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Knowledge Management for Digital Transformation: New Trends

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Prof. Smirnov Lab' Current Research Projects in the Area of Digital Business: Main Directions

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- **Information & Knowledge Management** (projects of Festo, Germany; Ford Motor Company, USA; Russian Ministry of Science & Higher Education; Russian Science Foundation; Russian Foundation for Basic Research):
  - **Context-Aware Knowledge Management;**
  - **Ontological Modelling of Socio-Cyber-Physical Systems;**
  - **Infomobility;**
  - **Context-Oriented Collective Interaction of R&D Expert Networks**.
- **Decision Support** (projects of Russian Science Foundation; Russian Foundation for Basic Research; Russian Academy of Sciences):
  - **Decision Support Models & Methods Based on Human-Computer Cloud;**
  - **Proactive & Context-Aware Recommendation Systems**.
- **Group Robotics** (projects of Russian Foundation for Basic Research; Russian Academy of Sciences; Festo):
  - **Context-Driven Robot Coalition Formation and Control:**
  - **Customer-Oriented Robot Configuration**.

Presentation Outline

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- **Introduction**
- Knowledge Management in Festo
- Future Work and Conclusion

Modern Operating Model for Digitalization

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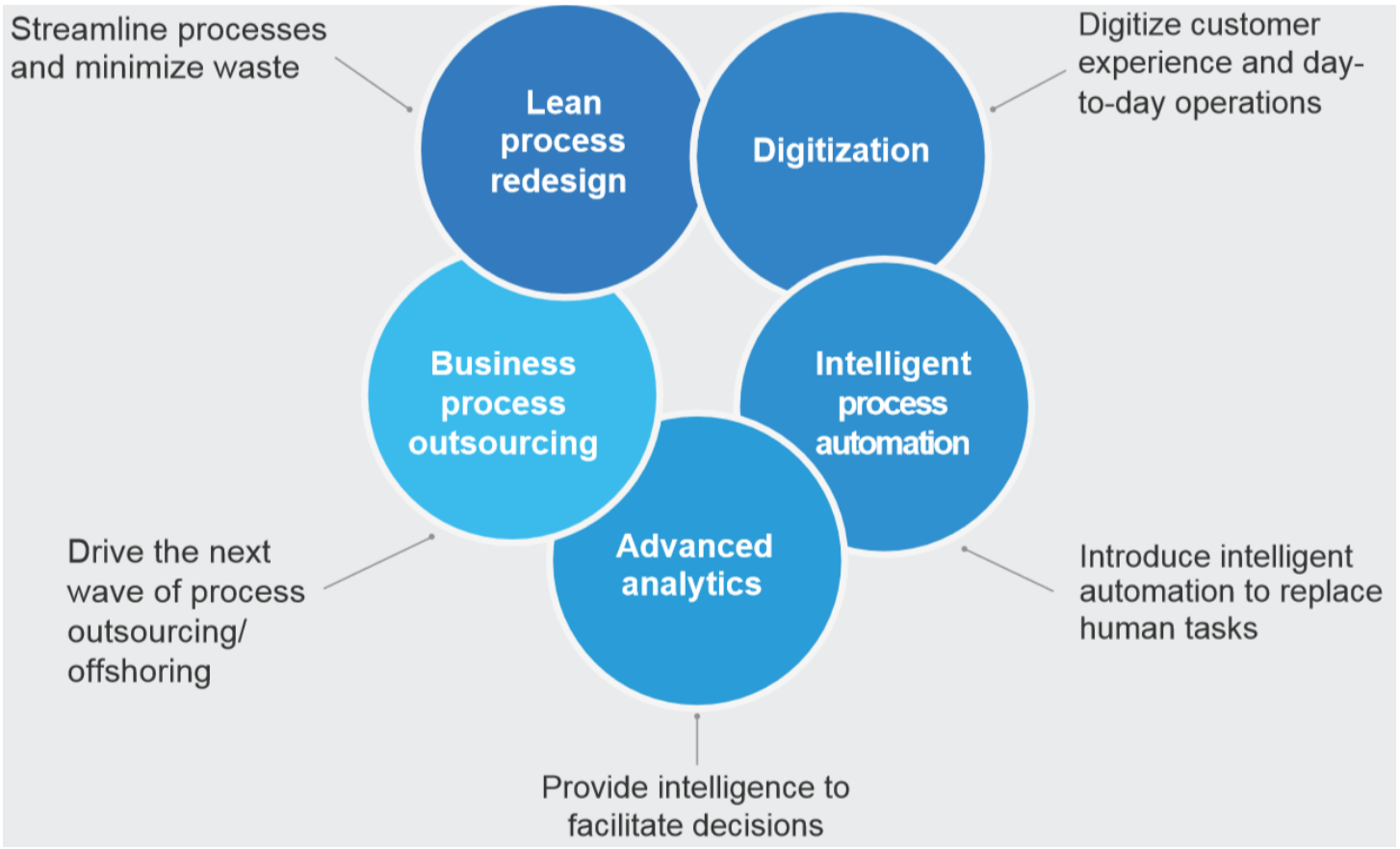

The next-generation operating model for the digital world. A. Bollard, E. Larrea, A. Singla, and R. Sood. Digital McKinsey, 2018

Cognitive Manufacturing / Industry 4.0

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Cognitive manufacturing—also known as smart manufacturing or ***Industry 4.0*** - uses cognitive computing, the Industrial IoT, and advanced analytics to optimize manufacturing processes in ways that were not previously possible.

Cognitive manufacturing is powerful because it combines sensor-based information with machine learning and other artificial intelligence capabilities to find patterns in structured and unstructured data from plant, enterprise and industry systems.

Key Issues Cognitive Technologies Address for Manufacturers:

- Solving business challenges;
- Creating new value from manufacturing data;
- Improving product quality;
- **Enhancing knowledge management**.

Source: Cognitive Manufacturing: An Overview and Four Applications that are Transforming Manufacturing Today (https://www.ibm.com/downloads/cas/VDNKMWM6)

Industrial Intelligence

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- **Industry 4.0 = Industry 4.0 Technologies** (IoT, blockchain, etc.) **+ Industrial Intelligence**.
- **Industrial intelligence is the alliance of artificial intelligence with automation** and energy technology, IT platforms and intralogistics.
  - **Industrial intelligence** can only play its part in **driving the digital transformation** if people have the requisite qualifications to combine all these aspects in a useful way and develop them further. It is crucial that experts from a huge range of fields collaborate much more closely than in the past.
- **Industrial intelligence stands on** two pillars:
  - technology,
  - **knowledge management (based on qualifications and process expertise of people).**

Source: "INDUSTRIAL INTELLIGENCE" - THE NEXT BIG STEP (https://vdmaimpulse.org/article/-/article/render/210089)

Facts about Knowledge Management (1/3)

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- "**A traditional knowledge management (KM) project** was usually a centralized effort to organize resources and content via taxonomies, cumber some e-forms and repositories, and complex review processes. It **missed the point** that knowledge resides with ***people*** and, especially in complex situations, is difficult to access and use without ***collaboration and context***."

  Source: Rozwell, C. (2012). Socialization of Knowledge Management Drives Greater Reuse. Retrieved from Gartner website: http:// www.gartner.com/id=2046916

- Many KM leaders agree that **a successful KM implementation is 20% technology and 80% people**, and ***includes management, incentives, culture, and communication***.

  Source: Rozwell, C. & Mann, J. & Drakos, N. (2012). Knowledge Management Projects With Focused Objectives Deliver Most Value. Retrieved from Gartner website: http://www.gartner.com/ DisplayDocument?doc_cd=235797&ref=ddisp

Facts about Knowledge Management (2/3)

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- **Knowledge sharing** can be defined as the "***exchange of knowledge*** *between and among* ***individuals***, and *within and among* ***teams***, organizational ***units***, and ***organizations***".

  Source: Schwartz D., Encyclopedia of Knowledge Management, 2006.

