Safari USPI 2024-04-16

Lessons learned from Large Capital Facility Projects

“Bridging the gap between IM and the business”

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- *> 25 years experience in LCF Projects in infrastructure and industry from specification up untill maintenance.*
- *> 20 years member of the Dutch NEN standardization committee ‘Information integration and interoperability’.*
- *> 20 years member of Executive Committee USPI.*
- *Member ISO TC 184/SC4; Industrial Data, initiator and editor of ISO 15926-11.*
- *PhD: A unified framework improving interoperability and symbiosis in the field of Systems Engineering.*

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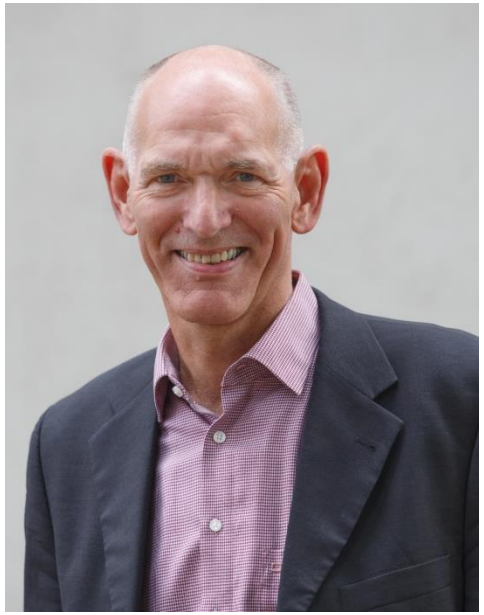

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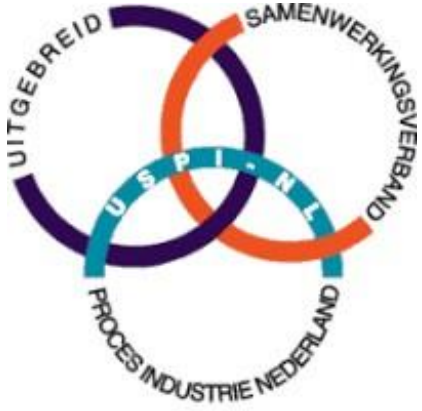
Agenda

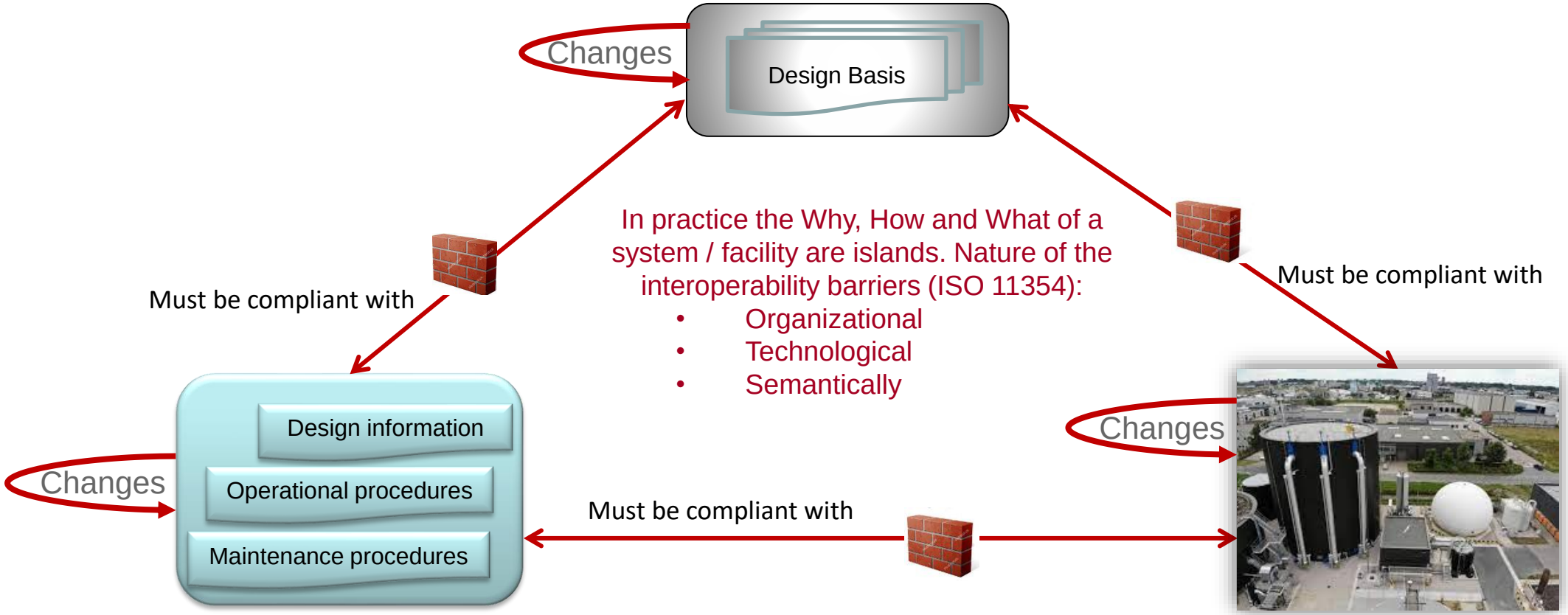


- Scope and context of information management in Large Capital Facility Projects
- Problem areas and challenges information management in LCF Projects
- Considerations for an information management strategy in your LCF project
- Closing remarks

The challenge of information management over the total life-cycle of a capital facility

Fragmentation over time

"As required" configuration of a facility (**Why)**
(what required is to be there, including it's behavior)



"As designed" configuration documentation **(How)**
(what we say that there is and say how it behaves)

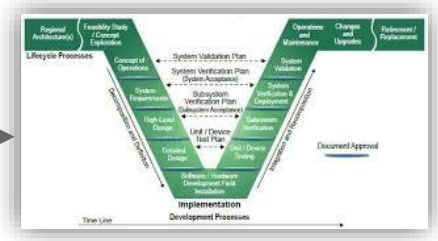
"As-is" Actual physical and operational configuration **(What)**
(what there actually is and how it really behaves)

Complexity of large capital facility projects from an information management point of view

Organizational fragmentation

Design & construct process & tooling

based to a greater or lesser extent on SE



ISO 15288
"System Life-cycle Processes'

Arc

fragmentation over time

Changes

Design Basis

"These islands has their own organizational fragmentation"

In practice the Why, How and What of a system / facility are islands. Nature of the interoperability barriers (ISO 11354):

- Organizational
- Technological
- Semantically

Must be compliant with

Must be compliant with

Design information

Operational information

Maintenance information

Changes

Changes

Must be compliant with

Design & construct process & tooling

Client / invest

Design & construct process & tooling

Supplier

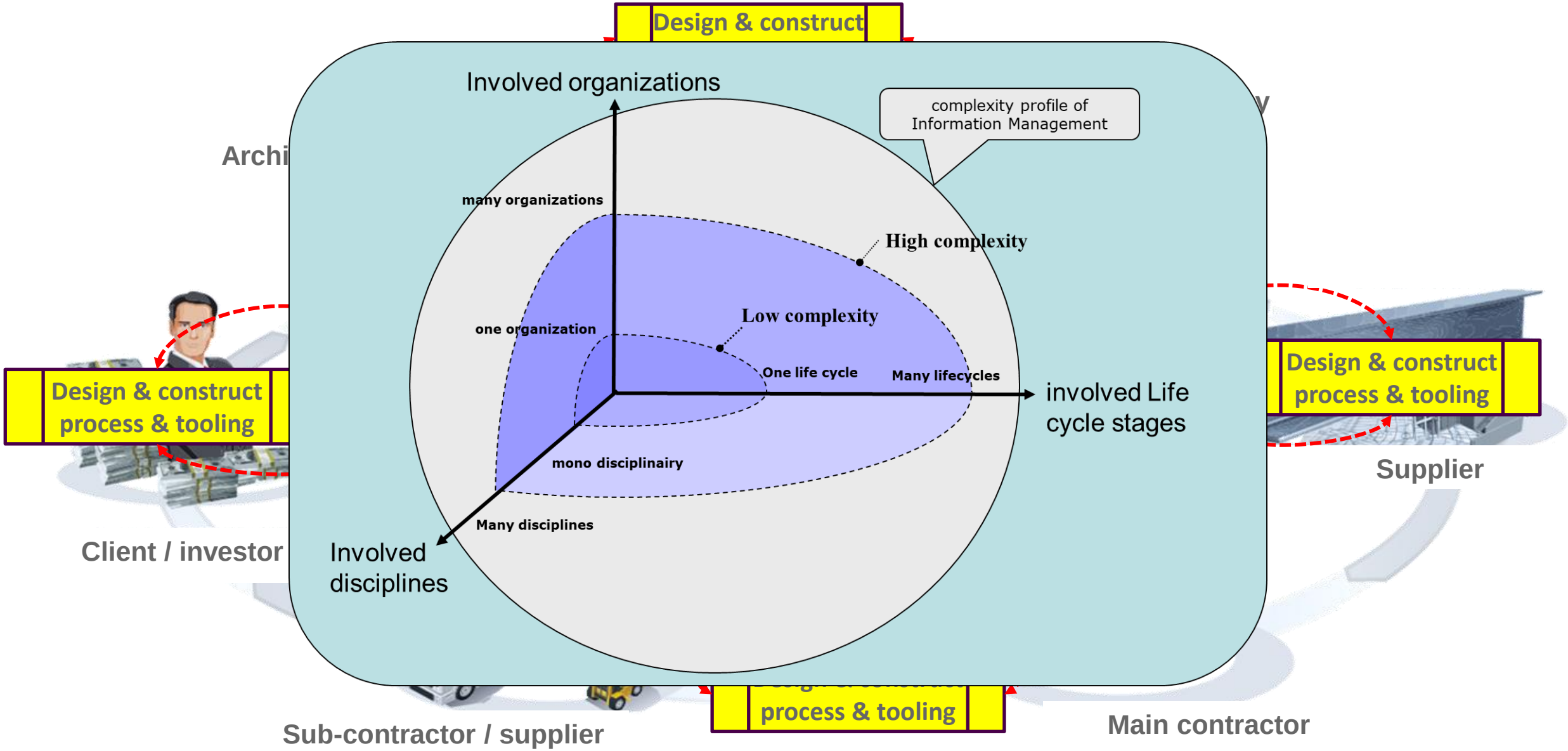
Design & construct process & tooling

Sub-contractor / supplier

Main contractor

Complexity of large capital facility projects from an information management point of view

