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PETROLEUM & CHEMICAL INDUSTRY COMMITTEE

Development of Digitization in Oil & Gas Engineering Processes

Nathalie Cabresin, Saipem
Cecile Gaudeaux, Air Liquide
Hans Keller, Siemens
Jean-Charles Guilhem, 2B1st Consulting

Summary

- Part 1: Saipem Use Case
  - Digitization in Oil & Gas Engineering Processes
- Part 2: Lesson learnt
  - Roadmap for Digitization

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Part 1: Use Case

Development of Digitization in Oil & Gas Engineering Processes

Nathalie CABRESIN

Oil & Gas Process Technologies Department Manager

SAIPEM

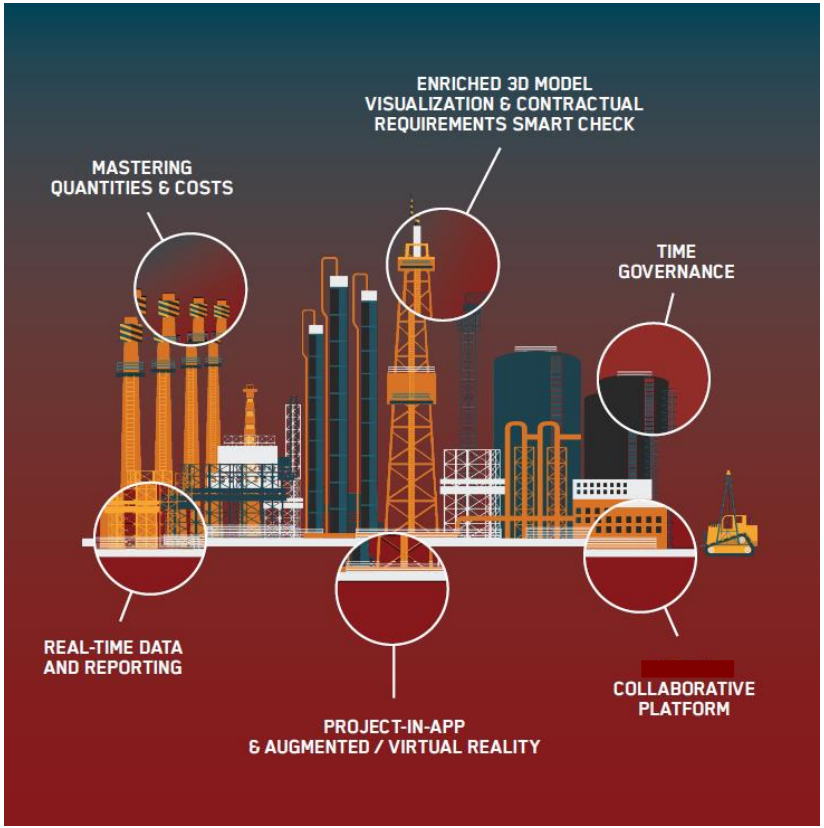
Use Case Summary

1. Digital Transformation for an EPCI Contractor
2. Evolution of Engineering methods
3. Data sources and Digital Collaborative Environment
4. EPC Contractor Project Information Management Plan and Engineering Digitalization
5. EPC Contractor Data Model
6. Objectives and Configuration of Engineering data Management tool.
7. Digital Lists, Digital Safety and Work Processes
8. Integration with Business Tools

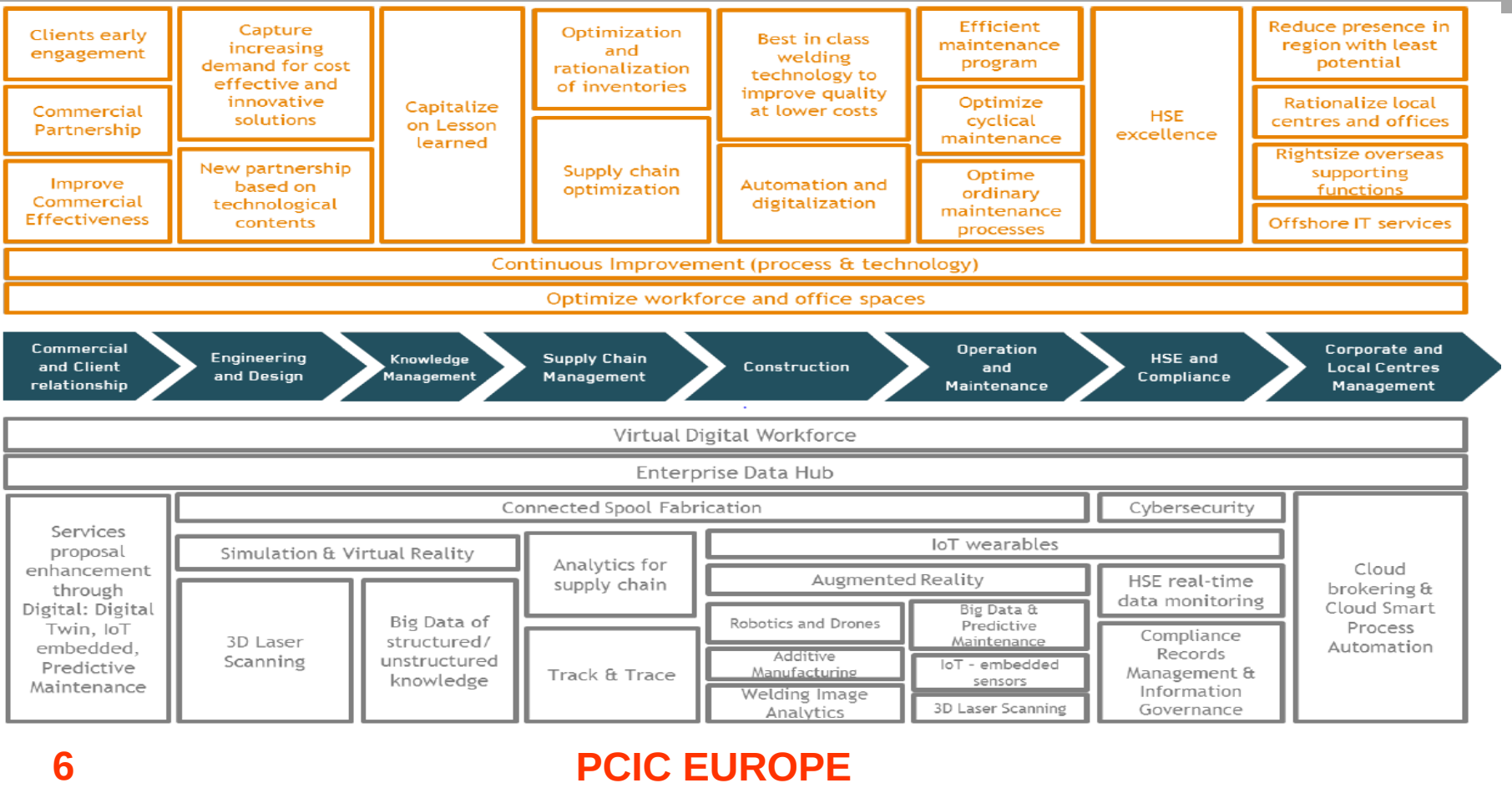
1-Digital Transformation for an EPCI Contractor