- Consider that **70-90% of corporate *knowledge is informal*** ("any unwritten information **that is known within an organization unit but often unknown outside of it**"), with the vast majority occurring within local workgroups and never shared across multiple inter-related functions.
- **Knowledge workers spend 15 - 30% of their time seeking specific information and these searches are successful less than 50% of the time.**

  Source: Harnessing Your Tribal Knowledge: Creating a more productive organization through systematic knowledge capture and dissemination. http://www.informationweek.com/ whitepaper/Business-Intelligence/Knowledge-Management/ harnessing-your-tribal-knowledg-wp1260312372749

Facts about Knowledge Management (3/3)

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- **Less than 10% of the knowledge you need to do your job is in your head. The other 90% is in other peoples' heads.** A KM framework that features ***social technologies*** *gives us a tool by which to access the information that only resides in someone else's brain or memory.*

  Source: Cross, J. Working smarter in the enterprise [Web log post]. Retrieved from Jay Cross website http:// www.jaycross.com/wp/2011/05/working-smarter-in-theenterprise-2/

- According to the McKinsey Global Institute, by **using social technologies**, companies **can raise the productivity of knowledge workers by 20 to 25 percent** *by improving collaboration and communication among and across teams.*

  Source: McKinsey Global Institute report, The social economy: Unlocking value and productivity through social technologies, https://www.mckinsey.com/industries/high-tech/our-insights/the-social-economy

Knowledge Management Strategies

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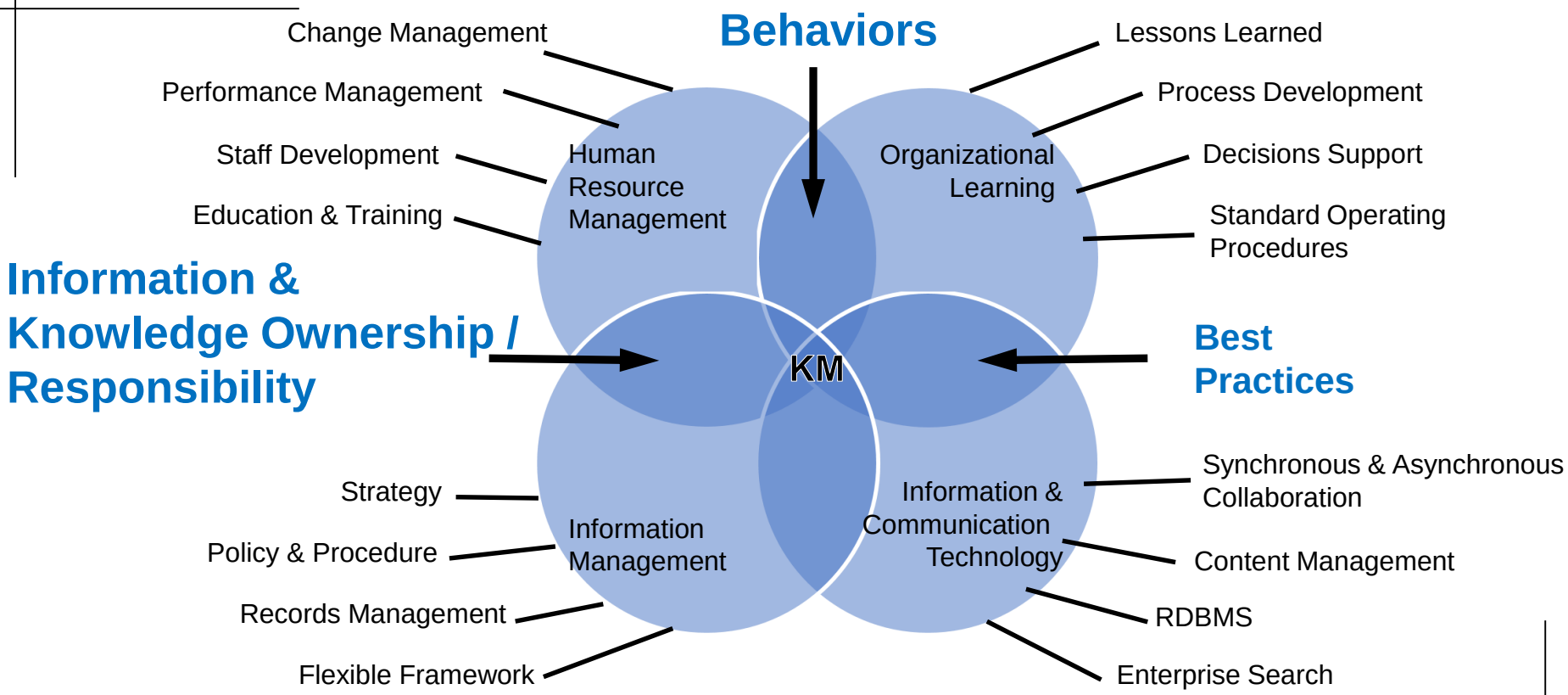

Information ownership and responsibility: The KM can provide devolved ownership and administration of information & knowledge assets to the divisions or units responsible for creating or managing those assets.
Behaviors: The use of the KM can promote the change of individual behaviors required to improve organization management.
Best Practices: The use of the KM can promote the use of best practices in everyday business.

Adapted from [Content Management in a Knowledge Management Context; http://www.prescientdigital.com/articles/content-management/content-management-in-a-knowledge-management-context]

Semantic Technology & Neighbors

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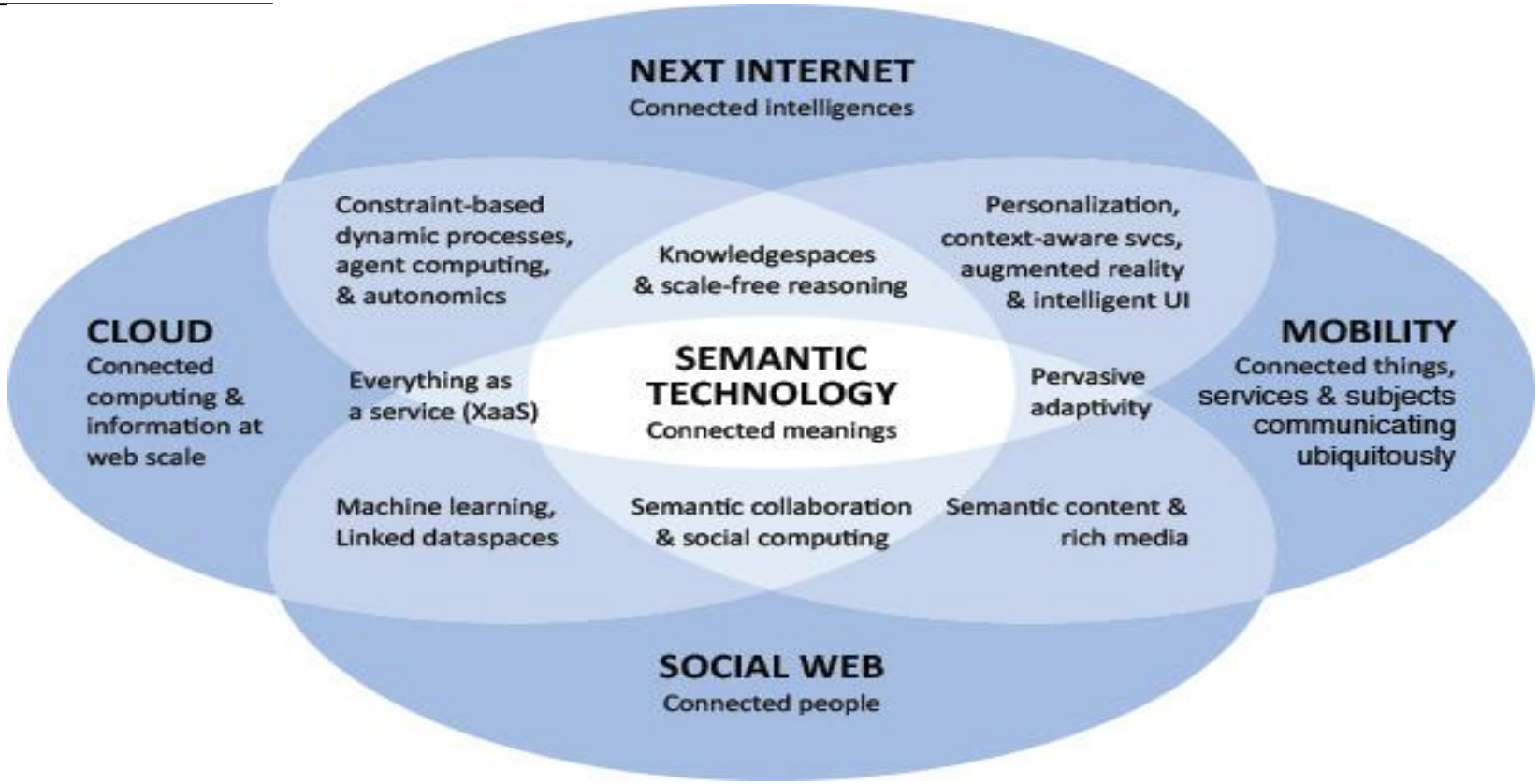

- Semantic Technology allows the meaning of and associations between information to be known and processed at execution time
- For a Semantic Technology to be truly at work within a system, there must be a knowledge model of some part of the world (**an active ontology**) that **is used by** one or more **applications** at execution time.