Combining fragmentation over time with organizational fragmentation shows the complexity of information management

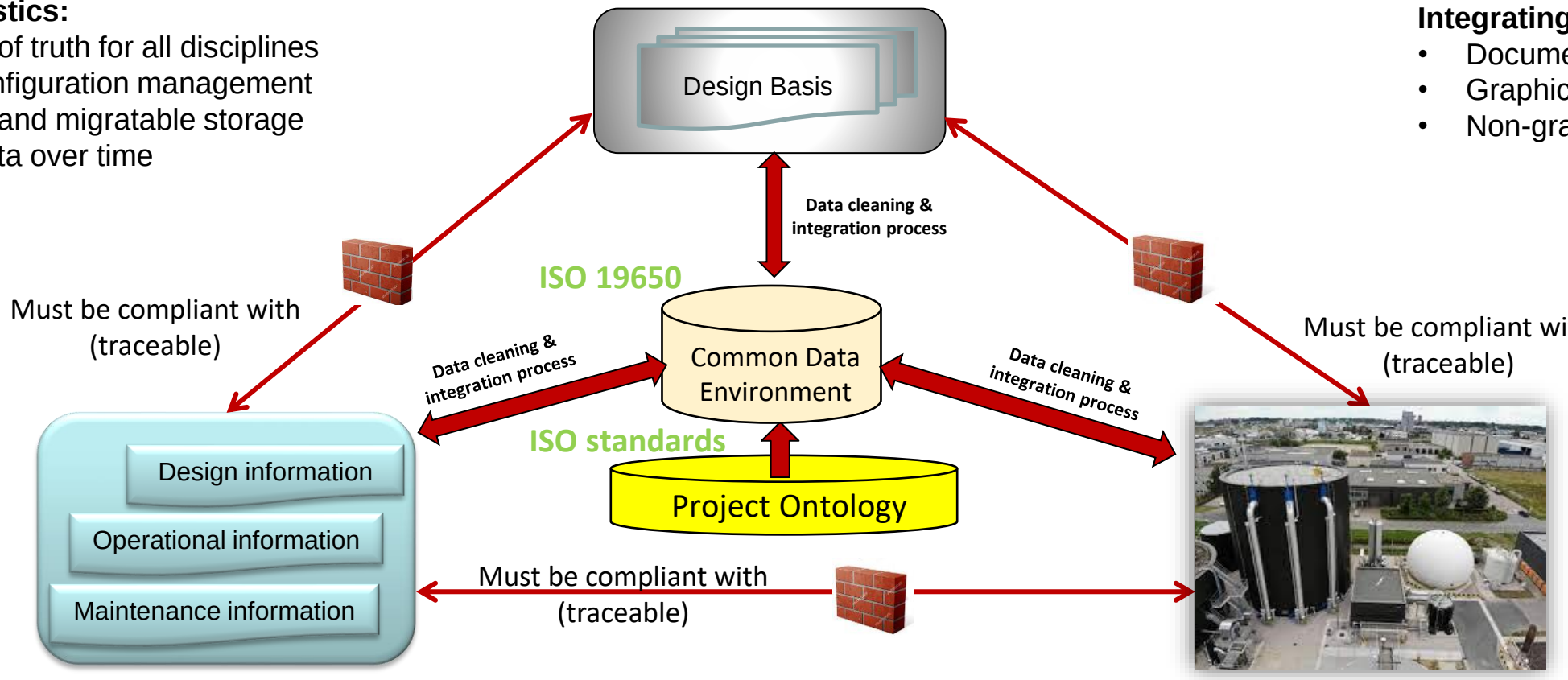


This safari is about using a Common Data Environment (CDE) as solution, rather than choosing a supplier specific, propriety solution

Key characteristics:
- Single point of truth for all disciplines
- Enabling configuration management
- Sustainable and migratable storage of project data over time

"As required" configuration of a facility (**Why**)
(what required is to be there, including it's behavior)

Integrating:
- Document versions
- Graphical models
- Non-graphical data

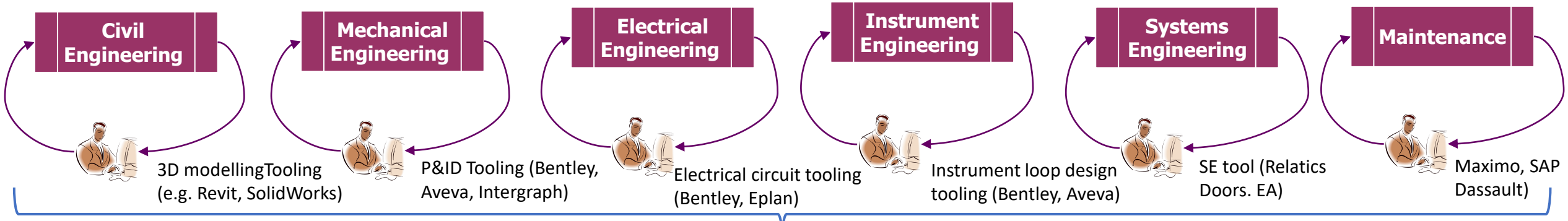


"As designed" configuration documentation **(How)**
(what we say will be there and how it will behave)

"As-is" Actual physical and operational configuration **(What)**
(what there actually is and how it really behaves)

Legacy of engineering tools in use, lacking interoperability

Developed over the last decennia, each based on their own model and terminology, nearly supporting open standards



Example of a project-oriented framework of standards for realizing a CDE / achieving interoperability

ISO 55000 Asset management

From a BIM perspective:

ISO 19650: Organization of information about construction works — Information management using building information modelling

- **Part 1:** Concepts and Principles
- **Part 2:** Delivery phase of the assets
- **Part 3:** Operational phase of the assets
- **Part 5:** security-minded approach to information management

From a non-graphical data integration perspective:

ISO 15926: Integration and interoperability of all information of the plant over the life cycle.

- **Part 4:** Initial Reference Data
- **Part 7:** Template methodology
- **Part 11:** RDF methodology

From a graphical data integration perspective:

- IFC (Building Smart)
- DEXPI
- STEP

- 3D project modeling standard
- Project Tagging & coding standard
- CDE Integral information model
- Project Reference Data Library (RDL)
- Project Document Management System
- Project ocument review procedure

ISO 8000 data quality (principles and process)

ISO 9001

ISO 15288 Systems Engineering

Available project IT toolkit for implementation of these standards

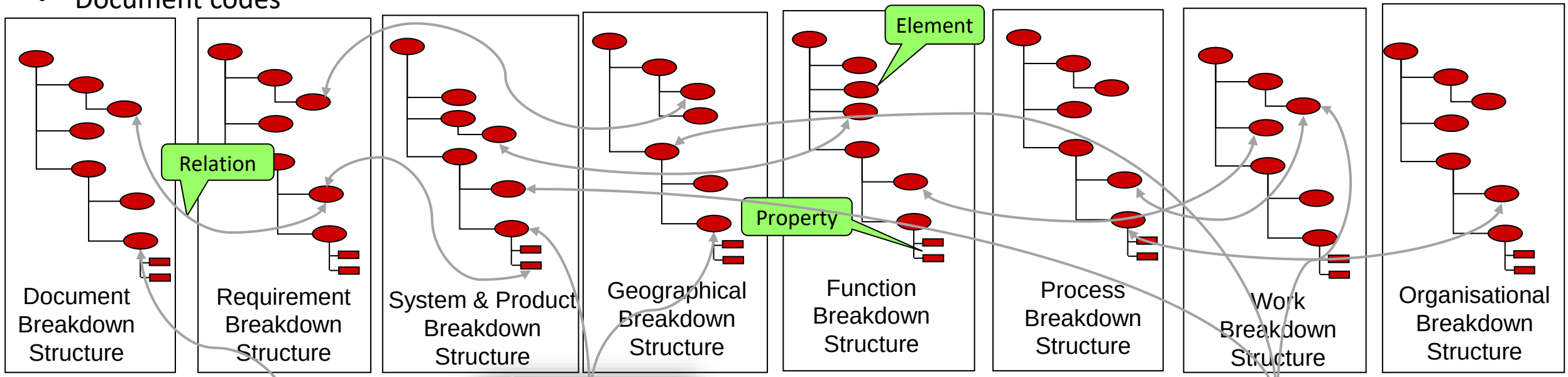
Breakdown structures are the basis of both a project and the content of a CDE (Single point of true)

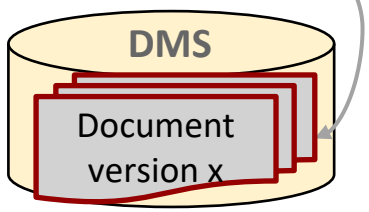
Basic scope of a CDE Just sharing and controlling consistent basic master data:

- Discipline codes
- Location codes
- WBS codes
- SBS codes
- Document codes

Advanced scope of a CDE (integrating data, models and document versions)

- project organization including disciplines and employees
- Geographical breakdown structure covering all rooms, spaces, area's
- Central Work breakdown structure and WP owners
- Complete System Breakdown structure including product breakdown
- Document versions including relations to all other structures



