

Metadata Matters

(Powering AI Data Discovery and Context)

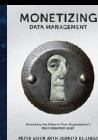


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Peter Aiken, Ph.D.

- I've been doing this a long time
- My work is recognized as useful
- Associate Professor of IS (vcu.edu)
- DAMA International (dama.org)
 - IDEAL Affinity Group
 - GenAI in Data Affinity Group
- Anything Awesome (anythingawesome.com)
- Experienced w/ 500+ data management practices worldwide
- 13 books and dozens of articles
- Multi-year immersions
 - US DoD (DISA/Army/Marines/DLA)
 - Nokia
 - Deutsche Bank
 - Wells Fargo
 - Walmart
 - HUD
 - NSA ...

\$1,500,000,000.00 USD

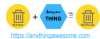


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Program Overview

Metadata Powers AI Data Discovery & Context

- Imagine
 - What is metadata?
 - Why should I care?
 - Understanding leverage
- Construct (from the customer perspective)
 - Customers think in objects
 - Customers understand metadata use
 - Customers value common vocabularies
- Metadata specific requirements
 - Sustained competitive advantage
 - Relationship to other popular silver bullets
 - Formalizing additional (conceptual) layers
- Approach Requirements (In Action) Skywise
- What does this have to do with the application of AI?
- Take Aways, References and Q&A



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Henri La Fontaine
Nobel Peace Prize, 1913

Paul Otlet

The Mundaneum was an institution which aimed to gather together all the world's knowledge and classify it according to a system called the Universal Decimal Classification. It was developed at the turn of the 20th century by Belgian lawyers Paul Otlet and Henri La Fontaine. (The Mundaneum has been identified as a milestone in the history of data collection and management, and (somewhat more tenuously) as a precursor to the Internet.)

Special thanks to Peter A. Campbell @ Solvay for this contribution



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Analogy: a Library Card Catalog

- Identifies
 - What books are in the library, and
 - Where they are located
 - Search by
 - Subject area
 - Author, or
 - Title
 - Catalog shows
 - Author
 - Subject tags
 - Publication date and
 - Revision history
 - Determine which books will meet the reader's requirements
 - Without the catalog, finding things is difficult, time consuming and frustrating
- from *The DAMA Guide to the Data Management Body of Knowledge* © 2009 by DAMA International

PC3557
.R5355
F57 1991
Grisham, John

The firm / John Grisham. 1st. ed.
New York : Doubleday, c1991.
421p. ; 24 cm.

1. Government investigators--Fiction.
2. Organized crime--Fiction.

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Meta Data, Meta-data, Metadata

- In the history of language, whenever two words are pasted together to form a combined concept initially, a hyphen links them

- With the passage of time, the hyphen is lost. The argument can be made that that time has passed

- So, the term is "metadata"

- By-the-way, there is a copyright on the term "metadata," but it has not been enforced

Check Status (TARR contains current status, correspondence address and attorney of record for the return to TESS)

Typed Drawing

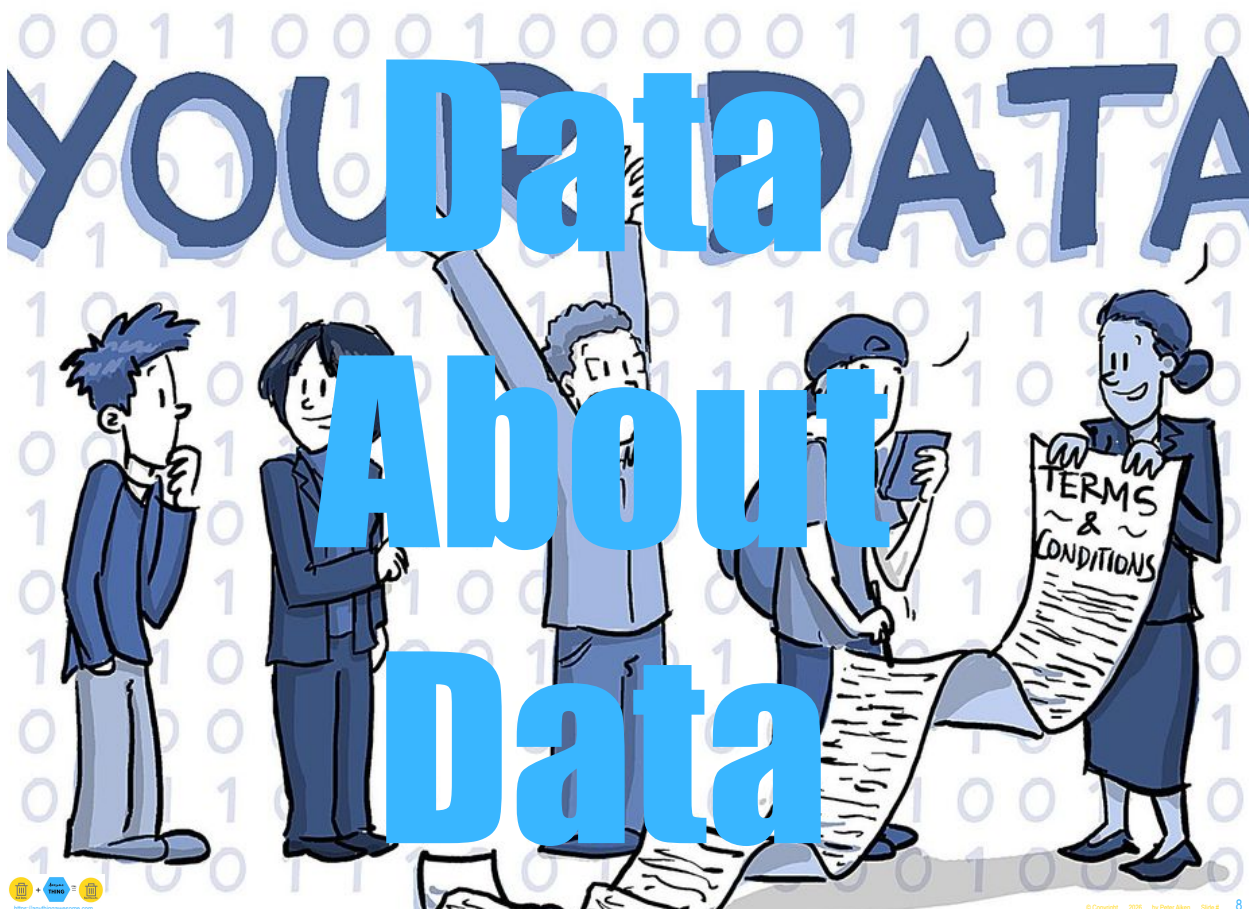
Word Mark	METADATA
Goods and Services	IC 009, US 038, G & S: COMPUTER PROGRAMS, FIRST USE: 1981092
Mark Drawing Code	(1) TYPED DRAWING
Serial Number	73561844
Filing Date	October 7, 1985
Current Filing Basis	1A
Original Filing Basis	1A
Published for Opposition	June 24, 1986
Registration Number	1409260
Registration Date	September 16, 1986
Owner	(REGISTRANT) MEGADYNE INFORMATION SYSTEMS CORPORATION BOULEVARD SANTA MONICA CALIFORNIA 90401 (LAST LISTED OWNER) METADATA INC. LIMITED LIABILITY COMPANY BRENTWOOD TENNESSEE 37027

Assignment Recorded	ASSIGNMENT RECORDED
Attorney of Record	RICHARD L. BERNACCHI
Type of Mark	TRADEMARK
Register	PRINCIPAL
Affidavit Text	SECT 15, SECT 8 (6-YR).
Live/Dead Indicator	LIVE



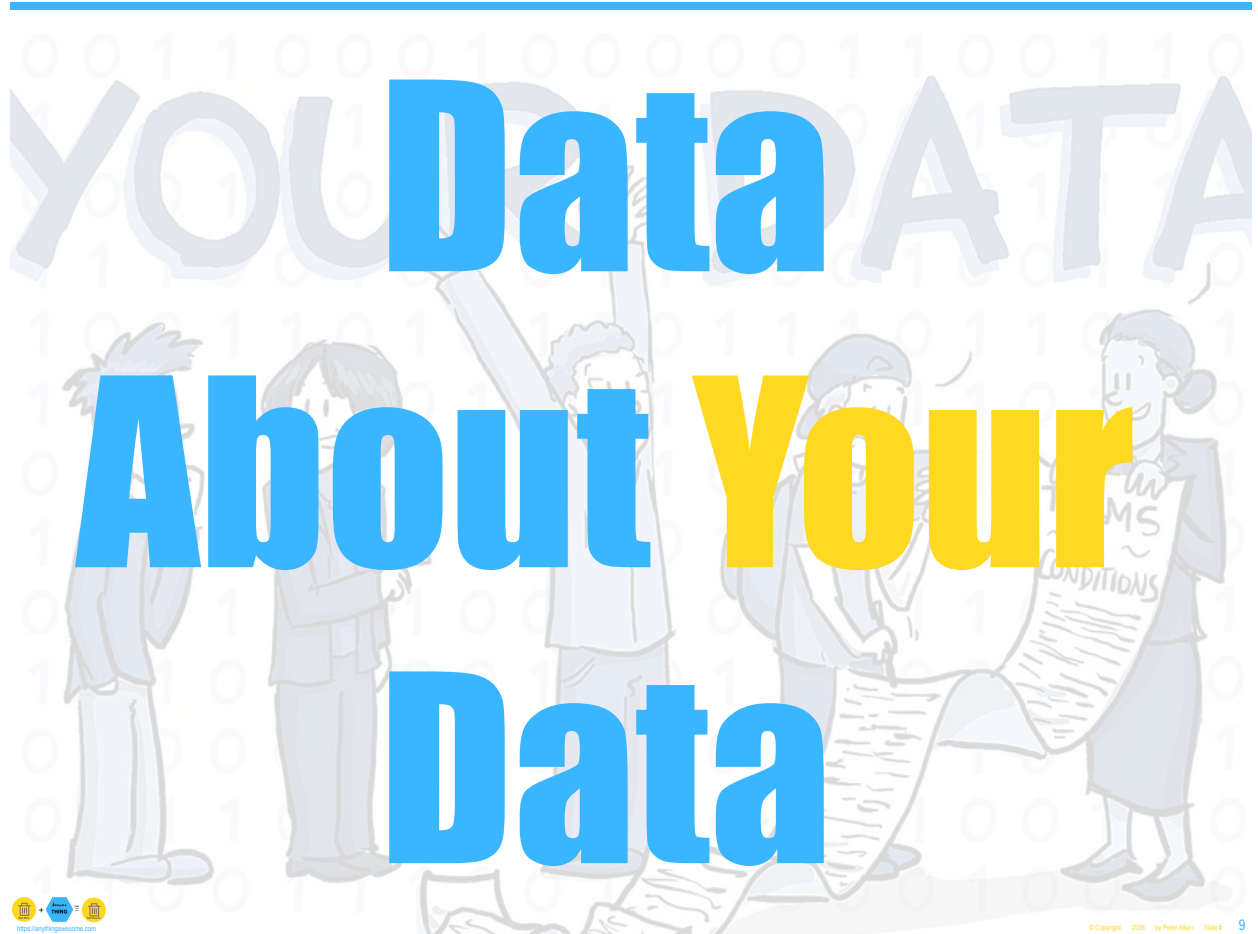
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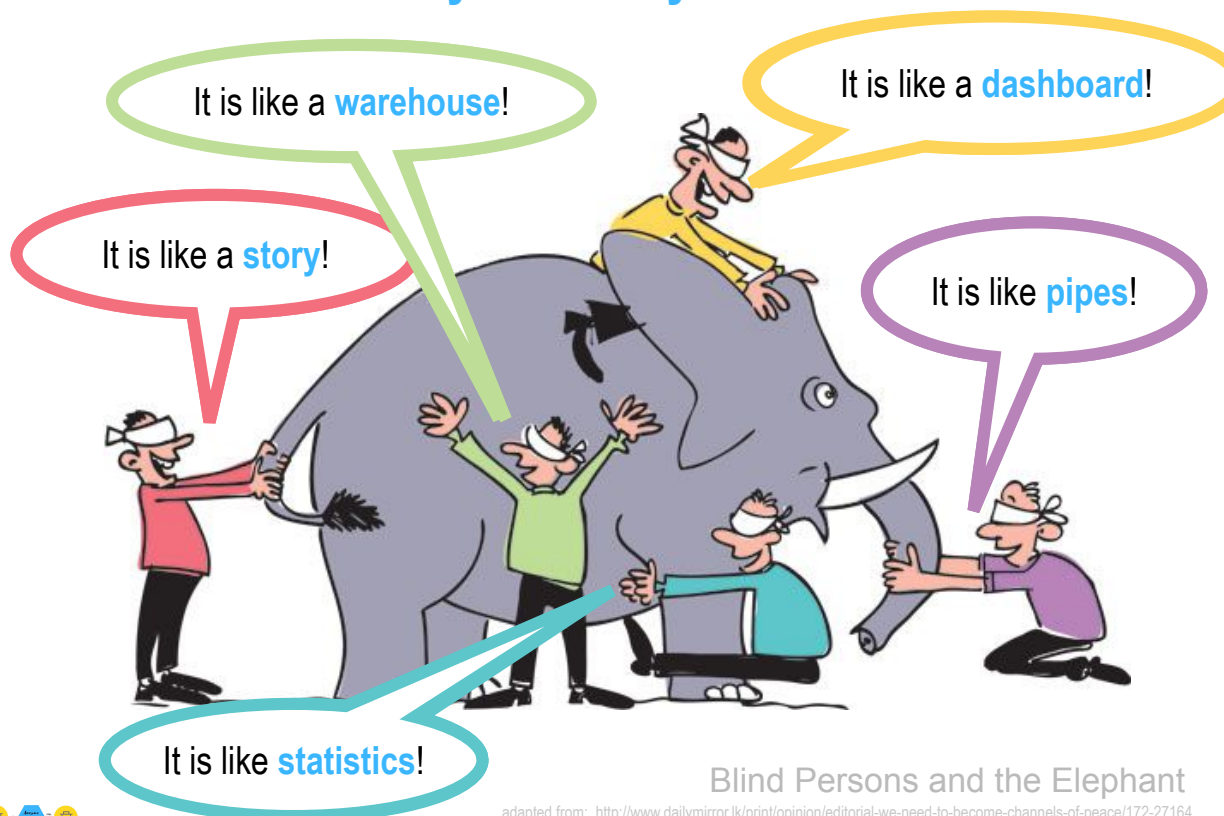


