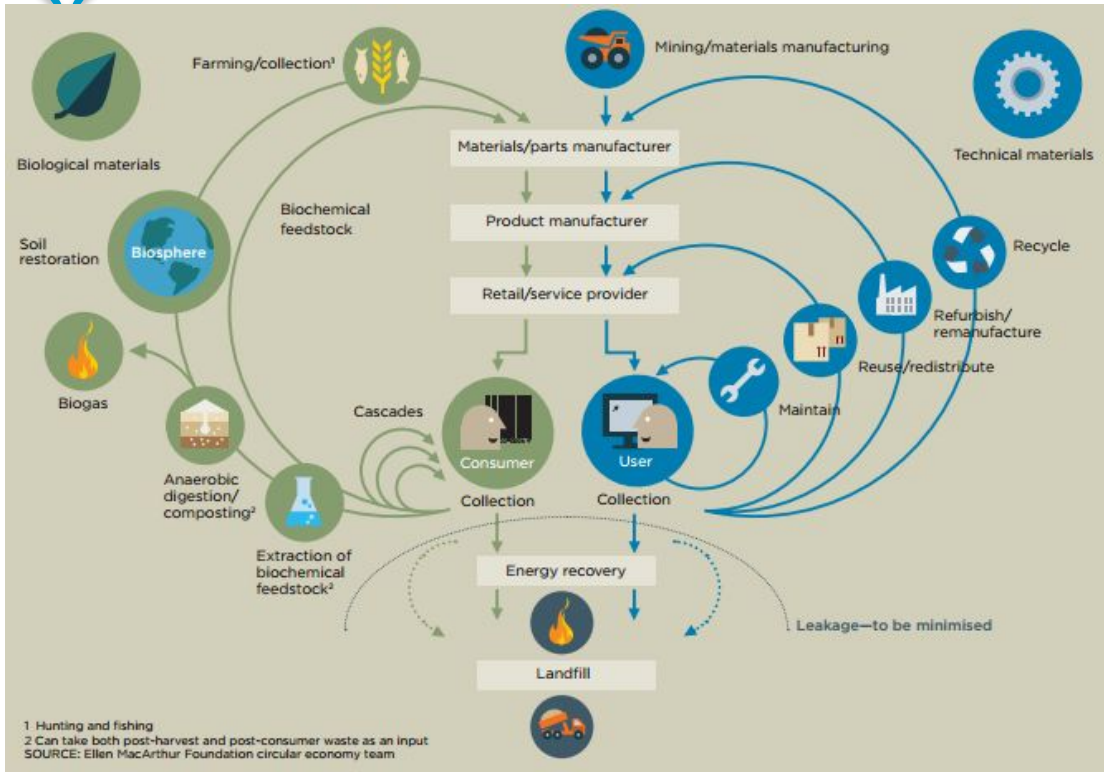


PLM and SLM Joined Digitally for the Connected World

Agenda

- Why connected assets / products
 - The circular economy
 - Outcome-based business models
 - Digital Thread
- Configuration management requirements in a connected world
- Adding structured data to product configuration
- Using Aras for maintaining product configuration

The necessity for a circular economy is one of primary reasons for connected products.



The Ellen Macarthur Foundation. Towards the Circular Economy. @2013

Evolving Strategies

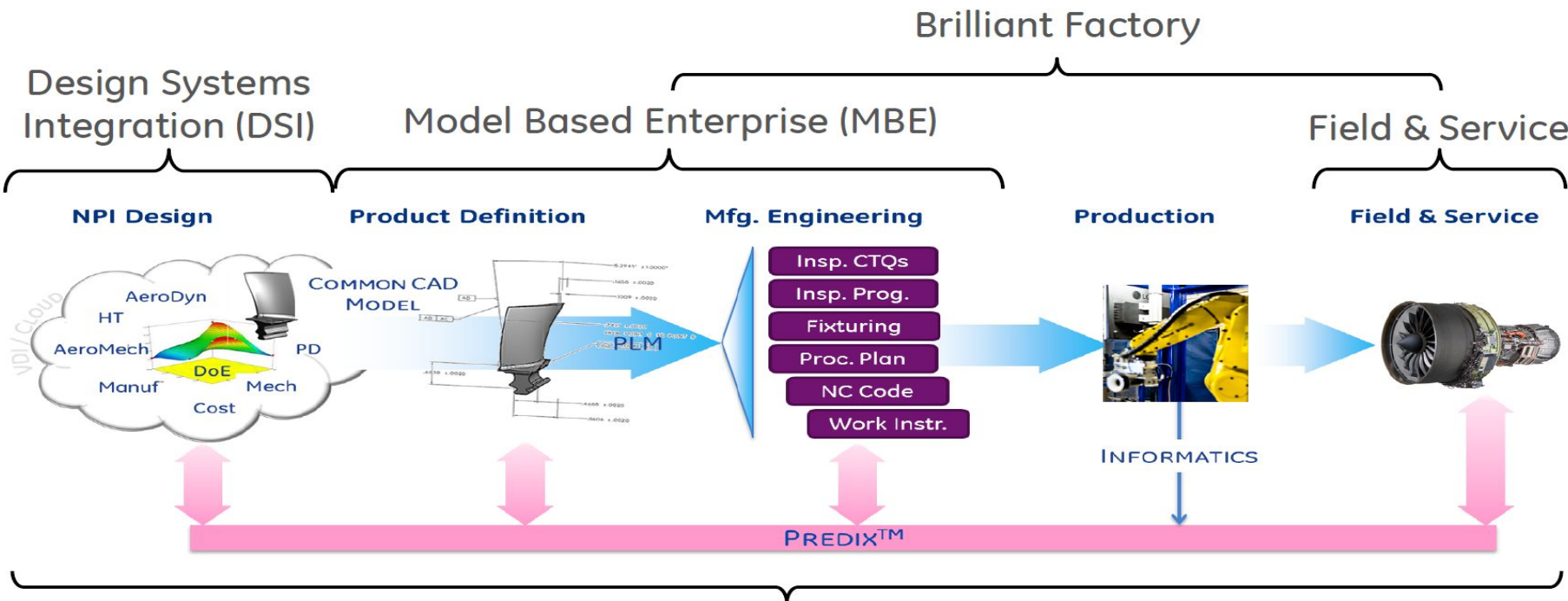
- Product reuse
- Part reuse
- Refurbishment
- Outcome based pricing (buy by the hour)
- Different product ownership models