Source: TopQuadrant

Context in Knowledge Management

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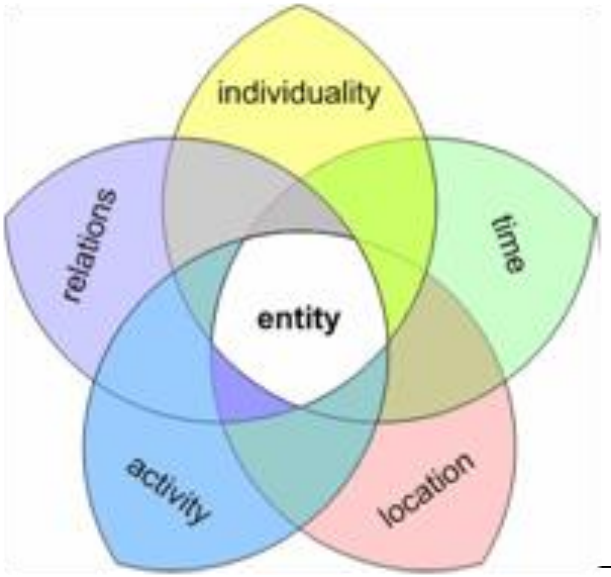
- 50% of the problems in the world result from ***people using the same words with different meanings.***

- the other 50% of the problems results from ***people using different words with the same meaning.***

Source: Kaplan S. The Words of Risk Analysis, *Risk Analysis*, Vol.17, N 4, August 1997

Fundamental categories for context information & knowledge



Presentation Outline

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- Introduction
- **Knowledge Management in Festo**
- Future Work and Conclusion

Festo Profile

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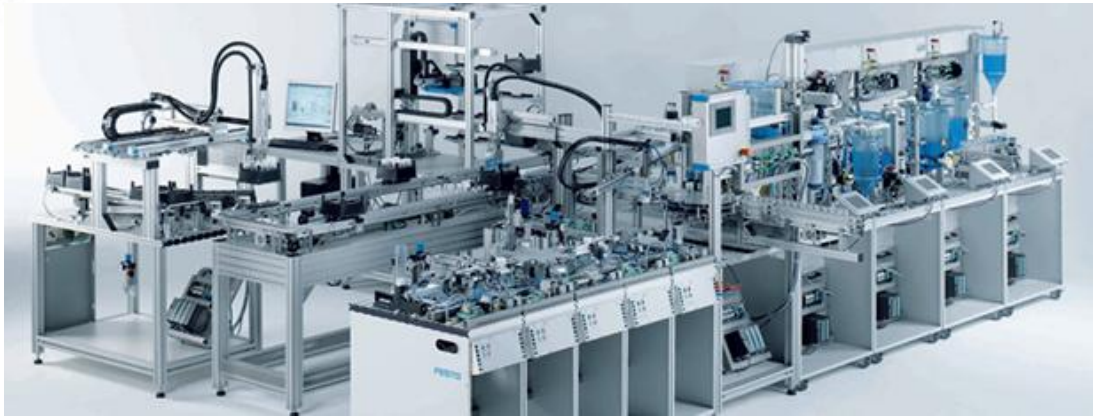
- Festo AG&Co KG (2003-…)
- more than 300 000 customers in 176 countries supported by more than 61 companies worldwide with more than 250 branch offices and authorized agencies in further 36 countries.
- pneumatic, electronic automation equipment and products for the process industry
- benefits for component manufacturers that tend to become system vendors in general.



FESTO Digitalization Framework and SPIIRAS Projects

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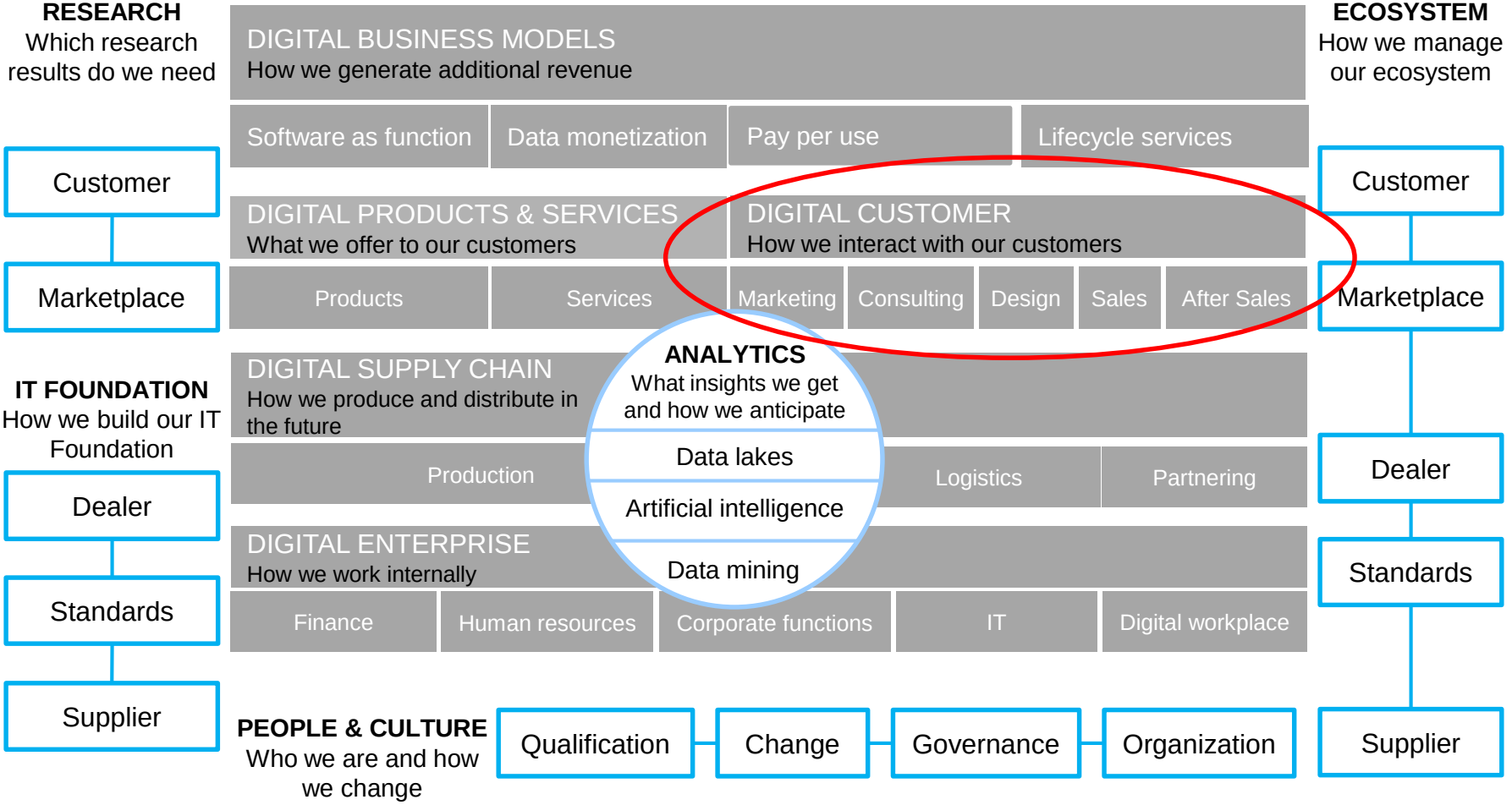