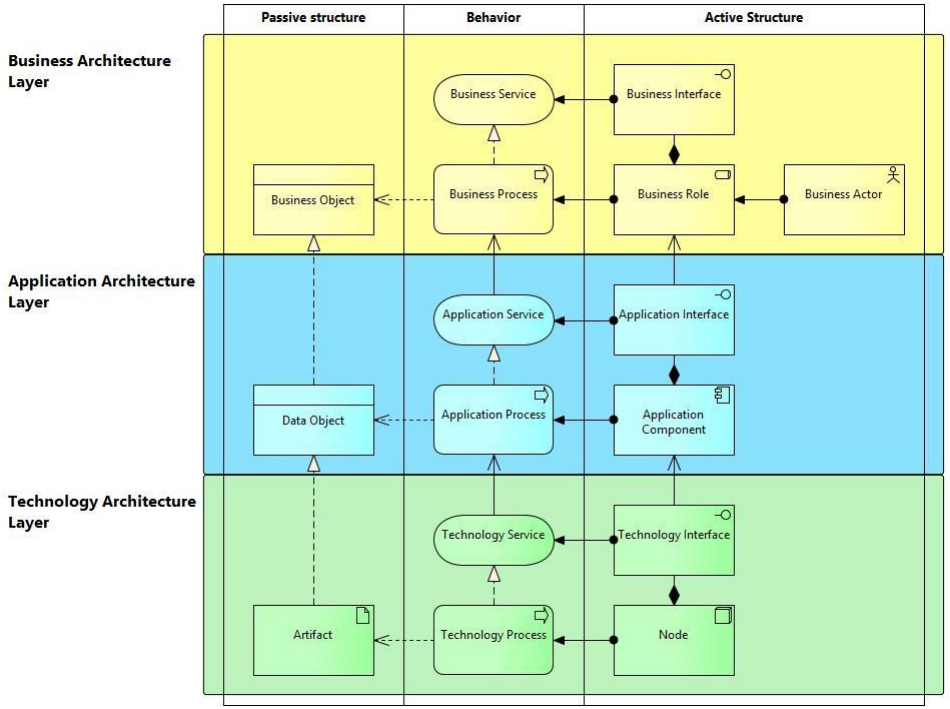


Example combined technology and semantic barrier:
Traditional process modelling versus semantic modelling

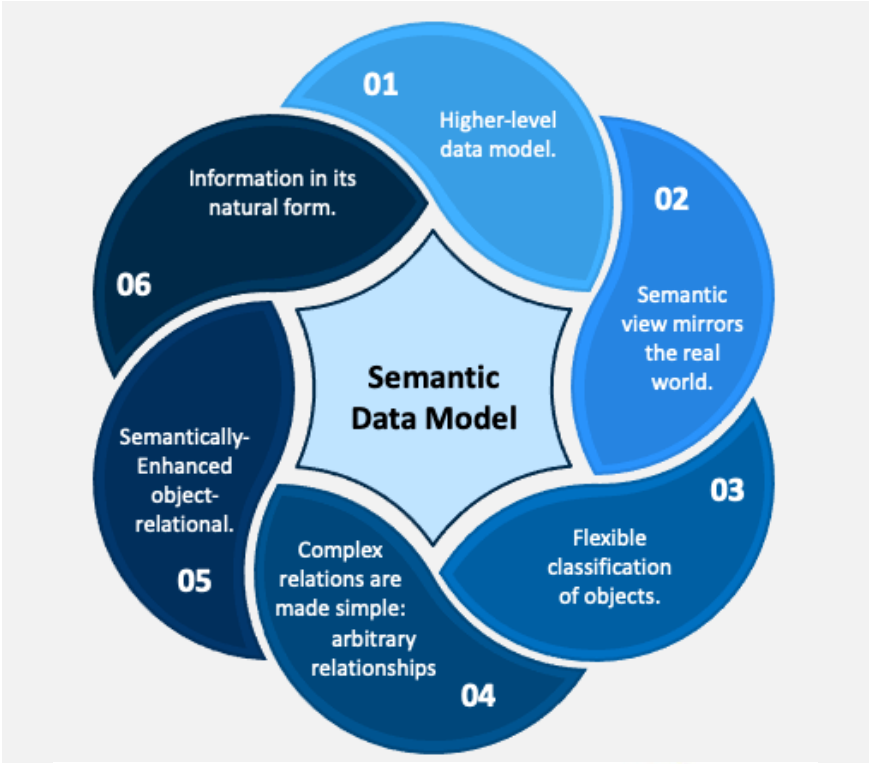
ArchiMate®

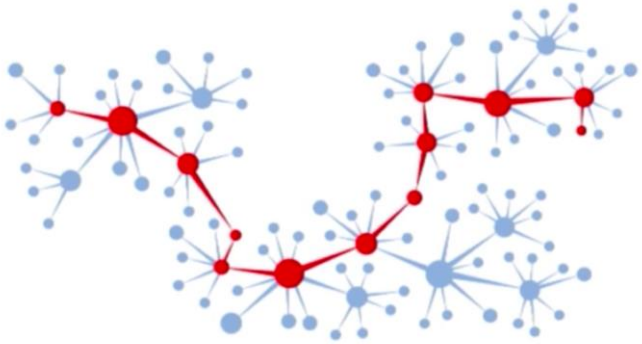
BPMN™

UML™



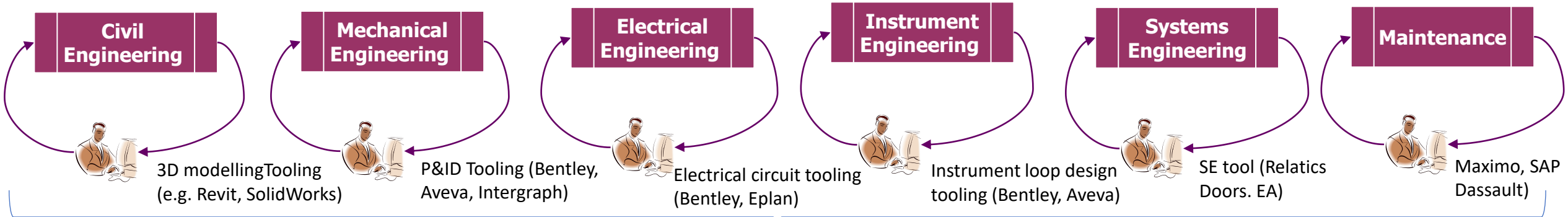
Semantics is partly defined by symbols and predefined (arbitrary) models





Semantics has no bias and can fully be defined by an ontology including a RDL, fit for purpose

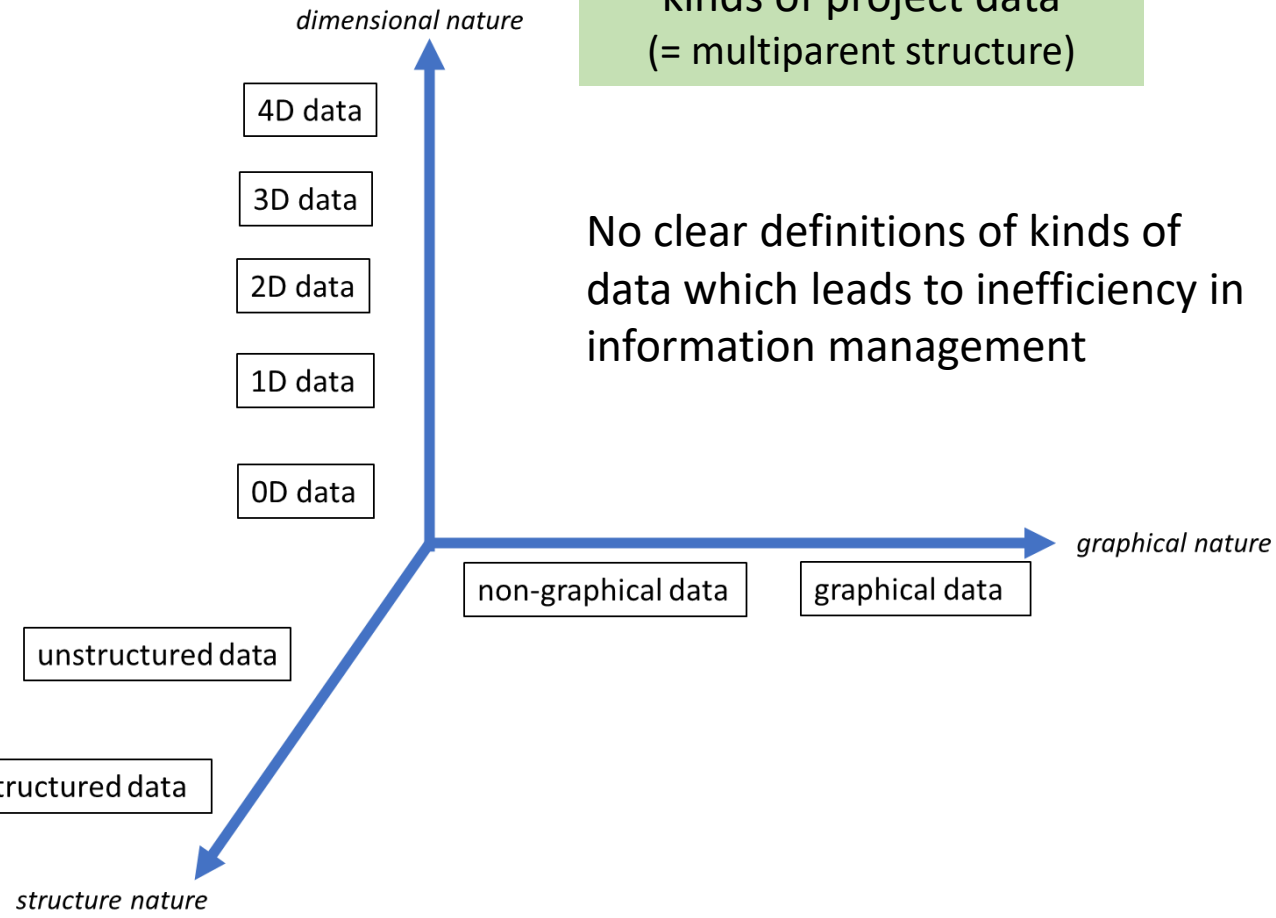
Data Quality and Consistency of data obtained from engineering tools



ISO 8000 data quality issues

- unprocessable (unreadable) data by computer
- data not understandable by human
- data not useful
  - not suitable for intended application
  - inaccessible
  - inaccurate (lacking fidelity)
  - unavailable
  - incomplete (against a specified list of required elements)
  - incorrect (e.g. lack of referential integrity)
  - no indication of context
  - imprecise
  - lacking provenance (traceability)
  - untimely
  - lack of trustworthiness
  - lack of visibility

kinds of project data (= multiparent structure)



