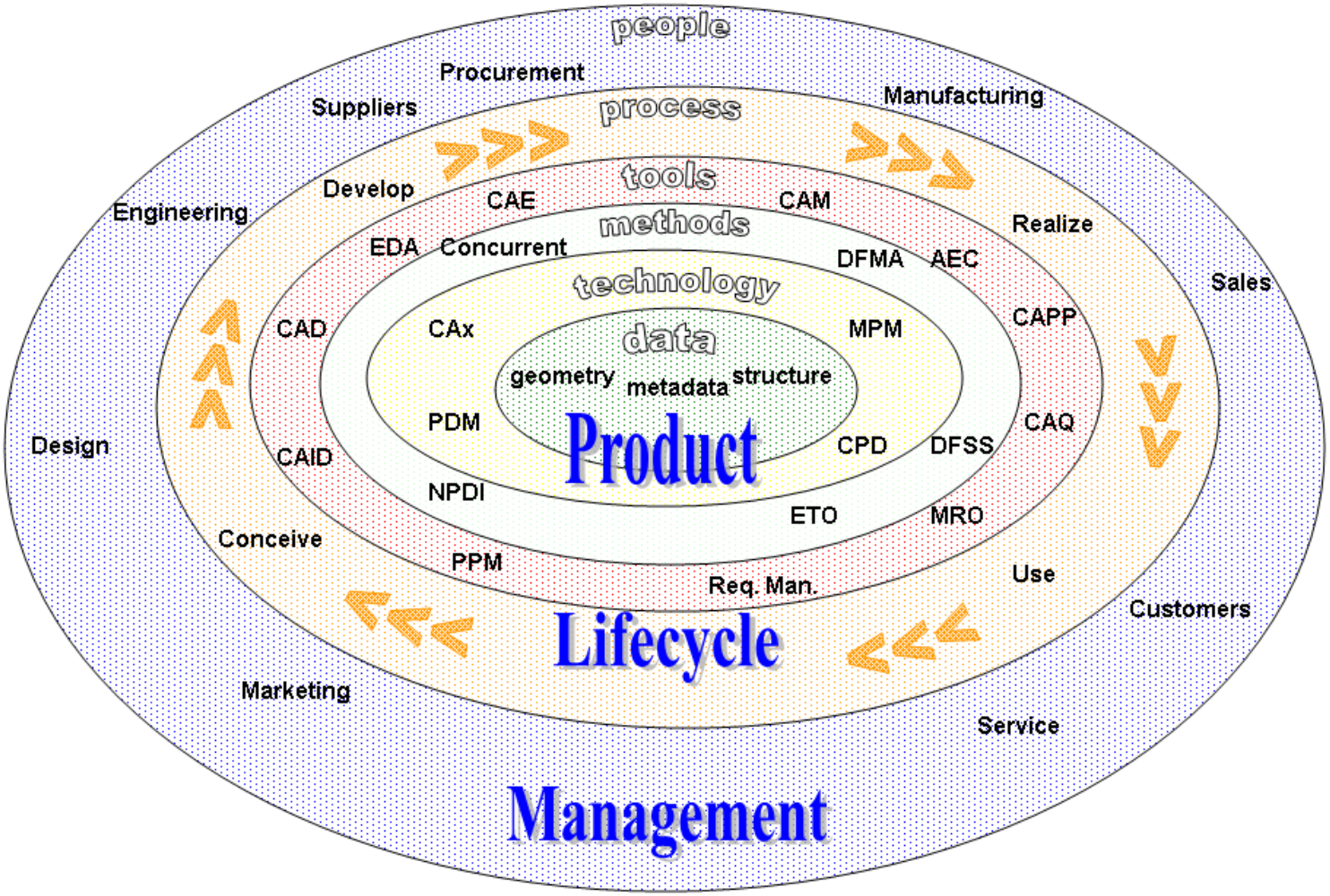
Future View of CERDEC ePDM

- Future View of CERDEC Electronic Product Data Management
  - Shift focus away from solely managing product data and individual configurations to a holistic approach
- Holistic future approach must involve:
  - Full Product Lifecycle Management
  - Implementation of the Digital Thread

Future View of CERDEC ePDM – Lifecycle Management

- Leverage current and evolving technologies to enable users to better manage and execute their tasks by providing a system engineering centric approach to product realization across a product lifecycle.
- Enterprise management of all Communications Electronic products through use of model based engineering and model based support.
- A digital thread that allows any user rapid and easy access to product engineering information, technical data, and program files.
- US Army wide system that links each command and promotes force wide sharing of product data.
- Possible DoD wide initiative for data management to promote cross service information sharing and product development.

Future View of CERDEC ePDM – Lifecycle Management



Diving Forces: System engineers and engineering managers.