„Speed is the currency of Digitization“ Andreas Oroszi, VP Digital Business

Sources: https://ru.pinterest.com/pin/342344009160980345/
https://twitter.com/WSWMUC/status/956670302272020480

Festo’ Viewpoit: Digital Customer Journey

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- Giving *customers comprehensive consultation in the virtual world* in future.
- Customers' benefits
  - sales and consultation processes will be more continuous
  - the supply chain more transparent, more stable and safer.
- Customers will be able to
  - configure their machinery more rapidly via a consistently structured digital interface
  - test their interaction and functioning in advance by means of simulation tools together with manufacturers and operators
- Embedded sensors in the products will warn against malfunctions or production stoppages before they can occur

- *The objective is to provide a **virtual solutions consultant** that bundles knowledge of our products and their interaction into a system and is at the disposal of customers and partners.*

(Gerhard Borho, member of the Festo’ Management Board)

Source: http://www.aerospacemanufacturinganddesign.com/article/festo-hannover-messe-digitalization-integrated-industries-33117/

Information Priority for Digital Customer Journey Stages

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Market evaluation	Engineering	Production	Sales	Maintenance	Phase out
Industrial Segment	Product Structure	Characteristics	Industrial Segment	Applications	Product Structure
Constraints	Characteristics	Constraints	Constraints	Product Structure	Characteristics
Characteristics	Constraints	Product Structure	Applications	Characteristics	
Product Structure		Applications	Characteristics	Constraints	
Applications			Product Structure		

Knowledge Logistics Approach (*proposed by Prof. A. Smirnov)*

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- Knowledge is critical core competency for future. ***Only 20% of a firm's knowledge is effectively used by today's organizations***.
- ***Different users (decision makers)*** of knowledge & information look at it from ***different aspects (contexts)***
- Distribution Channel (*Business Network*):
  - A Channel describes how a company gets in touch with its customers. Its purpose is to make the ***right quantities*** of the ***right products or services*** available at the ***right place***, at the ***right time*** to the ***right people*** (Pitt *et.al*., 1999)
- **Knowledge Logistics** Aim:
  - Acquisition, integration, and transfer of the ***right knowledge*** from ***right sources*** in the ***right context*** to the ***right person*** in the ***right time*** for the ***right purpose*** *(**Smirnov et al., 2003**)*

Sources:

- Pitt. L., Berthon P., and J.-P. Berthon (1999). Changing Channels: The Impact of the Internet on Distribution Strategy. Business Horizons, March-April.
- Smirnov A., Pashkin M., Chilov N., Levashova T. Haritatos F. (2003) Knowledge Source Network Configuration Approach to Knowledge Logistics. International Journal of General Systems, 2003, 32 (3), pp. 251—269.

Festo' Project History (2003 – now)

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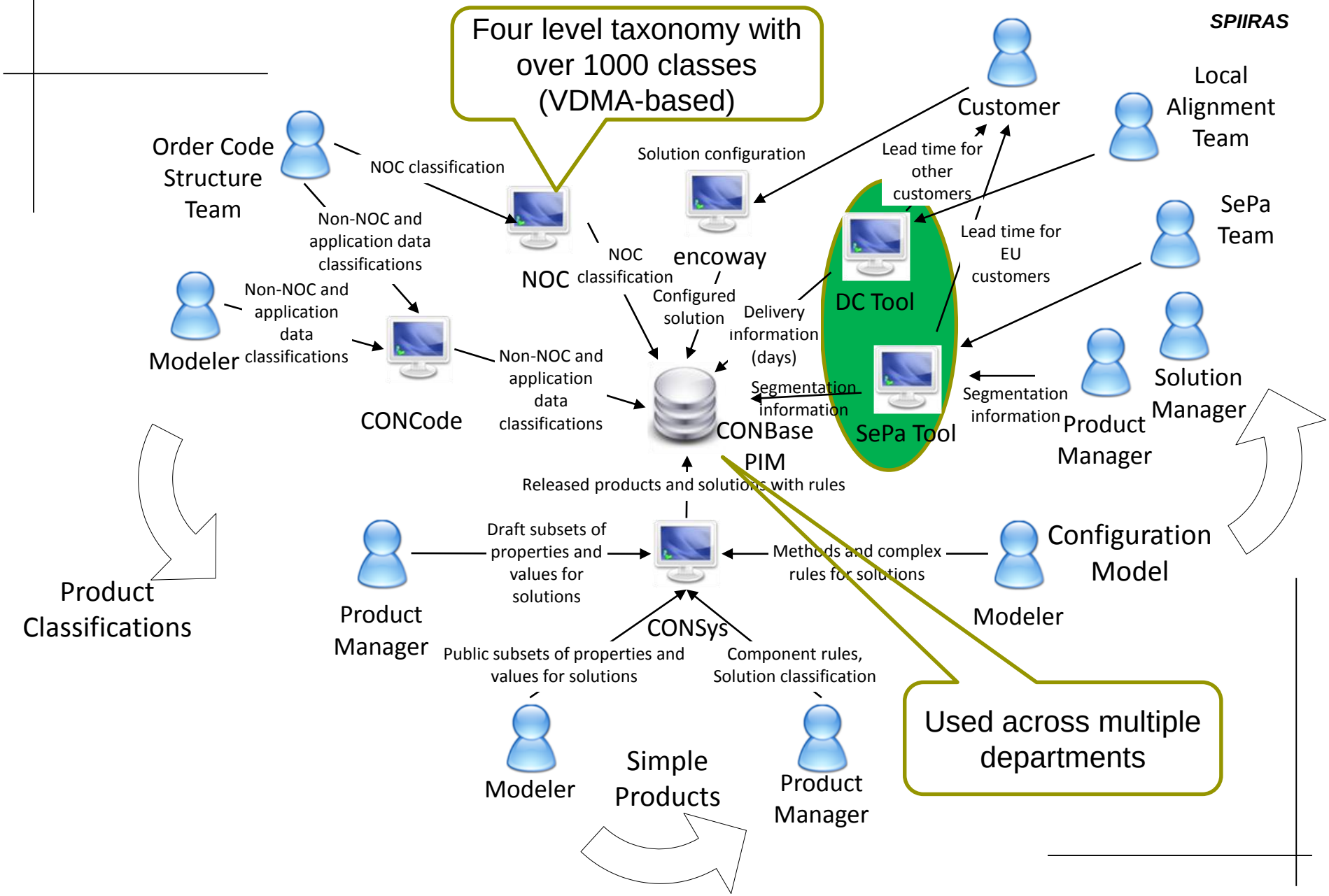

