Knowledge Graphs and Reasoning

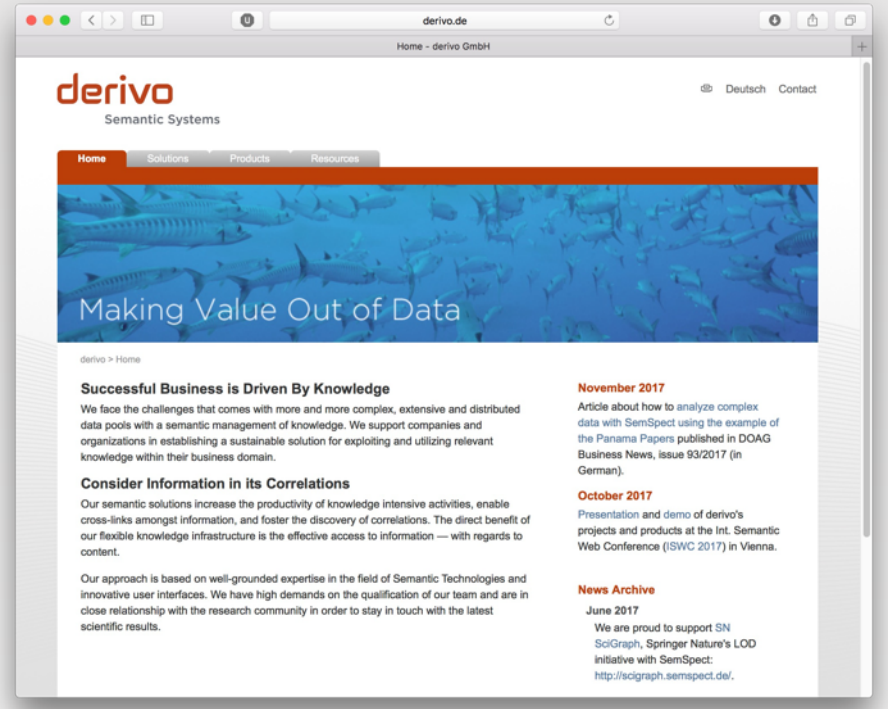
What does it take to manage the complexity of real-world industry problems?

