


ENGINEERING DESIGN FOR WEAVING A HETEROGENEOUS DIGITAL THREAD

PLM Road Map™ & PDT North America 2023
The Digital Thread in a Heterogeneous, Extended Enterprise Reality
 A call for PLM Professionals to share their knowledge & experience
 May 3 & 4

CIMdata 

NIST NATIONAL INSTITUTE OF
STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Rosemary Astheimer
Mechanical Engineer
Smart Connected Manufacturing Systems

1

Agenda

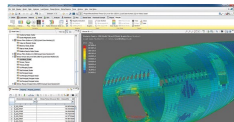
<p>1 Data</p> <p>What is data? How is it used with PDM to transfer knowledge.</p>	<p>2 Challenge</p> <p>There is a lot of data. Diverse constituents have to agree on how that data is exchanged.</p>
<p>3 Solution</p> <p>Standards are essential. Development and testing efforts are continual improving the standards.</p>	<p>4 Summary</p> <p>A digital definition is beneficial to anyone in the enterprise. The digital definition drives the successful weaving of the digital thread.</p>

2

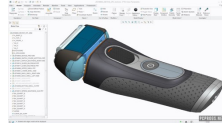
Rosemary Astheimer



Focus on Computer Aided-Design (CAD)



Composite Design



Product Manager – Creo Data Exchange



<https://resources.sw.siemens.com/en-US/case-study-airbus-group-innovations>

<https://www.ptc.com/en/blogs/cad/parametric-vs-direct-modeling-which-side-are-you-on>

3

NIST AT A GLANCE

<p>3,400+ FEDERAL EMPLOYEES</p>	<p>National Institute of Standards and Technology</p> <p>5 NOBEL PRIZES</p>	<p>2 CAMPUSES GAITHERSBURG, MD [HQ] BOULDER, CO</p>
<p>3,500 + ASSOCIATES</p>	<p>10 COLLABORATIVE INSTITUTES</p>	<p>400+ BUSINESSES USING NIST FACILITIES</p>
<p>NATIONAL OFFICE COORDINATING 16 MANUFACTURING INSTITUTES</p>	<p>51 MANUFACTURING EXTENSION PARTNERSHIP CENTERS</p>	<p>U.S. BALDRIGE PERFORMANCE EXCELLENCE PROGRAM</p>

4

NIST Joint Institute and Center Locations

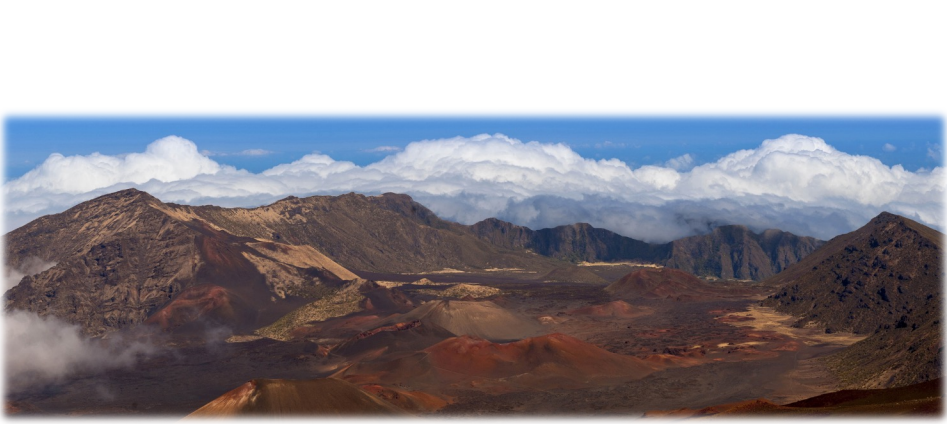


NIST

- Campaniles**
Gaithersburg, MD
- Boulder, CO**
- Joint Institutes and Centers**
 - National Cybersecurity Center of Excellence
 - Institute for Bioscience & Biotechnology Research
 - Joint Institute for Quantum Computer Science
 - Joint Quantum Institute
- JILA**
 - Hollings Marine Laboratory
 - Brookhaven National Laboratory
 - Joint Initiative for Metrology in Biology
- Atomic Clock Signal Stations**
 - NIST Kauai HI WWVH
 - NIST Ft. Collins CO WWV
- NIST Centers of Excellence**
 - Forensic Science
 - Disaster Resilience
 - Advanced Materials

5

Haleakalā Crater, Kauai



<https://resources.sw.siemens.com/en-US/cas-study/airbus-airport-innovations>

6



7

Product Data
NIST

Data

Information

Knowledge

1
4




Photo by Jill Rose, Pixels.