Festo' Product & Services Configuration: Multilevel Knowledge Management

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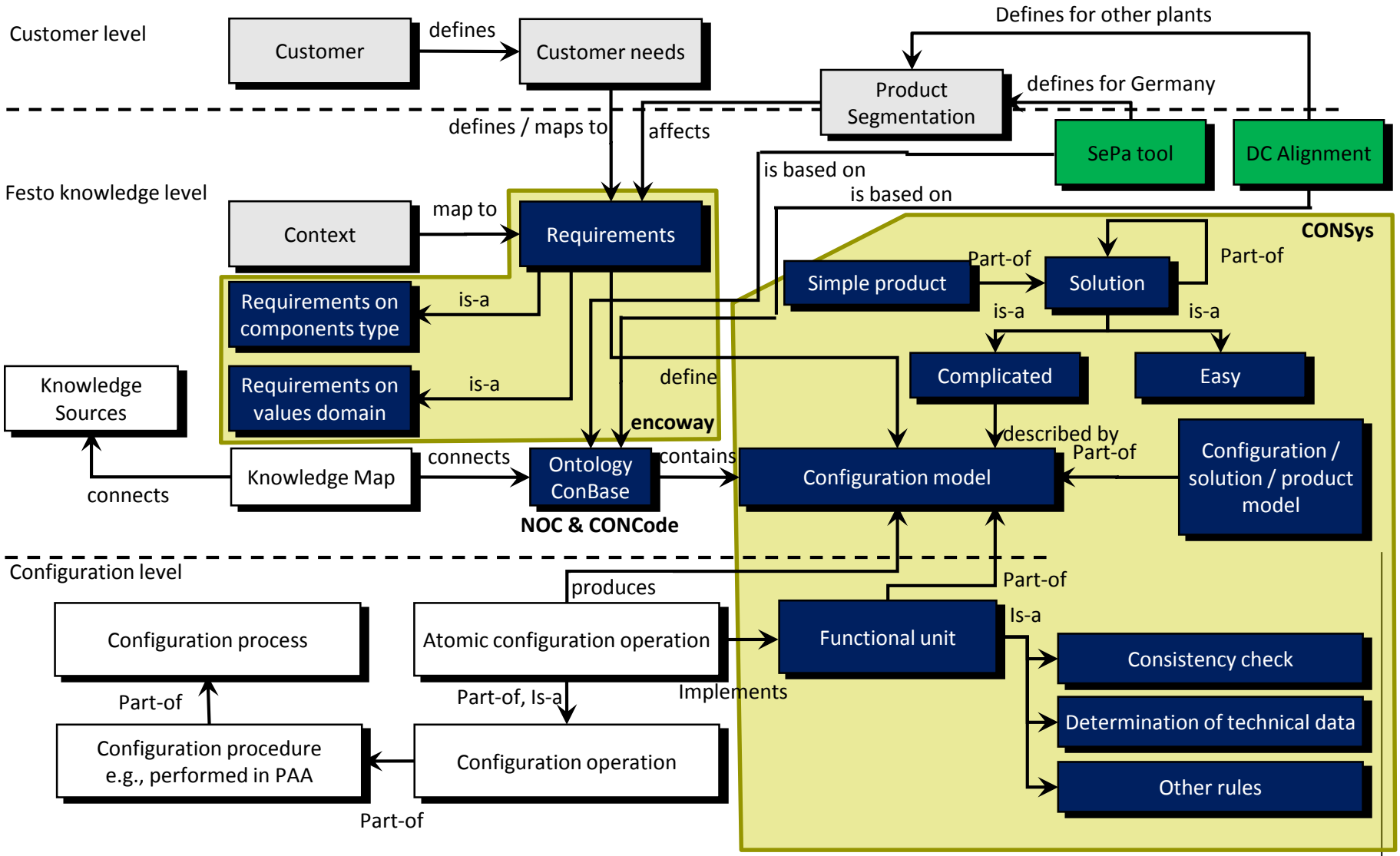

CONBase Ontology for Product Classification and Code Scheme

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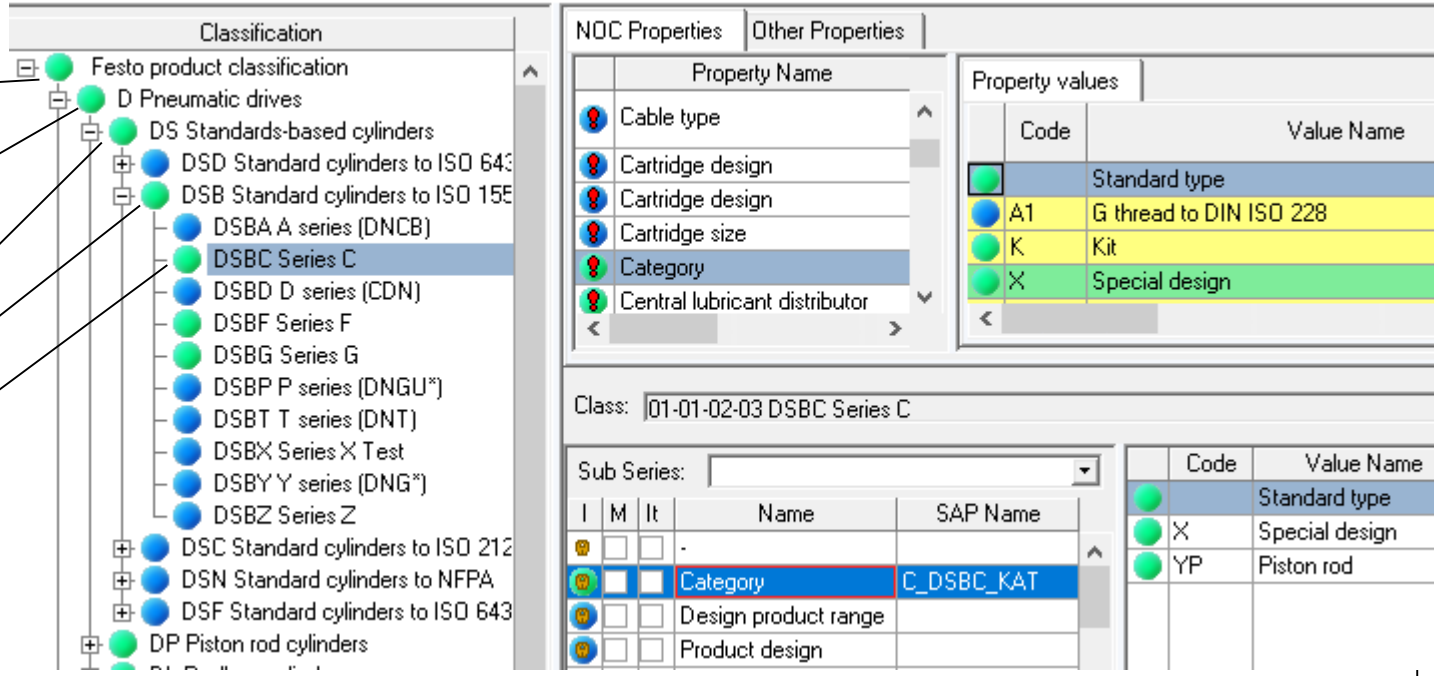
Classification (all products)

Product group

Product subgroup

Product segment

Product series



Specifications:

- initially is based on the VDMA classification (German Engineering Federation)
- 4 level taxonomy
- more than 2000 classes
- more than 2000 characteristics
- taxonomical relationships support inheritance

Ontology organization

- Configuration model
- Application data
- Product / system constraints
- Product data
- Product classification & characteristics

Complex Products Rule Example

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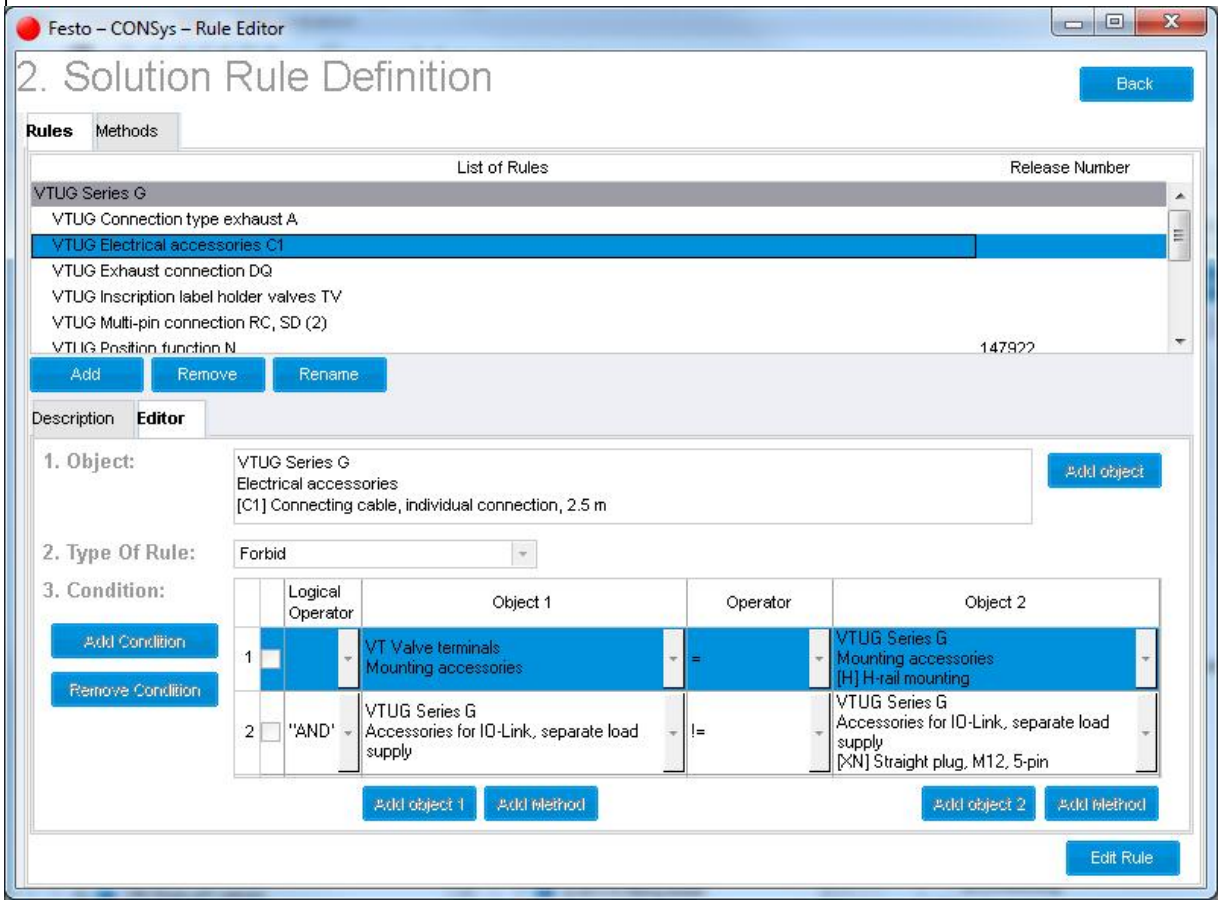