Opportunities of digital for EPCI contractor and engineering activities are double:

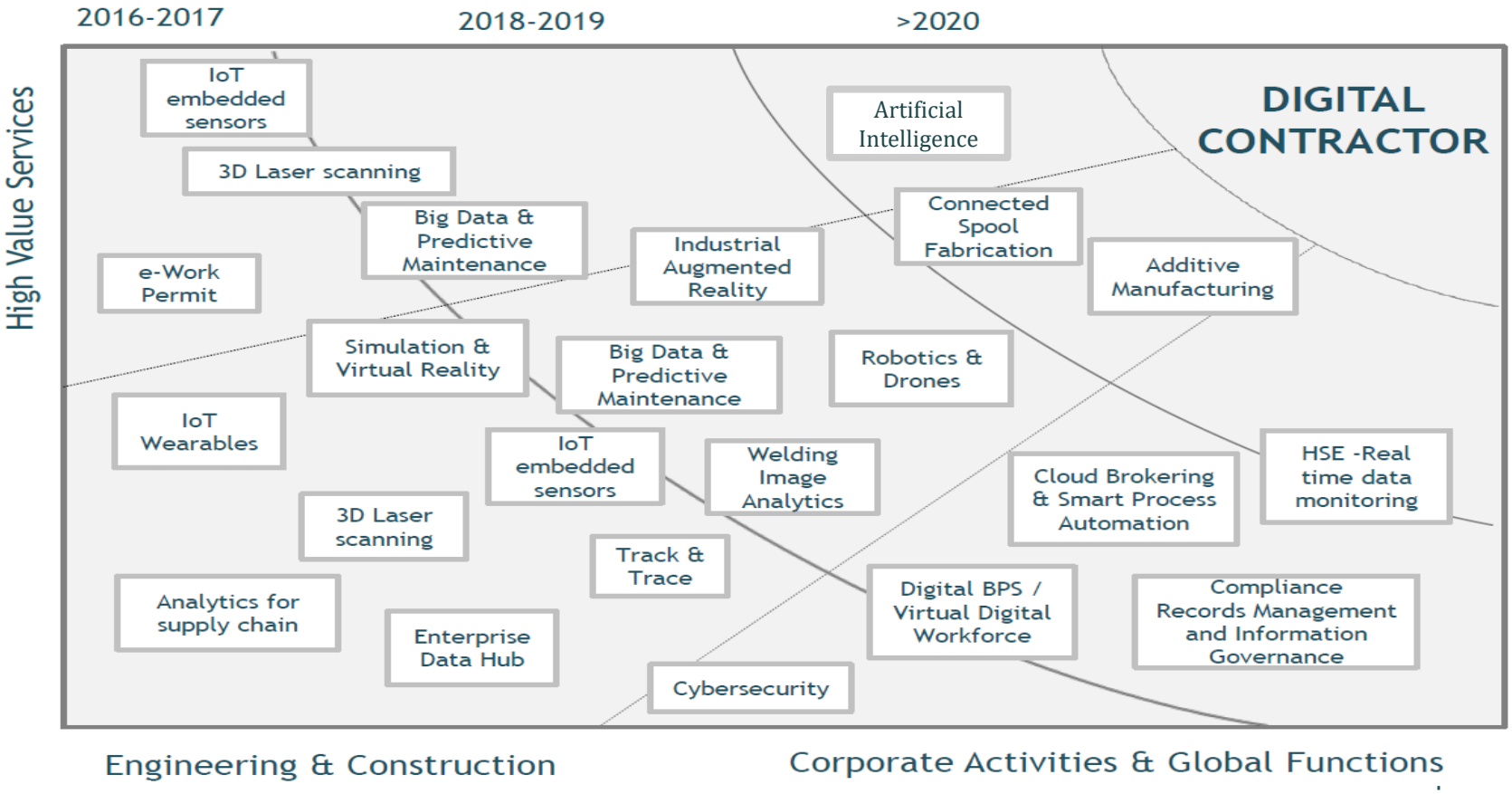
- collaborative platform
- digital twin



1-Digital Transformation for an EPCI Contractor



1-Digital Transformation Reality



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2-Evolution of Engineering Methods

- History of Engineering Methods

1990's	2010	2018
Document Centric Approach	Mixed Document and multiple, siloed Software Approach	Integrated Data Centric Approach (documents are generated from Data)
Central Computer	Personal Computer + Servers	Web Applications + Cloud
Manual Datasheets on tracing paper	Excel Datasheets	Digital Datasheets within the 1D Database
Manual Calculation Sheets Use of graphic charts (pressure drop calculations, line sizing)	Excel Calculation Sheets	Digital Calculation Sheets within the 1D Database
Drafted P&IDs (Autocad or Microstation)	Intelligent P&IDs (SP PID)	Integrated P&IDs with 2D Database and 3D Model
2D drawings and hard model	CAD 3D Model	Integrated 3D Model with P&IDs and 1D Database (lists)
Comments of Vendor documents on paper copies	Comments of Vendor documents by Red Lining on PDF files	Sharing of Project Databases with Partners, Sub-Contractors and Vendors
Paper documents handover to COMPANY (one entire storage room)	Electronic Document Management System (native + PDF files) + 3D Model (native Database)	Progressive Data and Document handover to COMPANY (Digital Twin, Information Visualization Portal)

2-Drivers for Engineering Methods evolution

- Requests from clients: More calculations and studies, Imposed softwares, imposed data format, 3D Model, Digital Twin, spare parts management…
- Requests from multicenters accessibility to data
- EPCI competition
- Need for continuous improvement and innovation
- Internal initiatives (Calculation Sheets, Calculation Tools, Databases…)
- Internal Innovation, Research & Development effort
- ICT Department Development of internal Tools
- New Commercial software releases

2- Key factors of Engineering Methods Evolution

- Work in a moving environment with compromises
- Select the good software at the right moment (privilege commercial software rather than internal development)
- Cost / Benefit evaluation
- Make choices based on priorities and business imperatives
- Management of project changes
  - Strong Top Management commitment
  - Dedicated transversal teams covering the E, P, C, I chain
  - Imply involved Disciplines
  - Training of Administrators and Users
  - Configuration and customization of the Tools to your own work processes, with the assistance from Software Editor or ICT. Each implementation of a structuring Tool such as Engineering Authoring Tools, an ERP or MSCM is unique.