HOLE	Score	10	11	12	13	14	15
BLUE	68.0	360	375	145	520	345	350
WHITE	66.1	307	340	127	492	318	328
HANDICAP		12	6	16	10	16	8
<i>GRN W/TH</i>		4	4	3	5	4	
PAR		4	4	3	5	4	4
LADIES'	70.8	307	340	127	492	318	328
PAR		4	4	3	5	4	4
HANDICAP		14	10	16	6	12	6

"Signed and attested scratch 64 post scores by Fred Anthony" by jaycammisau licensed under CC BY 4.0. Cropped.

8

Product Data

NIST

The diagram illustrates the progression from Data to Information to Knowledge. It consists of three columns. The first column is titled 'Data' and features a yellow sticky note with the handwritten numbers '1' and '4'. The second column is titled 'Information' and features a photograph of a white golf ball on a green field. The third column is titled 'Knowledge' and features a photograph of a golfer's legs and feet on a golf course. The NIST logo is in the top right corner.

9

Product Lifecycle Management

NIST


In industry, **Product Lifecycle Management (PLM)** is the **process** of managing the entire lifecycle of a product from its inception through the **engineering, design and manufacture**, as well as the service and disposal of manufactured products.^{[1][2]} PLM integrates people, data, processes and **business** systems and provides a product information backbone for companies and their extended enterprises.^[3]

WIKIPEDIA
The Free Encyclopedia

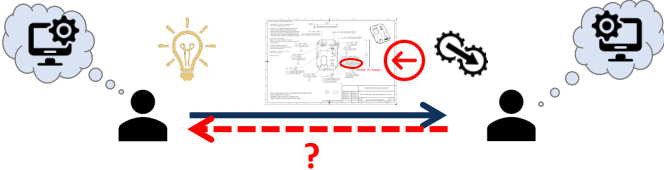
The diagram shows the Product Lifecycle Management (PLM) process flow. It is represented as a large blue arrow pointing to the right, divided into five segments: Concept, Design, Manufacture, Service, and Retire. The 'Design' and 'Manufacture' segments are circled in green. The NIST logo is in the top right corner.

10


Challenge: Communication



- Are they thinking what I'm thinking?
- I'll just make a "simple" change...




Product data management (PDM) should not be confused with **product information management (PIM)**. PDM is the name of a business function within **product lifecycle management (PLM)** that denotes the **management and publication of product data**.^{[1][2]} In software engineering, this is known as **version control**. The goals of product data management include ensuring all stakeholders share a common understanding, that confusion during the execution of the processes is minimized, and that the highest standards of quality controls are maintained.