- Valve terminal (VTUG) is not compatible with electrical accessories option C1 (individual connecting cable) if
  - mounting accessories is H-rail mounting

  and
  - accessories for input-output link is not 5 pin straight plug M12.

from Supplier to Customer by Using CONBase Ontology

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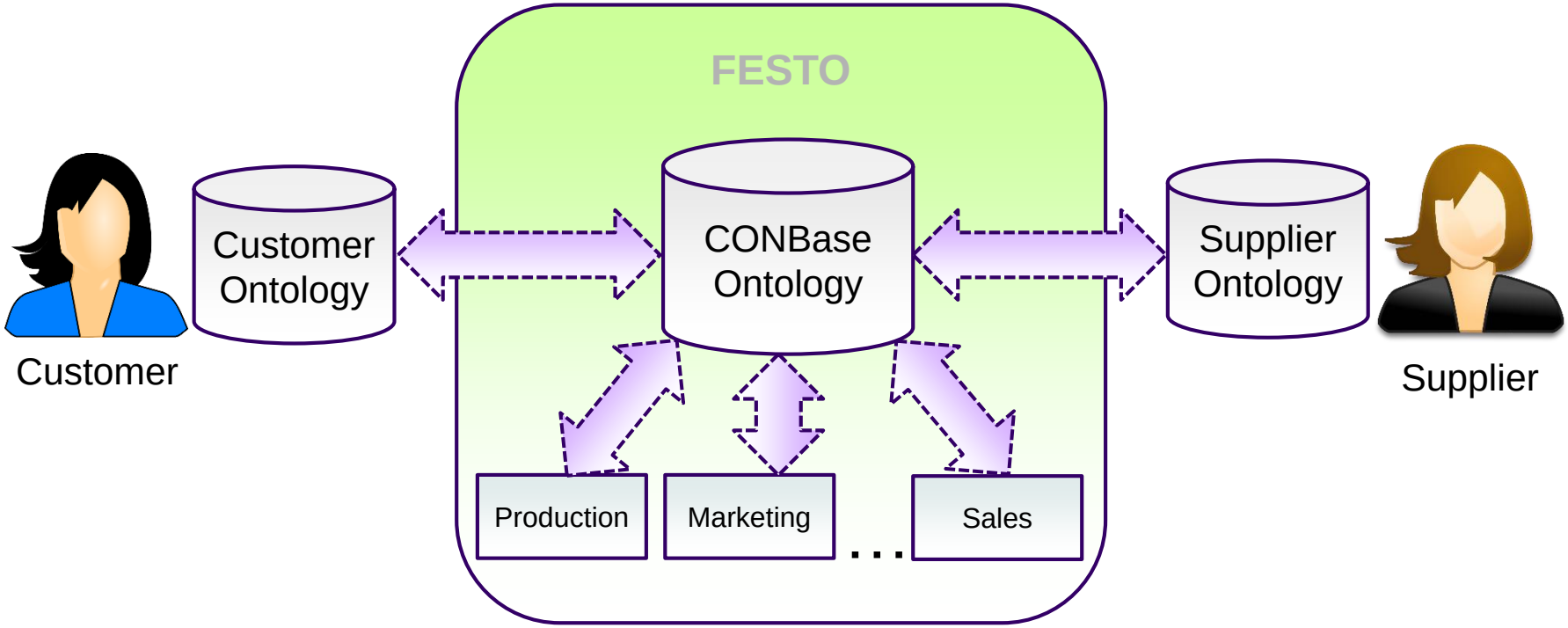
Digital Supply Chain (Pattern)



Ontology Matching

Role-based Perspectives of the Common Ontology

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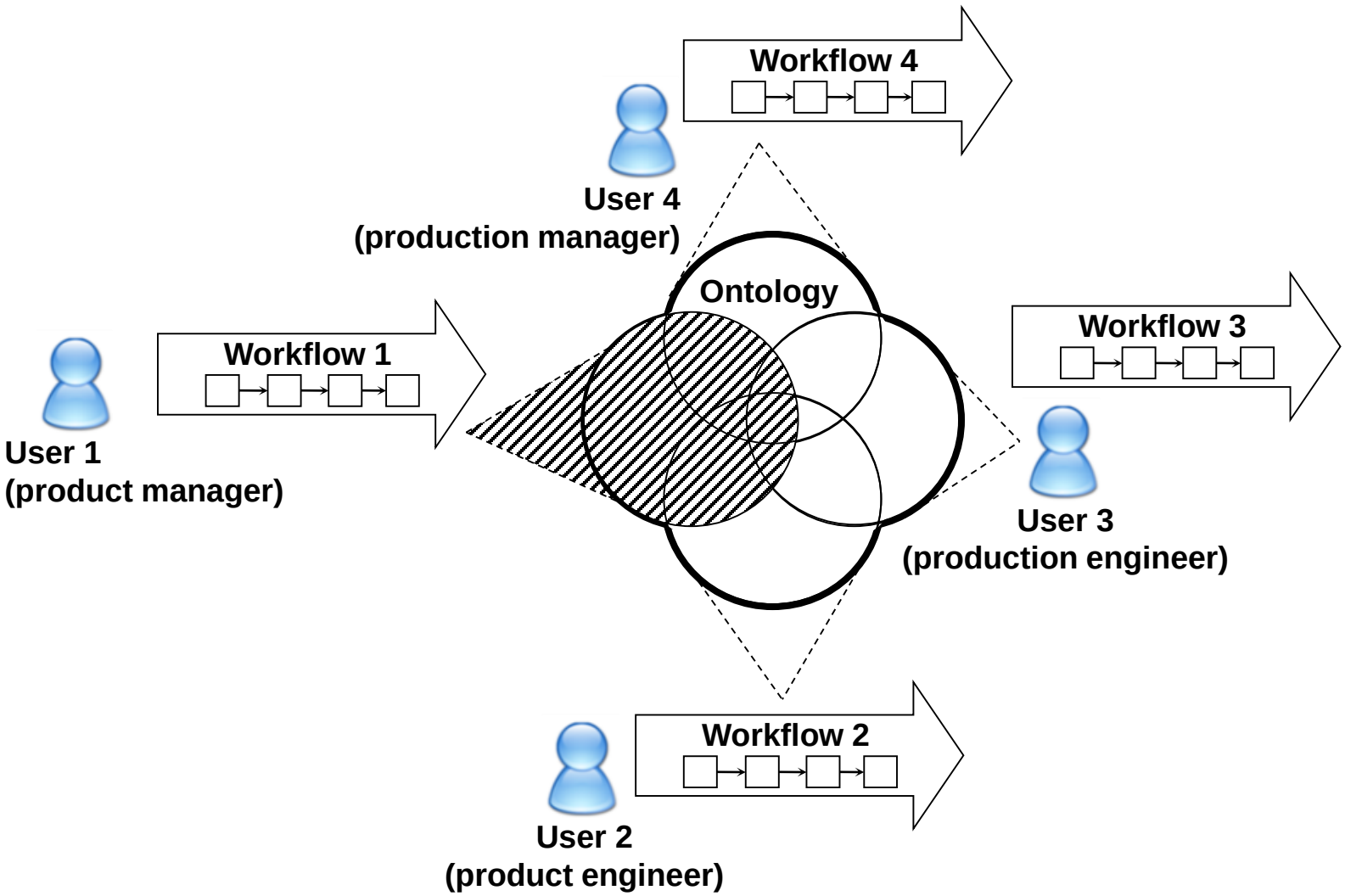