Circular Economy Continuum



An Outcomes-Based business model requires a Digital Thread.

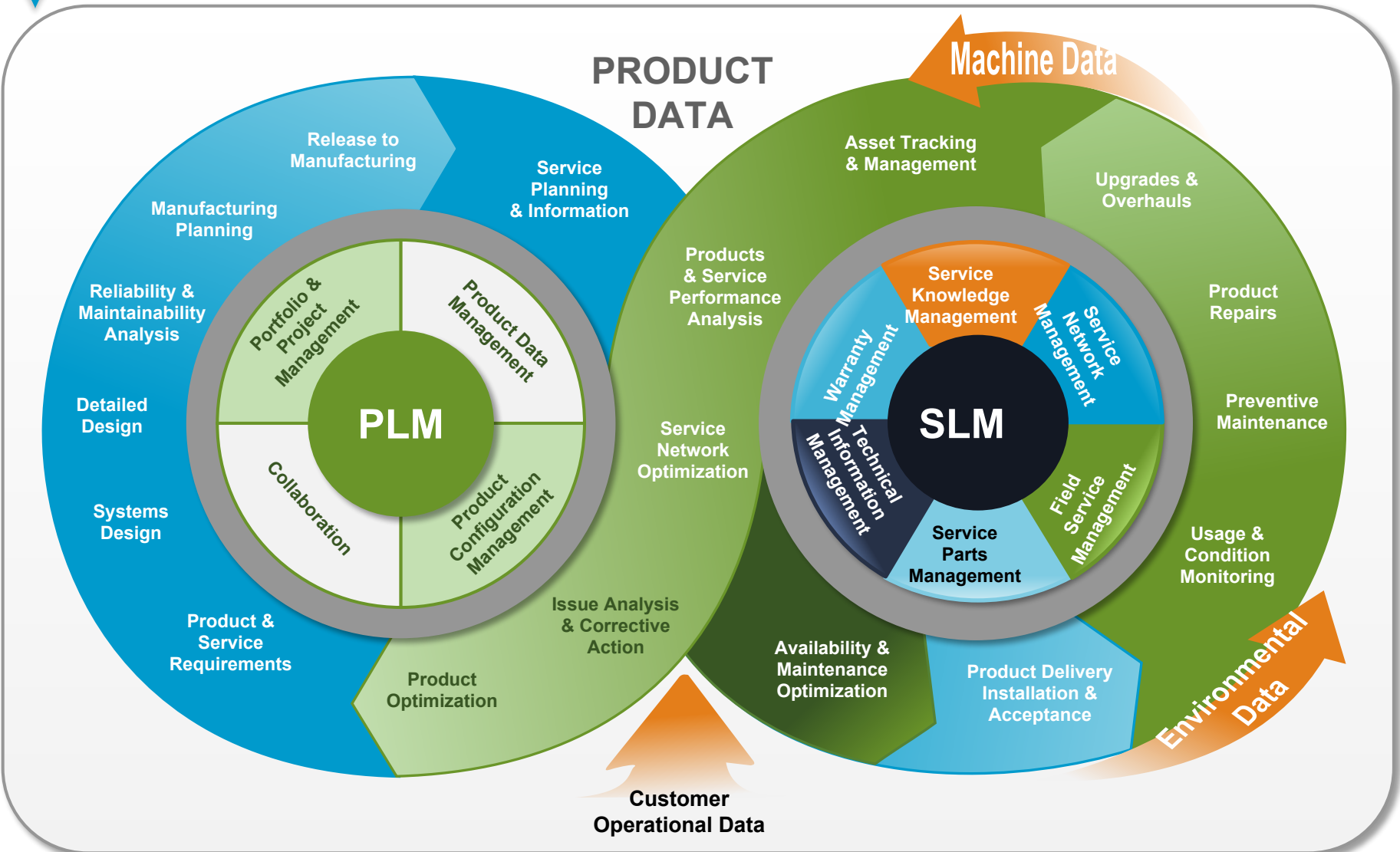
GE's Model of the Digital Thread



Digital Thread: Feed-forward, Feedback, Analytics, Apps



A connected PLM / SLM architecture enables the Digital Thread.

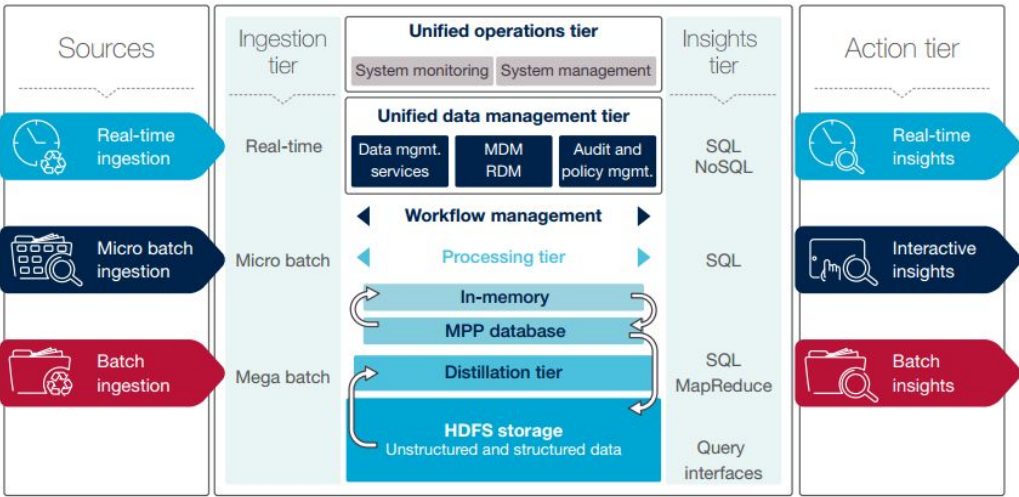


Connected products and analytics adds more data and complexity to configuration management.

Connected Assets



Data Lake Used to Collect Data From Assets and Enable Advanced Analytics and Machine Learning



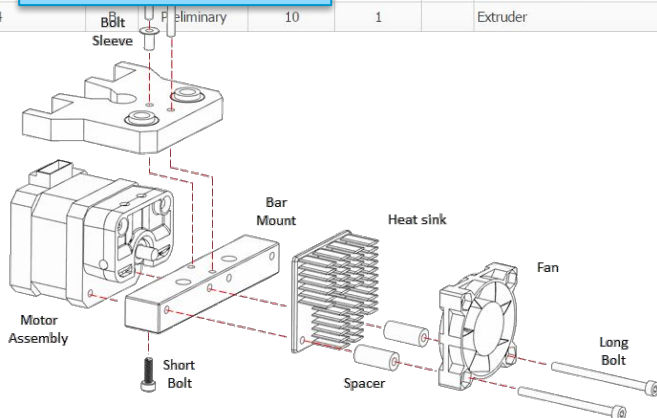
By 2020, over 40% of all data will result from machines talking to one another

From the dawn of civilization to 2003: we produced 5 Exabytes of data
 Now we produce 5 Exabytes of data EVERY TWO DAYS!

Yet, standard PLM / SLM configuration BOMs are not set up for connected products and analytics.

Insufficient for Analysis

Part Number	Quantity	Lock...	Name
MP2942	1		Body
MP2600	1		Spacer Black 5-16 in length .14in ID .25in OD
MP2347	1		RGB LED Strip Common Anode
MP2660	2		Spacer Black 1-2 in length .14in ID .25in OD
MP2939	20		Body Fan Assembly
MP2347	5		Fan 24V 40x40x10 1m leads
MP2600	2		Spacer Black 16.5mm length 3.2mm ID 7mm OD
MP2939	1		Body Hardware
MP2939	1		Body Panels
MP2939	1		Stepper Motor Assembly
MP2400	4		Thing-O-Matic 2 Radial Ball Bearings
MP2939	1		Cable Hardware
MP0900	2		Mechanical Endstop
MP2954	10		Extruder