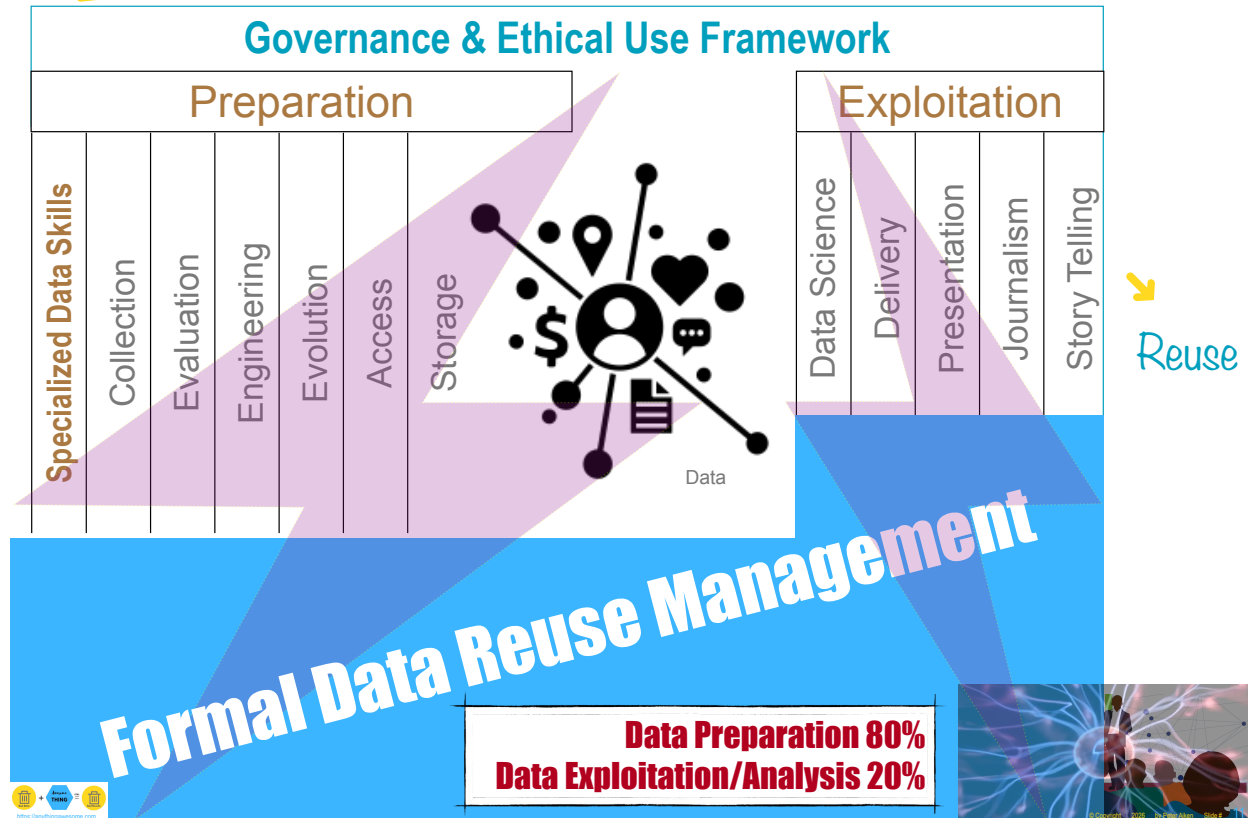
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Data Is Not Broadly or Widely Understood





The Prefix Meta-

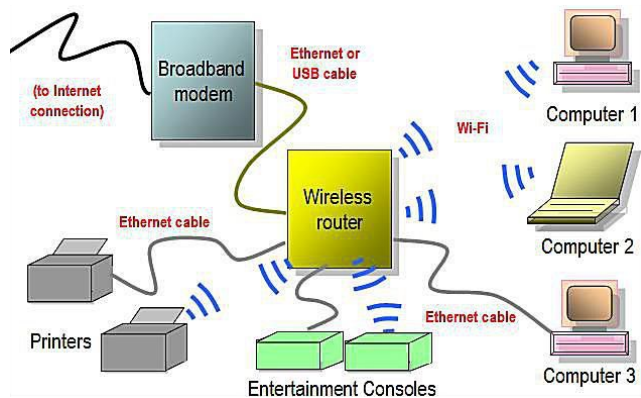
Meta

1. Situated behind: metacarpus.
2.
 - a. Later in time: metestrus.
 - b. At a later stage of development: metanephros.
3.
 - a. Change; transformation: metachromatism.
4.
 - a. Beyond; transcending; more comprehensive: metalinguistics.**
 - b. At a higher state of development: metazoan.**
5. Having undergone metamorphosis: metasomatic.
6.
 - a. Derivative or related chemical substance: metaprotein.
 - b. Of or relating to one of three possible isomers of a benzene ring with two attached chemical groups, in which the carbon atoms with attached groups are separated by one unsubstituted carbon atom: meta-dibromobenzene.

Definition of the prefix *meta-* (Emphasis added – source: *American Heritage English Dictionary* © 1993 Houghton Mifflin).

Likely, the Most Well Managed Metadata in Your Organization

- Tracking network users and access points is metadata
- Your organization's networking group allocates the responsibility for knowing (at least):
 - All the devices permitted to logon to your network
 - Locations of all permitted access points
- This responsibility belongs to one or more named individual(s)

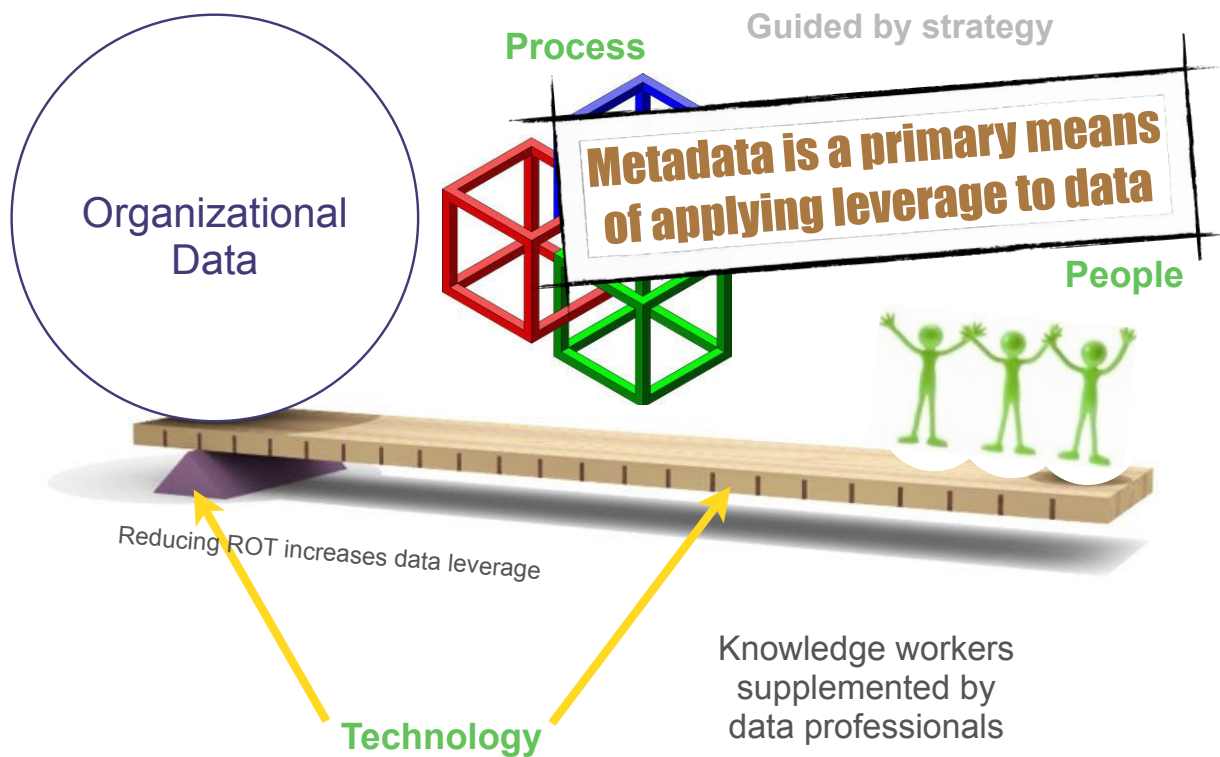


Leverage Is an Engineering Concept

- Using proper engineering techniques, a human can lift a bulk that is weighs much more than the human



A Wholistic Approach to Obtaining Data Leverage

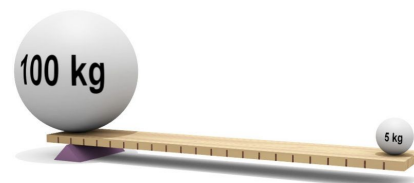
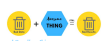


<https://www.computerhope.com/jargon/t/framework.htm>

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Data Leverage Is a Multi-Use Concept

- Permits organizations to better manage their data
 - Within the organization, and
 - With organizational data exchange partners
 - In support of the organizational mission
- Leverage is enabled by metadata
 - Obtained by implementation of data-centric technologies, processes, and human skill sets
 - Focus on the non-ROT data
 - The bigger the organization, the greater potential leverage exists
- Treating data more asset-like simultaneously
 - Lowers organizational IT costs and
 - Increases organizational knowledge worker productivity

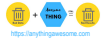


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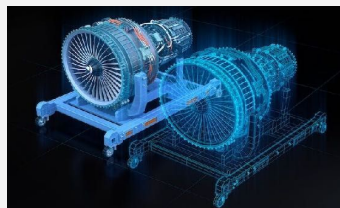


To Have Business Users Interact With ...

• Tires



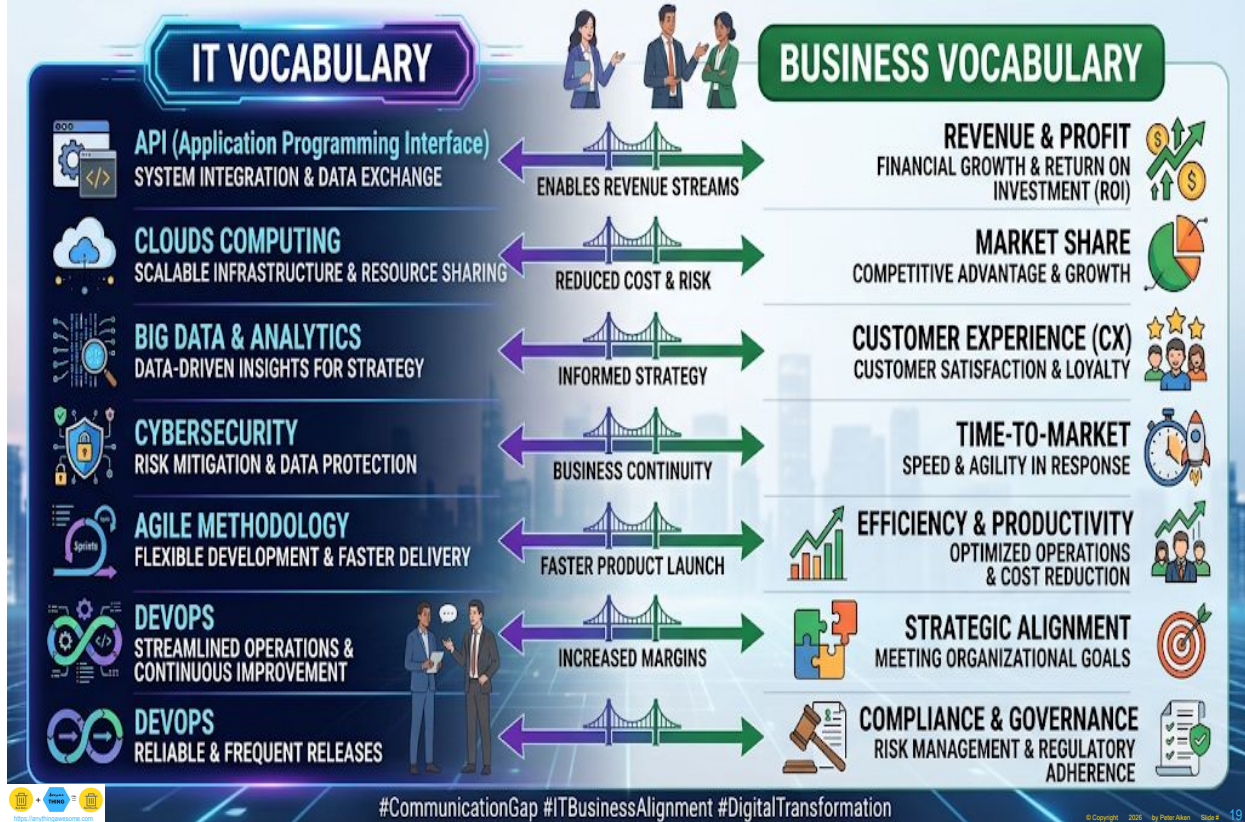
• Engines



• Seats



BRIDGING THE VOCABULARY GAP: IT VS. BUSINESS

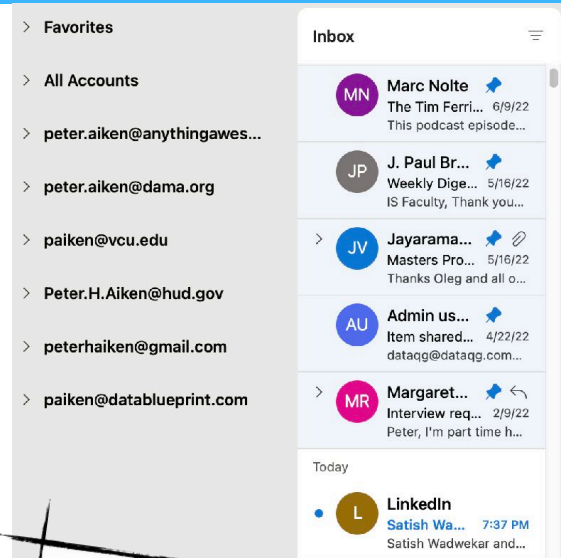


InBox Use of Metadata

Metadata is used to navigate/manage email

What: "Subject"
How: "Priority"
Where: "USERID/Inbox",
 "USERID/Personal"
Why: "Body"
When: "Sent" & "Received"

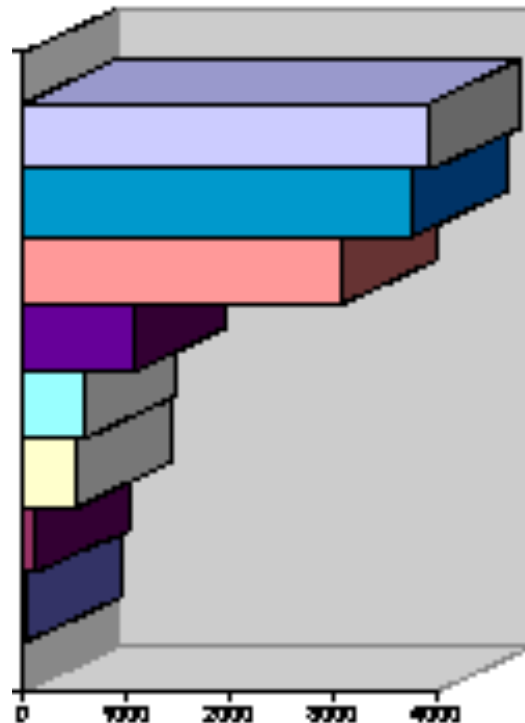
- Find the important stuff/weed out junk
- Organize for future access/
outlook rules
- Imagine how managing e-mail
(already non-trivial) would change
if Outlook did not make use of
metadata Who: "To" & "From?"