Source: Freeformer at the English language, via Wikimedia Commons

SYSTEMS ENGINEERING RESEARCH CENTER

Future View of CERDEC ePDM – Lifecycle Management

	Producibility	Reliability	Sustainability	Maintainability	Compatibility	Accessibility	Accountability	Auditability	Scalability	Recoverability
PTC Windchill	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
MS SharePoint	Fair	Good	Good	Fair	Good	Good	Fair	Fair	Fair	Fair
Shared Drives & Local Servers	Fair	Fair	Fair	Fair	Fair	Good	Poor	Poor	Poor	Fair
SCRO	Good	Good	Good	Good	Fair	Good	Excel	Excel	Fair	Good
Paper	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor

Identification & Analysis of Best Practices

- Identification and Analysis of Industry Best Practices
  - Benefits of ePDM
  - Highlights (security)
  - Compare & Contrast
  - Shortfall and Opportunities

SYSTEMS ENGINEERING RESEARCH CENTER

Identification & Analysis of Best Practices - Benefits of ePDM

- Faster development time
- Increased productivity
- Design efficiency
- Increased product quality
- Insight into critical business processes
- Better reporting and analytics
- Sustainability achievable

Identification & Analysis of Best Practices - Highlights

- Highlights
  - Implementation Strategy
  - Implementation Partner/ Consultant
  - Architecture Decisions should address Lifecycle Requirements
  - Process Impact Review
  - Configure Windchill vice Customize
  - Windchill is an Engineering Tool
  - PLM requires more than just Windchill
  - Security is dependent on Server and User Settings

Identification & Analysis of Best Practices - Compare and Contrast

- Compare
  - Use of consultant for implementation
  - Configured Windchill to maintain COTS
  - Architecture based on PTC recommendations with DoD/ Industry standards
  - Complete model-based engineering and non-engineering through Windchill
  - PLM through Windchill and other PTC software
- Contrast
  - In house team for implementation
  - Customized Windchill
  - Architecture based on established company standards
  - Model-based engineering through Windchill with SharePoint for non-engineering tasks
  - PLM through Windchill and combination of in-house and third party software

Identification & Analysis of Best Practices - Shortfalls and Opportunities

- Shortfalls
  - Windchill is excellent at engineering data management but not at PLM
  - Windchill is an engineering tool that must be used by non-engineers
  - Revisions to Windchill architecture after implementation are challenging
  - Windchill user interface requires personnel training
- Opportunities
  - Windchill is excellent for model-based engineering
  - Windchill database offers ideal start point for ePDM and PLM
  - PTC offers complimentary products that leverage Windchill data for PLM
  - Cloud based Windchill has been certified for DoD use
  - Cloud based Windchill can potentially reduce costs and expand use

Lessons Learned

- Lessons Learned
  - Implementation
  - Architecture
  - Configuration versus Customization
  - Evolving Technologies
  - Analytics for PLM

Lessons Learned - Implementation

- Implementation
  - Detailed Plan
  - Phased and Targeted Approach
  - Process Impact Considerations
  - User Training
  - Solution Testing
  - Solution Deployment
  - Driven by Engineers and Engineering Management

Lessons Learned - Architecture

- Architecture
  - Configuration must include requirements for all project phases not just implementation
  - 12 Integrated Product Support (IPS) Categories
  - DoD, ASME, and MIL-STD requirements
  - Detailed Contract requirements for Vendors

Lessons Learned - Configuration versus Customization

- Configuration versus Customization
  - Impacts on Product Support
  - Impacts to Data Migration
  - Impacts to Product Upgrade
  - Impacts to use of PTC and Third Party Software

Lessons Learned - Evolving Technology

- Evolving Technology
  - Model-Based Engineering is the future
  - Windchill offers the tools to support all processes of model-based engineering
  - PTC continues development of supporting software to achieve PLM through ePDM

Lessons Learned - Analytics for PLM

- Analytics for PLM
  - Requires Database with Relationships
  - No Silver Bullet exists
  - Use of Additional Software and Tools is Required
  - Requires high level analysts

Conclusions

- Conclusions
  - CERDEC is on the right path with implementing ePDM tools (Windchill).
  - Effective implementation requires a detailed plan.
  - Windchill implementations have failed due to lack of user training, not obtaining “buy-in” from users, and poor architecture decisions.
  - User training is critical to obtaining “buy-in” from Windchill users.
  - Database architecture needs to address all areas of PLM, and should not focus on product development solely.
  - Configure Windchill to meet CERDEC needs and avoid customizations.

Conclusions

- Conclusions
  - There is no industry standard in ePDM. Windchill is an industry leader in ePDM and PLM software and tools.
  - PLM requires a linked database (digital thread) and specialized software to extract the data and conduct analyses.
  - System Engineers, Senior Analysts and Engineering management, and technical management are the driving forces of PLM.
  - Engineers, Engineering/Technical Management and Executive Management are the primary stakeholders in PLM.
  - A technical background is essential to implementing PLM.
  - Systems engineers use the PLM system to better inform management and assist in making better decisions.

Recommendations

- Recommendations
  - Develop a detailed implementation plan that includes architecture, testing, training, and deployment requirements.
  - Implementation plan should have a detailed phase timeline and assign tasks to individuals to accomplish phase goals.
  - Consider partnering or consulting during implementation to avoid common failures.
  - Use of ePDM needs to expand within CERDEC to remaining directorates using a controlled, phased process.

Recommendations

- Recommendations
  - Use of ePDM needs to expand within CERDEC to remaining directorates using a controlled, phased process.
  - Establish training guidelines and procedures for new users based upon use level.
  - Determine control and utilization model for Windchill instantiation across CERDEC
    - Four potential models (Central Control/Central Utilization– Decentral/Decentral – Decentral/ Central – Central / Decentral)
    - Recommend Centralized Control and Decentralized Utilization with a controlling authority board with representatives from each directorate
  - Communication or involvement in DEWG
  - Briefings to Directorate Leads and CECOM