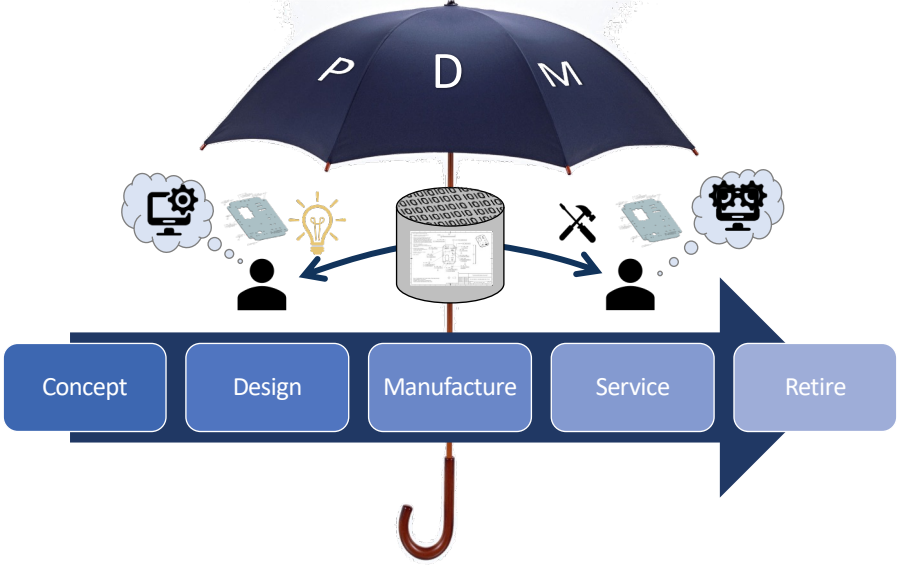


WIKIPEDIA
The Free Encyclopedia

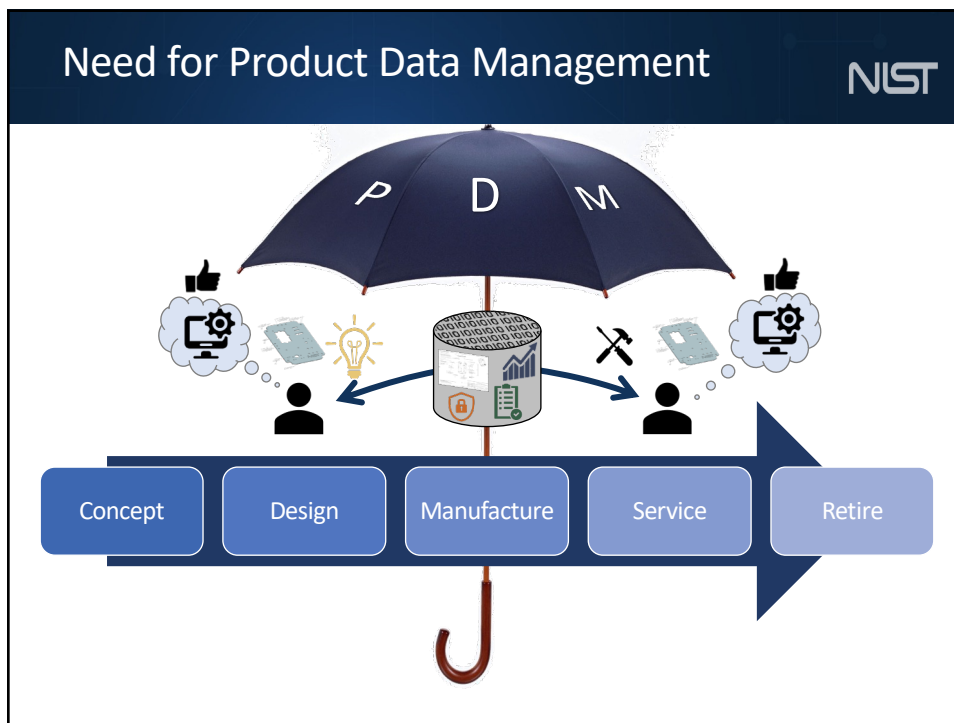
11

Need for Product Data Management





12



13

ENGINEERING DESIGN FOR **WEAVING** A HETEROGENEOUS DIGITAL THREAD

The Challenge

The background features a network of glowing blue and green nodes and lines, representing a digital thread or data network.

14

Product Data

Data

Information

Knowledge

Photo by Mike Haupt, Pexels.

HOLE	10	11	12	13	14	15
BLUE	65.0	390	375	145	599	360
WHITE	66.1	307	340	127	492	318
HANDICAP	12	6	18	10	8	8
EARL DUNFEE	4	4	3	5	4	4
PAR	4	4	3	5	4	4
LADIES'	70.8	307	340	127	492	318
PAR	4	4	3	5	4	4
HANDICAP	14	10	16	8	12	6

Signed and attested scratch 64 golf score by Earl Dunfee
by [jakeathomas](#), licensed under CC BY 4.0, Cropped.

15

Engineering Perspective

Design

CAD
Part
Assembly
Drawing/Documentation
Material Properties
Strength Analysis
Fluid Dynamics
...