**Customers understand
metadata even if they
do not know what the
term 'metadata' means**

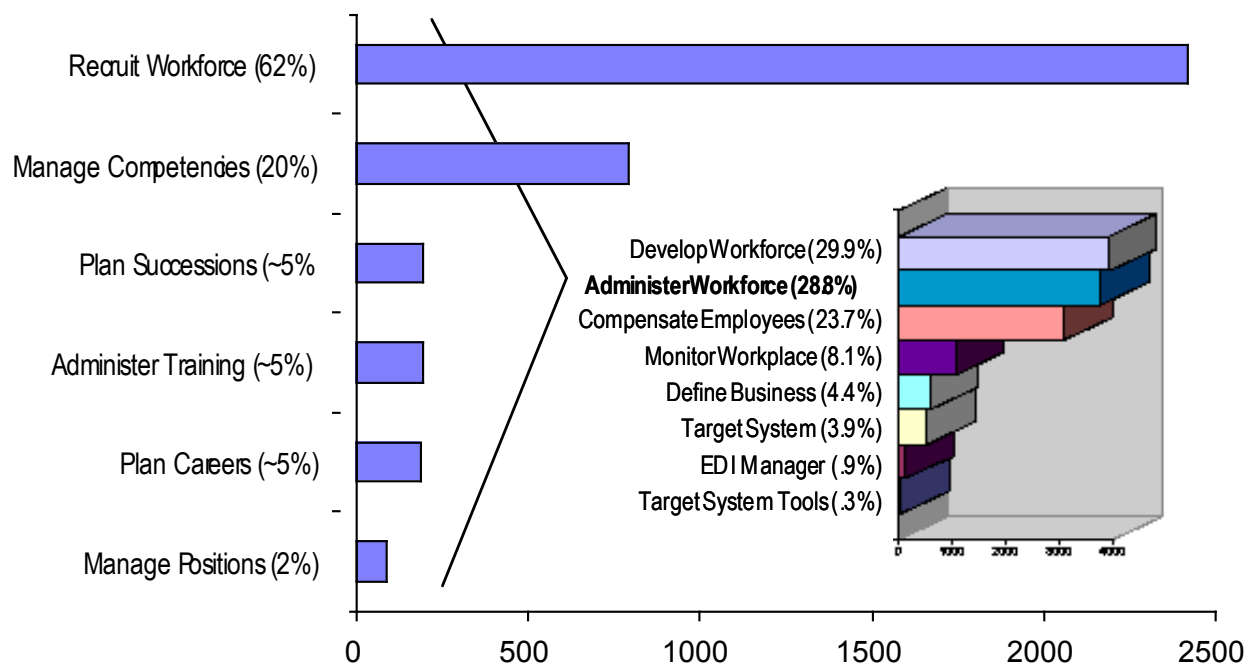
Metadata Uses

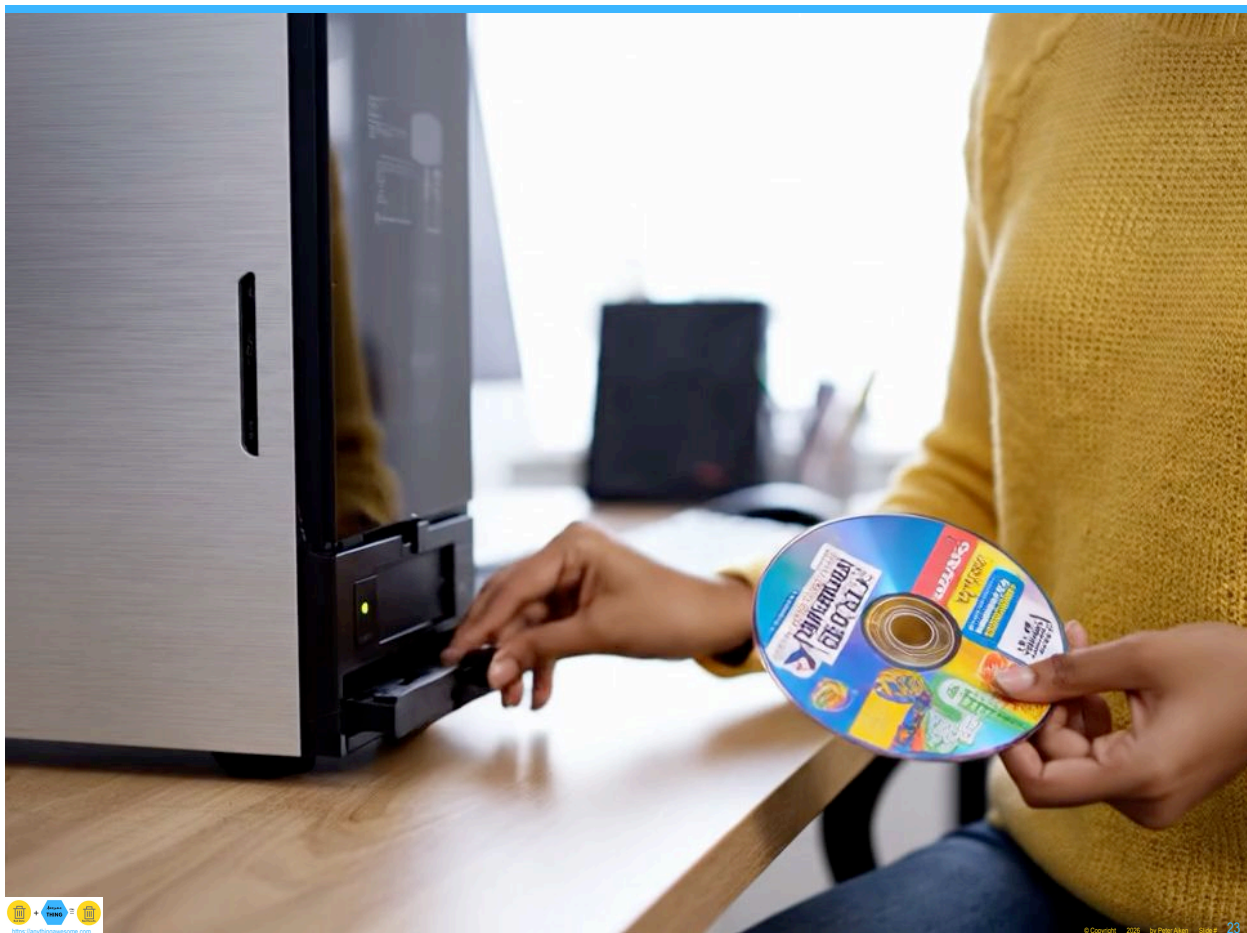
Develop Workforce (29.9%)
Administer Workforce (28.8%)
 Compensate Employees (23.7%)
 Monitor Workplace (8.1%)
 Define Business (4.4%)
 Target System (3.9%)
 EDI Manager (.9%)
 Target System Tools (.3%)



Metadata Uses

Administer Workforce



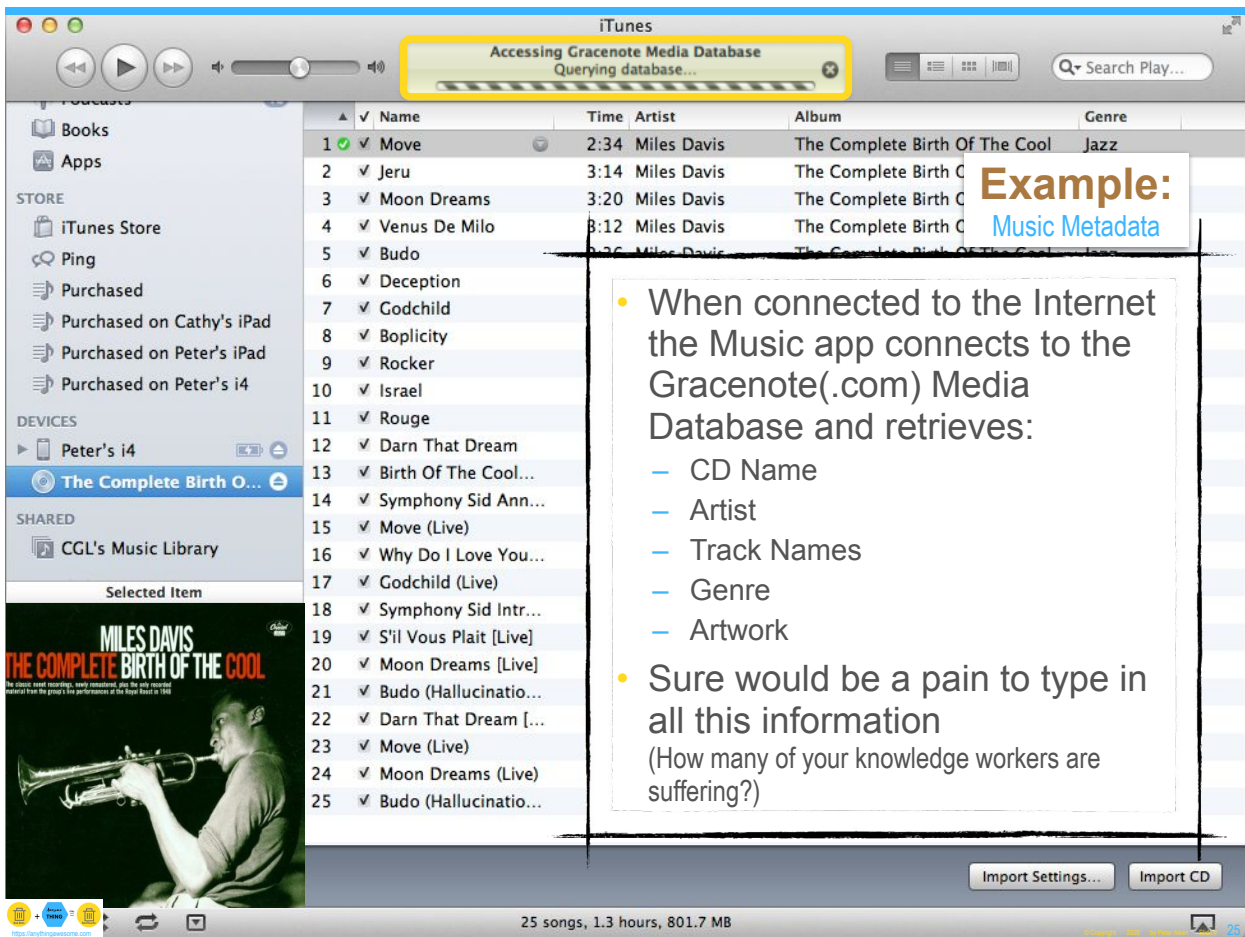


Example:
iTunes → Music™/.mp3 player app

- Example:
 - Music Metadata
- Insert a recently purchased CD
- Music can:
 - Count the number of tracks (25)
 - Determine the length of each track

	Name	Time	Artist	Album	Genre
1	Track 01	2:34			
2	Track 02	3:14			
3	Track 03	3:20			
4	Track 04	3:12			
5	Track 05	2:36			
6	Track 06	2:49			
7	Track 07	3:10			
8	Track 08	3:02			
9	Track 09	3:07			
10	Track 10	2:18			
11	Track 11				
12	Track 12				
13	Track 13				
14	Track 14				
15	Track 15				
16	Track 16				
17	Track 17				
18	Track 18				
19	Track 19				
20	Track 20				
21	Track 21				
22	Track 22	4:24			
23	Track 23	4:49			
24	Track 24	3:47			
25	Track 25	4:23			

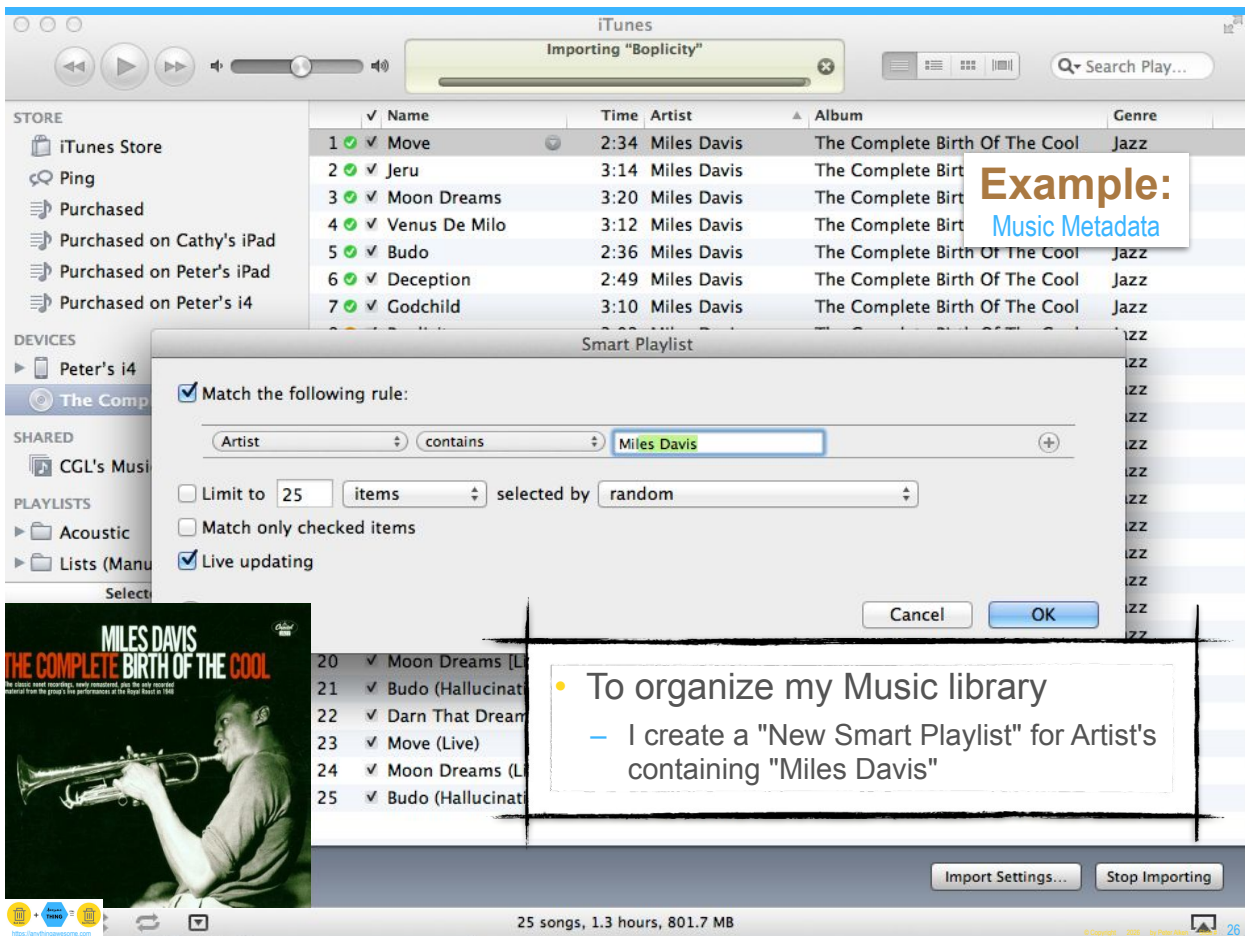
25 songs, 1.3 hours, 801.7 MB



Example: Music Metadata

- When connected to the Internet the Music app connects to the Gracenote(.com) Media Database and retrieves:
 - CD Name
 - Artist
 - Track Names
 - Genre
 - Artwork
- Sure would be a pain to type in all this information (How many of your knowledge workers are suffering?)