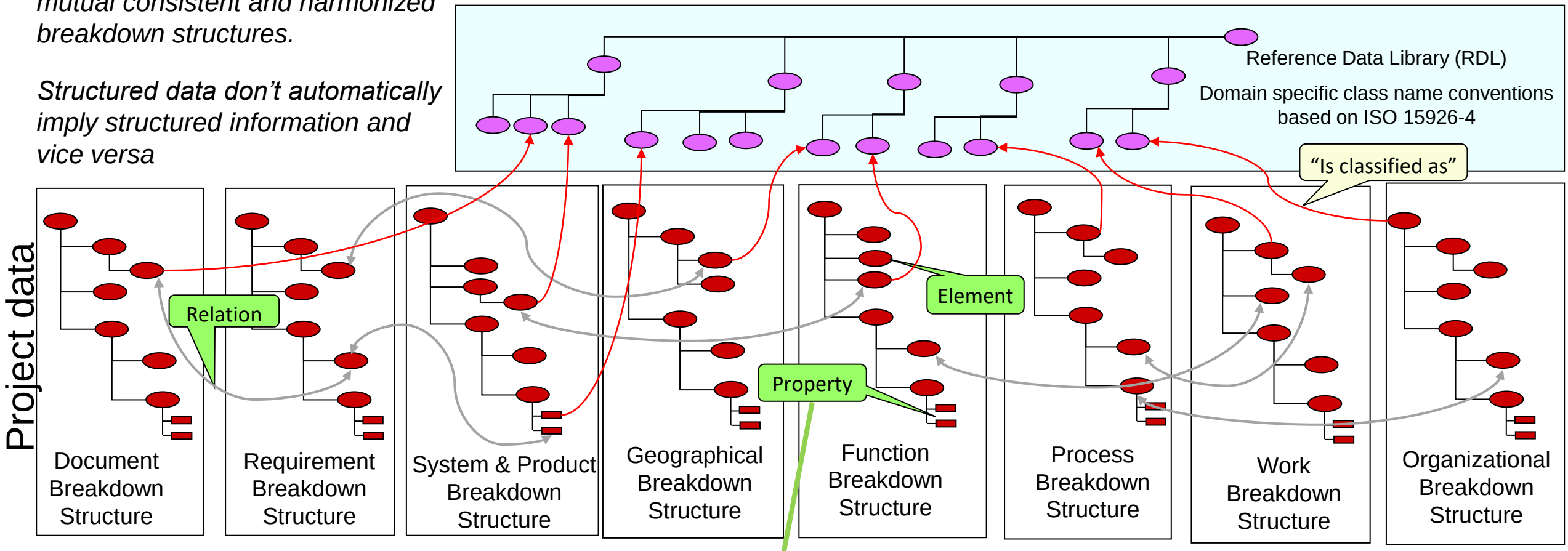
No clear definitions of kinds of data which leads to inefficiency in information management

Challenge: getting structured information represented by structured data from engineering

Structured information implies mutual consistent and harmonized breakdown structures.

Structured data don't automatically imply structured information and vice versa

Classifying all individuals in the project according a project RDL (compliant to ISO 15926-6) helps to arrive at structured information and data



Example

ID	Name	RDL class	Description	Nominal Value	Condition Nominal Value	Min Value	Condition min value	Max Value	Condition max value	Unit
PS0007	Pressure Drop	rdl:PressureDrop	Pressure drop in core	165	@2210 m3/h @32°C	140	@1500 m3/h @32°C	200	@3300 m3/h @32°C	kPa

Structured data rather than expressed in natural language ('prose') e.g.in a design document

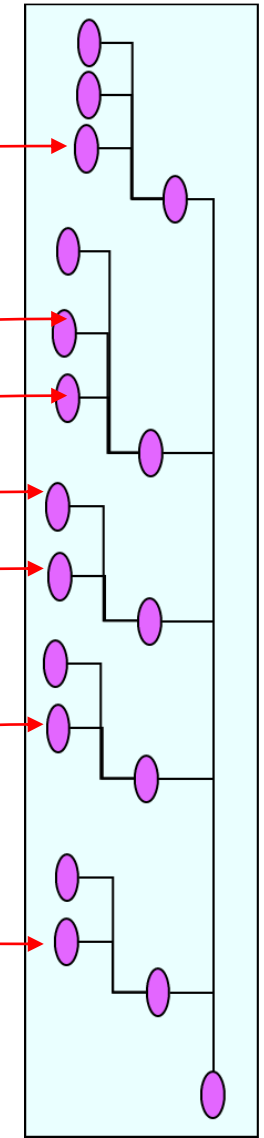
Example: expressing project requirements in structured, classified data (highest ambition level)

Example real project requirement:

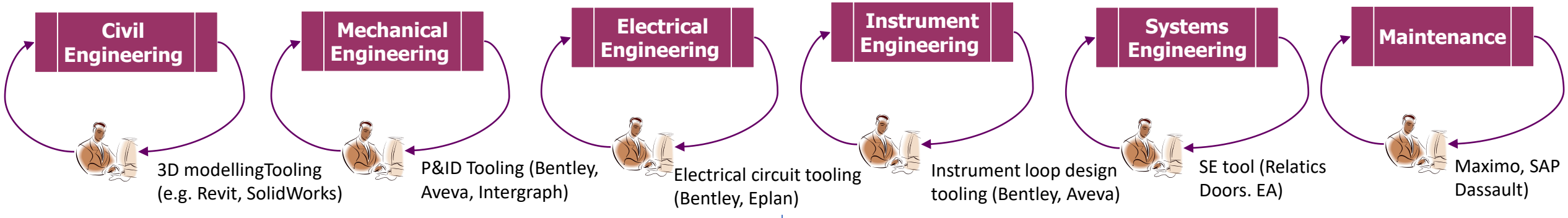
"Heating system will consist of heat exchanger tube type, suitable for thermal oil to hot water with pumps, piping, etc. to provide hot water to the central air handling units. Two pumps will be installed for circulating the hot water, each capable for 50% of the capacity"

Structured data representation of this requirement:

heating system	*shall have as part a*	<1:1>	heat exchanger
heat exchanger	*shall be performer of a*		exchanging heat between two streams
primary stream	*shall participate in a*		exchanging heat between two streams
secondary stream	*shall participate in a*		exchanging heat between two streams
primary stream	*shall be qualified as a*		thermal oil
secondary stream	*shall be qualified as a*		hot water
heat exchanger	*shall have as part a*		pump system
pump system	*shall have as part a*	<2:2>	pump
pump system	*shall have as part a*	<1:n>	pipe
pump system	*shall be performer of a*		providing hot water to central air handling units
pump	*shall be performer of a*		circulating secondary stream
pump	*shall have as aspect a*		pump capacity
pump capacity	*shall be qualified as a*		50% of the full heating system capacity
primary stream	*shall be a responsibility of a*		client
secondary stream	*shall be a responsibility of a*		contractor

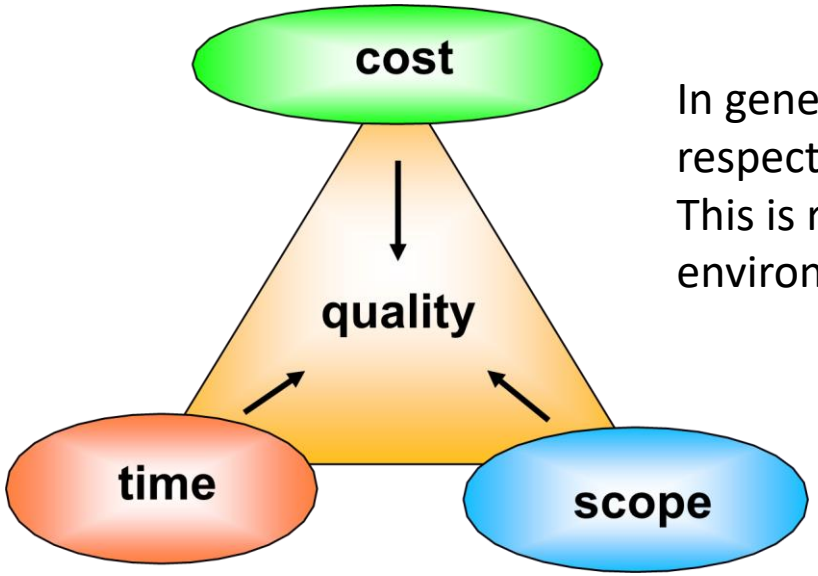


Change Management: how improve quality of engineering data (getting data ready for digital twin)



Delivering structured data with appropriate data quality by engineering requires changes in

- Workflows,
- Processes
- Roles (requiring new data quality and modeling skills)

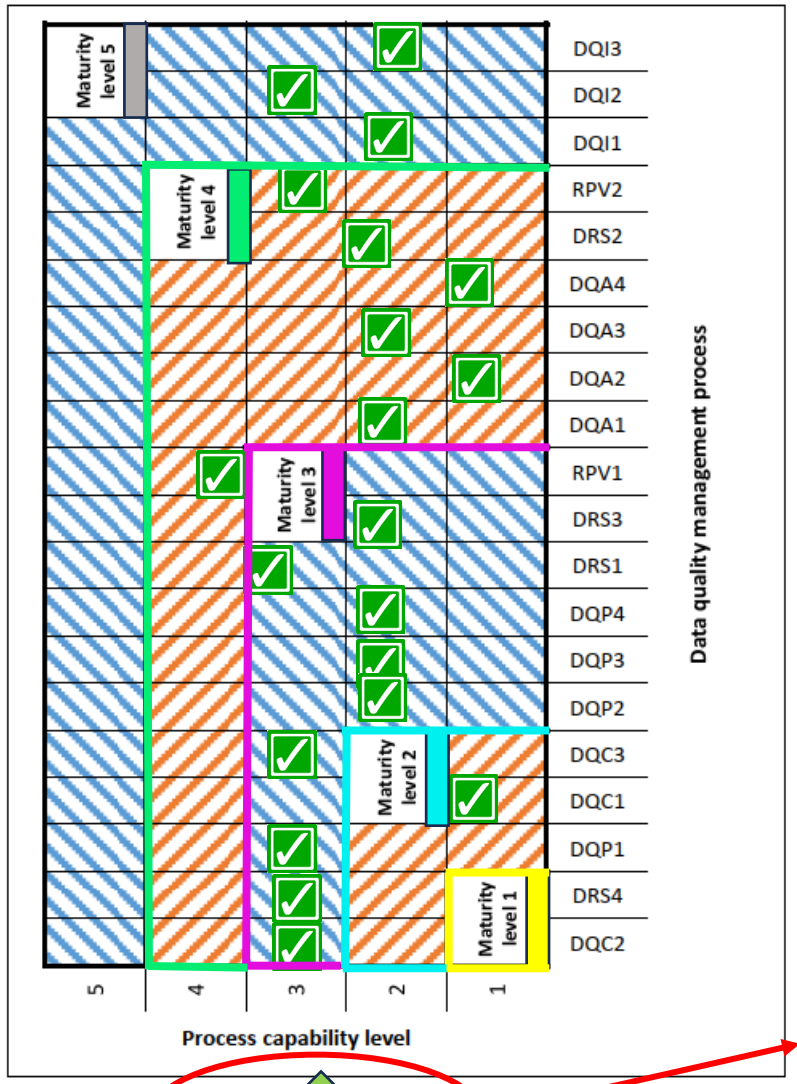


In general, this leads to resistance in engineering due to time and costs consequences with respect to their traditional way of working.
This is reinforced by, in general, lack of data management skills within traditional engineering environments

This often creates tension between quality of data and progress in the project as well as budget pressure:
Add (data quality) to the project management triangle to achieve the possibility of executing projects 'first time right'.

