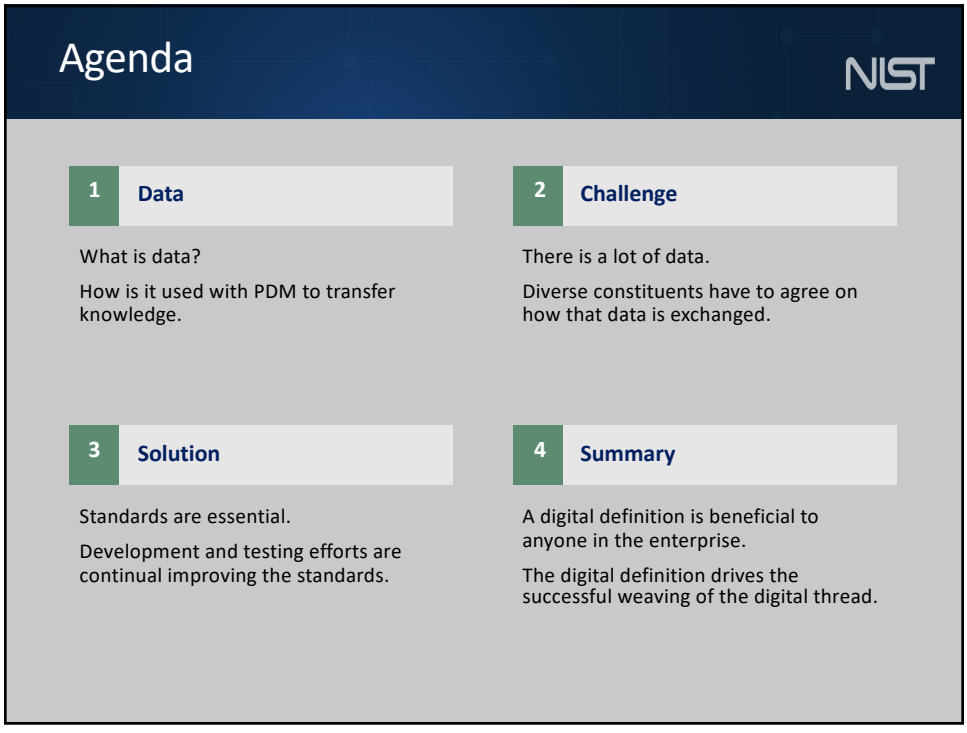
1

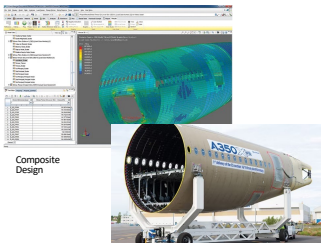


2

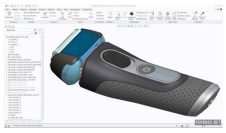
Rosemary Astheimer

NIST

Focus on Computer Aided-Design (CAD)