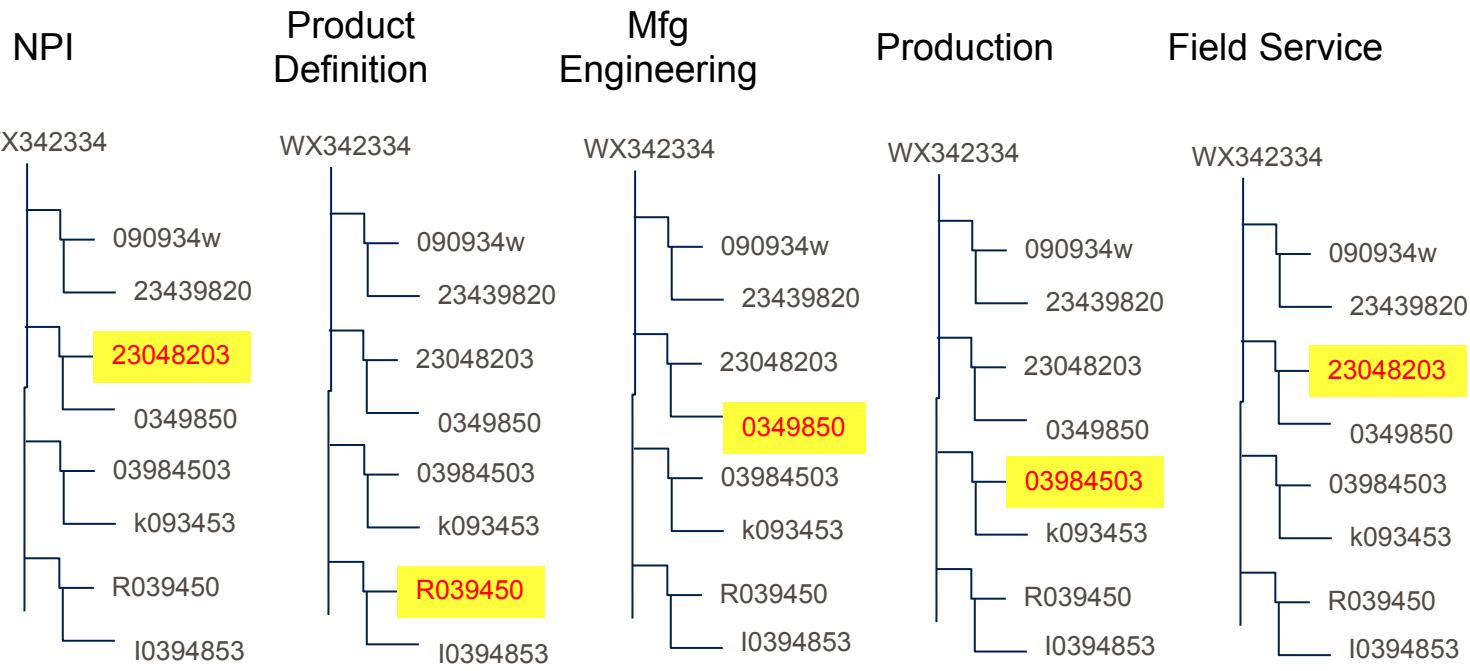
Structured Performance Data

- Describes the performance characteristics of the product
 - Pressures, temperatures, etc.
 - Maximums, minimums
 - Voltages, amperes, etc.
 - MTF, time in service, etc.
- Defines the performance characteristics of the parts and the system as a whole
- Enables comparative analysis to the operation of the parts and products collected via IoT

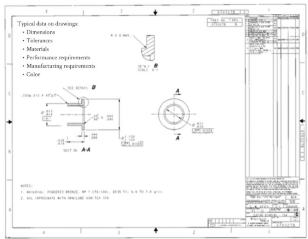
The PLM / SLM architecture must enable product data and product configuration management over time and states.

Product / Asset Configuration

- Hardware
- Software
- Electronics
- Revisions
- Tracibility
- Audit Trail



3d CAD model



Drawings

Table 1: Normally closed valve bodies

Body Material	End Connections	inches	Factor	Body Type (1)
Gray Iron	Threaded	1.25	20	RS
		1.5	20	RS
		1.75	20	RS
		2.0	45	RS
		2.25	45	RS
		2.5	86	RS
	Flanged	2.5	122	RS
		3	304	RS
		3	172	RS
		4	420	RS
		4	86	RS
		6	710	RS
Cast Steel	Threaded	1.25	20	RS
		1.5	20	RS
		1.75	20	RS
		2.0	45	RS
		2.25	45	RS
		2.5	86	RS
	Flanged	2.5	304	RS
		3	420	RS
		3	172	RS
		4	420	RS
		4	86	RS
		6	710	RS

1) RS = Heavy stem body, SC = Sampling stem body. See catalog pages 0216-0217 for construction details.

NOTE: Typically, pressure drop for gas flows should not exceed 10% of inlet pressure; however, for 2" and smaller valves, the drop should not exceed 25%. See page 0217 for design details. Do not exceed 2.5 DSG. Select valve size on basis of the lower of these parameters to avoid critical flow conditions.