Thorsten Liebig | derivo GmbH

derivo

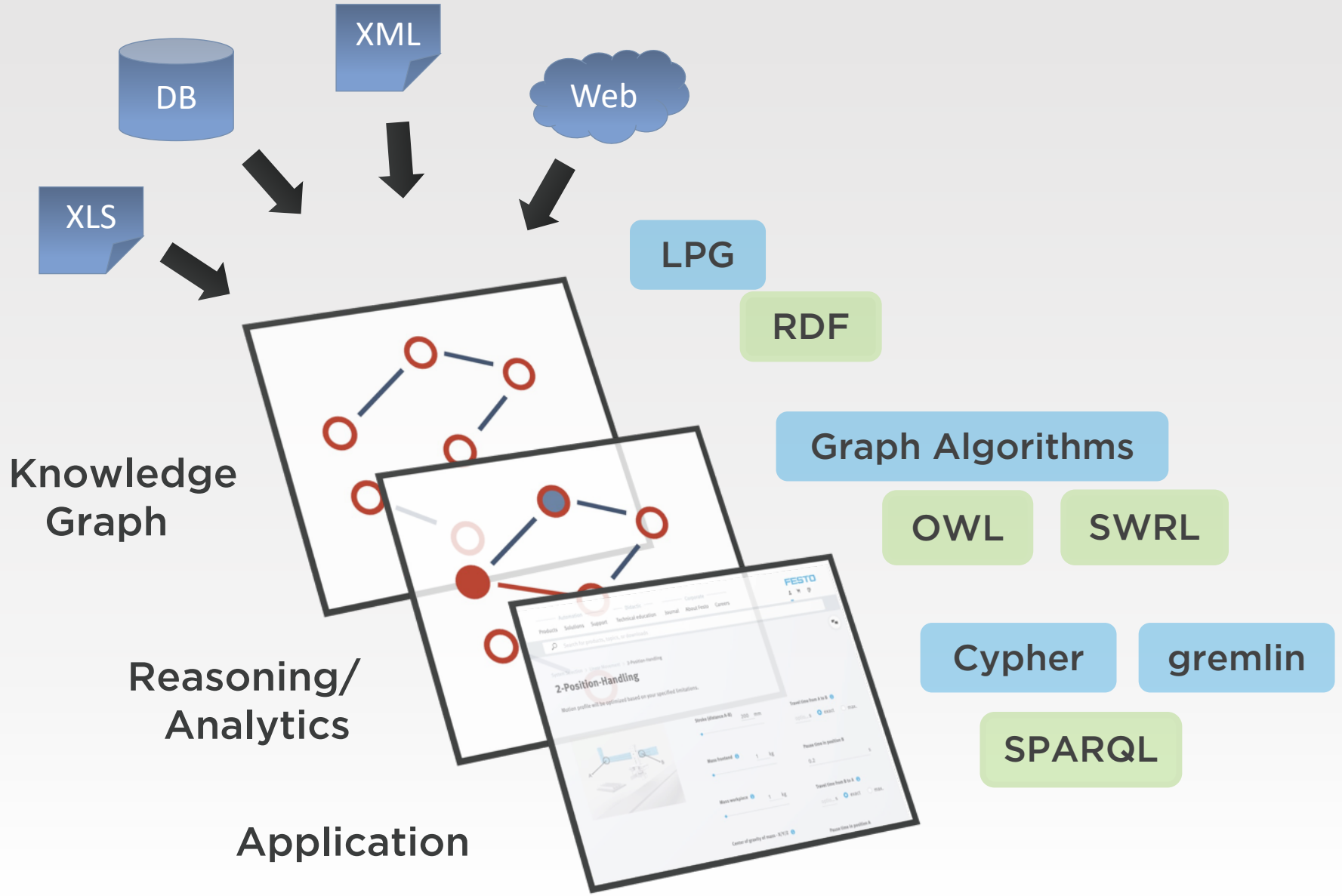
www.derivo.de

- SME, est. 2010
- Background KR & reasoning
- Consulting and development of semantic software tools & solutions
- Products:
  - Reasoning:
    - Konclude
    - GraphScale
    - Reseller of RDFox
  - Browsing:
    - SemSpect