Composite Design



Product Manager – Creo Data Exchange

PURDUE UNIVERSITY

CAD, PLM & PDM

PLM Software SIEMENS NX

CATIA

ptc creo

SOLIDWORKS

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

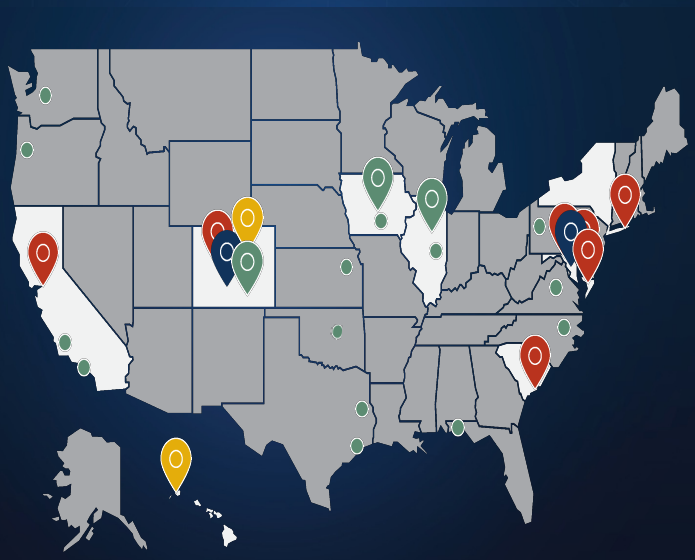
NIST AT A GLANCE

National Institute of Standards and Technology

- **3,400+** FEDERAL EMPLOYEES
- **5** NOBEL PRIZES
- **2 CAMPUSES** GAITHERSBURG, MD [HQ] BOULDER, CO
- **3,500 +** ASSOCIATES
- **10** COLLABORATIVE INSTITUTES
- **400+** BUSINESSES USING NIST FACILITIES
- NATIONAL OFFICE COORDINATING 16 MANUFACTURING INSTITUTES — ManufacturingUSA
- **51** MANUFACTURING EXTENSION PARTNERSHIP CENTERS
- U.S. BALDRIGE PERFORMANCE EXCELLENCE PROGRAM

4

NIST Joint Institute and Center Locations



NIST Campuses
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/case-study-airbus-group-innovations

6

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

Data

7

Product Data

NIST

Data | Information | Knowledge

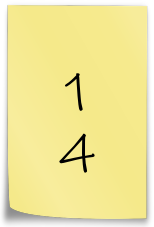


Photo by Jill Rose, Pexels.

"Signed and attested scratch 84 golf scorecard by Earl Anthony" by bitemarkmedia licensed under CC BY 4.0. Cropped.

8

Product Data

Data | Information | Knowledge

Photo by Jill Rose, Pexels.

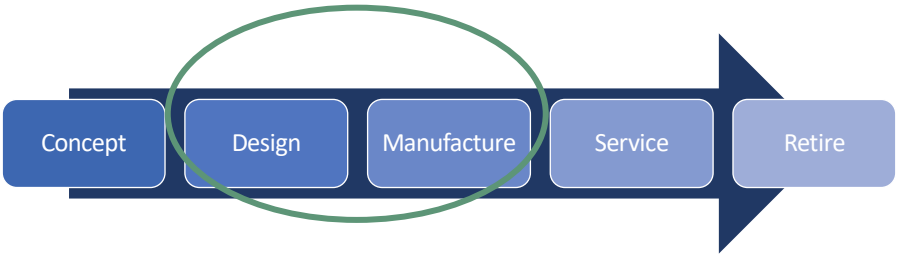
Photo by Kendel Media, Pexels.

9

Product Lifecycle Management

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]

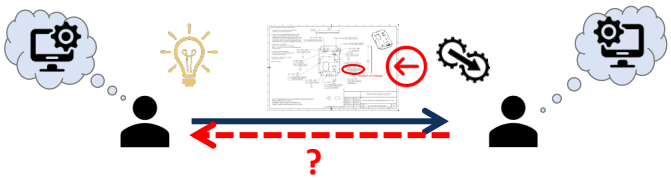
WIKIPEDIA
The Free Encyclopedia



10

Challenge: Communication

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

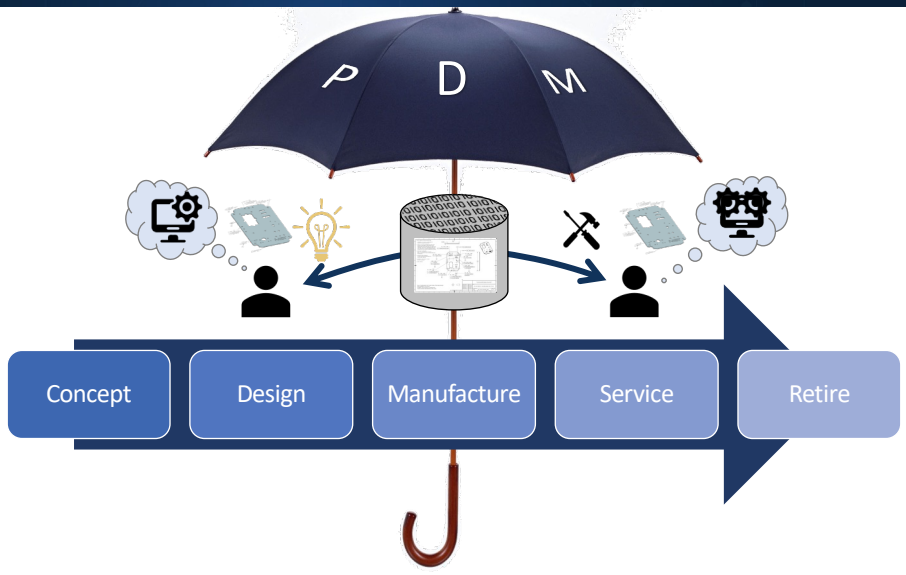


Product data management (**PDM**) should not be confused with product information management (PIM). PDM is the name of a business function within product lifecycle management (PLM) that denotes the management and publication of product data.[1][2] In software engineering, this is known as version control. 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