DMIS - Dimensional Measuring Interface Specification
QIF - Quality Information Framework

Manufacture

Gcode
Automated
Manufacture

Inspect

DMIS
Inspection Instructions
QIF
Inspection Data

Assemble

PDF
Assembly Instructions
Maintenance Manuals

Maintain


LOTAR
Archive
Recycle

LOTAR - Long-Term Archival and Retrieval

Retire

16

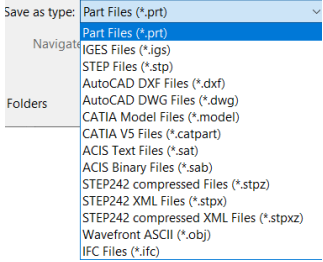
Multiple Formats




Multi-CAD
Acquisition
OEM, Tier 1, Tier 2

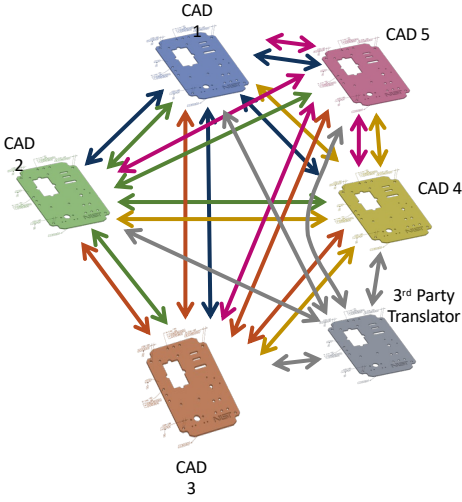
Reverse Engineer
Slow to develop and error-prone
Encrypted



Moving Target
Vendors develop at different paces
Support new technology



17





18

ENGINEERING DESIGN FOR WEAVING A **HETEROGENEOUS** DIGITAL THREAD

The Solution

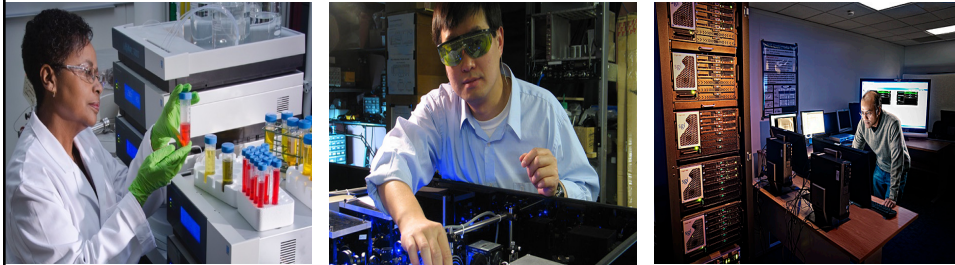
19

Standards! NIST

The diagram illustrates a central goal represented by a trophy icon. Five arrows point from this central icon to five different CAD models, labeled CAD 1 through CAD 5. CAD 1 is blue, CAD 2 is green, CAD 3 is orange, CAD 4 is yellow, and CAD 5 is pink. A sixth arrow points from the trophy icon to a grey component labeled '3rd Party Translator'. This visualizes the concept of creating a common standard that can interface with various different CAD systems and external translators.

20

To promote U.S. innovation and industrial competitiveness by advancing **measurement science, standards, and technology** in ways that enhance economic security and improve our quality of life.



21

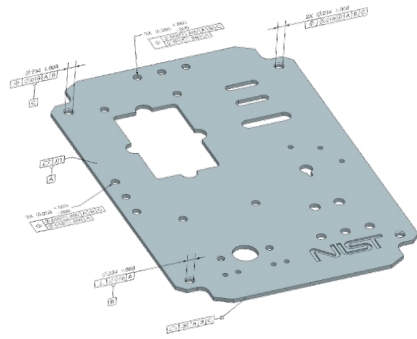
Standards - NIST Involvement

- | | |
|------|--|
| ISO | International Organization for Standardization
Independent, non-governmental organization
167 countries |
| ASME | American Society of Mechanical Engineers
Non-profit
Engineering Society, Standards Organization, R&D, Training |
| ANSI | American National Standards Institute
Non-profit
Oversees Development of Voluntary Consensus Standards |