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3- Data sources

- Manual Input (Lists, Data Sheets…)
  - Free input (Design conditions…)
  - Pick-Up List (Piping Class, Material…)
  - Reference to an Item of another List
- Calculation Tools output (Steady State Simulation (H&MB), Dynamic Simulation, Stress Calculation…)
- Catalogues (Piping Spec, Commodity Codes, Ident Codes, Dimensions, Weight, Vendor data…)
- 2D & 3D CAD Tools (Relations, Location, Weight, CoG)
- 3D Laser Scanning (Brownfield projects)
- Document metadata
- 4D (Planning & Schedule) and 5D (Cost) data from Business Tools
- Geographical Data (GIS, GPS, real time…)
- 6D Maintenance & Operation Sensors (Plant in operation)

3- Digital Collaborative Environment

Key Dimensions

1D - Real Time **Collaborative Environment**

2D - **Real Time Data** and Reporting

3D - Enriched **3D Model** Visualization

4D - **Time Governance**

5D - **Smart Object** Lifecycle

6D - **Project-in-App** & Augmented/Virtual Reality

Authoring (Data Responsibility & Ownership)

Certified Data Traceability

Real Time Data Sharing

Integration of Design Software Tools

Real Time Clash Detection

Real Time Enriched Plant Visualization

Integration of Schedule and Cost

Real Time Project Monitoring

Digital Warehouse and Material Tracking

Subcontractor Monitoring

Integrated Procurement (linked to the Model)

Real Time Work Front Analysis

Real Time Data Reporting (Dashboard)

Accounting System Integration

Real Time Manhours estimation

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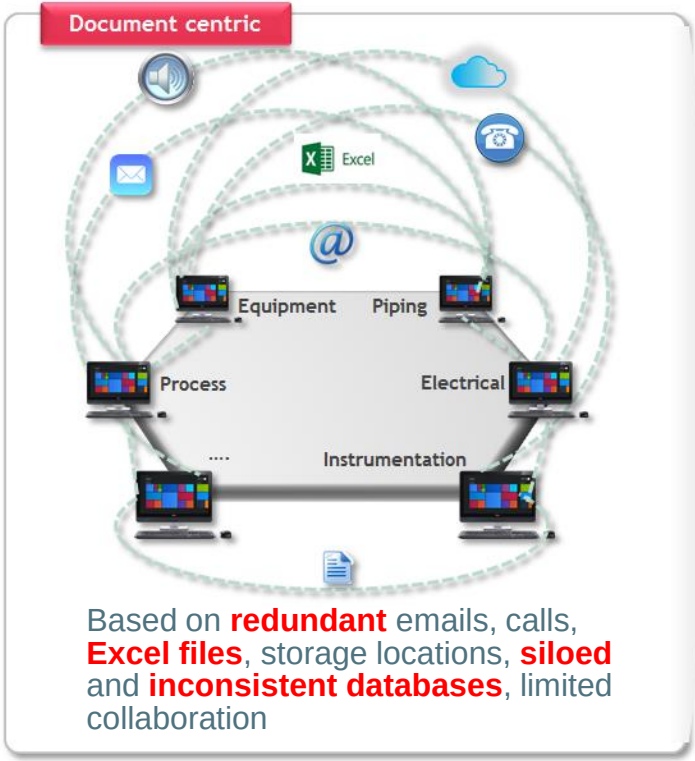
4- EPCI Contractor Project Information Management Plan

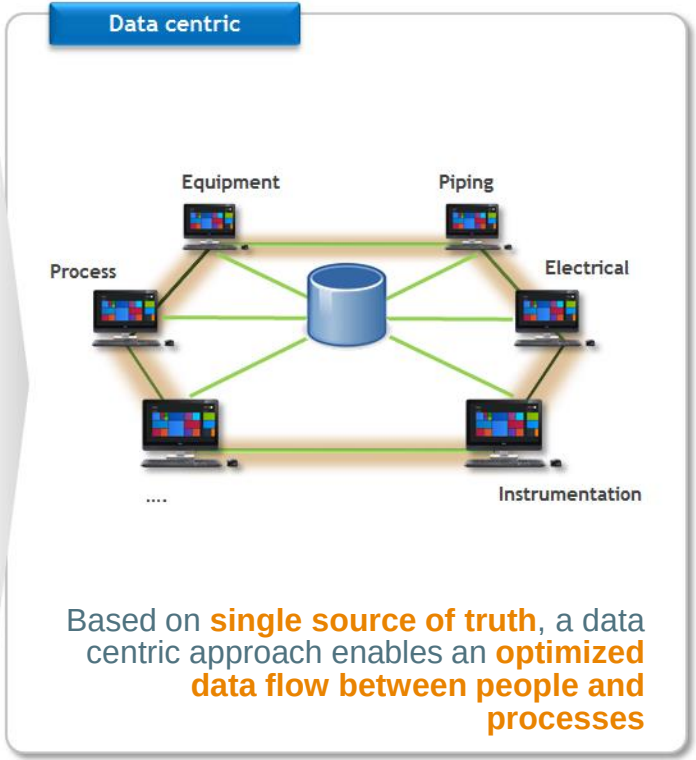
- Information Management and ICT Organization Chart
- Selection of Engineering, Business, Data Warehouse and Data Analysis/Visualization software
- Project Execution Management tools (Material Supply Chain Management, Reporting (xD information), Fabrication, Mechanical Completion)
- Exchange of Data between software and Engineering Workflows
- Data Quality Management
- Data Change Management
- Integration of Partner, Sub-Contractor and Vendor Data
- Collaborative approach, Project Visualization Portal
- Handover to COMPANY

From Documents to Data Value Selling

4- Data extracted from Documents

- Documents generated from Data

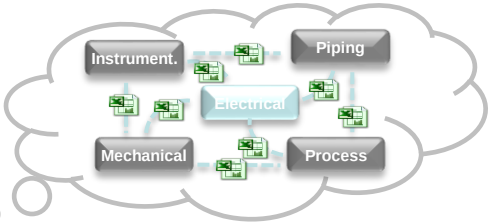




4- Digital Lists vs Shared Excel File Lists

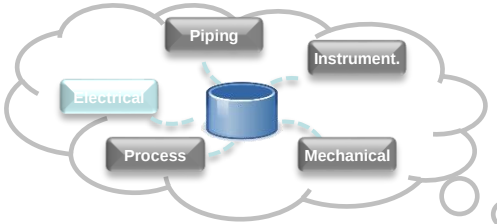
Moving from uncontrolled shared Excel file Lists to a controlled shared Database managing Digital Lists