Difference in maturity between project partners

project partner A
(familiar with data centric way of working)



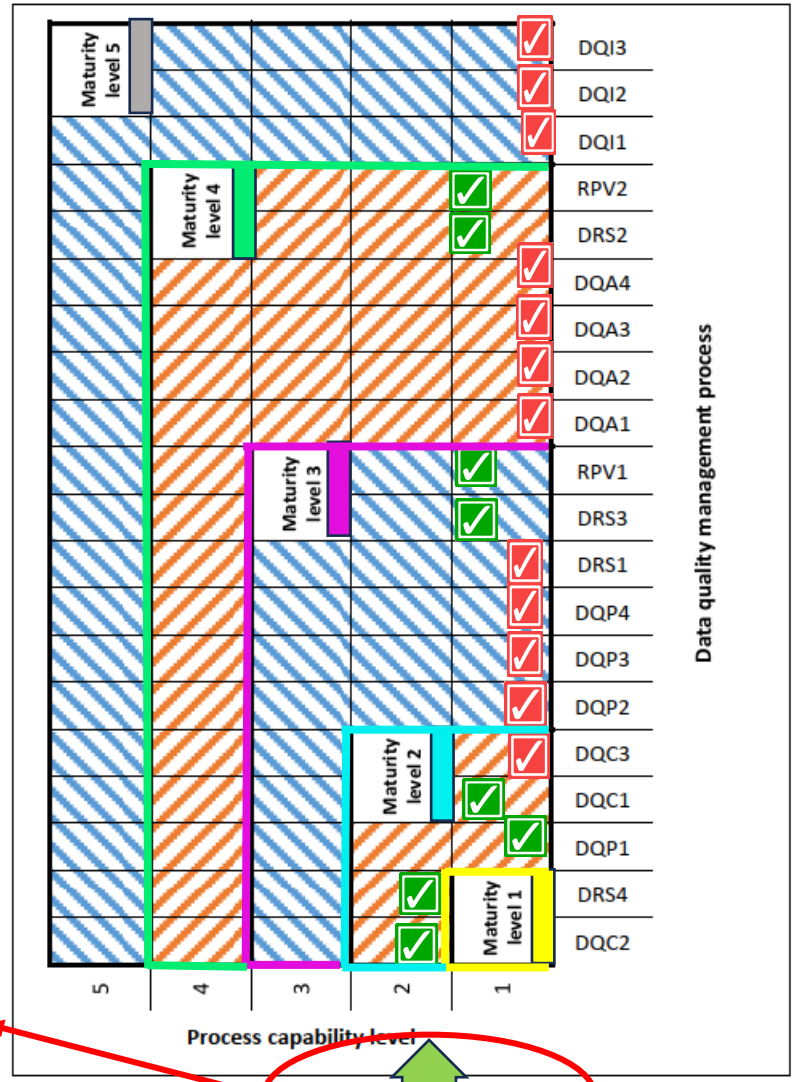
certain level of maturity

not implemented

ISO 8000 maturity keys

— DQC.2. Data Processing;
— DRS.4. Data Security Management;
— DQP.1. Requirements Management;
— DQC.1. Provision of Data Specifications and Work Instructions;
— DQC.3. Data Quality Monitoring and Control;
— DQP.2. Data Quality Strategy Management;
— DQP.3. Data Quality Policy/Standards/Procedures Management;
— DQP.4. Data Quality Implementation Planning;
— DRS.1. Data Architecture Management;
— DRS.3. Data Operations Management;
— RPV.1. Data Quality Organization Management;
— DQA.1. Review of Data Quality Issues;
— DQA.2. Provision of Measurement Criteria;
— DQA.3. Measurement of Data Quality and Process Performance;
— DQA.4. Evaluation of Measurement Results;
— DRS.2. Data Transfer Management;
— RPV.2. Human Resource Management;
— DQI.1. Root Cause Analysis and Solution Development;
— DQI.2. Data Cleansing;
— DQI.3. Process Improvement for Data Nonconformity Prevention;

Project partner B
(only familiar with document centric way of working)



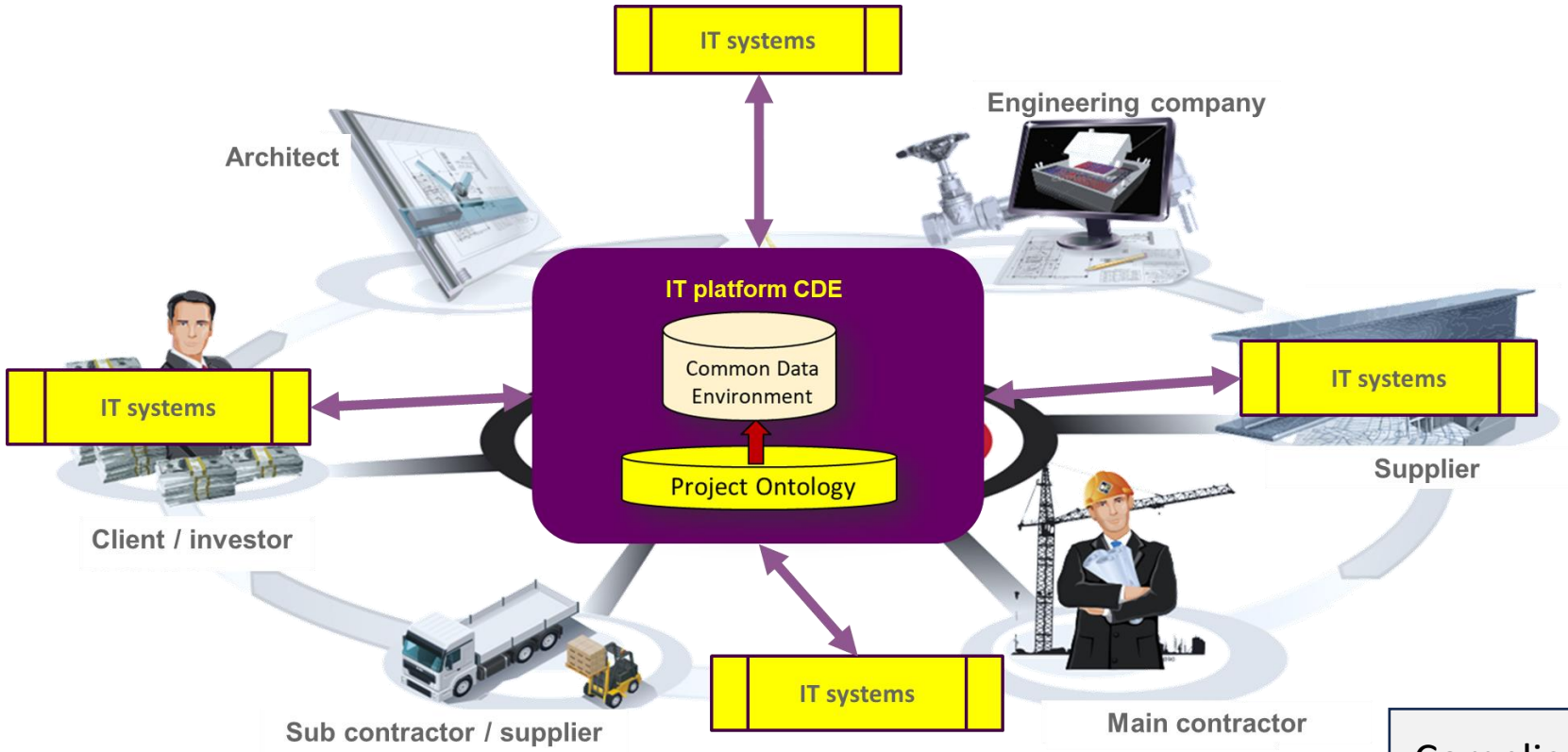
The lower the maturity level the harder to select, tailor and implement appropriate data standards

External maturity: Maturity of available data integration and exchange standards and easiness to implement

Security and Privacy Concerns

Creating a shared network environment involves:

- establishing a secure and efficient infrastructure
  - that enables data sharing, communication, and joint development efforts,
    - while safeguarding sensitive information and intellectual property.