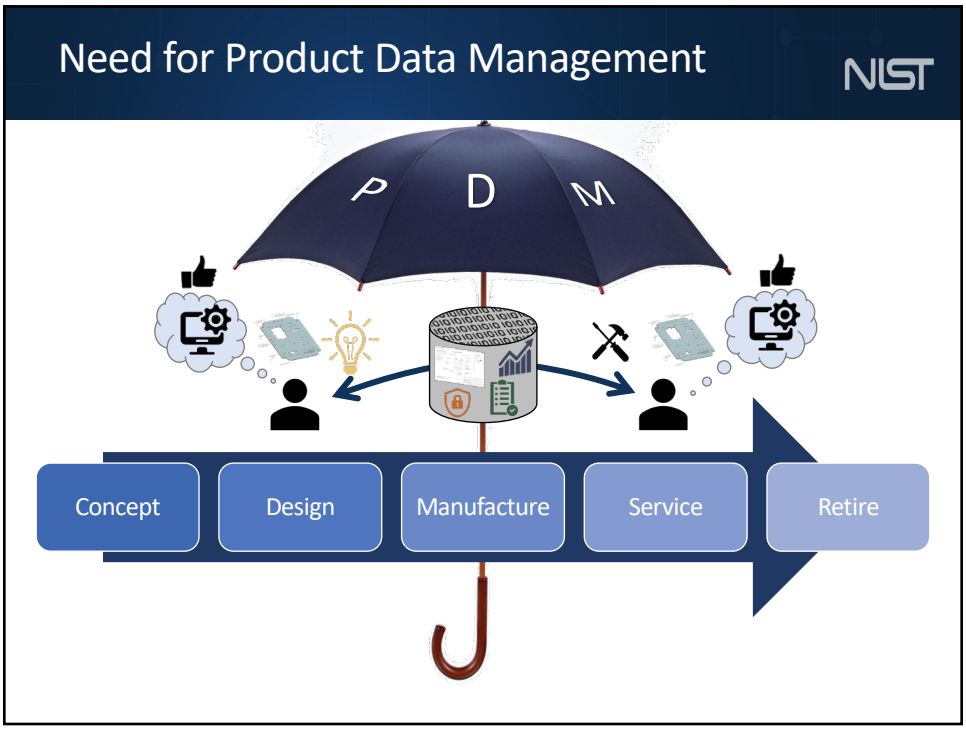
11

Need for Product Data Management



12

Need for Product Data Management



13

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

The Challenge

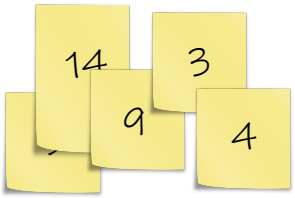
14

Product Data

Data

Information

Knowledge



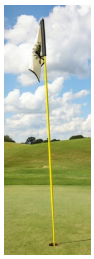
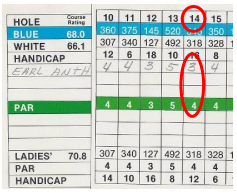