Process Documents

Structuring data is a way to manage the data onslaught and enable outcomes-based business models.

PLM Bill of Information

- Files are stored in PLM
- Data in files is unstructured

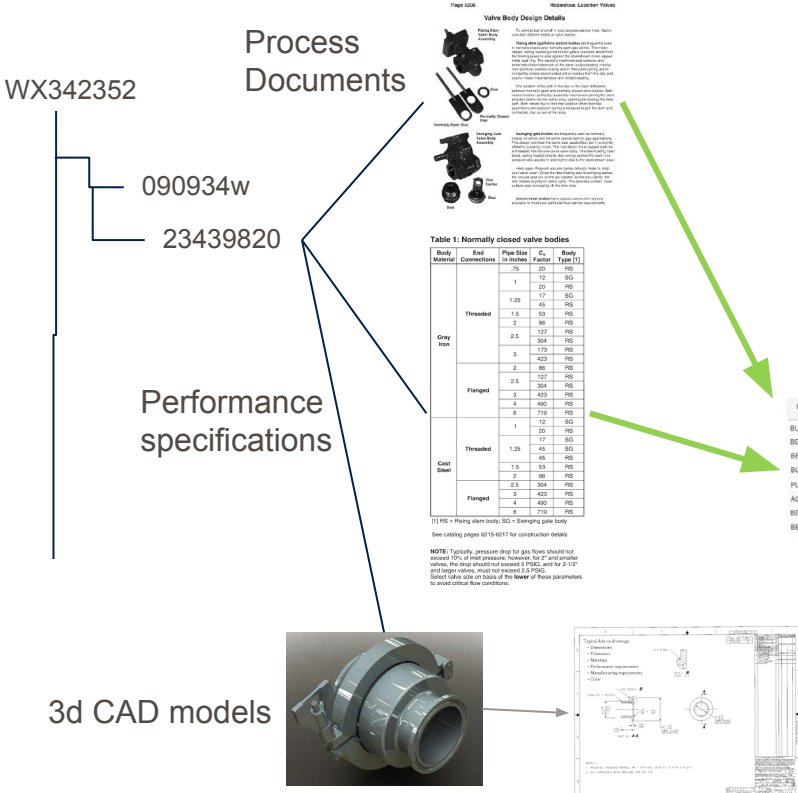
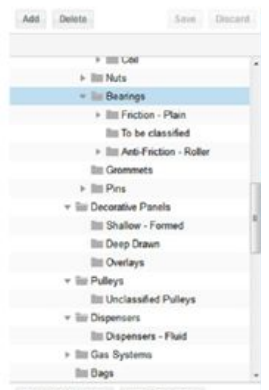


Table 1: Normally closed valve bodies

Body Material	End Connections	Pipe Size (inches)	CL (inches)	Body Type (1)
Gray Iron	Threaded	1.5	20	RS
		2	20	RS
		1.25	17	SO
		1.5	17	SO
		1.5	15	RS
		2	15	RS
	Flanged	2.5	127	RS
		3	127	RS
		3	119	RS
		3	433	RS
		2	85	RS
		2.5	127	RS
Cast Steel	Threaded	1.5	20	RS
		2	20	RS
		1.25	17	SO
	Flanged	1.5	17	SO
		1.5	15	RS
		2	15	RS

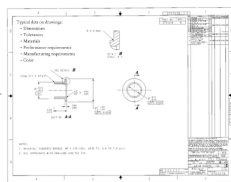
Standard Data Model



Standard Data Structure

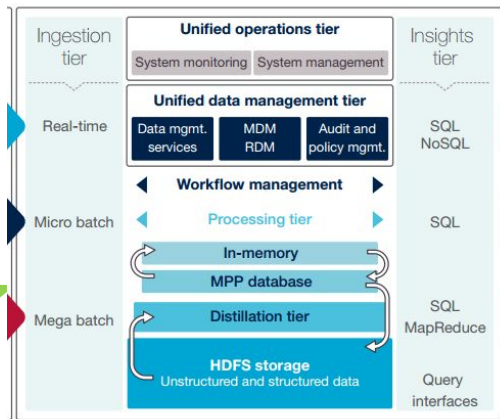
Item Description	Status	CreateUser	CreateDate	Diameter Inside	Diameter Outside	Drawing Number	Height
BUSHING-HINGE	In Work	Admin	6/13/2008	6.4540mm	9.4565mm	8557878	14.6850mm
BEARING-SLEEVE	In Work	Admin	6/13/2008	6.2550mm	12.7150mm	8559878	32.2500mm
BEARING-BRONZE	In Work	strajpd	6/01/2009	6.2700mm	12.7300mm	8559101	32.2500mm
BUSHING-BRONZE	In Work	Admin	6/13/2008	6.2620mm	12.4640mm	8557253	14.6750mm
PLASTIC-BUSHING	In Work	Admin	6/13/2008	6.4020mm	18.4000mm	92311117	15.7000mm
AGITATOR SHAFT	In Work	Admin	6/13/2008	19.1150mm	25.4400mm	92312913	33.3200mm
BEARING - FDA	In Work	Admin	6/13/2008	09.8305mm	9.8145mm	9763278	6.6230mm
BEARING-UPPER	In Work	strajpd	6/01/2009	5.9020mm	6.9905mm	9763368	6.5700mm

Drawings



Data Lake

- Standardized data
- Consistent data format
- Algorithms used to identify issues
- Available for analytics



Aras Innovator with additional collaboration functions is a good tool for structuring data.