Shared Lists



- Different file formats
- Different content and versions
- Low data quality
- Heavy manual effort
- No analysis
- …

Digital List



- No file exchanged
- Shared content and data versions
- High data quality
- Enforced workflow
- Several analysis enabled
- …

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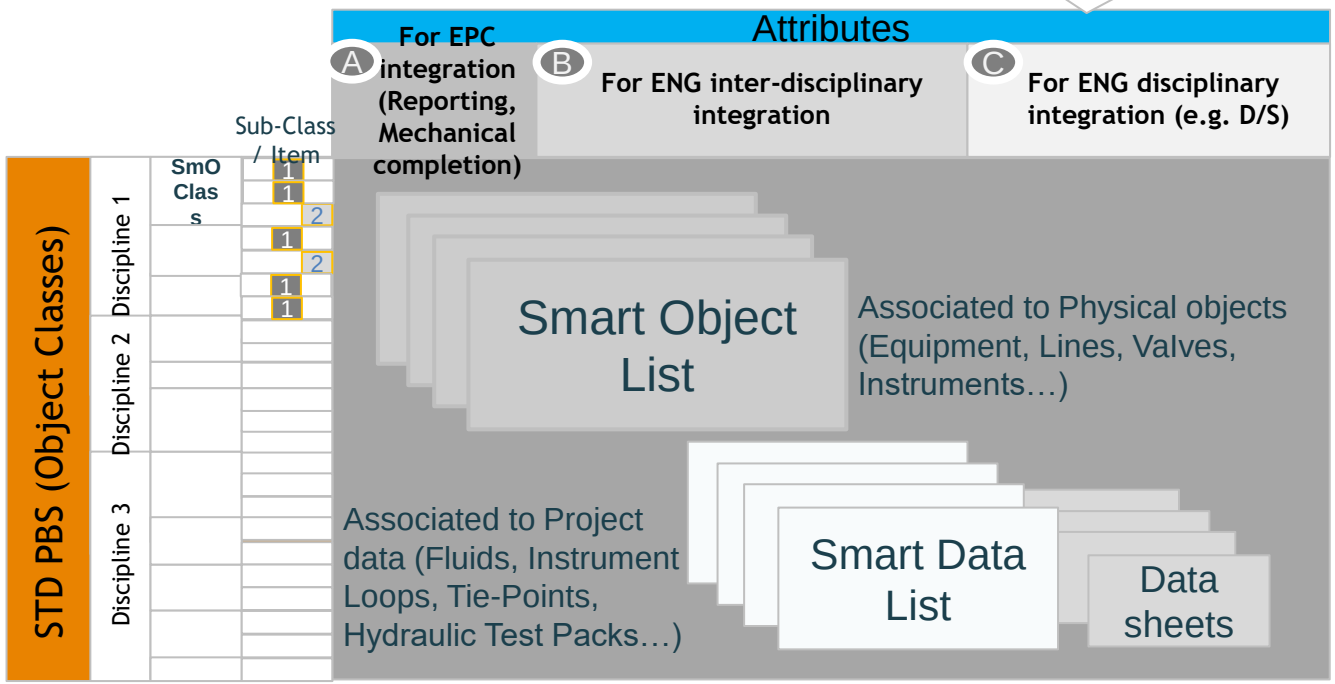
5- EPCI Contractor Data Model

Why “Smart Objects”: they are hub for aggregating information from multiple environments

- Property name
- Property definition
- Property data type
- CFIHOS unique id

Relation with other possible Project Attribute taxonomy, e.g.:

- Client
- ENG partners
- etc



5- EPCI Contractor Data Model

- Data Asset material break through in Classes and Sub-Classes by discipline
- Data Item tagging procedure as per Client requirement
- Data Attributes classification
- Data Classification of attributes per owner discipline (role)
- Data Attributes specific to EPCI Execution:
  - Smart Object Maturity (Level of Development) status
  - HOLD Log, Variation Log, Management of changes (revision, status)
  - Design, Procurement and Installation Responsibility
  - Planning, Cost

Basic			Front End	Detailed Engineering		
Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Conceptual	Basic Process	Basic Engineering	Design summary and validation	Engineering for Procurement	Engineering for Construction	Engineering during Construction
Identification, definition and functional analysis of primary and secondary systems.	Process specifications and functional specifications of the constituent elements of the systems.	Design of the constituent elements of the systems with reference to constructability and safety.	Completion and technical-economic optimization of design and plant engineering aspects of the systems.	Definition of the scope of supplies. Technical bid evaluation, issue of orders and follow-up.	Issue of documentation valid for construction.	Documentation follow-up during construction, precommissioning, commissioning and start-up.