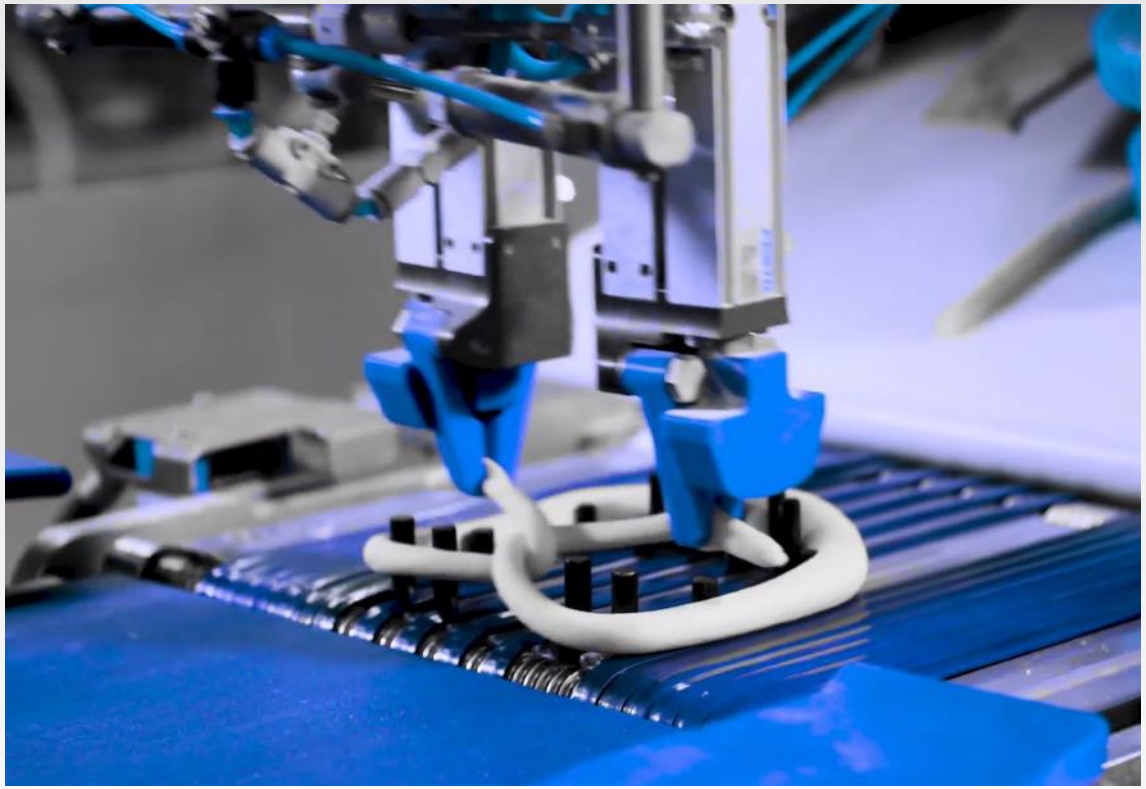


BOSCH BERTELSMANN FESTO SIEMENS SCHAEFFLER SPRINGER NATURE

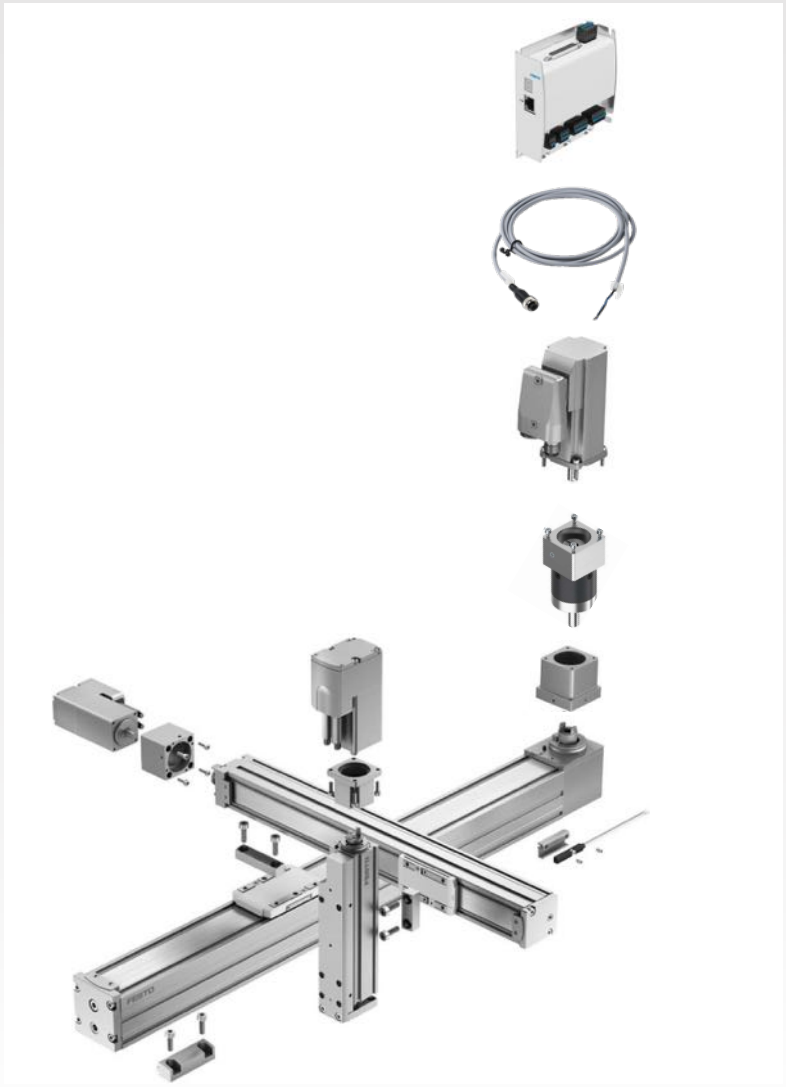
Knowledge Graph Stack

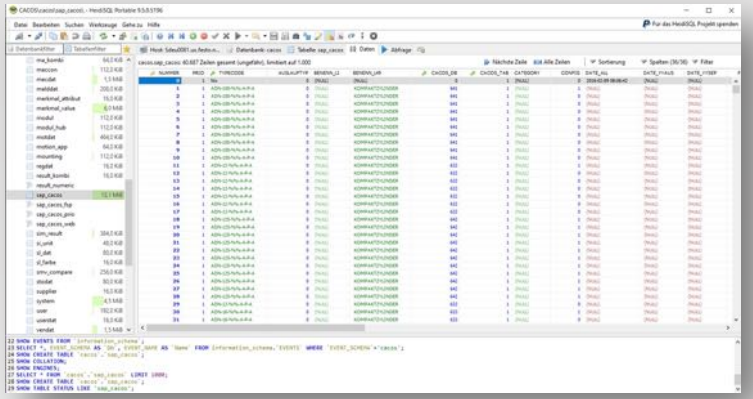


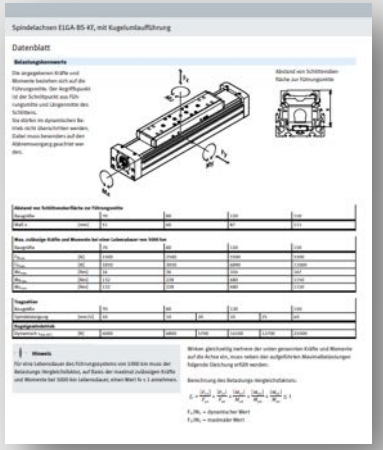