Data Structure Collaboration

The screenshot displays the Aras Innovator user interface. On the left is a navigation menu with 'Manage Classifications' selected. The main area is split into two panes: 'Classification Structure' and 'Category'.

Classification Structure: A tree view showing a hierarchy starting from 'Root', with 'Consumables' and 'Parts' expanded. 'Parts' contains sub-categories like 'Cosmetic, Storage', 'Electrical', 'Filter', 'Manuals', 'Mechanical Parts', 'Seals, Gaskets', 'Systems - Air', 'Systems - Gas', 'Systems - Sealed-Refri...', 'Systems - Water', 'Valves', 'Tools', 'Manufacturers', 'Models', and 'Test Category'.

Category: The 'Parts' category is selected. It shows:

- Name:** Parts
- Description:** The Item Number under "Parts" category would be the OEM Manufacturer item number. Mike J - There are a lot of very specific parts that are unique to an appliance type. Where should these go? See Repair Clinic Part Titles
- Options:** Active
- Version:** 1

On the right, a metadata table shows:

LC Status:	New
Requested By:	
Approved By:	
Approved On:	
Created By:	Innovator Admin
Created On:	2015-07-10T02:09:37
Modified By:	Innovator Admin
Modified On:	2015-09-04T03:03:57

Below the category details are tabs for 'Attributes', 'Reference Documents', 'Team', and 'Comments'. The 'Comments' tab is active, showing a 'Write Comment' text area with an 'Add' button and an 'All Comments' section below it.

A tooltip at the bottom indicates 'Shrirang Kamble is editing.'

Aras Innovator with additional collaboration functions is a good tool for structuring data (cont.)

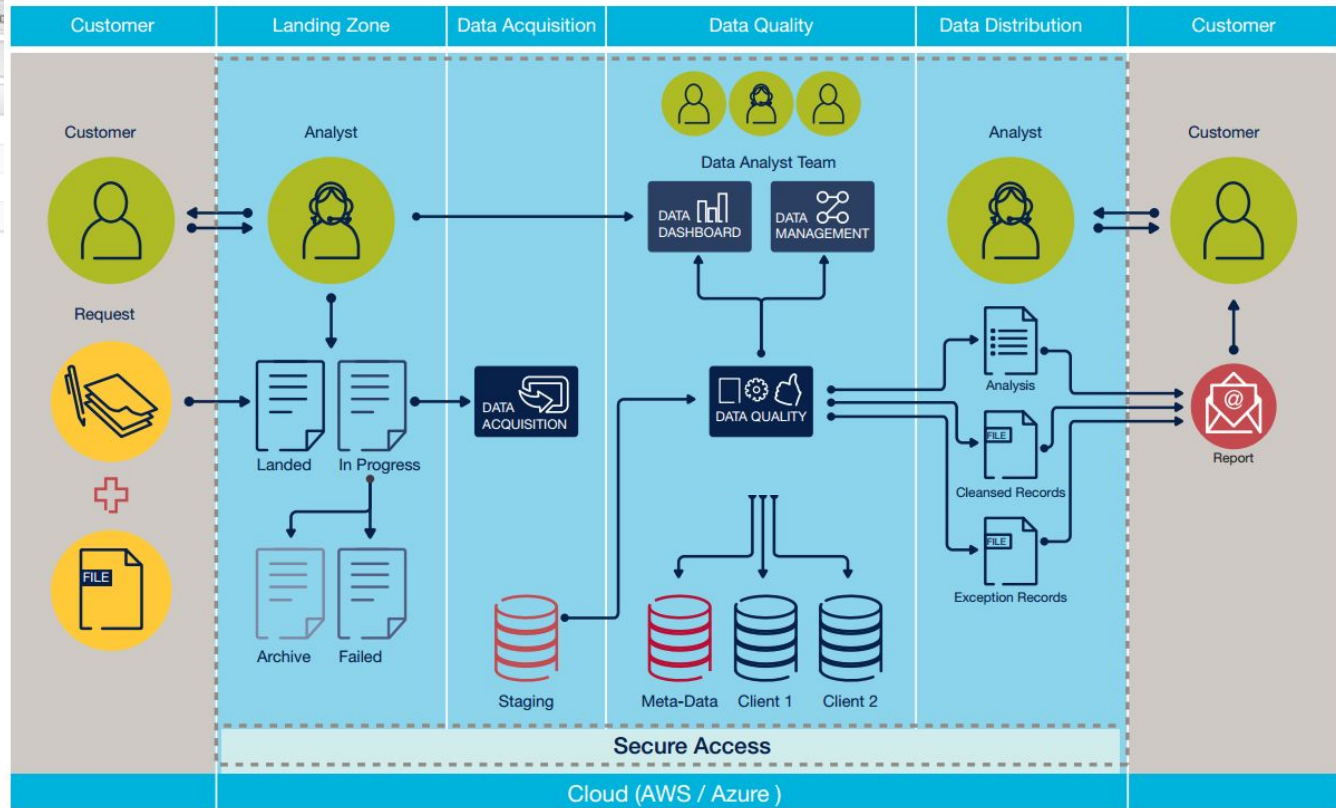
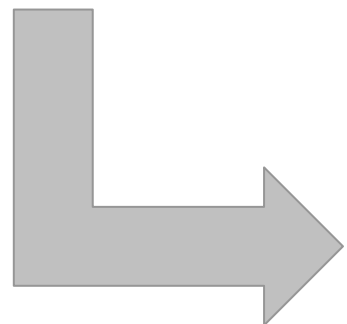
Capturing Knowledge For Future Reference