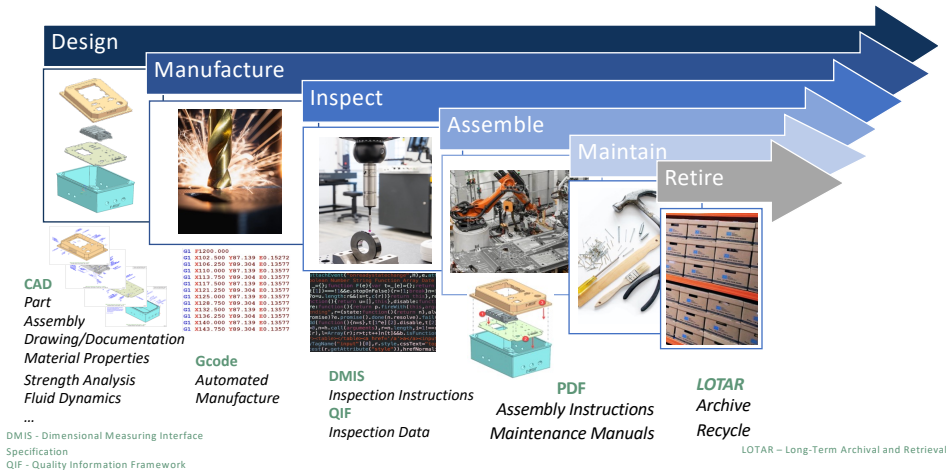
Photo by Mike Haupt, Pexels.



"Signed and attested scratch 64 golf score by Earl Anthony", by Mikemhmmdist, licensed under CC BY 4.0. Cropped.

15

Engineering Perspective



DMIS - Dimensional Measuring Interface Specification
QIF - Quality Information Framework

LOTAR – Long-Term Archival and Retrieval

16

Multiple Formats

NIST

Multi-CAD

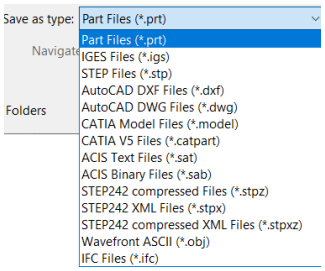
- Acquisition
- OEM, Tier 1, Tier 2

Reverse Engineer

- Slow to develop and error-prone
- Encrypted

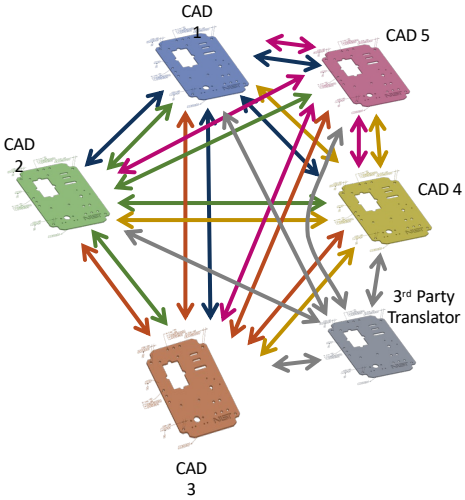
Moving Target

- Vendors develop at different paces
- Support new technology



17

NIST



18

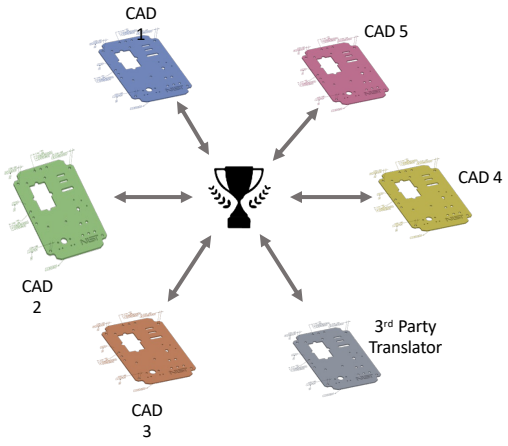
ENGINEERING DESIGN FOR WEAVING A **HETEROGENEOUS** DIGITAL THREAD

The Solution

19

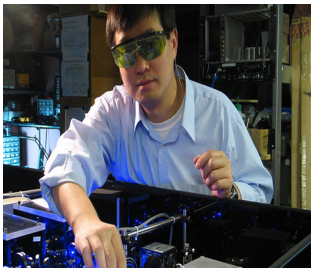
Standards!