Festo

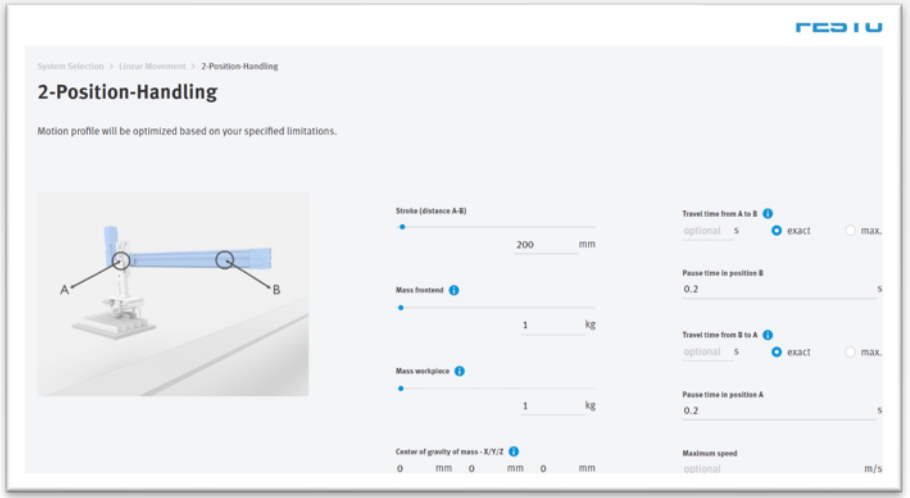


Festo Use-Case

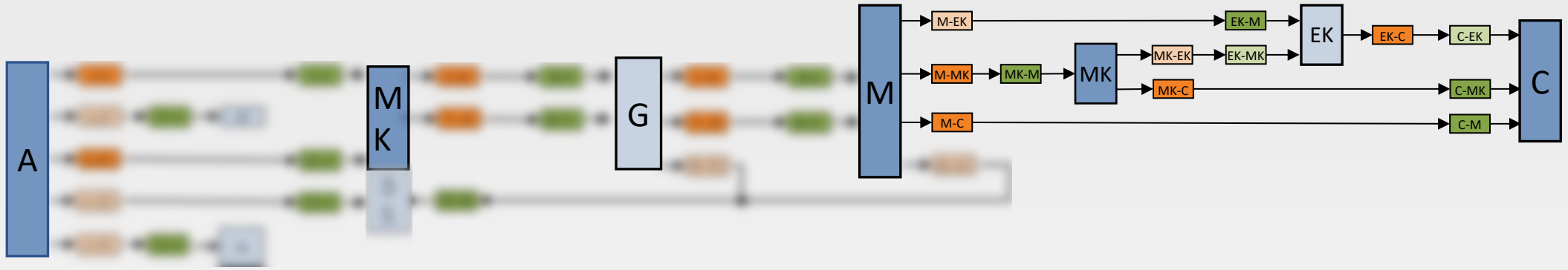




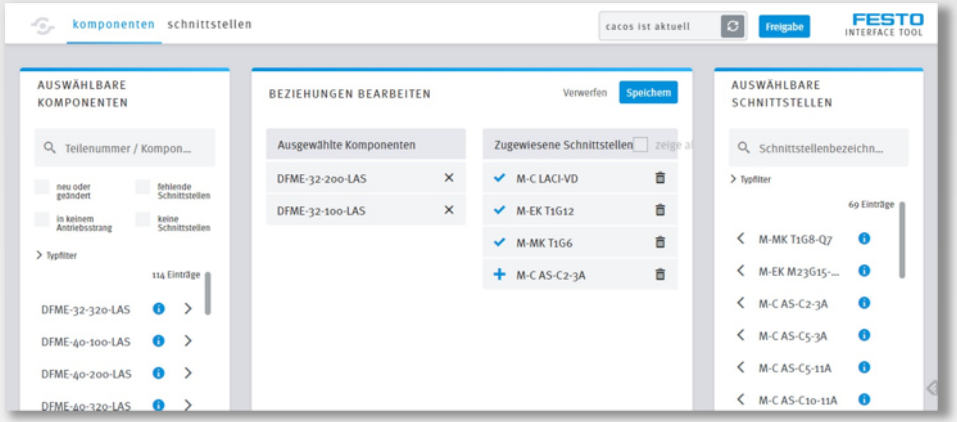


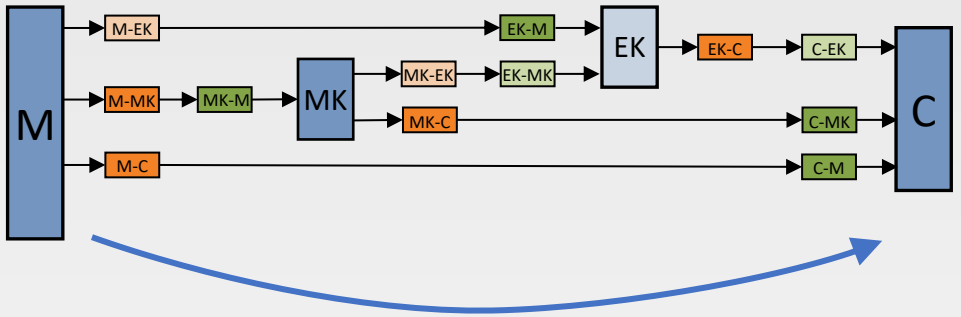


Festo Use-Case



Festo Use-Case