HOLDs chasing

First Gate Milestone:
FEED Completion

Clear all the design issues and HOLDs

Second Gate Milestone:
Before massive issue of IFC docs

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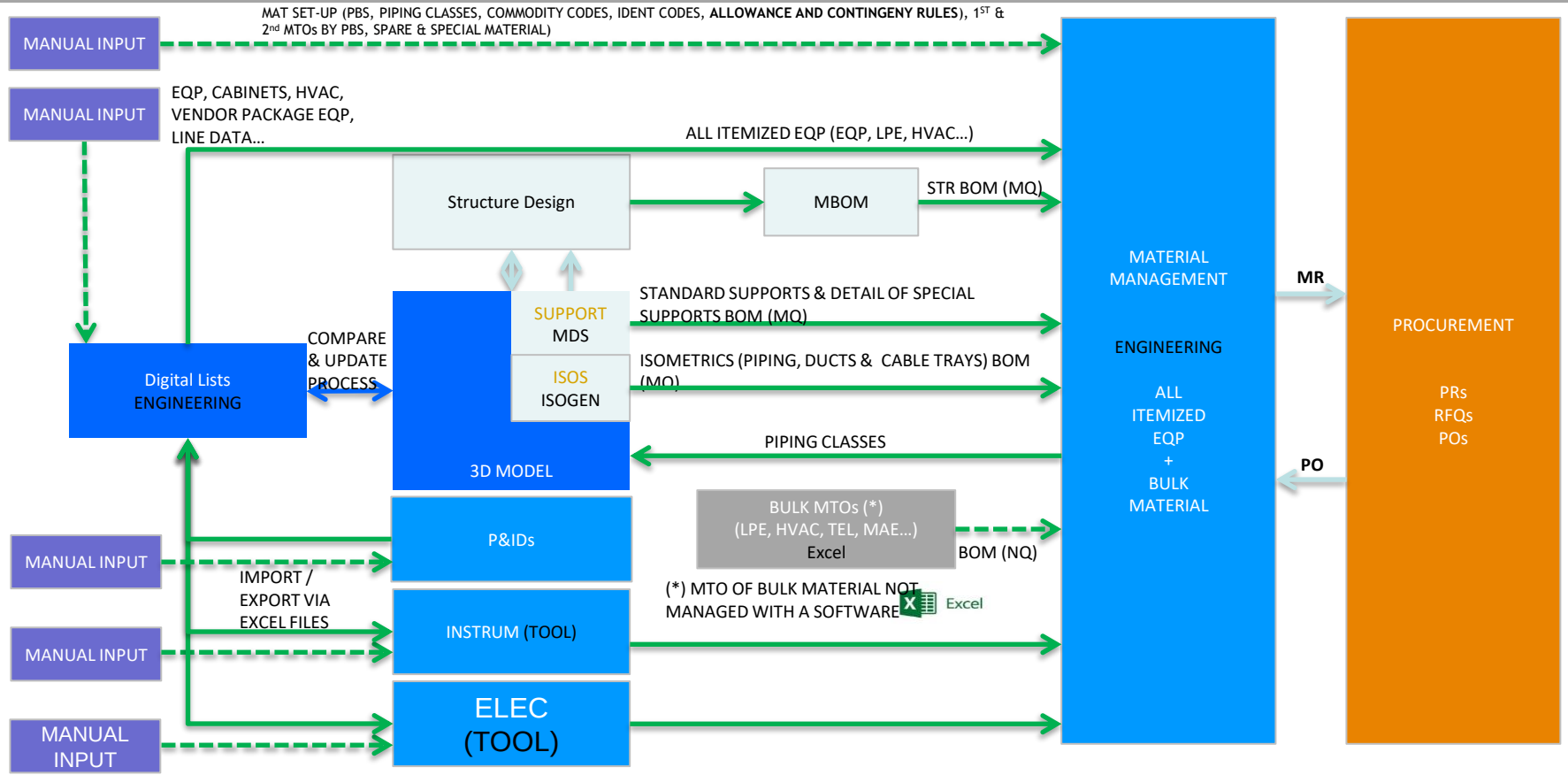
6- Project Information & Supply Chain Management with Mixed engineering tools environment



6- Objectives in using Engineering tool

- Make a day-to-day engineering tool used by everyone, anywhere
- Manage through Engineering tool Project Digital Lists, covering Engineering, Procurement (Material Requisitions) and Construction (Mechanical Completion) needs,
- Manage Process, Safety, Mechanical, Instrumentation Digital Data Sheets, starting from most numerous and common equipment: Pumps, Drums, Filters, HEs, ON/OFF Valves, CVs, PSVs, FTs, ROs, Analyzers, bulk material…
- Exchange and interconnect informations to lists, MDR, 3D Models…
- Keep compliant with Engineering work processes an EPCI contract execution

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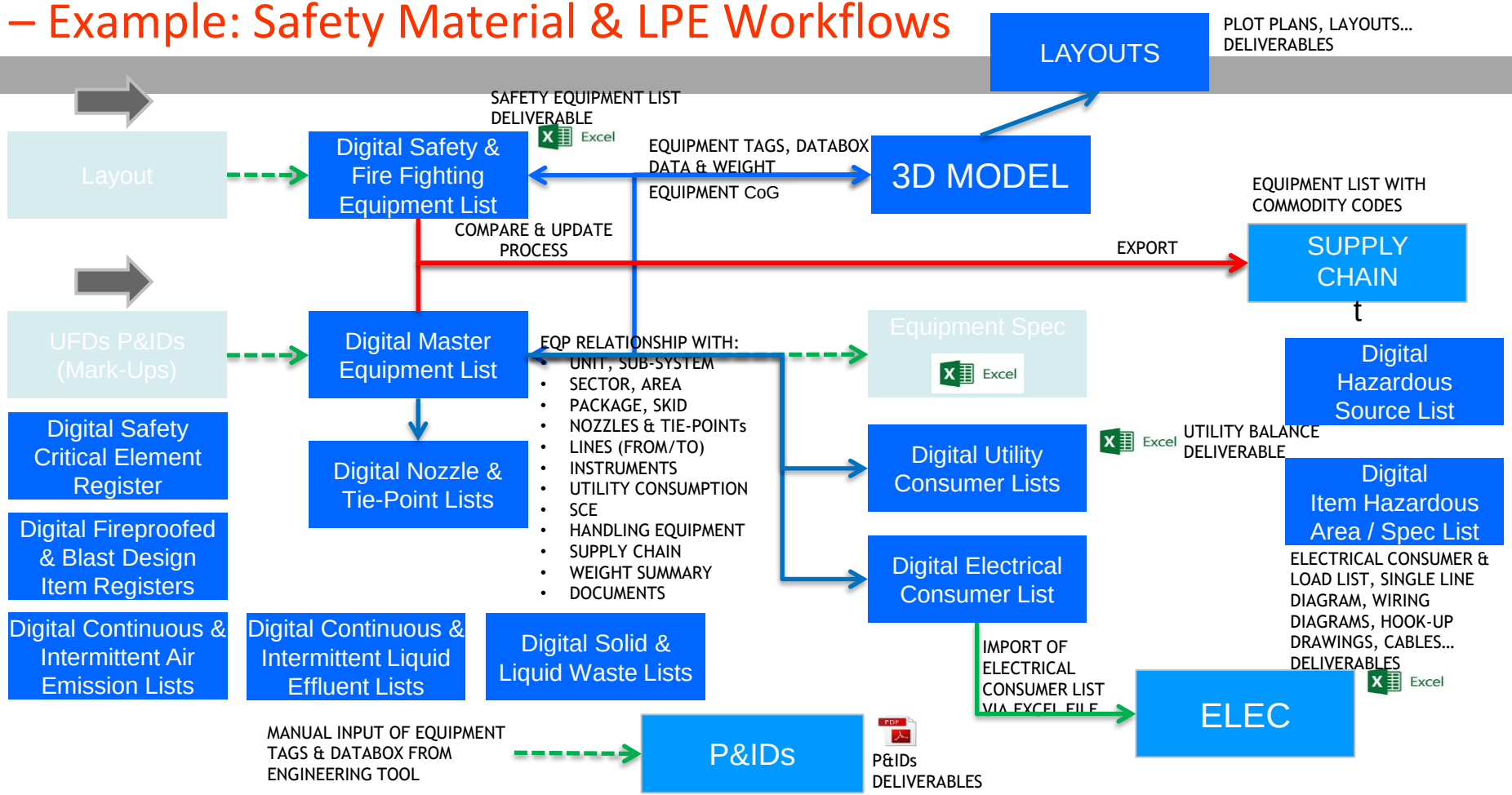
8 – Example: Safety Material & LPE Workflows



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8 – Project Life-Cycle Management Methodology

The vision is to build a common **digital and data-centric collaborative methodology for the management of the entire project life-cycle**, that stores and processes the entire project data and conjugates it in multiple different dimensions, according to the different activities and operations performed by all the stakeholders along the full project life-cycle.