Aspects to concider

Cloud-based Collaboration Platforms

Multi-Factor Authentication (MFA)

Virtual Private Networks (VPNs)

Access Control and Segmentation

Compliance and Legal Considerations

Joint Security Policies and Procedures

Complicates collaboration between domain area's, organizations, Information management and IT

Cultural and Organizational Barriers in adapting a CDE:

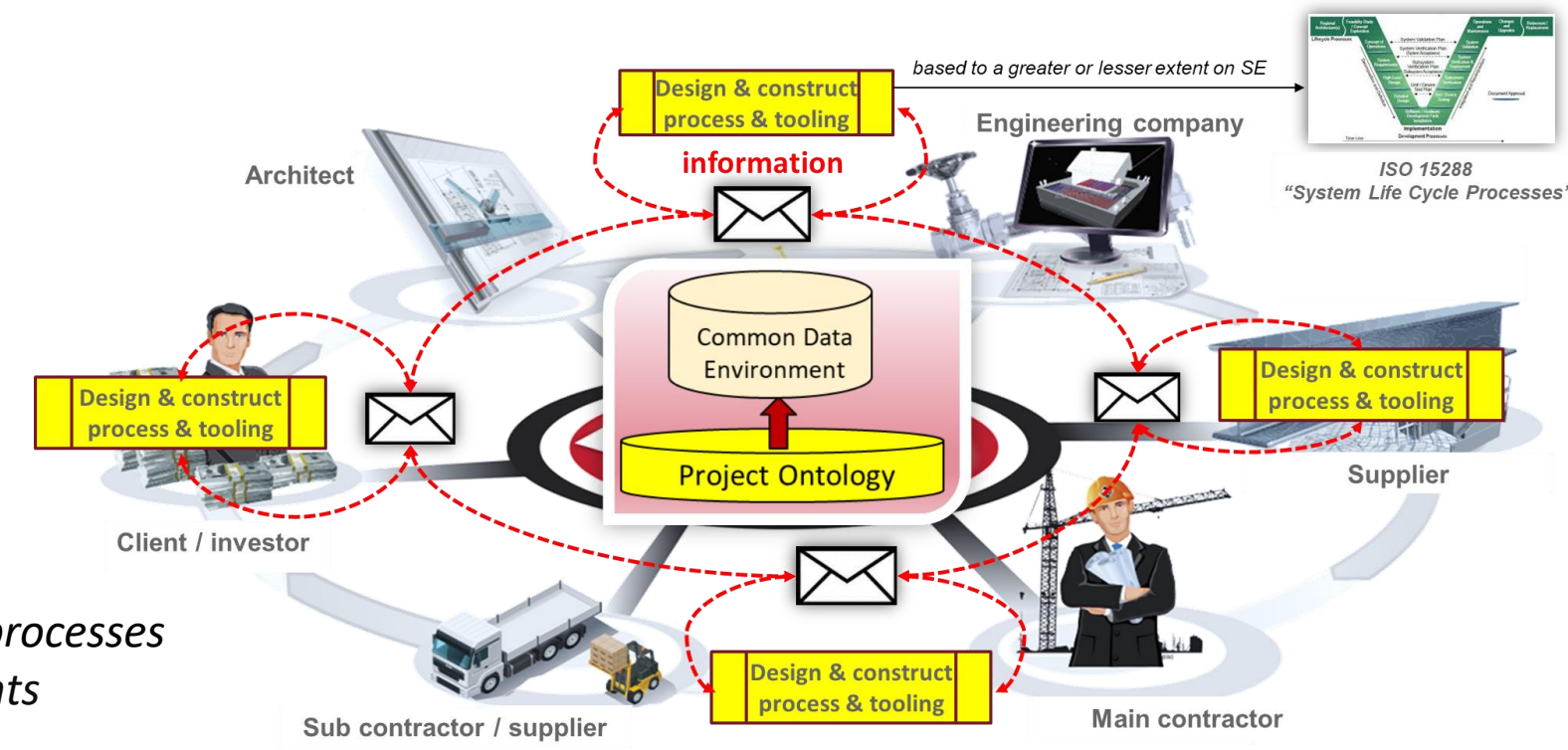
Different organizational cultures and structures can lead to misalignments in goals and expectations, hindering collaboration.

Bias within traditional project management (demonstrative):

- ‘Engineering always exceeds time and budget’,
- ‘IT makes things complex and doesn’t deliver’,
- ‘Construction makes it working ……’

Collaboration and integral design aiming for ‘First Time Right’ is hindered by:

- *Different maturity levels*
- *Different knowledge level*
- *Different ambitions*
- *Different strategies*
- *Different discission making structures and processes*
- *Cultural diversity, specific between continents*
- *Degree of presence of egos*



Training and Skill Development

Civil Engineering

Mechanical Engineering

Electrical Engineering

Instrument Engineering

Systems Engineering

Maintenance

3D modellingTooling (e.g. Revit, SolidWorks)

P&ID Tooling (Bentley, Aveva, Intergraph)

Electrical circuit tooling (Bentley, Eplan)

Instrument loop design tooling (Bentley, Aveva)

SE tool (Relatics Doors. EA)

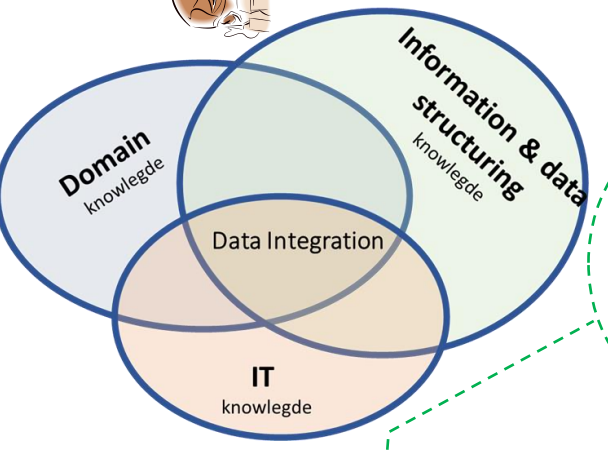
Maximo, SAP Dassault)

Includes coding (Tags)

Identify data (information) streams

Semantic modelling tooling skills

project ontology



Data cleaning & integratie proces

- Referential integrity (including codes)
- Classification of all individuals
- Unambiguous, human-readable content
- Traceability of
  - changes
  - deprecations
  - additions

Common Data Environment

new roles: “Data cleansing and classification” skills by Information Delivery Team (ISO 19650)

Stakeholders: configuration management, V&V, authorities, maintenance, asset management etc.

Considerations for your project strategy,

and the (new) roles required and their responsibility for the chosen strategy

Use the knowledge captured in standards to organize IM in your project

ISO 15288
System Life Cycle Processes

What to do

ISO 15926
Life Cycle Data Integration

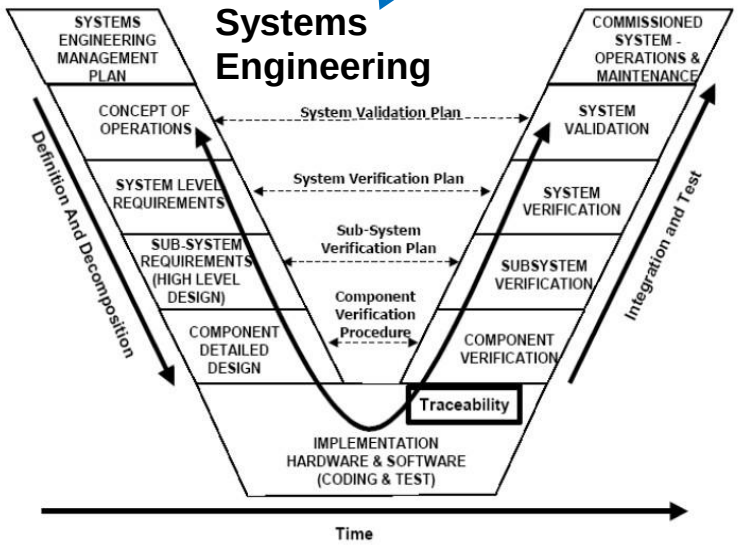
How to define

Life Cycle Data Integration

ISO 11354
Enterprise Interoperability

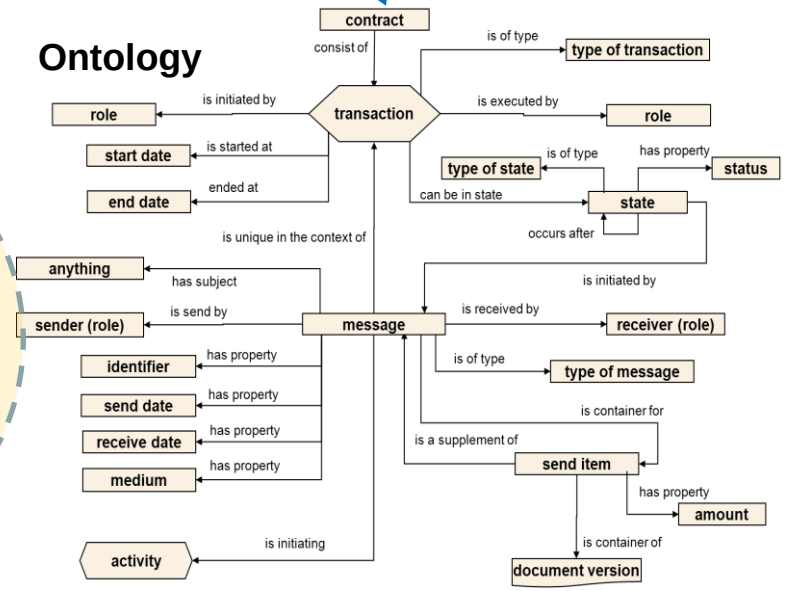
By which approach

Systems Engineering



ISO 19650

Ontology



ISO 8000

Respect the learning cycle of your project organization

Creation ability

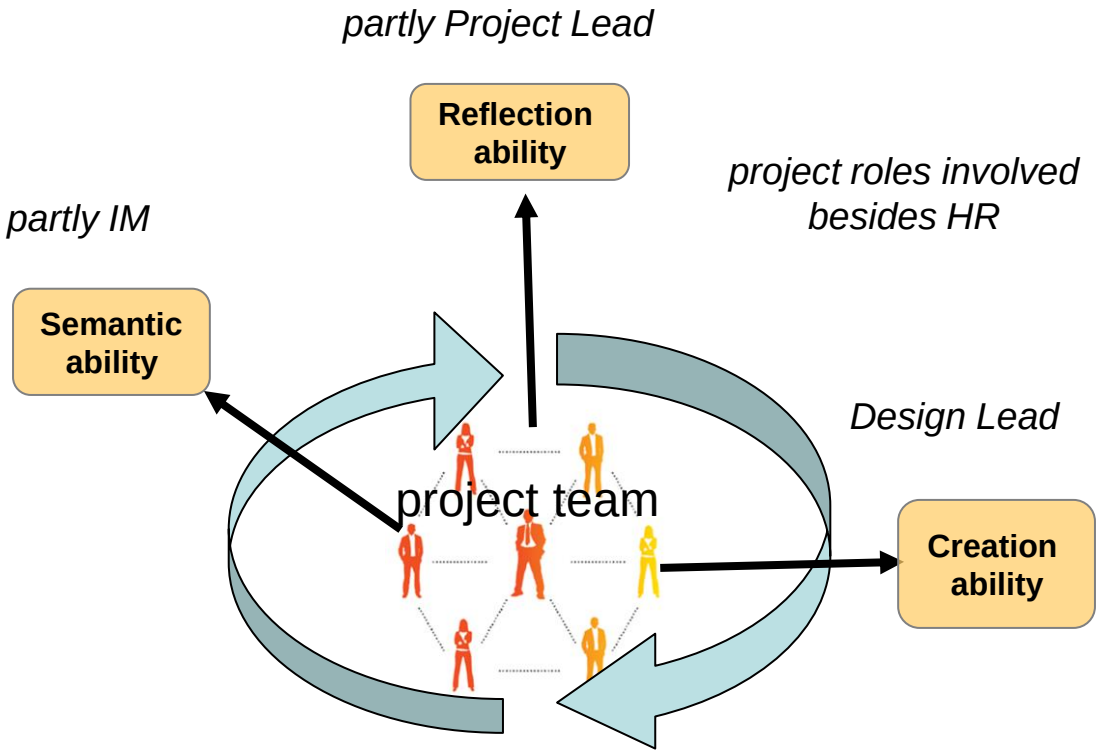
Creation ability" refers to the capacity or skill to generate new ideas, objects, or concepts that are original and valuable. It includes the practical ability to bring these ideas into reality, which can involve, engineering, software development, or other forms of physical and digital construction.