The screenshot displays the Aras Innovator software interface, which is used for managing classification structures and capturing knowledge. The interface is divided into several main sections:

- Contents (Left Panel):** A navigation menu with categories such as Administration, Change Management, Cloud Services, Dashboards, Design, Documents, My Innovator, Noetic Data, Attributes, Categories, Items, Manage Classifications, Requests, Noetic Data - Admin, Portfolio, Sourcing, and Templates.
- Classification Structure (Middle-Left Panel):** A tree view showing a hierarchy of folders. The 'Parts' folder is expanded, showing sub-folders like 'Adhesives', 'Bags', 'Belts', 'O-Ring', 'Poly-V Belts', and 'Elastic'. The 'Adhesives' folder is currently selected.
- Category Form (Middle-Right Panel):** A form for creating or editing a category. The 'Name' field contains 'Non-Elastic Or Standard'. The 'Description' field is empty. The 'Options' section has the 'Active' checkbox checked. The 'Version' field contains '1'. The 'Advanced View' tab is active, and there are 'Save' and 'Discard' buttons.
- Activities Wall (Right Panel):** A list of recent activities. The activities include:
 - chandraSekhar Gogineni Working on "Belts"
 - Shrirang Renamed "Molded Components"
 - Hrishikesh Konka Added "dummy Parts"
 - Shrirang Updated "Molded Components"
 - Hrishikesh Konka Updated "dummy Parts"
 - Shrirang Updated "Molded Components"
 - chandraSekhar Gogineni Updated "Belts"
 - Hrishikesh Konka Updated "dummy Parts"
- Working Users (Bottom-Left Panel):** A window showing a search bar and a list of users. One user, 'Shrirang Kamble', is listed as 'working on "Adhesives"'. The window title is 'Working Users'.
- Rule (Bottom-Middle Panel):** A window showing a list of rules. Two rules are visible:
 - Innovator Admin** This is my first test comment commented on 2015-09-15T15:30:23
 - Shrirang Kamble** This is demo comment commented on 2015-09-15T15:31:57

Once the structure and attributes are defined, “Data Quality as a Service” can populate the attributes.

The screenshot shows a software interface with two main panels. On the left, a 'Classification Structure' tree lists various categories like Filter, Gas Systems, Glass, Handles, Heating Elements, Hinges, Hoses And Tubes, Knobs, Lubricants, Molded Components, Motor, Packaging, Power Transmission, Pump, Sealed System, Seals, Stampings, and Tubs. On the right, a 'Category' form is shown for 'Gas'. It includes fields for Name, Description, Options (Active checkbox), and Version (1). A metadata section on the right shows LC Status (New), Requested By, Approved By, Approved On, Created By (Innovator Admin), Created On (2015-07-13T12:54:57), Modified By (Innovator Admin), and Modified On (2015-07-13T12:54:57). Below the category form, an 'Attributes' table lists: Name, Product Length, Item weight, Product Width, and Product Height.



After PLM / SLM integration and structured data, maintenance can change dramatically.