22

Standards for Design

NIST



CAD Design
Best Practices

ASME Y14.5 (GD&T)
Documenting Tolerance for
Manufacturing

ISO 10303 (STEP)
Design Requirements for Manufacturing

23

Standards for Design

NIST



ISO 6983 (G-Code)
Programming Language for Manufacturing

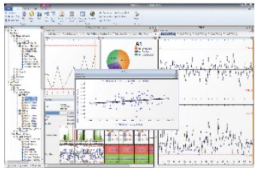
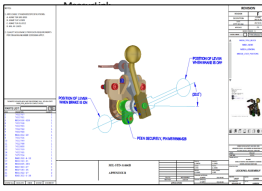

ANSI MTC1.4-2018(MTConnect)
Streams Data from Running Machines


ANSI DMIS
Programming Language for Inspection

http://qfstandards.org/wp-content/uploads/2014/08/NIST_GCR_20-024.pdf

24

Standards for Manufacturing



ISO 23952 (Quality Information Framework)
Stores As-Measured Product Data

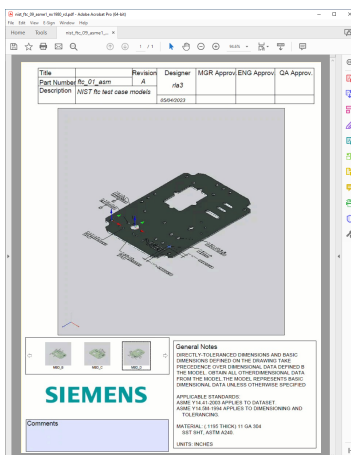
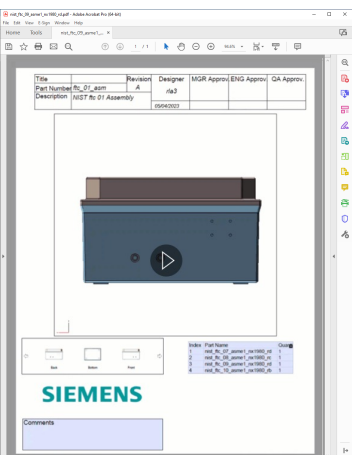
MIL-STD-31000B (Technical Data Package)
Authoritative PDF with All Technical Data

LOTAR
Long Term Archival and Retrieval

https://qfstandards.org/wp-content/uploads/2014/08/NIST_GCR_20-024.pdf


25

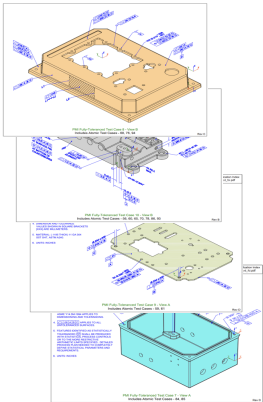
Example MIL-STD-31000B TDP

26

Testing Efforts





https://www.mbx-if.de/cax/cax_vendors.php

The MBx Interoperability Forum is significantly improving STEP translator quality and decreasing translator time-to-market!

STEP PROCESSORS CURRENTLY BEING TESTED IN THE CAX-IF

The following list gives an overview about the vendors and systems who actively participate in the CAX-IF testing and technical meetings. Previous participants are listed below.

Vendor	Product
Autodesk	Inventor
CT CoreTechnologie	3D Evolution ¹⁾
Dassault Systemes	S/Capexence CATIA V5
Datakit	OpenCascade OpenCAD ¹⁾
Elysium	3DxSLATE ¹⁾ CADobly ¹⁾
International TechnaGroup	SADW ¹⁾ CADix ¹⁾
Kubotek Kosmos	3D Framework KeyCreator
Siemens PLM	K-Compare (Mindtoll & R K-Change (Vias & Cores)
Open Design Alliance	Open STEP (Viaser)
Techsoft 3D	HOOOPS Exchange ¹⁾