NIST



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

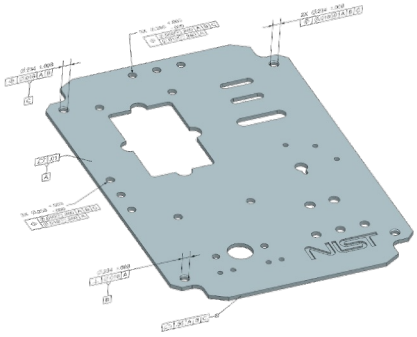
ISO International Organization for Standardization
Independent, non-governmental organization
167 countries

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



CAD Design

Best Practices

ASME Y14.5 (GD&T)

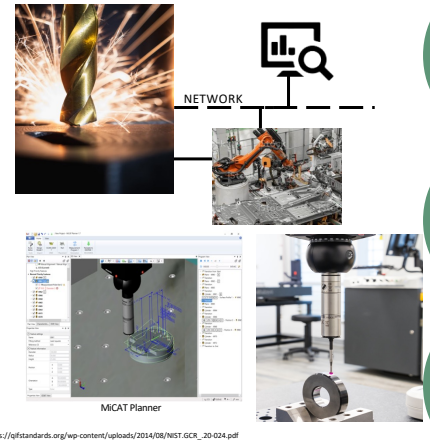
Documenting Tolerance for Manufacturing

ISO 10303 (STEP)

Design Requirements for Manufacturing

23

Standards for Design



https://qifstandards.org/wp-content/uploads/2014/08/NIST.GCR_.20-024.pdf

ISO 6983 (G-Code)

Programming Language for Manufacturing

ANSI MTC1.4-2018(MTConnect)

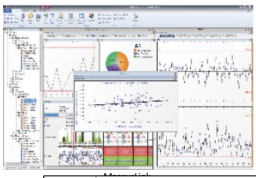
Streams Data from Running Machines

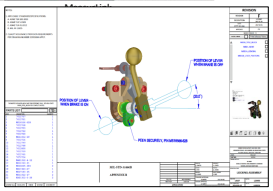
ANSI DMIS

Programming Language for Inspection

24

Standards for Manufacturing





MIL-STD-31000B Example TDP

https://qifstandards.org/wp-content/uploads/2014/08/NIST.GCR_20-024.pdf

ISO 23952 (Quality Information Framework)

Stores As-Measured Product Data

MIL-STD-31000B (Technical Data Package)

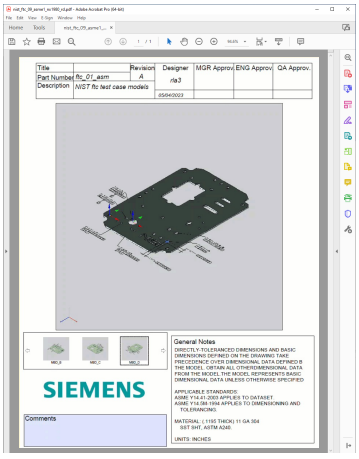
Authoritative PDF with All Technical Data

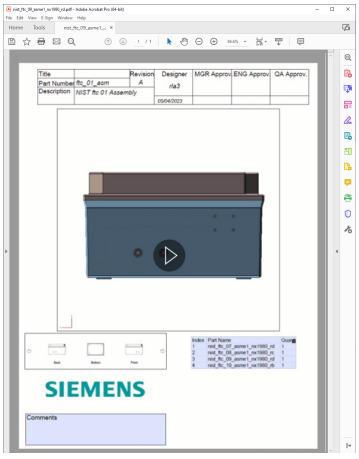
LOTAR

Long Term Archival and Retrieval

25

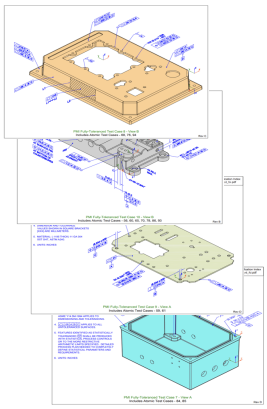
Example MIL-STD-31000B TDP





26

Testing Efforts



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.