Role-based Knowledge Management (*Trend 1*): Major Ideas

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- **The different stages** of the PLM process in the company are **associated with different roles** like product managers, sales personnel or even customers.
- **Structural information** about workflows and the problem domain is collected and described **in the common ontology**.
- **User roles** are identified and their **relevant parts of the common ontology** are defined.
- **Tasks assigned to the identified roles** are defined.
- **Knowledge required for performing identified tasks** is defined.
- Based on the identified roles, tasks and knowledge, new **knowledge-based workflows** are defined.
- Corresponding **role-based knowledge support of the workflows** is provided based on the usage of the common ontology and knowledge / information storages.

Knowledge Sharing in Expert Teams & Networks

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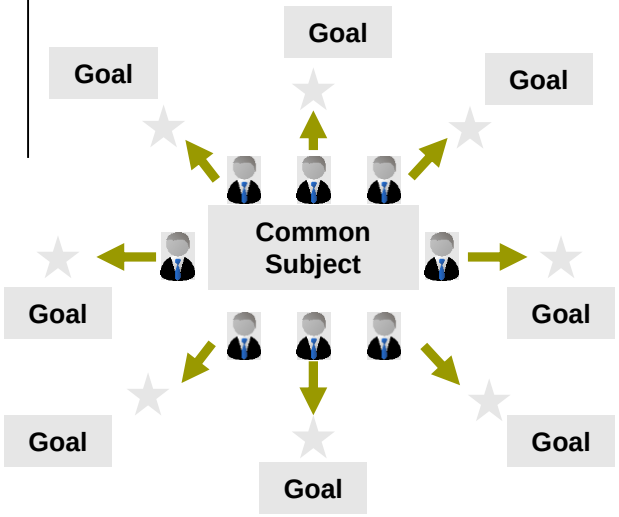
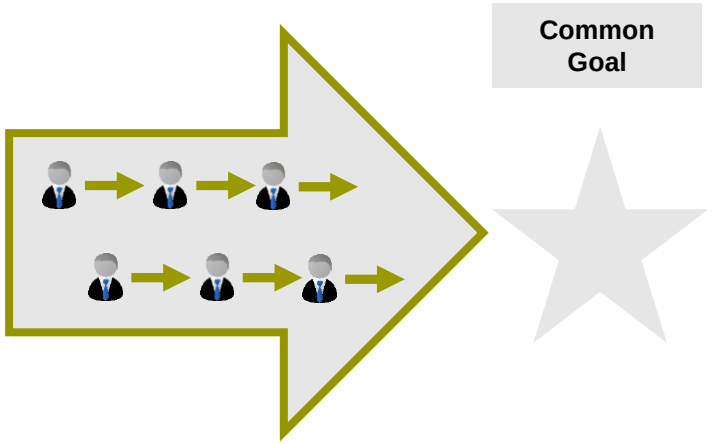
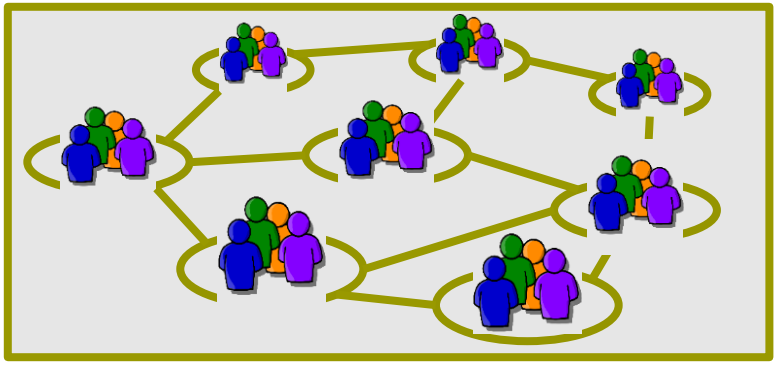


Common Subject => Functional Team



Common Goal => Goal-oriented (project) team

- Knowledge
- Competences



- Capabilities
- Raitings, etc.

Motivation: Implementations for Knowledge Management

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- ***Siemens*** *used points to reward contributors* to the corporate Knowledge Management System (KMS), and these points were either used to demonstrate a status of an expert or they could be redeemed for material rewards. This system worked with mixed results: in some countries knowledge workers put significant value on the expert status, in other countries they preferred to receive material goods (Voelpel et al., 2005).
- ***BP*** *used visual intervention* called “15 minutes of fame”, a display of someone’s profile that was recently updated, on their Connect KMS (Grant, 2013), and this mechanics exploited the dynamics of expression and promoted people to update their profiles to get noticed.
- ***Texas Instrumental*** *gave “Not invented here, but I did it anyway” award* in a case contest, where employees could share their experience of knowledge reuse (Davenport and Prusak, 1998). The competition dynamics and the rewarding mechanics legitimized and encouraged searching for existing knowledge and its reuse.

Motivation: Some Personalization Aspects

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Motivation draws from research in *persuasive technologies* to further encourage adoption of behaviors. Major factors for persuasive technology *personalization*:

- *Age:* Older users are considered to rely more on social influence in their technology adoption than young ones. Younger employees tend to be more autonomous in their usage and adoption of IT.
- *Gender:* Women are motivated by immersion and social factors, while men are more achievement-oriented and display more competitiveness and need for winning than women.
- *Culture or nationality*: Europe and North America are highly individualistic cultures - foster competition and rivalry (such as leaderboards and points) have a great impact on one's engagement. In Asia (specially China) and other countries are low in individualism - the competitive aspect are not such a strong motivator.

Knowledge Sharing based on Dynamic Motivation (*Trend 2*): Major Ideas

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- ***Knowledge worker (expert) activities*** are based on ***motivational factors*** related to cooperation & competition (as ***social influence strategies***).
- ***Decision makers (managers)*** within company could use or create ***different motivation strategies*** for their employees (knowledge worker) to join and compete for a victory.
- ***Company*** **has to use** ***different motivation strategies for different knowledge workers (roles) in different situations (context).***
- ***Company*** **has to use** ***for different expert teams*** (functional team and project team) ***different motivation strategies.***
- ***Company*** **has to use** ***different sets of KPI*** for evaluation of employees efficiency & quality ***(role-based motivation strategies).***

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Multi-Aspect PLM Ontology (*Trend 3*): Reference Model