Reflection ability

Possession of the means or skill of an individual (person or organization) to recognizing and understanding personal and organizational strengths, skills and development areas in order to self-improve.

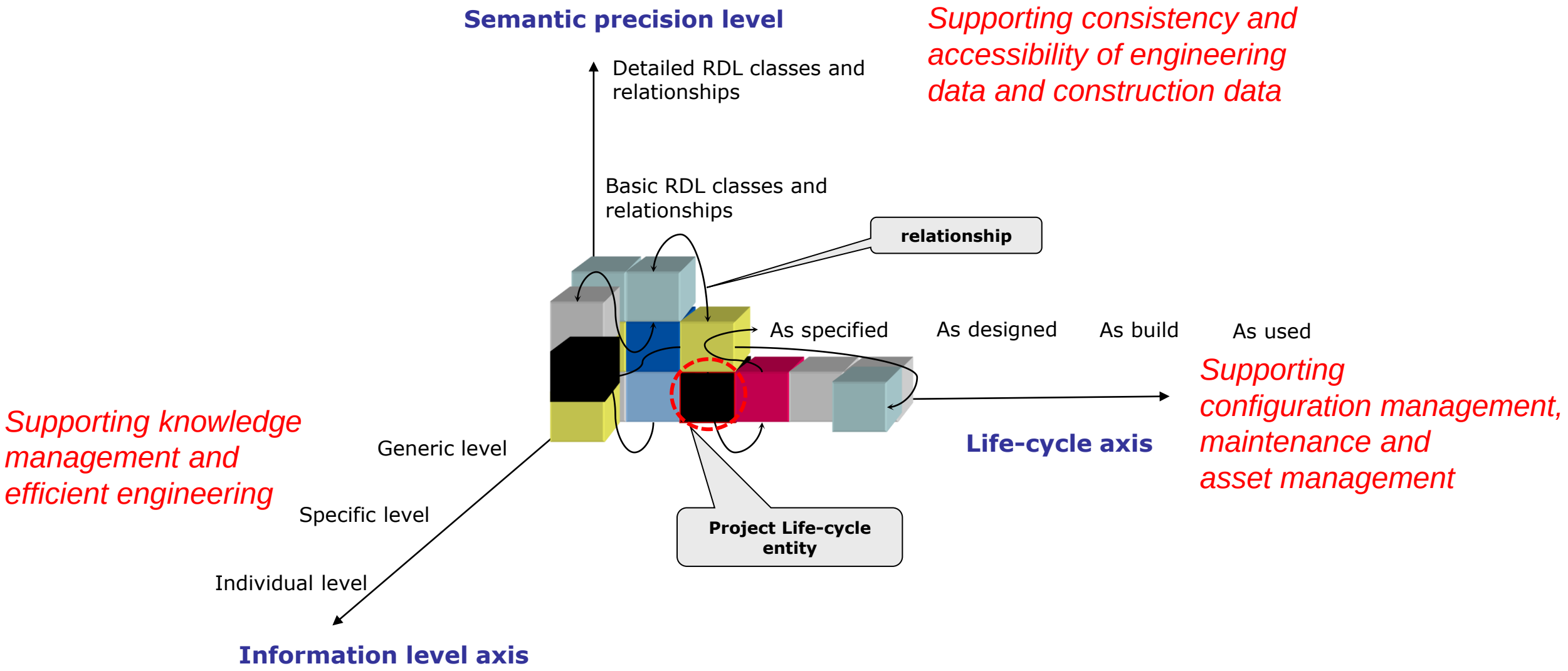
Semantic ability

Semantic ability is fundamental for effective communication and is involved in reading, writing, speaking, and listening. It is also critical for cognitive functions like reasoning, problem-solving, and memory, as these often require understanding and manipulating language-based information.



Development only takes place simultaneously along all axes

Select an appropriate framework to define your facility asset life-cycle data



Define your interoperability approach (ISO 11354), given the lack of interoperability

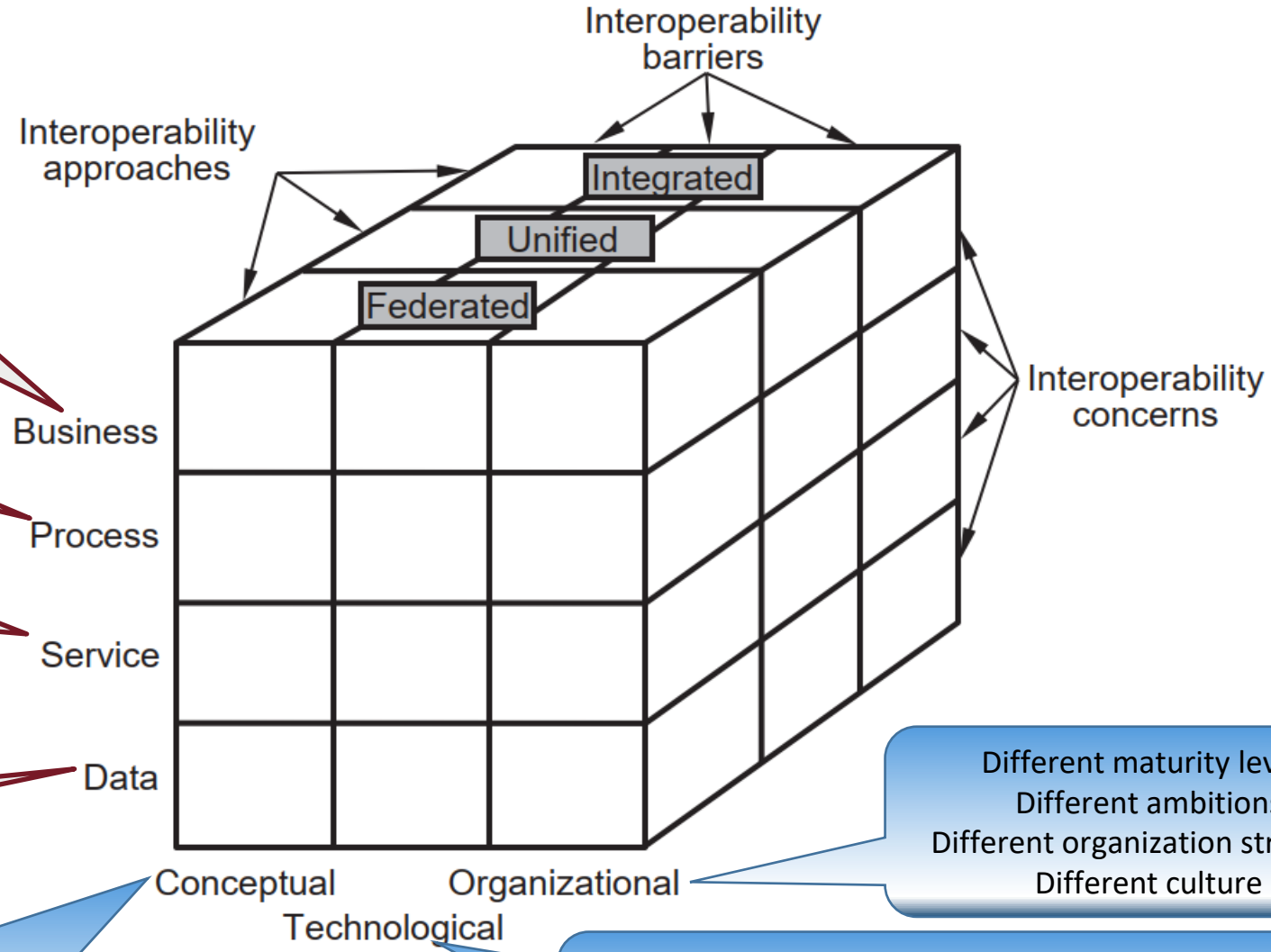
" The ability of effective interaction between enterprises based on the exchange of information"

Difference in strategy of value creation for participants
Difference in formal and informal relationships versus contractual obligations.

different process models, different modes of control and different assignments of responsibilities and authorization for process operation and change management.

different service models, different granularity, different modes of control and/or different assignments of responsibilities and authorization for service selection, operation and change management.

entities having different data systems using different data schemas with different syntax and semantics



Different maturity levels
Different ambitions
Different organization structure
Different culture

Different terms for the same thing
Different level of explicitness (data versus documents)
Different exchange protocol (semantically)

Different implementation of SE
Different IT systems
Different methods for the same goal
Different exchange protocols (technological)

Define your data quality requirements (ISO 8000)

The main purpose of part 8 of ISO 8000 is to provide a foundation for measuring information and data quality. Information and data quality is defined and measured according to the following categories:

- **Syntactic quality is the degree to which data conforms to its specified syntax, i.e. requirements stated by the metadata.**
- **Semantic quality is the degree to which data corresponds to what it represents.**
- **Pragmatic quality is the degree to which data is found suitable and worthwhile for a particular purpose.**

Measuring syntactic and semantic quality is performed through a verification process, measuring pragmatic quality through a validation process.