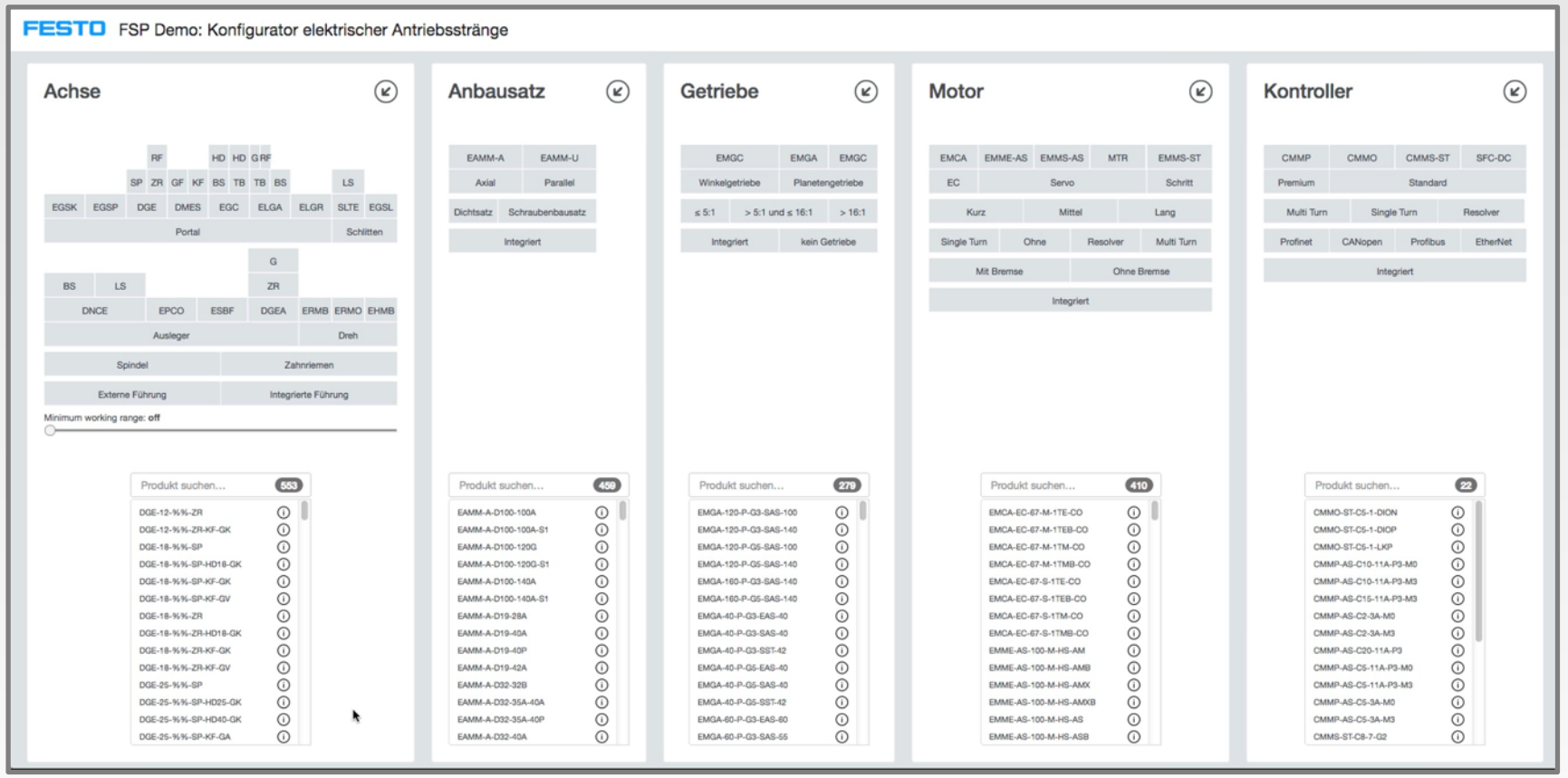

```
Motor(?m), (not (MotorWithEncoder))(?m), Controller(?c), Motorcable(?mk),
has-interface(?m, ?mcs), M-C(?mcs), interface-compatible(?mcs, ?cms), C-M(?cms),
has-interface(?c, ?cms),
has-interface(?m, ?mmks), M-MK(?mmks), interface-compatible(?mmks, ?mkms), MK-M(?mkms),
has-interface(?mk, ?mkms),
has-interface(?mk, ?mkcs),  MK-C(?mkcs), interface-compatible(?mkcs, ?cmks), C-MK(?cmks),
has-interface(?c, ?cmks),
->
direct-compatibel(?m, ?c)
```