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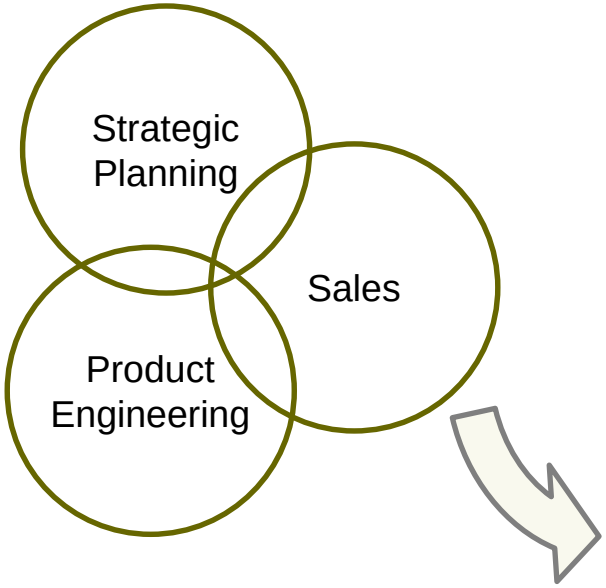
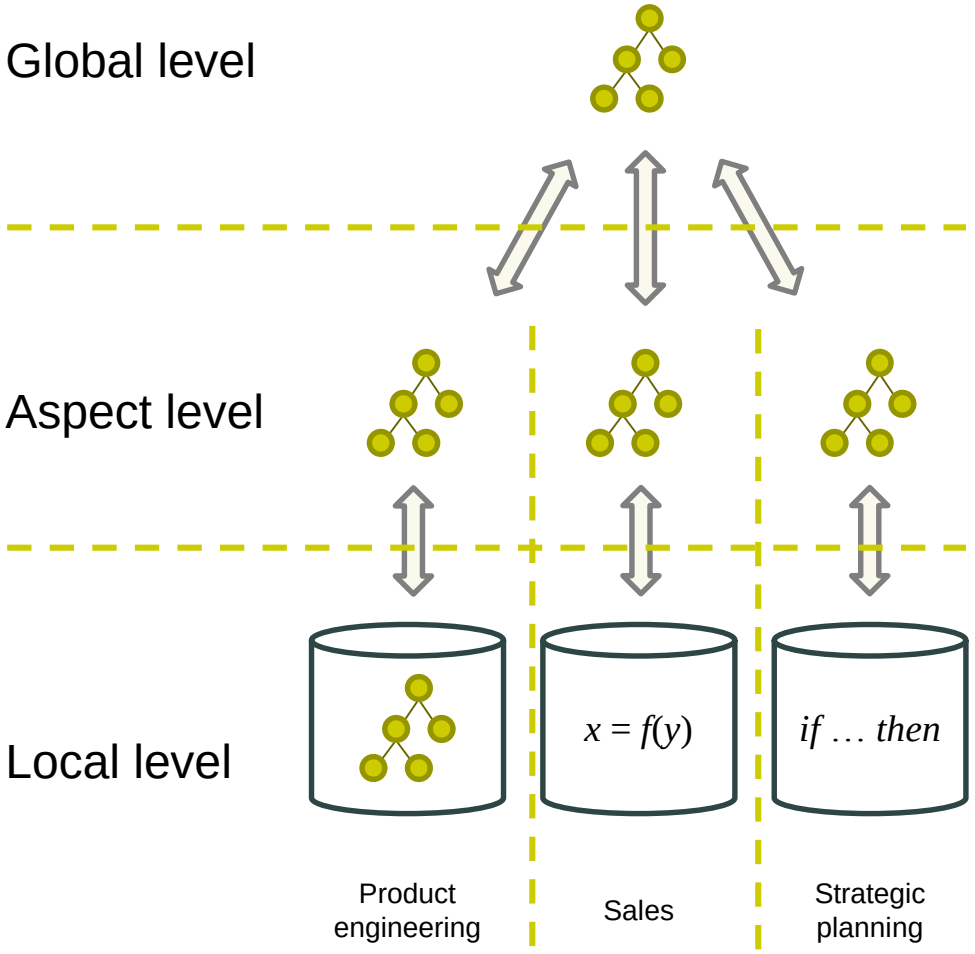
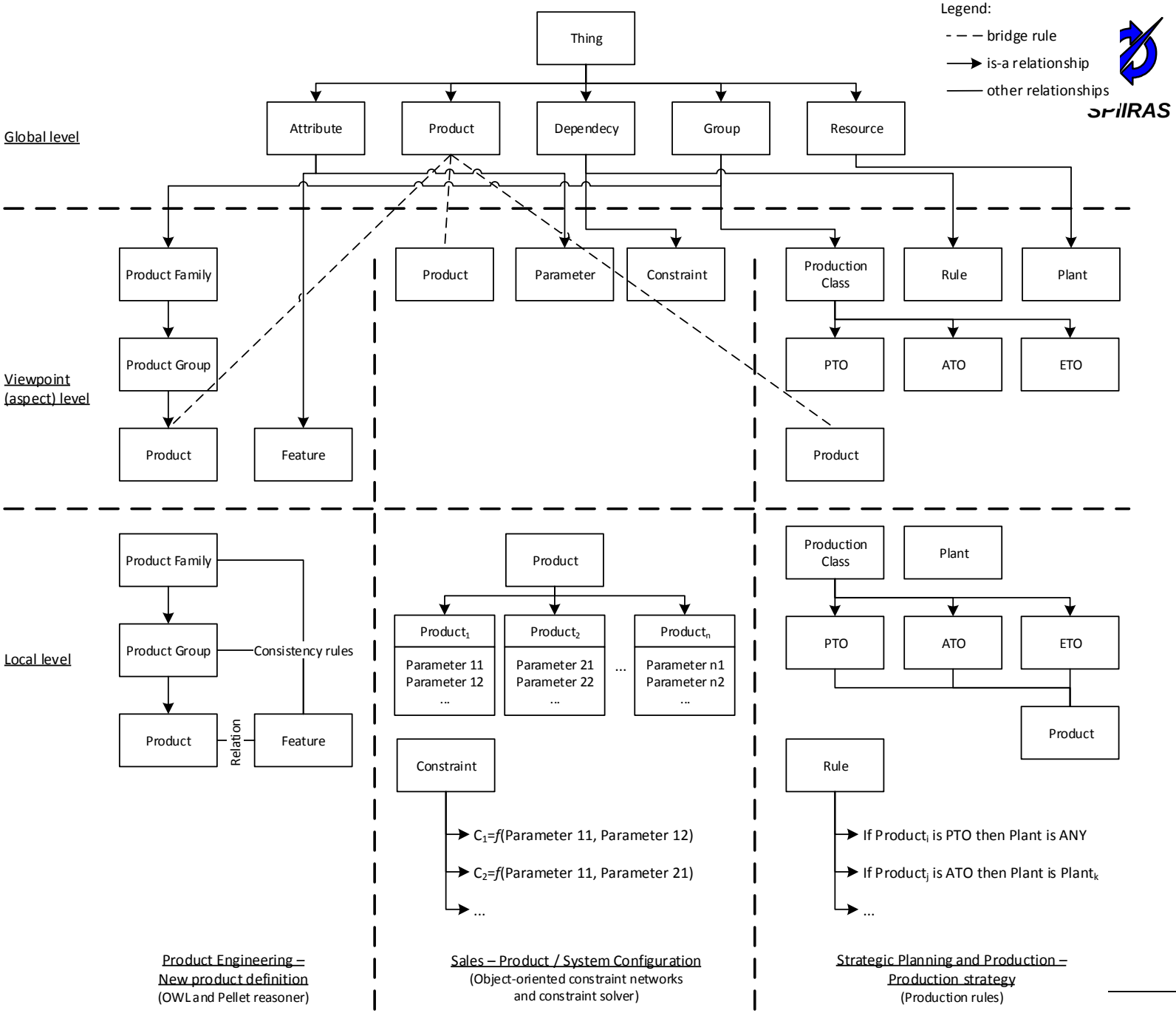




Multi-Aspect PLM Ontology is represented by MVP-OWL *

Source: (*) Hemam M, Boufaïda Z (2011) MVP-OWL: a multi-viewpoints ontology language for the Semantic Web. Int J Reason Intell Syst 3:147.

Multi-Aspect PLM Ontology (a part)



Conclusions

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- **Knowledge Management** is becoming de facto one of the required business strategies **to support innovation and competitive advantage.**
- **Knowledge Sharing is essential for a knowledge-intensive & innovation-oriented companies**. There is a **need to create** an **IT & HR environment where knowledge and ideas are shared between experts (knowledge workers)** and across teams (departments, organizations, etc.).
- **The problem of heterogeneity** of the business processes and their respective information models is addressed through having **multiple aspects within the common ontology**:
  - **Multi-aspect ontology** provides for **the common vocabulary enabling the semantic interoperability** between different business processes and IT systems supporting these
  - It makes it possible to preserve **internal notations and formalisms suitable for efficient solving particular tasks** (e.g., configuration, planning, consistency checking, and others).

Thank You!!!

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