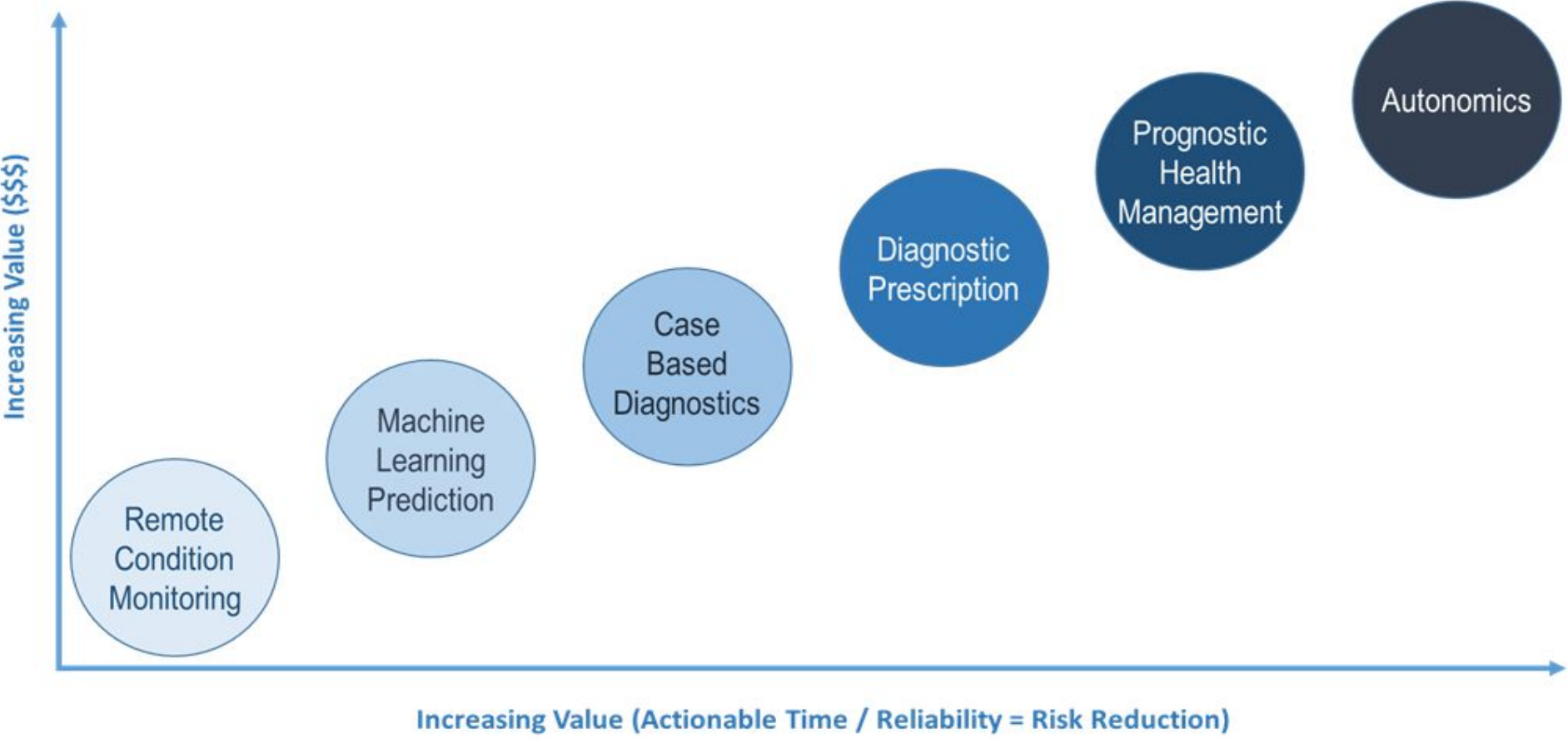
Asset Maintenance Use Case

- A manufacturing defect is identified in a wheel bearing
- There are two bearing types installed on a family of locomotives: “oil lubricated” or “sealed / greased”
- Simply search the attribute “bearing lubrication” for the value “oil”
- The result is all the bearings that are subject to the recall and the serial number locomotive and the bearing location



Better data results in more service value.

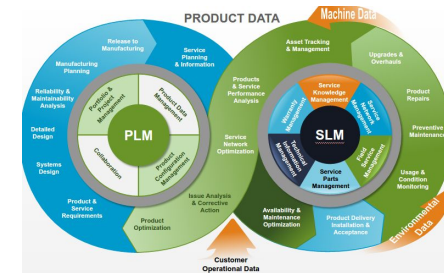
Service Value



Increasing the accessibility of structured engineering data enables value from outcome-based business models.

Value Areas

- Reduced supply chain costs
 - Reduction in duplicate parts in inventory
 - Reducing supplier base to the most reliable cost effective part
 - Accurate BOM's and better obsolescence control
 - More information for customers and purchasing on part attributes
- Improving the ability to manage as-maintained configurations at the Serial # Level
 - Flexible BOM structure with a robust Engineering Change Management Process
 - Feeding operational quality, safety and reliability data back to Engineering
 - Improving the ability to plan and manage product recalls and modifications
- Enabling more accurate diagnostic tools with accurate parts data and asset configuration
- Providing sales and engineering more information on fielded assets to identify new reliability enhancements, new product options and new product design ideas.



People matter, results count.



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