	Name	Time	Artist	Album	Genre
1	Move	2:34	Miles Davis	The Complete Birth Of The Cool	Jazz
2	Jeru	3:14	Miles Davis	The Complete Birth Of The Cool	Jazz
3	Moon Dreams	3:20	Miles Davis	The Complete Birth Of The Cool	Jazz
4	Venus De Milo	3:12	Miles Davis	The Complete Birth Of The Cool	Jazz
5	Budo	3:26	Miles Davis	The Complete Birth Of The Cool	Jazz
6	Deception				
7	Godchild				
8	Boplicity				
9	Rocker				
10	Israel				
11	Rouge				
12	Darn That Dream				
13	Birth Of The Cool...				
14	Symphony Sid Ann...				
15	Move (Live)				
16	Why Do I Love You...				
17	Godchild (Live)				
18	Symphony Sid Intr...				
19	S'il Vous Plait [Live]				
20	Moon Dreams [Live]				
21	Budo (Hallucinatio...				
22	Darn That Dream [...]				
23	Move (Live)				
24	Moon Dreams (Live)				
25	Budo (Hallucinatio...				



Example: Music Metadata

- To organize my Music library
 - I create a "New Smart Playlist" for Artist's containing "Miles Davis"

Smart Playlist

☒ Match the following rule:

Artist contains Miles Davis

☐ Limit to 25 items selected by random

☐ Match only checked items

☒ Live updating

	Name	Time	Artist	Album	Genre
1	Move	2:34	Miles Davis	The Complete Birth Of The Cool	Jazz
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Example: Music Metadata

- Notice I didn't get the desired results
- I already had another Miles Davis recording, "Live at the Fillmore East"
- Must fine-tune the smart playlist request to get the desired results
 - Now specify that Album must also contain "The complete birth of the cool"
- Now I can move the smart playlist "Miles Davis" to a folder
- Or not?

The screenshot shows the iTunes interface with a Smart Playlist dialog box open. The dialog box has the following settings: Match all of the following rules: Artist contains Miles Davis, Album is The Complete Birth Of The Cool. It also has options for Limit to 25 items, selected by random, Match only checked items, and Live updating. The background shows a music library with Miles Davis tracks, including "Bitches Brew" and "Directions (First Set)".

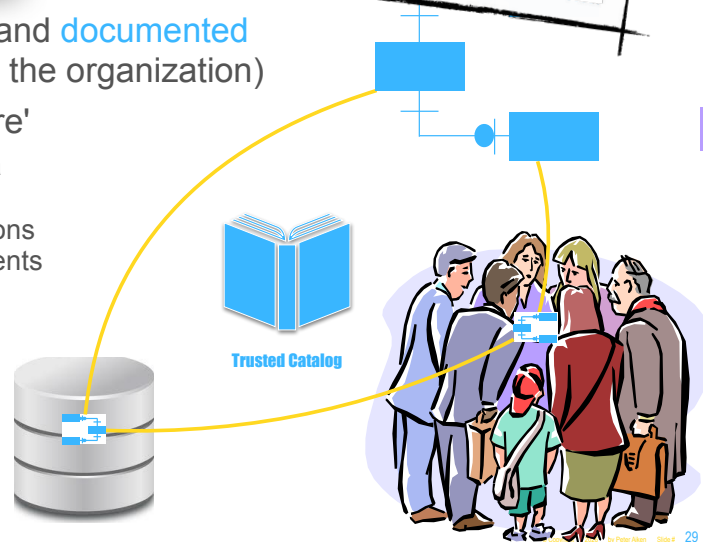
Example: Music Metadata

- Your knowledge of metadata:
 - Interface
 - Processing
 - Data Structures
- are applied to
 - Podcasts
 - Movies
 - Books
 - .pdf files
- Economies of scale are enormous

The screenshot shows the iTunes TV Shows library with a list of Covert Affairs episodes. The list includes episode numbers, names, and durations. A text box on the right explains the example, highlighting the application of metadata knowledge to various media types.

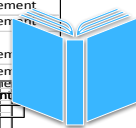
-

Common vocabulary expressing integrated requirements ensuring that data assets are stored, arranged, managed, and used in systems in support of organizational strategy



Entity	Description	Domain Area
Donor	Funder	Business Development
Solicitations	Need for Work	Business Development
Solicitations Proposal	Response to Need for Work	Business Development
Pre-Positioning	Intelligence Gathering	Business Development
Award/Sub-Award	Funding Vehicle	Business Development
Terms Conditions	Details about a Funding Vehicle	Business Development
Budget	Amount of Money Available	Business Development
Work Plan	Set of Activities to Complete	Business Development
PMP	Monitoring Plan for Activities	Business Development
An NGO Project is defined as a self-contained set of interventions or activities with the following characteristics:		
a) an external client;		
b) purchase order, contract or agreement;		
c) expected deliverables, outcomes and results;		
d) a beginning and end date of implementation;		
e) an approved budget; and		
full and/or part time NGO staff		
Project		Project Management
Geographic Area		Project Management
Office Locations	Location in which a Central Office resides	Project Management
Project Roles		Project Management
Project Artifacts		Project Management
Project Budget		Project Management
Project Work Plan		Project Management
Milestones	Schedule of completed activities	Project Management
Monitoring	Plan to measure Activities	Project Management
Evaluation	Assessment of Activities	Project Management
Indicators	Target of Outcome	Project Management
Outcomes	Statement of what needs to be accomplished	Project Management
Acct Receivable	Payments to NGO	Financial Management
Chart of Accounts	Defined Accounts	Financial Management
Payroll	Process to Pay Worker	Financial Management
Supplier	Provider of Goods or Service	Financial Management
Contract	Binding Agreement	Financial Management
Purchase Order	Statement of Good or Service	Financial Management
Performance	Level of Success	Talent Management
Benefits		Talent Management
Skills		Talent Management
Person who has been hired by NGO		Talent Management
Potential hire of NGO		Talent Management
Donor		Business Development
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Performance	Level	

- aka
 - data dictionary
 - data item dictionary
 - data directory
 - data catalog
 - data repository
 - metadata repository
 - data resource dictionary
 - data asset dictionary
 - data definition dictionary
 - data structure dictionary
 - data element dictionary
 - enterprise repository
 - term bank
- Start of Enterprise Taxonomy
- Defines Initial Entities for Conceptual Data Model
- Engages the Business Community to Validate Entities and provide meaningful, agreed upon business definitions



Falling Down

(Because of a Poor Foundation)

The Ongoing Data Explosion vs. Organizational Readiness.



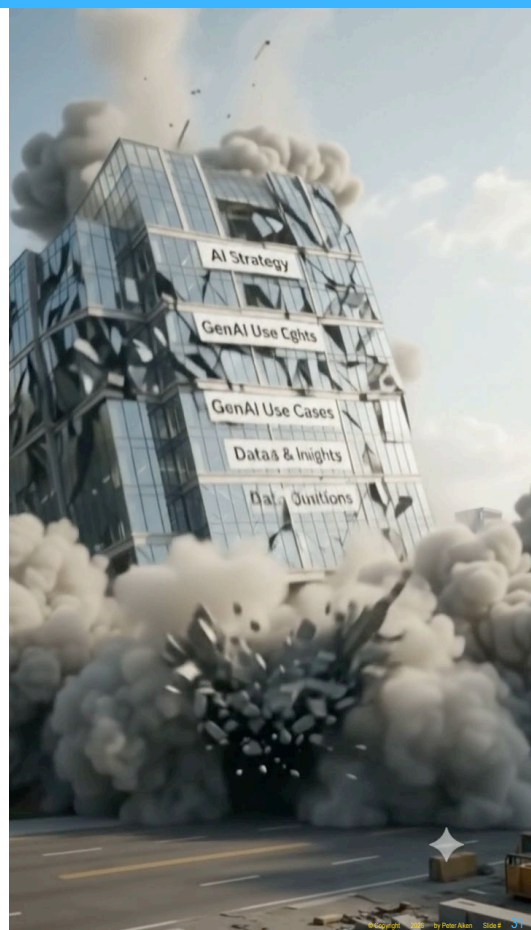
Information technology programs **rarely teach formal data management.**



IT initiatives focus 90% on the technology and ignore the **information.**



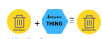
Result: Organizations lack the necessary prerequisites to properly leverage their data assets.



<https://anythingsays.com>

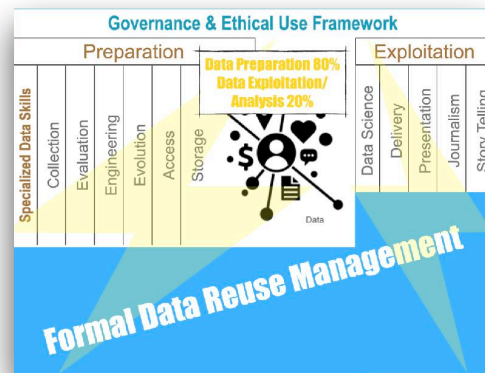
Keep the Proper Focus

- Wrong question:
 - Is this metadata?
- Right question:
 - Would we obtain value if we include it in the scope of our metadata practices?
- Value proposition
 - Is this aspect of our data worth including within the scope of our metadata practices?



<https://anythingsays.com>

Metadata Yields ...



Valuable information about your data assets:

- Do we have these specific (or this class of) data assets? **Yes!**
- What is the quality of ... **Not suitable!** **35¢/apiece**
- What will be the cost to improve this class of data assets?
- Can these data assets be provided more granularly? **Not easily!**
- ... (increasing insight)



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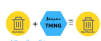
Program overview

- Imagine
 - What is metadata?
 - Why should I care?
 - Understanding leverage
- Construct (from the customer perspective)
 - Customers think in objects
 - Customers understand metadata use
 - Customers value common vocabularies

- Metadata specific requirements
 - Sustained competitive advantage
 - Relationship to other popular silver bullets
 - Formalizing additional (conceptual) layers

- Approach Requirements (In Action) Skywise
- What does this have to do with the application of AI?
- Take Aways, References and Q&A