¹⁾ Multi-CAD Processor supporting all major CAD systems

Recommended Practices / Functionality	AP203		AP214		AP242		AP243		AP248		AP262	
	Model	Export	Model	Export	Model	Export	Model	Export	Model	Export	Model	Export
AP203 BOM Domain Model XML Assembly Structure	X	X	X	X	X	X	X	X	X	X	X	X
AP242 BOM Domain Model XML Kinematics	X	X	X	X	X	X	X	X	X	X	X	X
Security	X	X	X	X	X	X	X	X	X	X	X	X
Assembly	X	X	X	X	X	X	X	X	X	X	X	X
Open-Source/Industry Model	X	X	X	X	X	X	X	X	X	X	X	X
STEP Data	X	X	X	X	X	X	X	X	X	X	X	X
3D Topology/Geometry	X	X	X	X	X	X	X	X	X	X	X	X
Assembly Structure	X	X	X	X	X	X	X	X	X	X	X	X
Combinatorial Material												
Block Style												
Text Color	X	X	X	X	X	X	X	X	X	X	X	X
Text Content	X	X	X	X	X	X	X	X	X	X	X	X
Text Format Color	X	X	X	X	X	X	X	X	X	X	X	X
Text Format Color	X	X	X	X	X	X	X	X	X	X	X	X
Text Style	X	X	X	X	X	X	X	X	X	X	X	X
Curve Style	X	X	X	X	X	X	X	X	X	X	X	X
Assembly Structure Mapping												
Single Level	X	X	X	X	X	X	X	X	X	X	X	X
Multi Level	X	X	X	X	X	X	X	X	X	X	X	X
Instance List	X	X	X	X	X	X	X	X	X	X	X	X
Instance Identifier	X	X	X	X	X	X	X	X	X	X	X	X
Reference Relationships												
Instance Reference	X	X	X	X	X	X	X	X	X	X	X	X
Instance External Reference	X	X	X	X	X	X	X	X	X	X	X	X
Instance External Reference	X	X	X	X	X	X	X	X	X	X	X	X
Instance Instance Properties												
Instance Instance Properties												
Instance Instance Properties												

https://www.mbx-if.de/cax/vendor_info.php?id=8

27

ENGINEERING DESIGN FOR WEAVING A HETEROGENEOUS DIGITAL THREAD

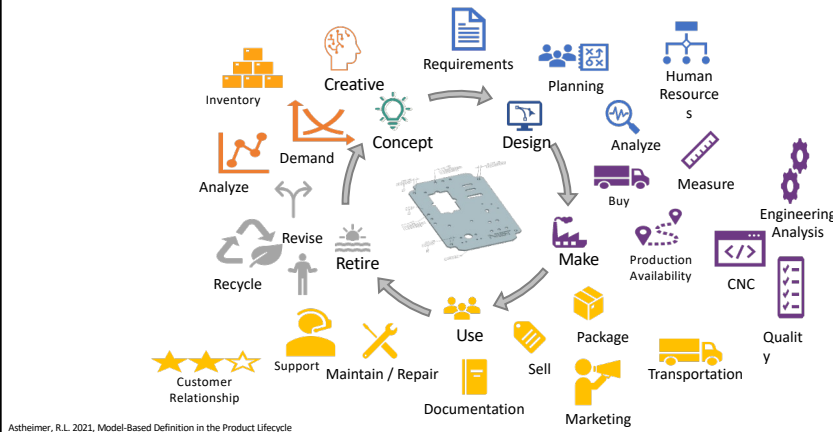
Summary



28

Lots of Uses

NIST



29

The Necessity of Standards

NIST

Technology standards establish specifications and procedures designed to maximize the reliability and effectiveness of goods and services people interact with daily.

<https://spectrum.ieee.org/government-in-standards-is-crucial#toggle-gdpr>

30

Product Data



Data

Information

Knowledge








Photo by Mike Haupt, Pexels.




Happy Gilmore, Universal Pictures, 1996.

31

ENGINEERING DESIGN FOR WEAVING A HETEROGENEOUS DIGITAL THREAD





NATIONAL INSTITUTE OF
STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Rosemary Astheimer
Mechanical Engineer
Smart Connected Manufacturing Systems

32



STAY IN TOUCH

Rosemary Astheimer
rla3@nist.gov

 NIST.gov     @nist