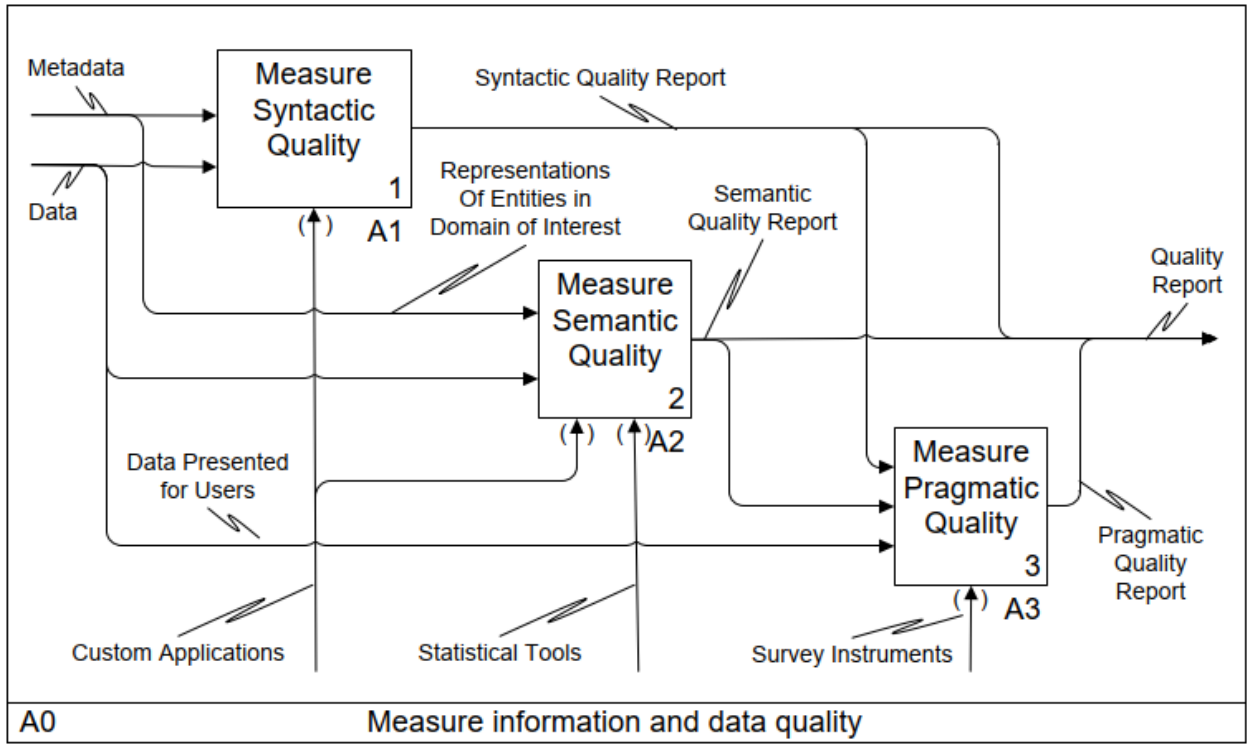
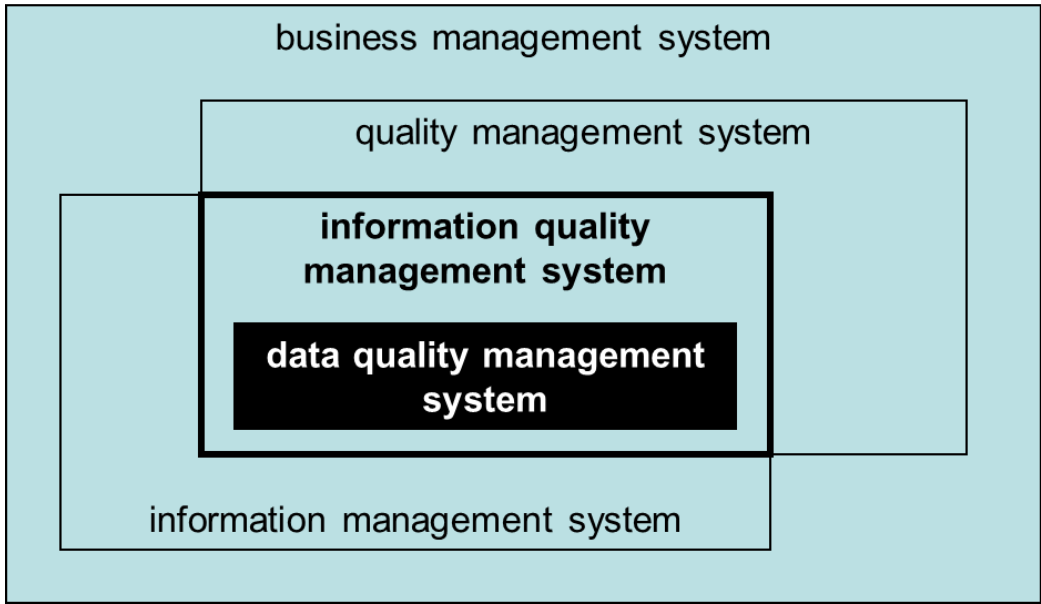


Figure D.2.2 — A0 Measure information and data quality

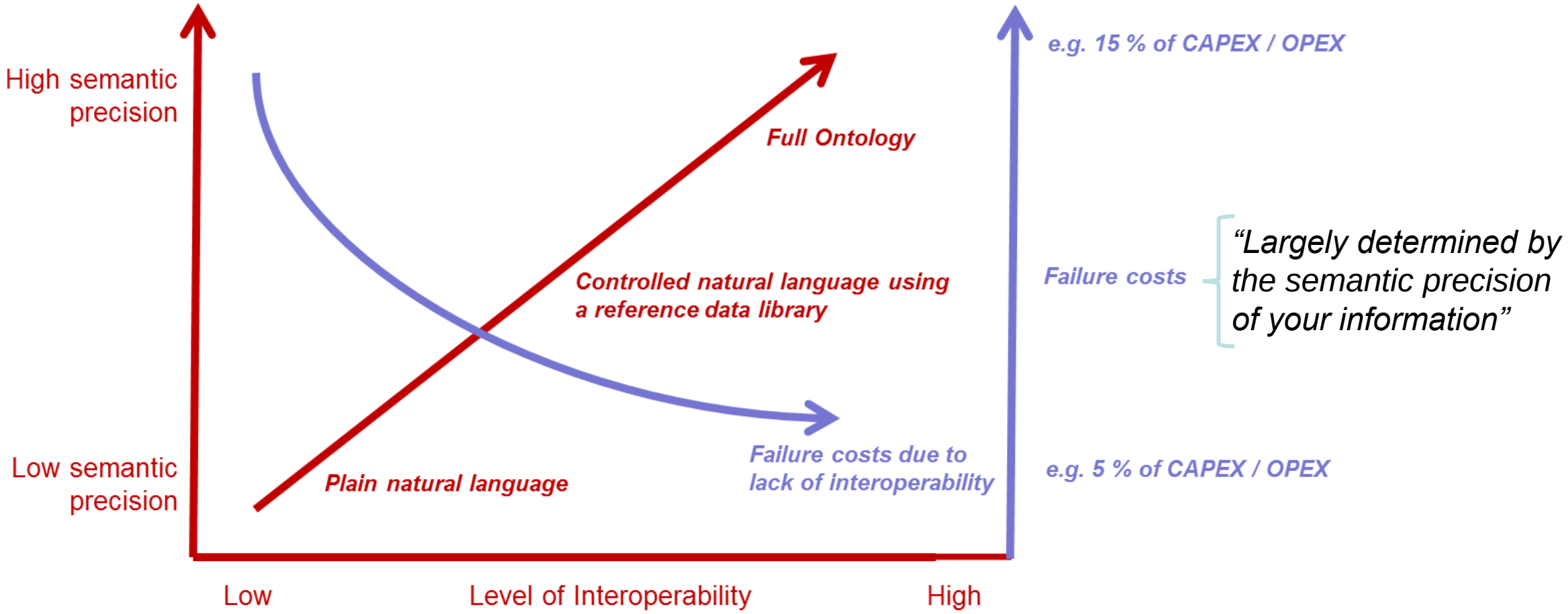
"Challenge is to work towards syntactic and semantic data quality in balance with pragmatic quality"

"Integrate information quality and data quality in your overall business management system"



Define your ambition for semantic precision within your project

(and consider the pros and cons over the entire life cycle of the facility)



"Largely determined by the semantic precision of your information"

Closing remarks (candidate chapters for a follow-up ‘deep dive’ safari)

1. Partners in a project consortium all have their own methods, standards and tools
2. Partners has different maturity in the practice of data quality and data modeling skills
3. Contracts in many cases don’t take explicit into count data quality and data exchange
4. The vision and support of senior management is crucial for what can be achieved
5. Lack of integrated and data driven approach of basic project breakdown structures
6. Lack of IT platforms and software supporting data integration based on open standards
7. In general, within companies there is lack of knowledge of data integration standards
8. Select data standards and chose those elements from it that works for the project
9. It is not self-evident that the added value of a CDE is seen through engineering, maintenance and operations, mostly because of lack of pragmatic data quality
10. Organize integration between domain knowledge, information and data structuring knowledge and IT knowledge.

Proposed USPI Safaris and Workshops 2024

Day	Event	Organizers
Thursday 26 Feb 14:00-15:30	Safari: Green-House Gas (GHG) estimation based on design data	Ian Cornwell Kraken IM
Q4 2024	Safari: Equipment Information Requirements with IOGP (JIP33, JIP36) and Standards Norway (EPIM STI)	Jason Roberts, Anne Devaharan, Peter Townson, Bjorn Berli
Tuesday 16 Apr 14:00-15:30	Workshop (1/3): Lessons learned from large capital facilities with examples	Paul van Exel, Leo van Ruijven
12-17 May 08:00-17:00	ISO TC 184/SC 4/WG 3, Seoul FTF	Paul van Exel
Thursday 6 June 14:00-17:00	Members Board (MB) Meeting	Anders Thostrup / Hugo Belder Shell Office Amsterdam TBD
04-07 June 2024 09:00-16:00	L3DEX & Tagging FTF	Peter Paul Pruijn, Martin te Lintelo,
Tuesday 11 June 14:00-15:30	Workshop (2/3): Lessons learned from large capital facilities with examples	Paul van Exel, Leo van Ruijven
Tuesday 10 Sep 14:00-15:30	Workshop (3/3): Lessons learned from large capital facilities with examples	Paul van Exel, Leo van Ruijven
Tuesday 17 Sep 14:00-15:30	Safari - Asset Administration Shell (AAS) with IDTA	Peter Paul Pruijn
20-25 Oct 08:00-17:00	ISO TC 184/SC 4/WG 3, Stavanger, Norway	Paul van Exel

Today

“Lessons learned from large capital facility projects: Bridging the gap between IM and the business.

Thanks for your attention,
USPI would like to work on this with you….

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