**Metadata Powers
AI Data Discovery & Context**

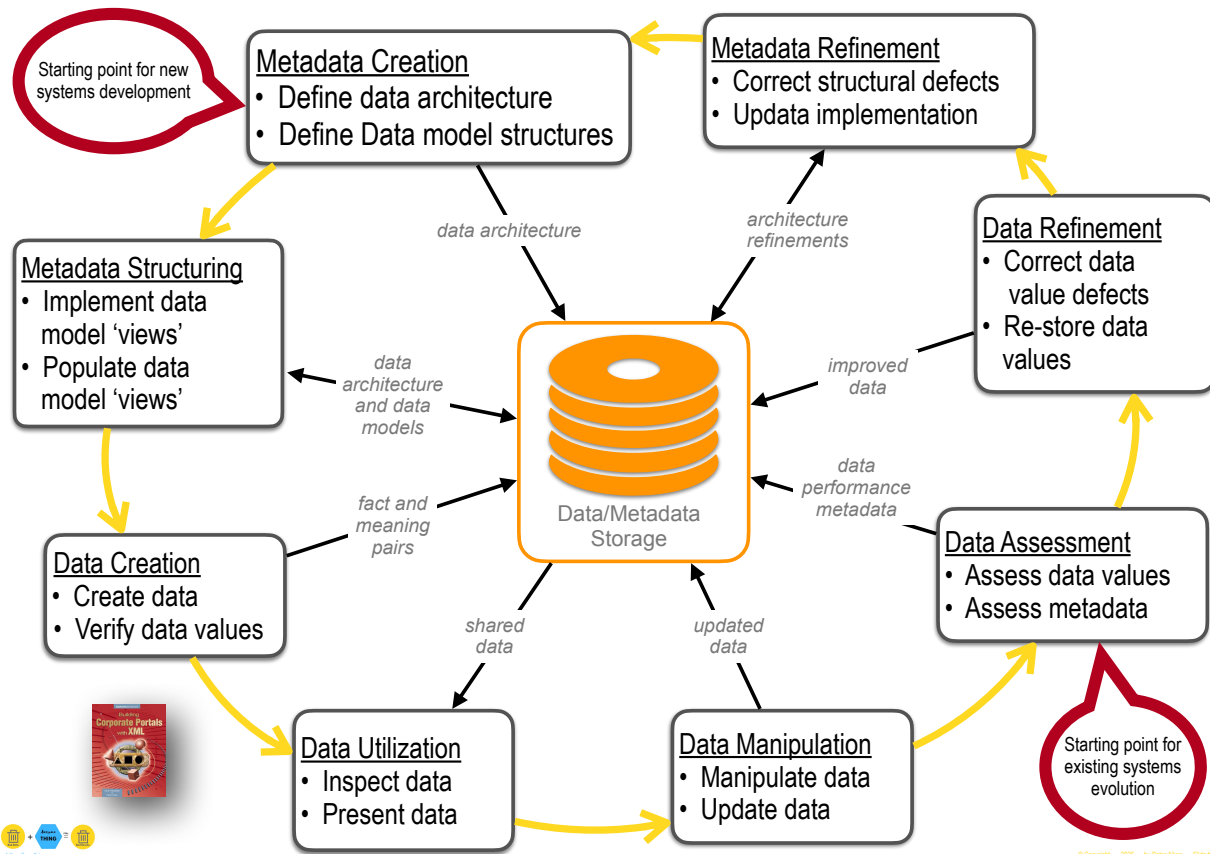


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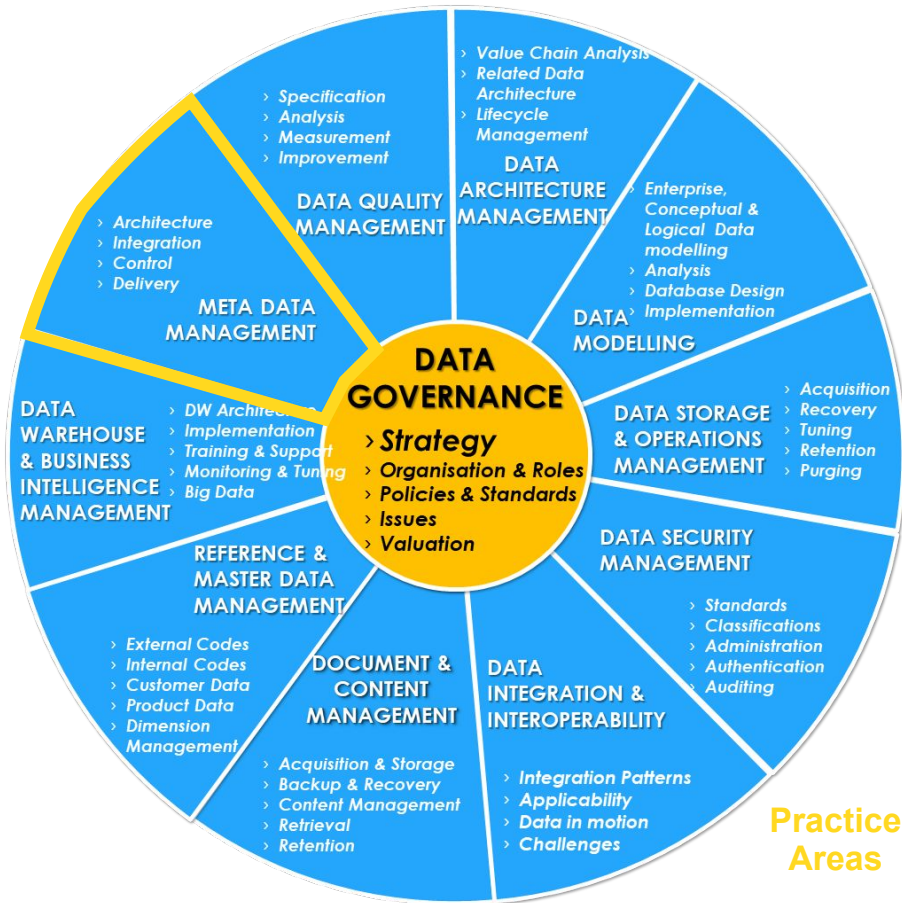
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Extended Data Life Cycle Model With Metadata Sources and Uses



Data Management Body of Knowledge (DM Bok V2)



Practice Areas



from The DAMA Guide to the Data Management Body of Knowledge 2E © 2017 by DAMA International

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Metadata Management

Metadata Management

Definition: Planning, Implementation, and control activities to enable access to high quality, integrated metadata

Goals:

1. Provide organizational understanding of business terms and usage.
2. Collect and integrate metadata from diverse sources.
3. Provide a standard way to access metadata.
4. Ensure metadata quality and security.

Business Drivers

Inputs:

- Business Requirements
- Metadata Issues
- Data Architecture
- Business Metadata
- Technical Metadata
- Process Metadata
- Operational Metadata
- Data Governance Metadata

Suppliers:

- Business Data Stewards
- Data Managers
- Data Governance Bodies
- Data Modelers
- Database Administrators

Activities:

1. Define Metadata Strategy (P)
2. Understand Metadata Requirements (P)
 1. Business User Requirements
 2. Technical User Requirements
3. Define Metadata Architecture (P)
 1. Create MetaModel (D)
 2. Apply Metadata Standards (C)
 3. Manage Metadata Stores (C)
4. Create and Maintain Metadata (O)
 1. Integrate Metadata (O)
 2. Distribute and Deliver Metadata (O)
5. Query, Report and Analyze Metadata

Participants:

- Data Stewards
- Project Managers
- Data Architects
- Business Analysts
- System Analysts

Deliverables:

- Metadata Strategy
- Metadata Standards
- Metadata Architecture
- MetaModel
- Unified Metadata
- Metadata Stores
- Data Lineage
- Impact Analysis
- Dependency Analysis
- Metadata Control Process

Consumers:

- Application Developers
- Analyst
- Data Integrators
- Business Users
- Knowledge Workers
- Customers & Collaborators
- Data Scientists
- Data Journalists

Technical Drivers

Techniques:

- Data Lineage and Impact Analysis
- Metadata for Big Data Ingest

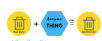
Tools:

- Metadata Repository Management Tools
- Metadata Repositories in other Tools

Metrics:

- Metadata Coverage Scorecard
- Metadata Repository Contribution
- Metadata Usage Reports
- Metadata Quality Scorecard

(P) Planning, (C) Control, (D) Development, (O) Operations



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W-28137 - SECURITY - YOU MAY NOT UPDATE ON THIS SCREEN

187 Class List

SYSTEMS ANALYSIS AND DESIGN

HUBONA 6

Screen: _____ SID: _____ Course: INF0361902 Term: 993 Fall 1999

Page 1 of 3

Line	Student Name	Student ID	Col	Cls	Maj	Registration Status
1	AKHTAR, HASINA		BUS	JR	ISY	Enrolled
2	BATDORF, MARK A.		BUS	JR	BFO	Enrolled
3	BOWKER, ASHLEY		BUS	UC	ISY	Enrolled
4	BRINKLEY, STEPHEN C		BUS	UC	ACC	Enrolled
5	DANIELSEN, ANTHONY		BUS	UC	ISY	Enrolled
6	DAUGHTRY, DAVID L		BUS	UC	ISY	Enrolled
7	DAWSON, STEFANI P		BUS	SR	FIN	Enrolled
8	DEBERRY, CHERYL M		BUS	UC	ISY	Enrolled
9	DIDDEN, CHRISTOPHER		BUS	UC	ISY	Enrolled
10	DIGGS, SAMUEL		DVO	US	DHU	Enrolled
11	DIXON, BRIAN		BUS	UC	ISY	Enrolled
12	GRANT, JAMES T		BUS	SR	ISY	Enrolled
13	HAAS, MICAH P		CHS	SR	MAS	Enrolled
14	HAMILTON, GARY M		BUS	UC	ISY	Enrolled
15	HOLICKY, JOSEPH J, III		BUS	UC	ISY	Enrolled



Sun 05 Sep 11:13



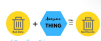
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Parent

Student
Data
Base
Master

1. Hierarchical Databases
 2. Network Databases
- (Both types are 10x faster than relational databases)

Children



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Build Your Own Metadata Repository

Microsoft Access - [Table_Column : Form]

File Edit View Insert Format Records Tools Window Help

METADATA REPOSITORY

Logical Construction

Select... table of interest from the alphabetized drop-down list. Double-click column name selection for column metadata.

Tables

FT_T_ACCT

Entity to display name and description of associated table.

Domains to display names of entities and attributes for domains of interest.

Return to FIT Metadata Repository selections.

Column Name

Column Name	Key Function
ACCT_ID	Primary
BK_ID	Primary
ORG_ID	Primary
BK_ID	Foreign
ORG_ID	Foreign
PLNE_ORG_ID	Foreign
PLNE_PRODLN_ID	Foreign
INSTR_ID	Foreign
ACTP_ACCT_TYP	Foreign
ACTP_ORG_ID	Foreign
LAST_CHG_USR_ID	
LEV_SRVC_MNEM	
ACCT_RST_IND_TYP	
MGRN_DLNCY_IND	
DPSTRY_AFRM_TYP	
THPTY_AFRM_INST_ID	
NAME_SORT_KEY_TXT	
ACCT_NME	
ACCT_DESC	
ACCT_CLS_DTE	
ACCT_CLS_REAS_TYP	
ACCT_OPEN_DTE	

Sample Low-Tech Repository

Logical Construction

Double-click column name selection for column metadata.

Tables

FT_T_ABDF

Entity to display name and description of associated table.

Column_Details

COLUMN_NAME	ACTG_BAS_ID
DATA_TYPE	CHAR
DATA_LENGTH	4
DATA_PRECISION	
CHAR_COL	4
DECL_LENGTH	
USE AVG_COL_LEN	NO
DATA_SCALE	
GLO	NO
YN	N
NUM_DISTINCT	
LOW_VALUE	CHAR_CS
COLUMN_ID	1
DEFAULT_LENGTH	

Primary Key Table Foreign Key Table Table Usage

Column Name

Column Name	Key Function
ACTG_BAS_ID	Primary
INC_OWNER_BAS_TYP	
IV_OWNER_BAS_TYP	
LAST_CHG_USR_ID	
ACCRL_BAS_TYP	
CTL_ACCT_OF_IND	
DBL_ENTRY_ACTG_IND	
MULTI_IND	
PRIN_INC_OWN_IND	
MULT_ACCT_POST_TYP	
MAINT_CRVLCOVL_IND	
ACTG_BAS_DESC	
AC	

Primary_Key_Table

Column Name ACTG_BAS_ID

FTI data tables using this column as primary key...

Primary Key Table

Primary Key Table
FT_T_ABDF
FT_T_TEDF
FT_T_VCBP

Foreign_Key_Table

Column Name ACTG_BAS_ID

FTI data tables using this column as key...

Foreign Key Table

Foreign Key Table
FT_T_IAIA
FT_T_ITER
FT_T_JECL
FT_T_TEDF
FT_T_TERS
FT_T_VCBP

FTI Metadata Model

The diagram illustrates the FTI Metadata Model, a complex database schema for managing metadata. It consists of several tables and their relationships:

- Attributes_name**: A table with columns `Attribute_Name` (VARCHAR(50)) and `Attribute_Name` (VARCHAR(50)).
- Attributes_domain**: A table with columns `FK2,FK3` (FK1), `Domain` (Entity Name, Attribute Name, Format, Length, Precision), and `VARCHAR(255)`.
- Attributes**: A table with columns `Attribute_Name` (VARCHAR(50)), `Entity_Name` (VARCHAR(50)), `Domain_Name` (VARCHAR(50)), and `Description` (LONGCHAR).
- Entity_Desc**: A table with columns `FK1,I2` (I1), `Entity_Name` (Short_Name, Plural_Name, Description, Description_Add1, Description_Add2, Description_Add3, Description_Add4), and `VARCHAR(255)`.
- Entry_Names**: A table with columns `PK` (Entity Name) and `VARCHAR(50)`.
- Physical_short**: A table with columns `FK2,I2` (FK1,I1), `Logical Entity Name` (Physical Table Name, Short_Name), and `VARCHAR(255)`.
- Columns_by_Table**: A table with columns `PK,FK2,I3,I4` (Table Name, Column Name), and `VARCHAR(255)`.
- Table_Name**: A table with columns `PK,I1` (Table Name) and `VARCHAR(255)`.
- Column_Key**: A table with columns `FK1,I3` (Table Name, Column Name, Key_Function), and `VARCHAR(50)`.
- Column_Details**: A table with columns `FK1` (FK1,I1), `TABLE_NAME` (COLUMN_NAME, DATA_TYPE, DAT DATA, TYPE, OWNER, DATA_PRECISION, DATA_SCALE, N, COLUMN_ID, DEFAULT_LENGTH, DATA_DEFAULT, NUM DISTINCT LOW, VALUE, CHAR_COL_DECL_LENGTH, GLO, USE AVG_COL_LEN), and `VARCHAR(255)`.
- CoreTableMetadata**: A table with columns `FK2,I2` (Table, Column, Requirement, Format), and `VARCHAR(255)`.
- CoreColumnNames**: A table with columns `PK` (Column), and `VARCHAR(200)`.
- CoreTableNames**: A table with columns `I1` (Table), and `VARCHAR(255)`.
- Key_Relationships**: A table with columns `PK` (Foreign Key Table, Primary Key Table, Column Name), and `VARCHAR(255)`.
- Column_Name**: A table with columns `PK` (Column Name) and `VARCHAR(50)`.
- Foreign_Key_Table**: A table with columns `PK` (Foreign Key Table, Column Name), and `VARCHAR(50)`.
- Primary_Key_Table**: A table with columns `PK` (Primary Key Table, Column Name), and `VARCHAR(50)`.

The relationships between these tables are indicated by lines with crow's foot notation, showing various cardinalities and foreign key constraints.



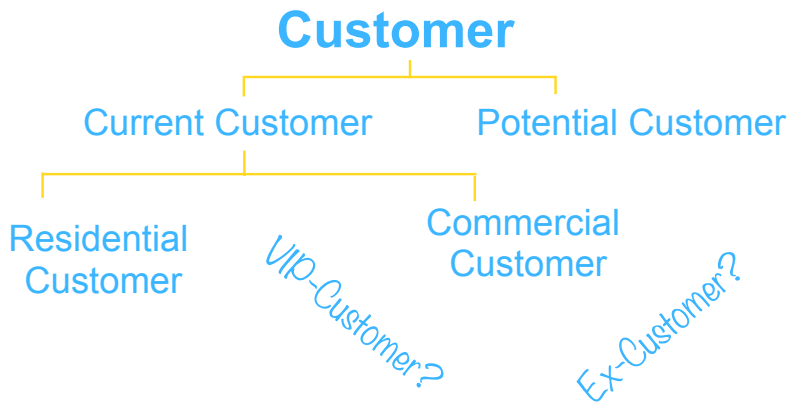
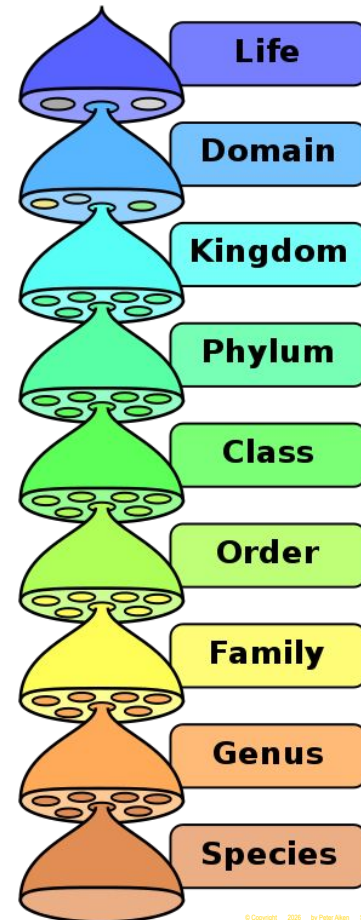
Case Study

Reverse-engineering a commercial client-server system from PeopleSoft yielded a valuable resource and proved to be cost-effective. The authors describe the motivations for, approach to, and results of this project, commissioned by the Commonwealth of Virginia's government.