Key Dimensions

- **1D** - Real Time **Collaborative Environment**
- **2D** - **Real Time Data** and Reporting
- **3D** - Enriched **3D Model** Visualization
- **4D** - **Time Governance**
- **5D** - **Smart Object** Lifecycle
- **6D** - **Project-in-App** & Augmented/Virtual Reality

8 – Engineering Digitization Key Features

Key Dimensions

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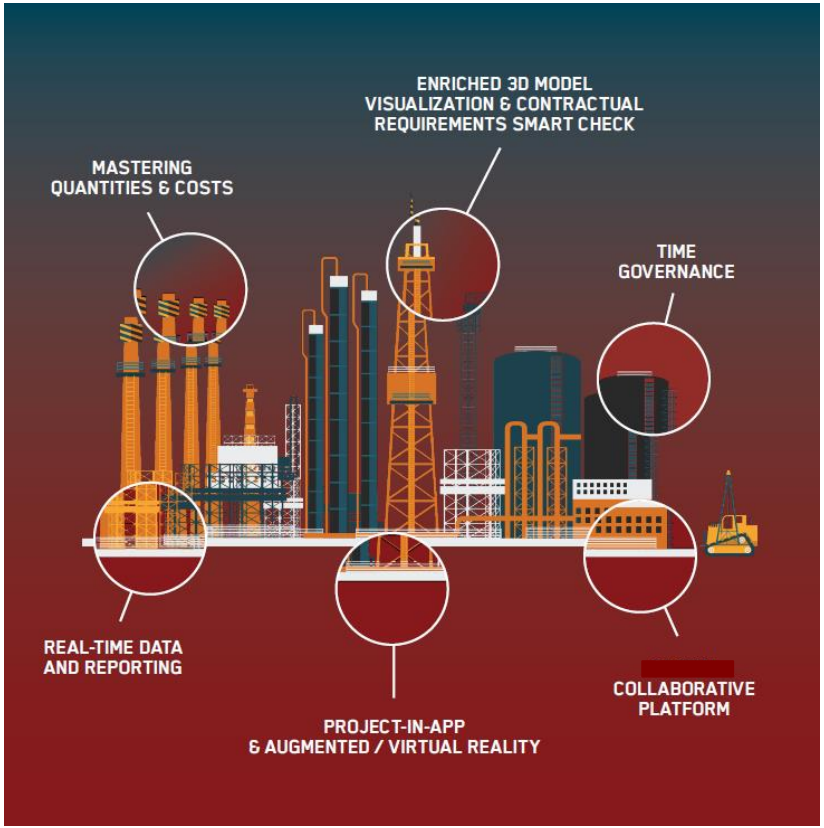
6D - **Project-in-App** & Augmented/Virtual Reality

- Digital collaborative platform integrating stakeholder's activities, all along full project life-cycle
- Data centric methodology inducing redefinition of work processes
- Real time decision and continuous hand over to client

Use Case Conclusion

Opportunities of digital for EPCI contractor and engineering activities are double:

- collaborative platform
- digital twin



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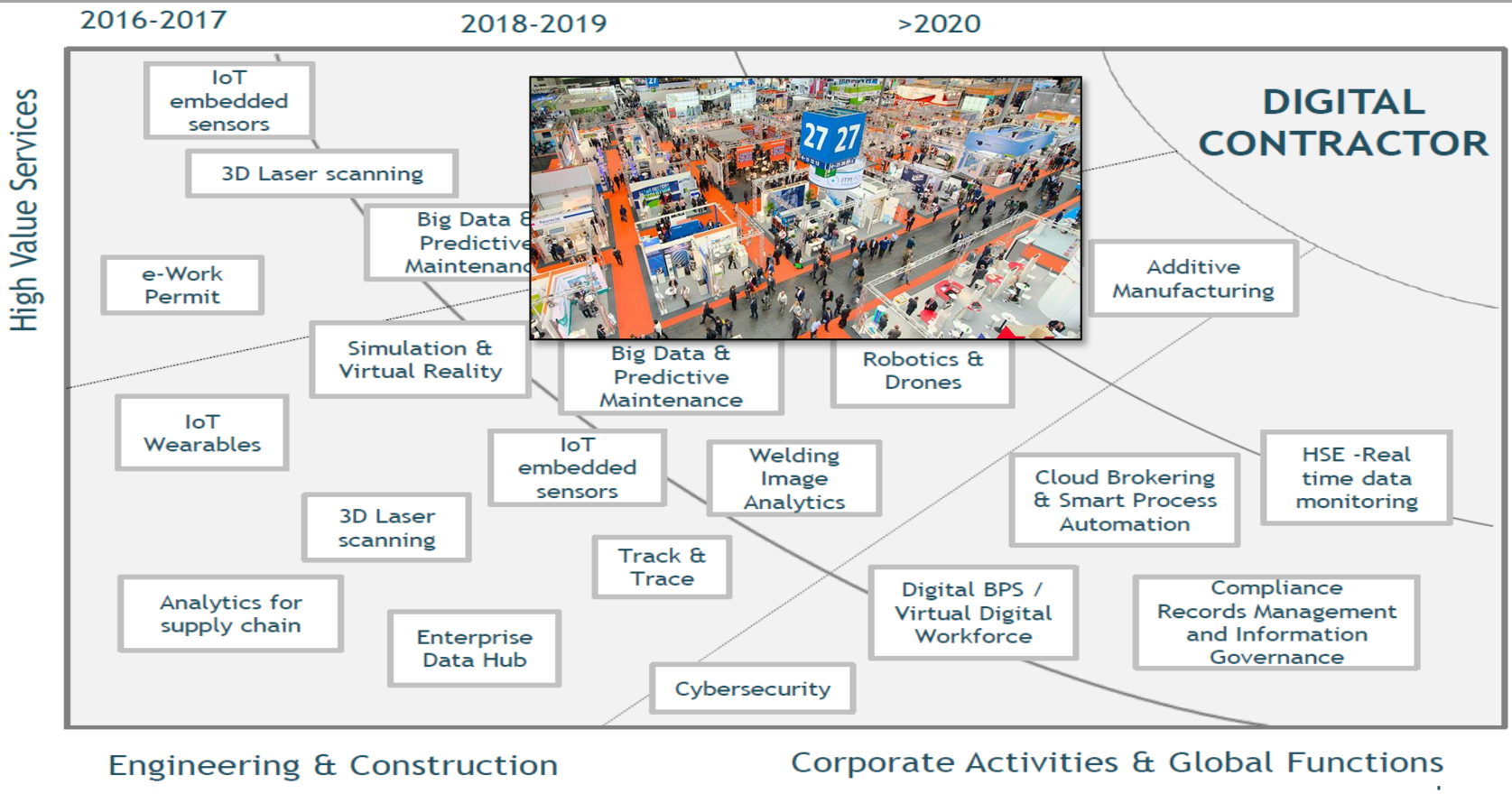
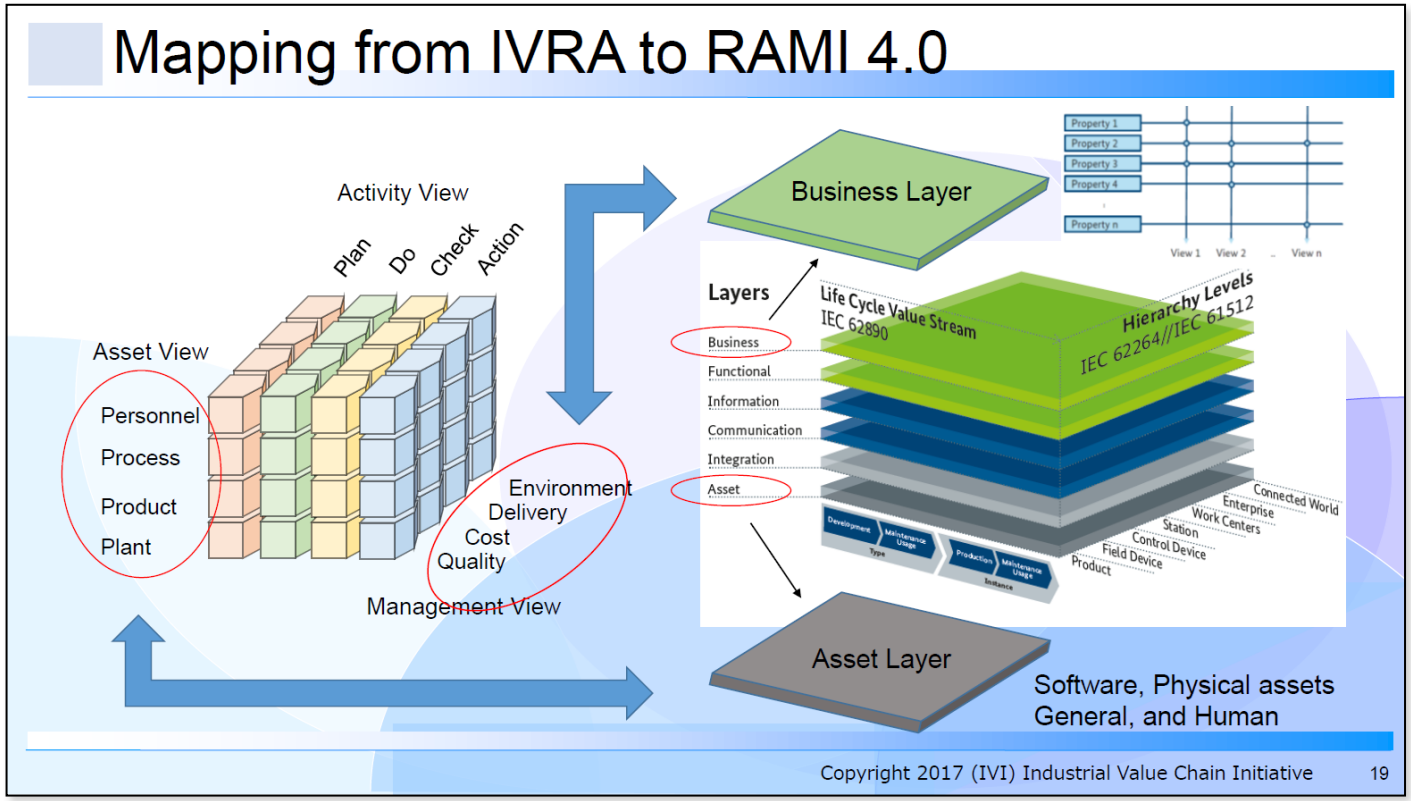
Part 2: Lesson Learnt

Road Map to Digitization

Digitization Technologies are Available



Interoperability is Possible : Japan IVRA and German RAMI 4.0



with Courtesy of Yasuyuki Nishioka, Prof. Dr. Hosei University

Interoperability is Possible : USA OPC Foundation and German RAMI 4.0

- April 2018: Agreement signed in Hannover Fair
- Since 1996, the OPC Foundation has facilitated the development and adoption of the OPC information exchange standards in Microsoft Window operating System.
- OPC Foundation's mission is to maintain interoperability from embedded world to enterprise cloud.
- OPC Foundation serves over 580 members worldwide in the Industrial Automation, IT, IoT, IIoT, M2M, Industrie 4.0, Building Automation, machine tools, pharmaceutical, petrochemical, and Smart Energy sectors.
- IEC-62541: Open Platform Communication Unified Architecture (OPC UA)
- https://opcfoundation.org.

Digitization Standards Exist

STANDARDIZATION COUNCIL INDUSTRIE 4.0

Topics	Standards supporting Industrie 4.0
Functional Safety	IEC-61511, IEC-62061
Products Classification	IEC-61360, ISO-13584
Communication Protocols	IEC-61784, IEC-62541
Interfaces Configuration	IEC-61804, IEC-62453
Engineering	IEC-61131, IEC-61987, IEC-62424, IEC-62714, ISO-17506
Digital Factory Reference Model	IEC-62794, IEC-62832
Architecture	IEC-61512, IEC-62850, IEC-62890, IEC-62264
Cybersecurity	IEC-27000 series, IEC 62443

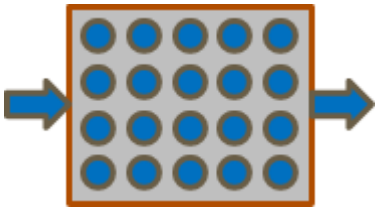
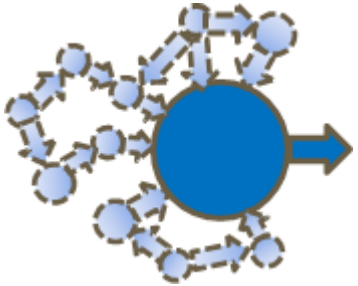
Road Map to Digital Transition