MBx Interoperability Forum
CAx Interoperability Forum
User Group
Implementor Group
Implementation Support
Participating Vendors
AP242 Implementation Coverage
CAE Interoperability Forum
EWIS Interoperability Forum
MBx-IF Calender

Vendor	Product
Autodesk	Inventor
CT CoreTechnologie	3D_Evolution (*)
Dassault Systèmes	3DExperience CATIA V5
Datakit	OpenCascade CrossCAD (*)
Elysium	3DxSUITE (*) CADdoctor (*)
International TechneGroup	CADiQ (*) CADbix (*)
Kubotek Kosmos	3D Framework KeyCreator K_Compare (Validate & R K-Display (View & Conve
Siemens PLM	NX
Open Design Alliance	Open STEP Viewer
Technia 3D	HOOPS Exchange (*)

(*) Multi-CAD Processer supporting all major CAD systems

Recommended Practices (Implementation)	AP203 Ed.2 Import	AP203 Ed.2 Export	AP214 Ed.3 Import	AP214 Ed.3 Export	AP242 Ed.1 Import	AP242 Ed.1 Export	AP242 Ed.2 Import	AP242 Ed.2 Export	AP242 Ed.3 Import	AP242 Ed.3 Export
AP242 BO / Domain Model XML Assembly Structure										
AP242 BO / Domain Model XML Kinematics										
Geometry										
Wireframe	X	X	X	X	X	X	X	X	X	X
Geom. Bounded Surface Model	X	X	X	X	X	X	X	X	X	X
BREP Solid	X	X	X	X	X	X	X	X	X	X
3D Tessellated Geometry					X		X		X	
Assembly Structure	X	X	X	X	X	X	X	X	X	X
Alternative Shapes										
Composite Material										
Model Styling										
Solid Color	X	X	X	X	X	X	X	X	X	X
Face Color	X	X	X	X	X	X	X	X	X	X
Edge / Curve Color	X	X	X	X	X	X	X	X	X	X
Point Styling	X	X	X	X	X	X	X	X	X	X
Invisibility	X	X	X	X	X	X	X	X	X	X
Curve Style	X	X	X	X	X	X	X	X	X	X
Assembly Instance Styling										
Single-Level	X	X	X	X	X	X	X	X	X	X
Multi-Level	X	X	X	X	X	X	X	X	X	X
Instance Color	X	X	X	X	X	X	X	X	X	X
Instance Invisibility	X	X	X	X	X	X	X	X	X	X
External References										
Simple External References	X		X		X		X		X	
Nested External References	X		X		X		X		X	
External Element References										
Geometric Validation Properties										
Assembly Validation Properties										

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

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

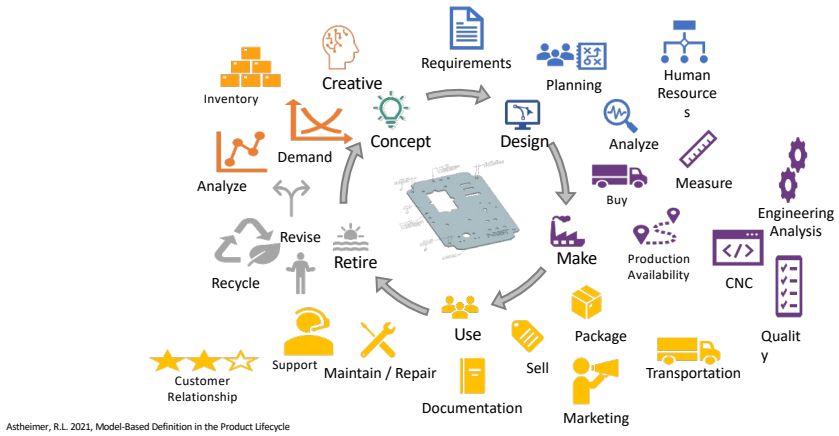
27

ENGINEERING DESIGN FOR WEAVING A HETEROGENEOUS DIGITAL THREAD

Summary

28

Lots of Uses



Astheimer, R.L. 2021, Model-Based Definition in the Product Lifecycle

29

The Necessity of Standards

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

NIST

Data

Information

Knowledge

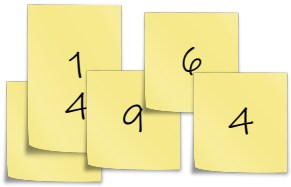


Photo by Mike Haupt, Pexels.

Happy Gilmore, Universal Pictures, 1996.

31

ENGINEERING DESIGN FOR WEAVING A HETEROGENEOUS DIGITAL THREAD

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

Rosemary Astheimer
Mechanical Engineer
Smart Connected Manufacturing Systems

32


NIST
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE
STAY IN TOUCH
Rosemary Astheimer
rla3@nist.gov
NIST.gov
@nist

33