Reverse-Engineering New Systems for Smooth Implementation

Taxonomy (Noun)

1. the science or technique of classification.
 - a classification into ordered categories:
2. a proposed taxonomy of educational objectives
3. Biology. the science dealing with the description, identification, naming, and classification of organisms.

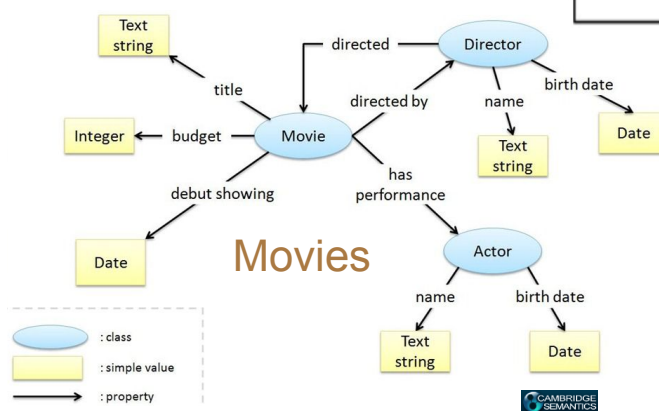
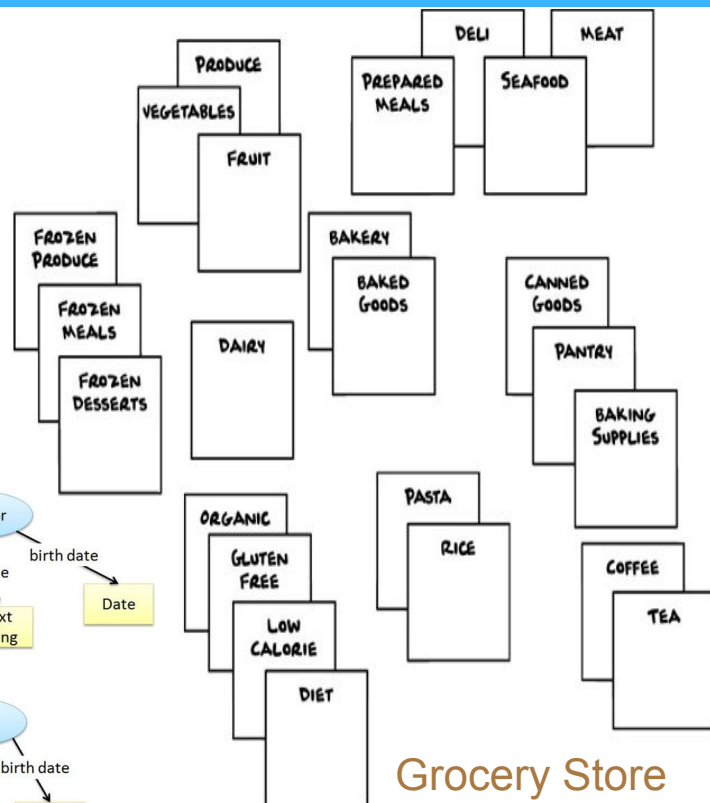


https://en.wikipedia.org/wiki/Taxonomic_rank & <https://www.dictionary.com/browse/taxonomy>

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Ontology Map

- Always exist
- but the one you have today
- may be messy
- or nonsensical

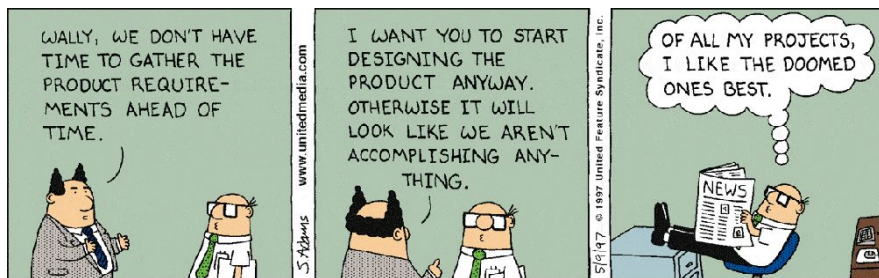


Example from: *How to make sense of any mess* by Abby Covert (2014) ISBN: 1500615994

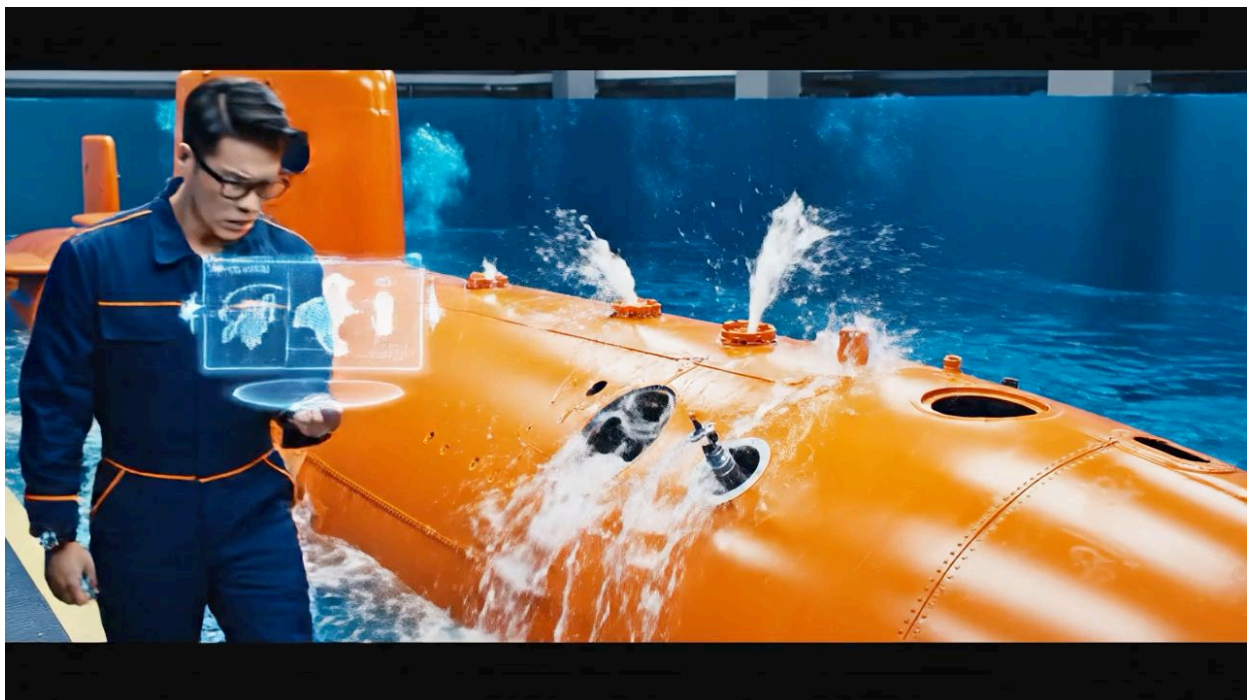
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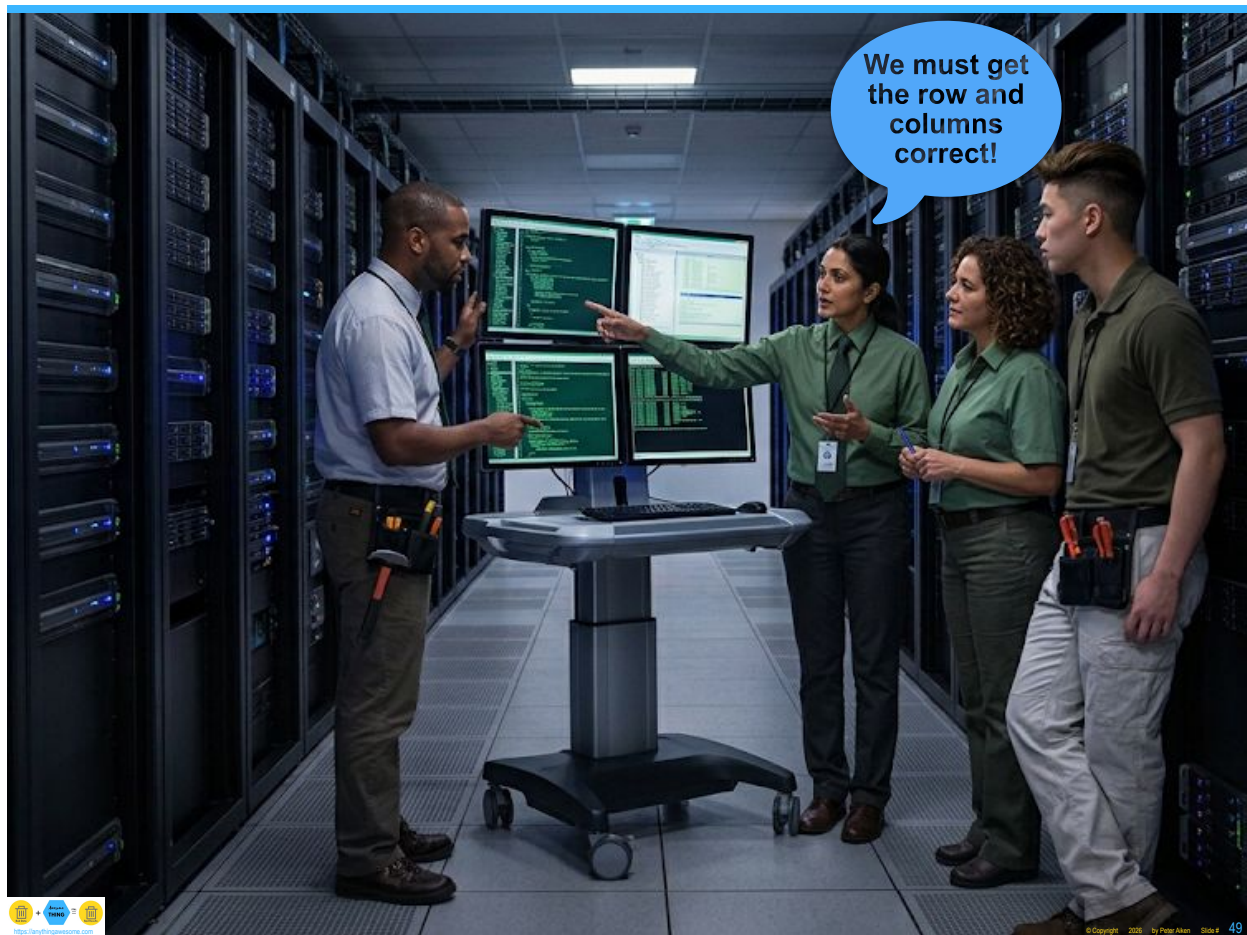
Someone must directly go to the customer site, explore together, and use it while making changes

- Forward Deployed Engineering (FDE) originated as a proprietary operational strategy