From a Technical Approach

To a Value Creation Approach

Digitization Business Model

New Business Model | Data Management | Digital Twin

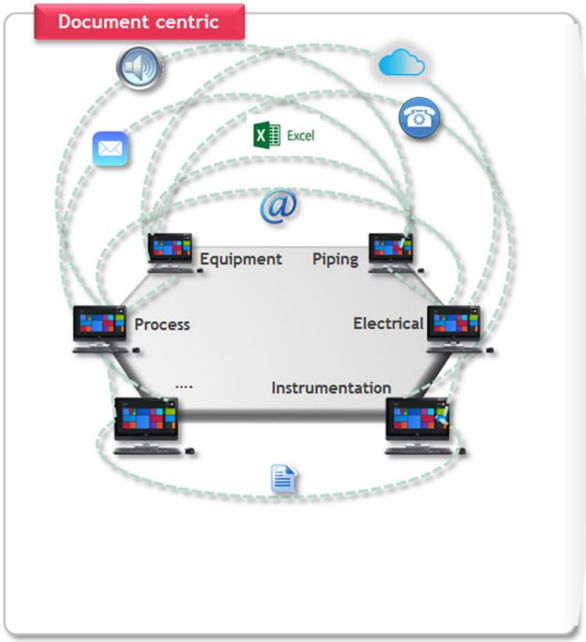
1908 - Ford T	1960 - Toyota	1980 - VW	2015 - Gafam
			
Fully Integrated Business Model	Kanban 1-to-1 Value Chain Cost Control	Outsourcing Globalization Added Value Dilution	Agile Business Model No Value Chain, but Value Network

From Value Chain to Value Network

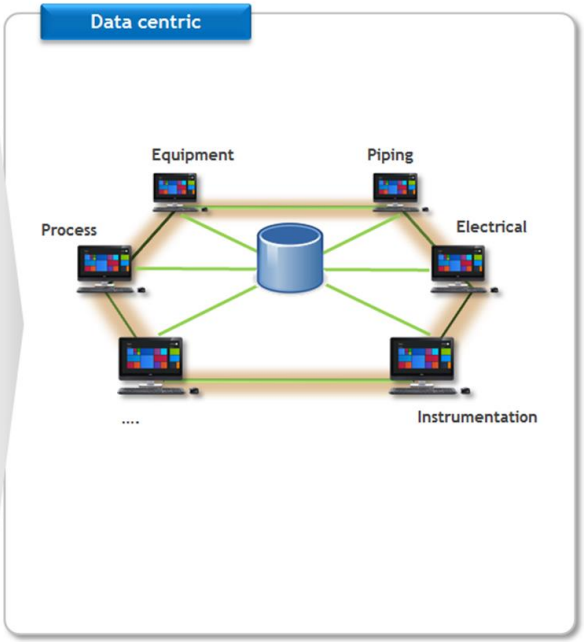
Digitization Data Management

New Business Model | Data Management | Digital Twin

Data extracted from Documents



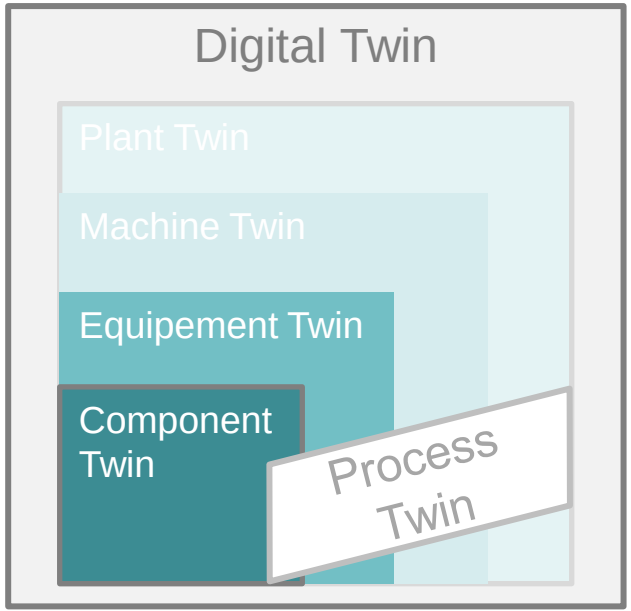
Documents generated from Data



Digitization Process for Digital Twin

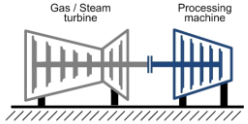
New Business Model | Data Management | Digital Twin

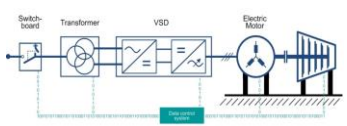
Top-Down

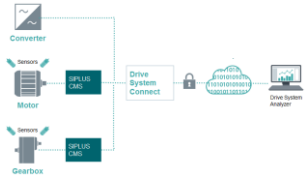


Bottom-Up

Digital Twin Use Case: Turbine Replacement from E via EA to EAD







Mechanical Turbine	Electric Drive Train Integration into SCADA	Digital Services
• Operating compressor (pumps or fans) with gas or steam turbine • Burn fossil fuels with high emissions • Low efficiency • High maintenance effort • High OPEX	• Emission-free Solution – Zero CO_2 /NO_x • Minimized Maintenance • Maximized Uptime • Lower OPEX	• Fleet-Management • Remote services • Condition Monitoring / Services • Predictive Maintenance • Remote diagnostics

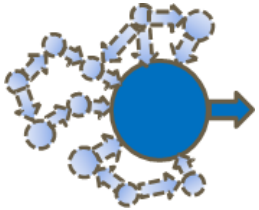
Digitization Rely on Tools & Processes

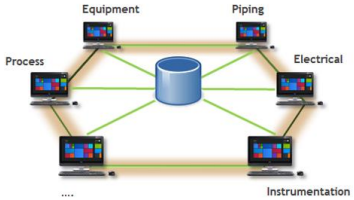
To
Secure
Intellectual Property

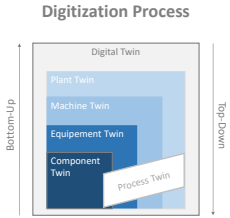
To
Ensure
Traceability

To
Evaluate Risks &
Measure Value Creation

New Business Model → Data Management → Digital Twin







Questions

New Business Model → Data Management → Digital Twin