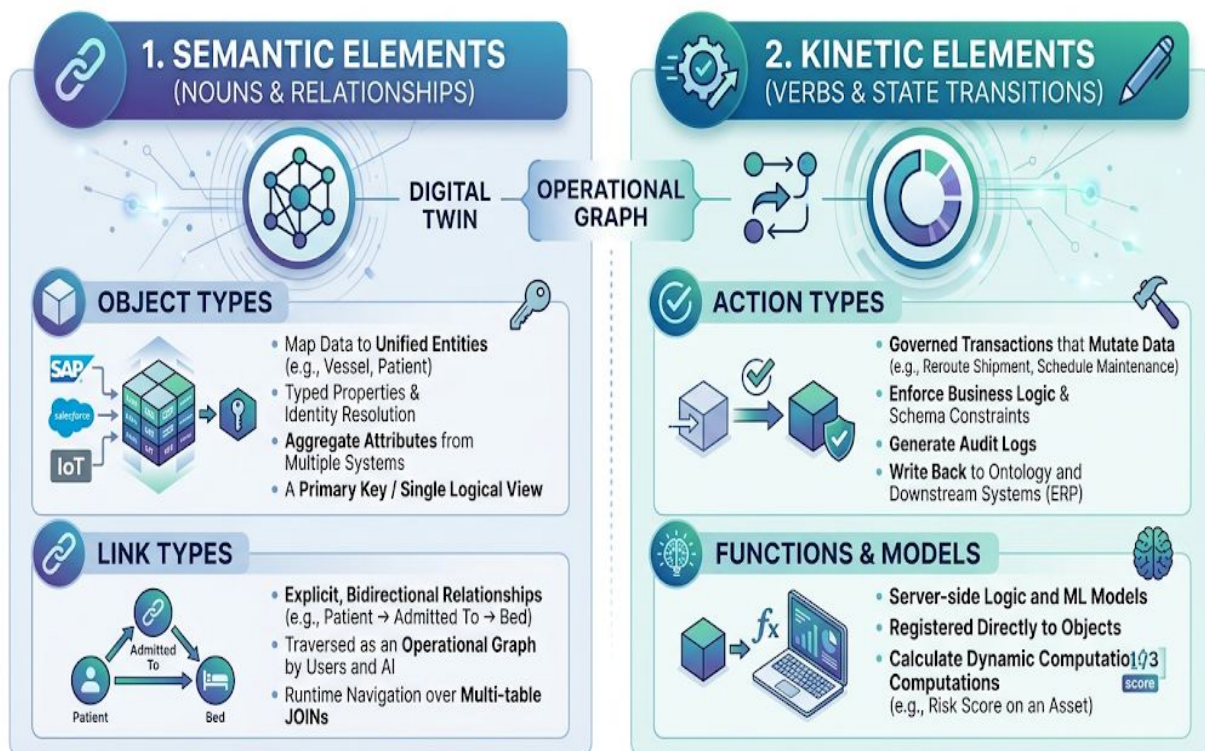


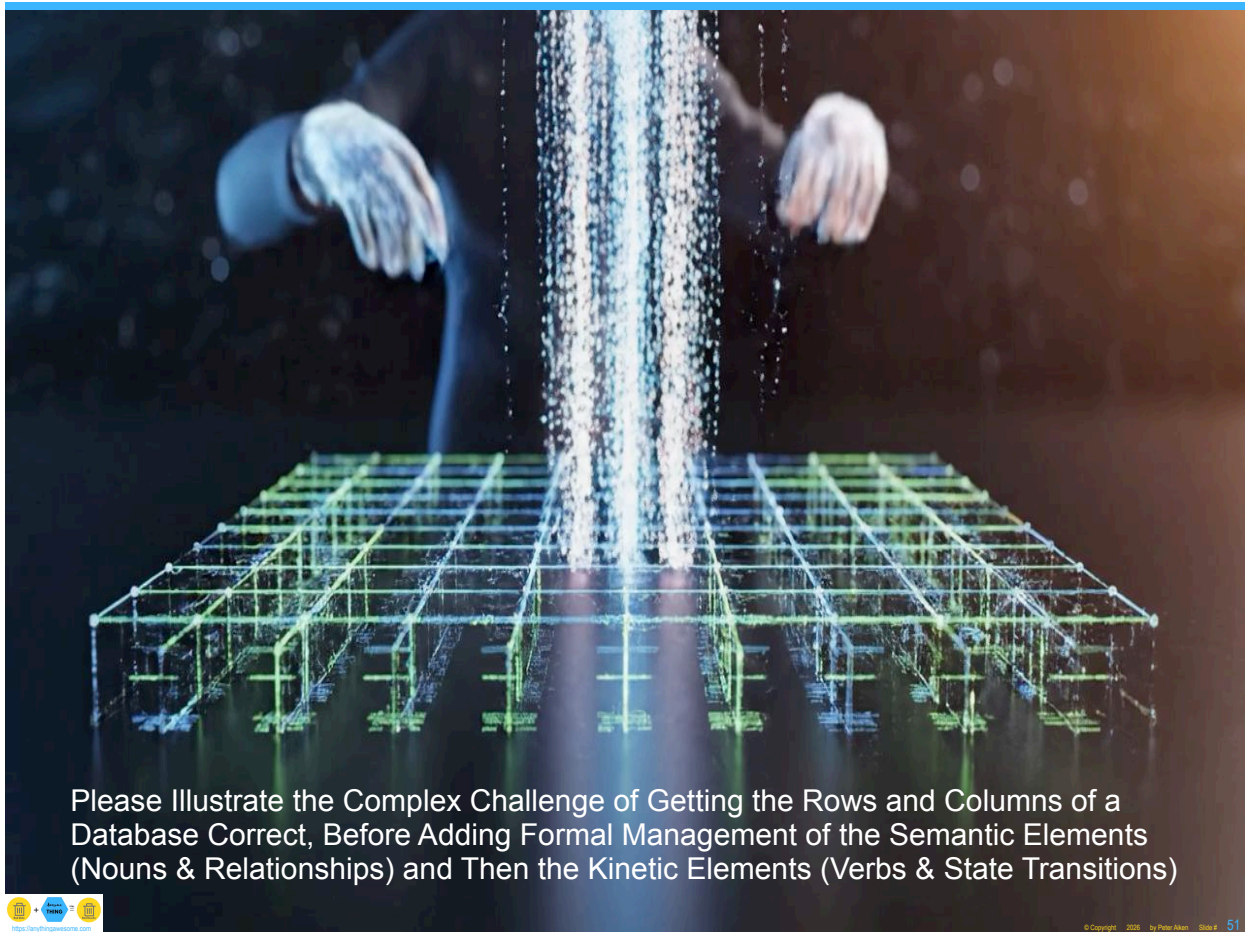
Please Illustrate a Designer Designing a Leaky Submarine - Then the Leaks Stop Once the Designer Has To Go Down in the Submarine To Test the Design





Two Complementary Core Ontology Primitives

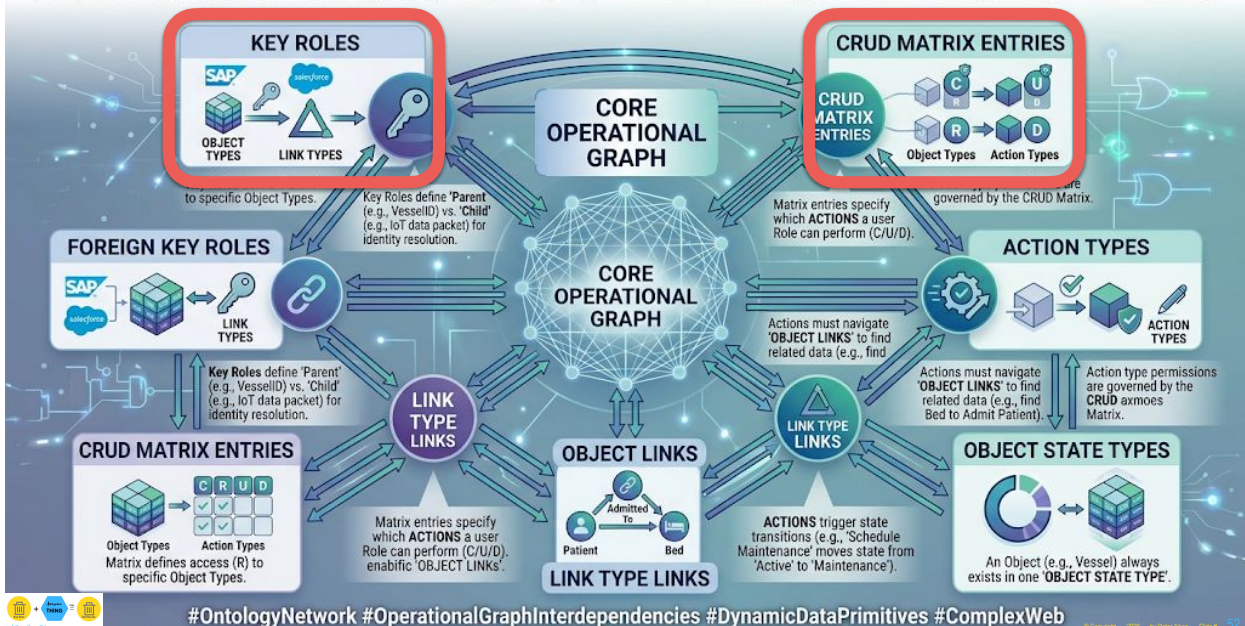




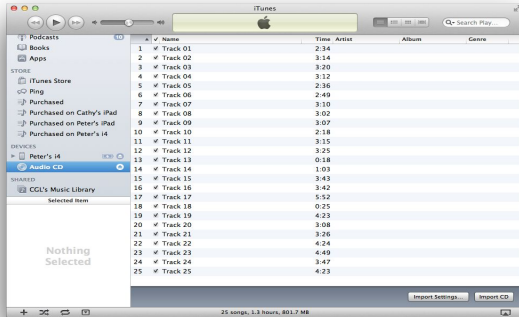
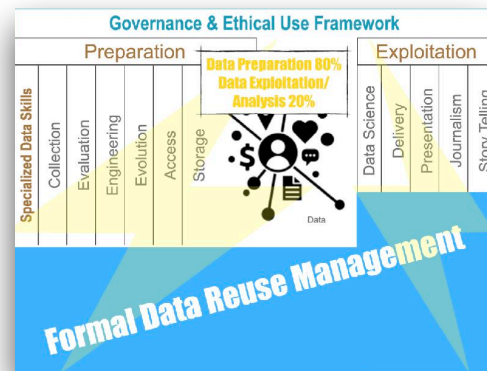
Data Item Connectivity

- Data item specific attributes
- Key roles
- Foreign key roles
- CRUD matrix entries
- Object links
- Link type links
- Action types
- Object state types

A COMPLEX WEB OF INTERRELATIONSHIPS BETWEEN ONTOLOGY PRIMITIVES AND ATTRIBUTES



Metadata Yields ...



Valuable information about your Music™ assets:

- Do we have these specific Miles Davis recordings?

Yes!

- Most my played Miles Davis recording

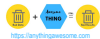
Bitches Brew

- What will be the cost to acquire more of this class of data assets?

\$1.29/each

- Can I listen to the entire album before dinner?

Not easily!



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Program Overview

- Imagine
 - What is metadata?
 - Why should I care?
 - Understanding leverage
- Construct (from the customer perspective)
 - Customers think in objects
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 - Sustained competitive advantage
 - Relationship to other popular silver bullets
 - Formalizing additional (conceptual) layers

- Approach Requirements (In Action) Skywise

- What does this have to do with the application of AI?

- Take Aways, References and Q&A

**Metadata Powers
AI Data Discovery & Context**



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Imagine

- “Interoperable digital solutions for end-to-end operations”
 - What organization would not value that goal?
- “the only provider delivering a truly unified digital offer”
 - Deliberate use of the word “truly”
- Offer extends beyond the brand
 - On ramp for former competitors
- Solutions
 - Planning & Operations Control
 - Business Operations
 - Technical Operations
- Combined Expertise
 - Delta
 - GE Aerospace
 - Liebherr
 - Collins



IMAGINE



<https://aiinstitute.hbs.edu/platform-digit/submission/skywise-bringing-data-analysis-to-the-airline-industry/>

Skywise

**DIGITAL INNOVATION AND TRANSFORMATION**
MBA STUDENT PERSPECTIVES

COURSE ASSIGNMENTS

Assignment: Competing with Data

Skywise: Bringing Data Analysis to the Airline Industry

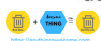
By Crimson Ranger

Alumni

POSTED NOV 13, 2019

Airbus launched its Skywise system to allow its airline customers to collect and better analyze their aircraft data with the goal of improving operations and reducing costs.

The global airline industry is constantly looking for ways to manage controllable costs (maintenance, fleet optimization, aircraft performance) as it responds to cost trends outside of its control (fuel prices, taxes, global growth trends, macroeconomic shocks). Against this backdrop, aircraft manufacturers seek to differentiate themselves by offering superior after sale services to further reduce the operating costs of their aircraft. In June 2017, Airbus launched its open aviation data platform, Skywise, “to support the digital transformation of the industry and add value for our customers’ operations”^[1].



Kinetic Primitives of Skywise

Objects



The digital twins of physical assets. Every engine part is a distinct, governed object in Skywise.

Links



The relationships between objects. Connecting sensor telemetry directly to specific tail numbers.

Actions



*Governed **Write-Backs** that allow shop-floor engineers to trigger procurement directly from analytics.*

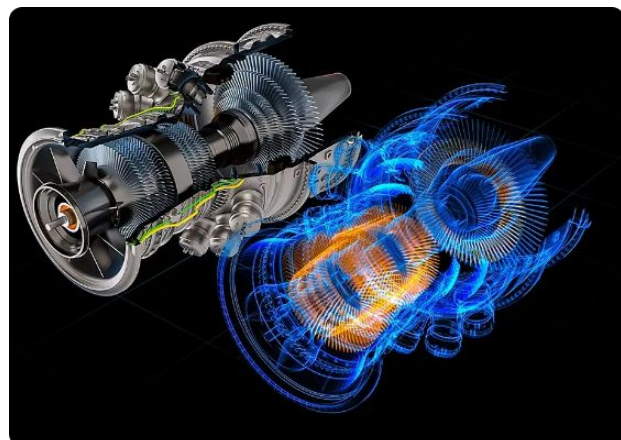
The Ontology: Mapping Reality

- Extensions beyond rows and columns
- Foundry maps relational data into a Digital Twin. Instead of querying tables, data professionals interact with high-level Objects:

✈ **Aircraft:** Aggregates flight history, sensor feeds, and age.

⚙ **Components:** Links parts to maintenance cycles and serials.

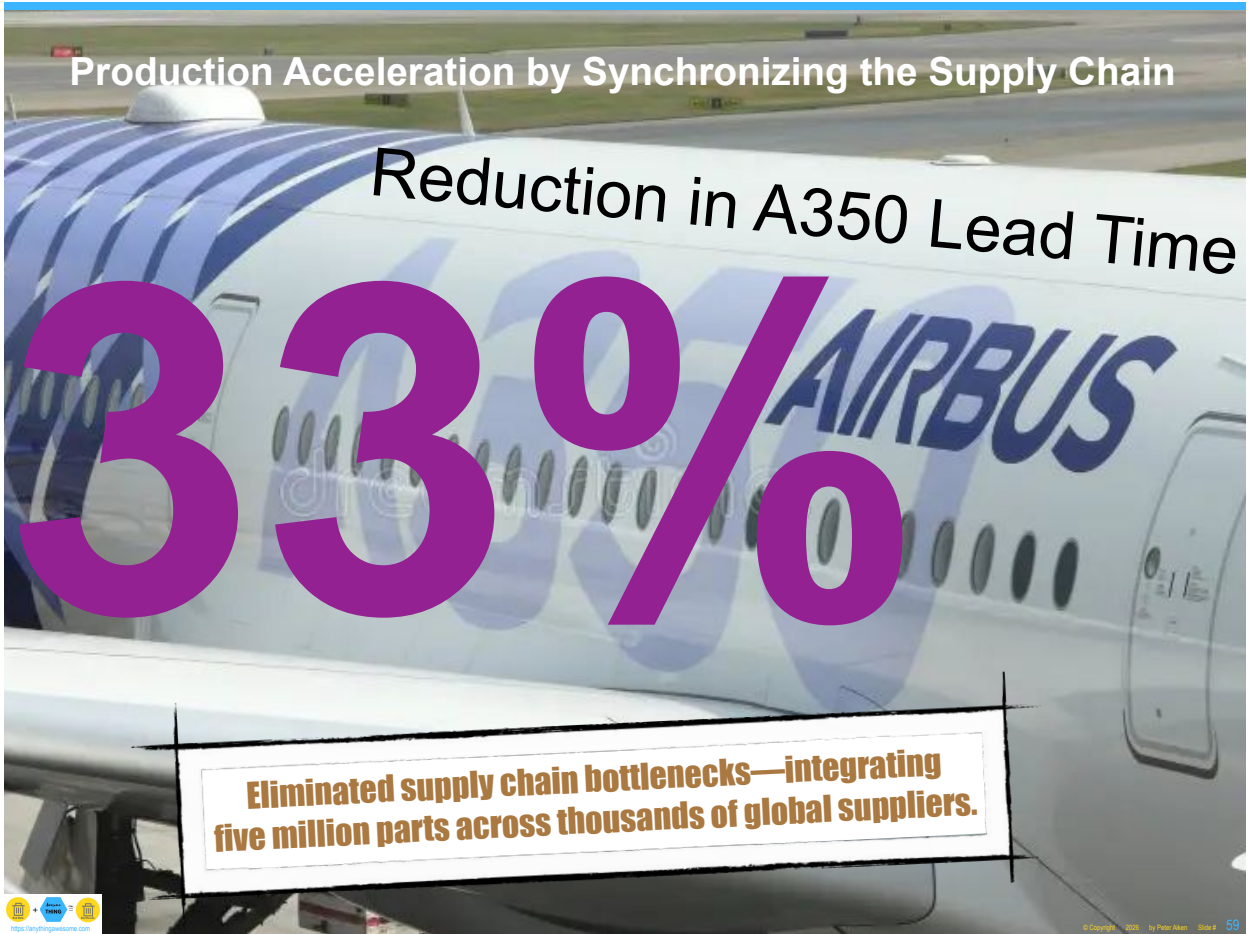
🔧 **Maintenance:** Connects labor availability to parts inventory.



Production Acceleration by Synchronizing the Supply Chain

Reduction in A350 Lead Time

33%

A close-up view of the side of a white Airbus A350 aircraft, showing the fuselage and windows. The word "AIRBUS" is visible in blue lettering on the side.

Eliminated supply chain bottlenecks—integrating five million parts across thousands of global suppliers.

Operational ROI: Predictive Maintenance



By the Numbers

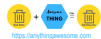
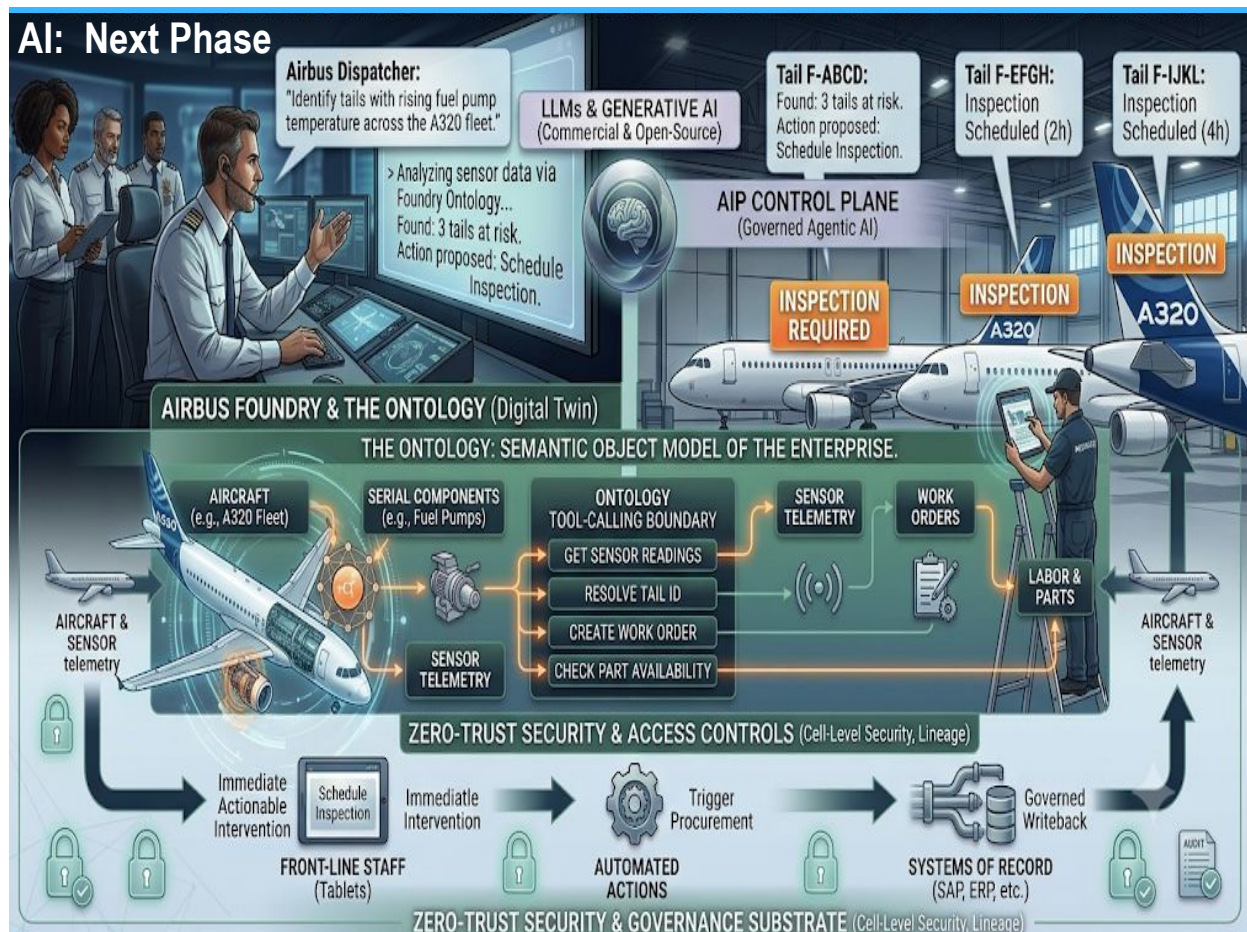
<u>Capability</u>	<u>Status / Metric</u>	<u>Impact</u>
Fleet Connectivity	12,300+ Aircraft	Total global visibility.
Daily Data Ingest	~1 Terabyte / A350	Petabyte-scale time series management.
Data Throughput	Petabyte Scale	Industrial-grade processing.
Global Users	55,000+ Personnel	Democratized data access.
Partner Airlines	150+ Companies	Global industry standard.
Certified App Partners	20+	Extensible API-first ecosystem.

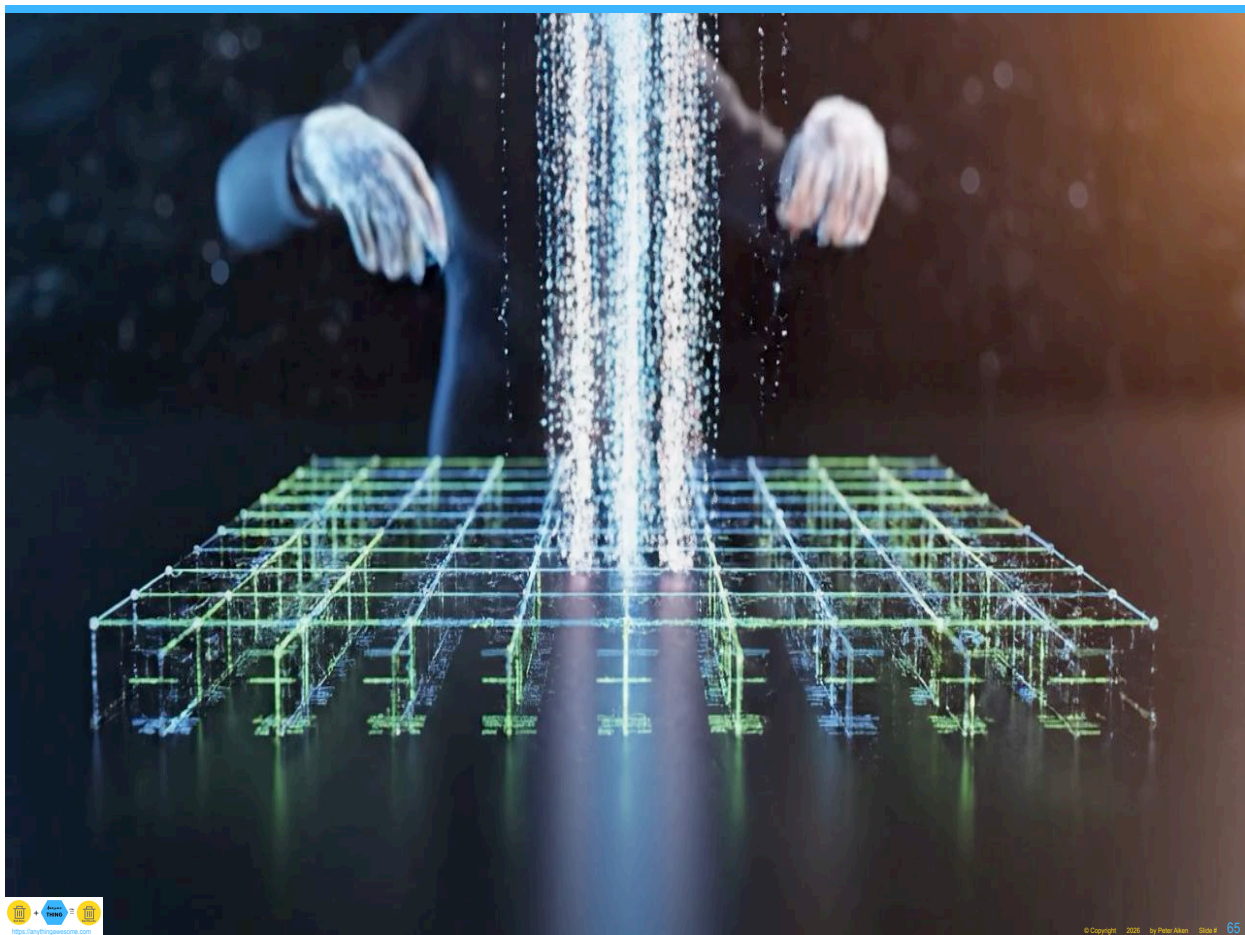


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Metadata Powers AI Data Discovery & Context

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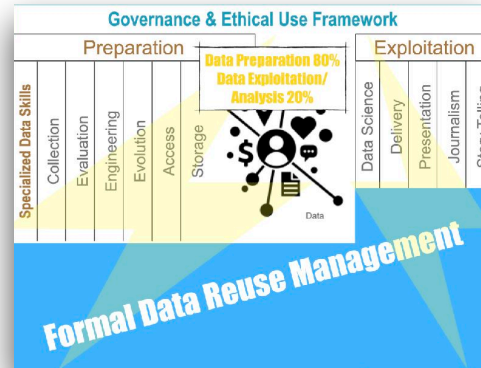
**Metadata Powers
AI Data Discovery & Context**





Metadata Program Take Aways

- 'Data about **your** data'
- Metadata is not a type of data
- Metadata unlocks the value of data, and therefore requires management attention [Gartner]
- Metadata is less about what and more about how
- Metadata must be the language of data governance in order to keep it focused
- Metadata definitions the essence of correctly specifying most organizational challenges
- Should we include this data item within the scope of our metadata practices?



Metadata Management Is Table Steaks To Play With AI



General Limitation



[Bad **Metadata**]+ Anything Awesome [will always yield] Bad Results



Goodness In → Goodness Out

References & Recommended Reading

11.4.1 General Reading

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Collier, Ken. Executive Report, Business Intelligence Advisory Service, *Finding the Value in Metadata Management* (Vol. 4, No. 1), 2004. Available only to Cutter Consortium Clients, <http://www.cutter.com/bia/fulltext/reports/2004/01/index.html>.

Hay, David C. Data Model Patterns: A Metadata Map. Morgan Kaufmann, 2006. ISBN 0-120-88798-3. 432 pages.

Hillmann, Diane I. and Elaine L. Westbrook, editors. Metadata in Practice. American Library Association, 2004. ISBN 0-838-90882-9. 285 pages.

Inmon, William H., Bonnie O'Neil and Lowell Fryman. Business Metadata: Capturing Enterprise Knowledge. 2008. Morgan Kaufmann ISBN 978-0-12-373726-7. 314 pages.

Marco, David, Building and Managing the Meta Data Repository: A Full Life-Cycle Guide. John Wiley & Sons, 2000. ISBN 0-471-35523-2. 416 pages.

Marco, David and Michael Jennings. Universal Meta Data Models. John Wiley & Sons, 2004. ISBN 0-471-08177-9. 478 pages.

Poole, John, Dan Change, Douglas Tolbert and David Mellor. Common Warehouse Metamodel: An Introduction to the Standard for Data Warehouse Integration. John Wiley & Sons, 2001. ISBN 0-471-20052-2. 208 pages.



from *The DAMA Guide to the Data Management Body of Knowledge* © 2009 by DAMA International71

References, Cont'd

Poole, John, Dan Change, Douglas Tolbert and David Mellor. Common Warehouse Metamodel Developer's Guide. John Wiley & Sons, 2003. ISBN 0-471-20243-6. 704 pages.

Ross, Ronald. Data Dictionaries And Data Administration: Concepts and Practices for Data Resource Management. New York: AMACOM Books, 1981. ISN 0-814-45596-4. 454 pages.

Tannenbaum, Adrienne. Implementing a Corporate Repository. John Wiley & Sons, 1994. ISBN 0-471-58537-8. 441 pages.

Tannenbaum, Adrienne. Metadata Solutions: Using Metamodels, Repositories, XML, And Enterprise Portals to Generate Information on Demand. Addison Wesley, 2001. ISBN 0-201-71976-2. 528 pages.

Wertz, Charles J. The Data Dictionary: Concepts and Uses, 2nd edition. John Wiley & Sons, 1993. ISBN 0-471-60308-2. 390 pages.



from *The DAMA Guide to the Data Management Body of Knowledge* © 2009 by DAMA International72

References, Cont'd

11.4.2 Meta-data in Library Science

Baca, Murtha, editor. Introduction to Metadata: Pathways to Digital Information. Getty Information Institute, 2000. ISBN 0-892-36533-1. 48 pages.

Hillmann, Diane I., and Elaine L. Westbrooks. Metadata in Practice. American Library Association, 2004. ISBN 0-838-90882-9. 285 pages.

Karpuk, Deborah. METADATA: From Resource Discovery to Knowledge Management. Libraries Unlimited, 2007. ISBN 1-591-58070-6. 275 pages.

Liu, Jia. Metadata and Its Applications in the Digital Library. Libraries Unlimited, 2007. ISBN 1-291-58306-6. 250 pages.

11.4.3 Geospatial Meta-data Standards

<http://www.fgdc.gov/metadata/geospatial-metadata-standards>.



from *The DAMA Guide to the Data Management Body of Knowledge* © 2009 by DAMA International73

References, Cont'd

11.4.4 ISO Meta-data Standards

ISO Standards Handbook 10, Data Processing—Vocabulary, 1982.

ISO 704:1987, Principles and methods of terminology.

ISO 1087, Terminology—Vocabulary.

ISO 2382-4:1987, Information processing systems—Vocabulary part 4.

ISO/IEC 10241:1992, International Terminology Standards—Preparation and layout.

FCD 11179-2, Information technology—Specification and standardization of data elements - Part 2: Classification for data elements.

ISO/IEC 11179-3:1994, Information technology—Specification and standardization of data elements - Part 3: Basic attributes of data elements.

ISO/IEC 11179-4:1995, Information technology—Specification and standardization of data elements - Part 4: Rules and guidelines for the formulation of data definitions.

ISO/IEC 11179-5:1995, Information technology—Specification and standardization of data elements - Part 5: Naming and identification principles for data elements.

ISO/IEC 11179-6:1997, Information technology—Specification and standardization of data elements - Part 6: Registration of data elements.



from *The DAMA Guide to the Data Management Body of Knowledge* © 2009 by DAMA International74

Upcoming Events

Time: 19:00 UTC (2:00 PM NYC) | Presented by: [Peter Aiken, PhD](#)

Data Quality by Design: Ensuring Reliable Inputs for AI Systems

10 November 2026

Data Governance/Stewardship in Action: Governing AI's Data for Long-Term Value

8 December 2026

Data Governance for the AI Era: Building Trust, Accountability, and Value

13 January 2027

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