SWRL + NAF

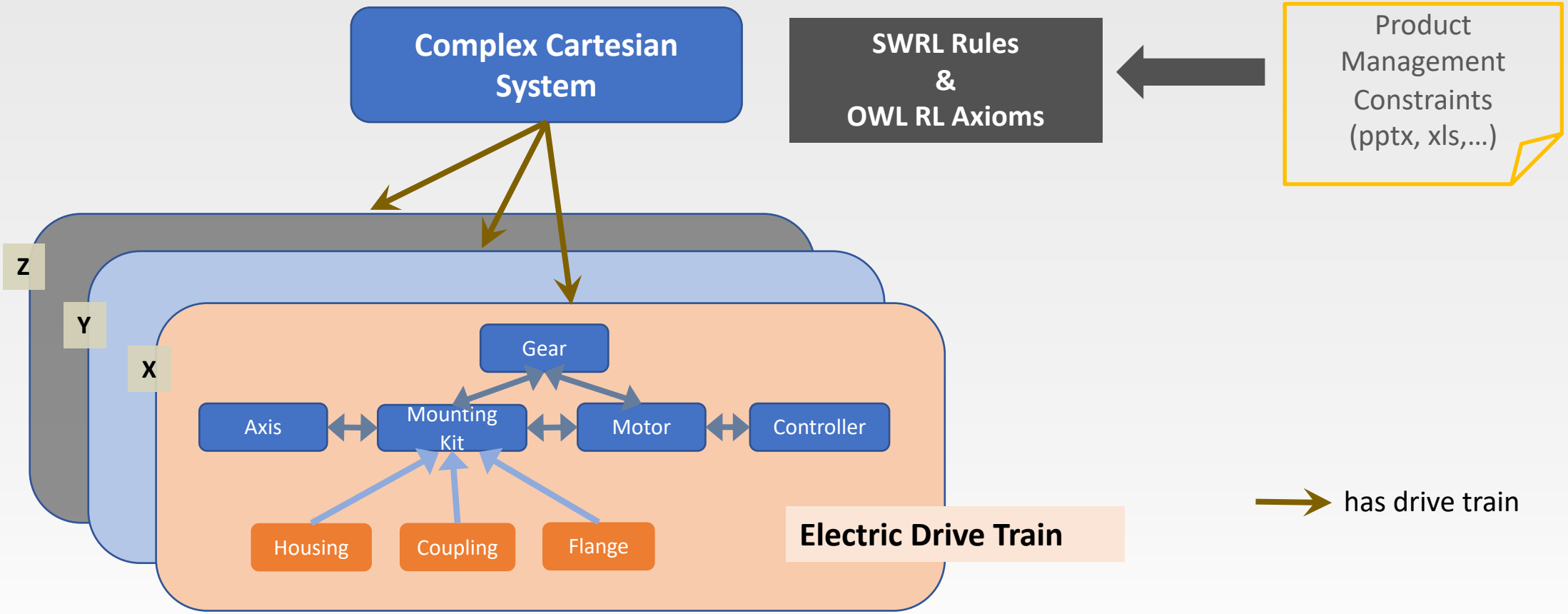
incremental reasoning

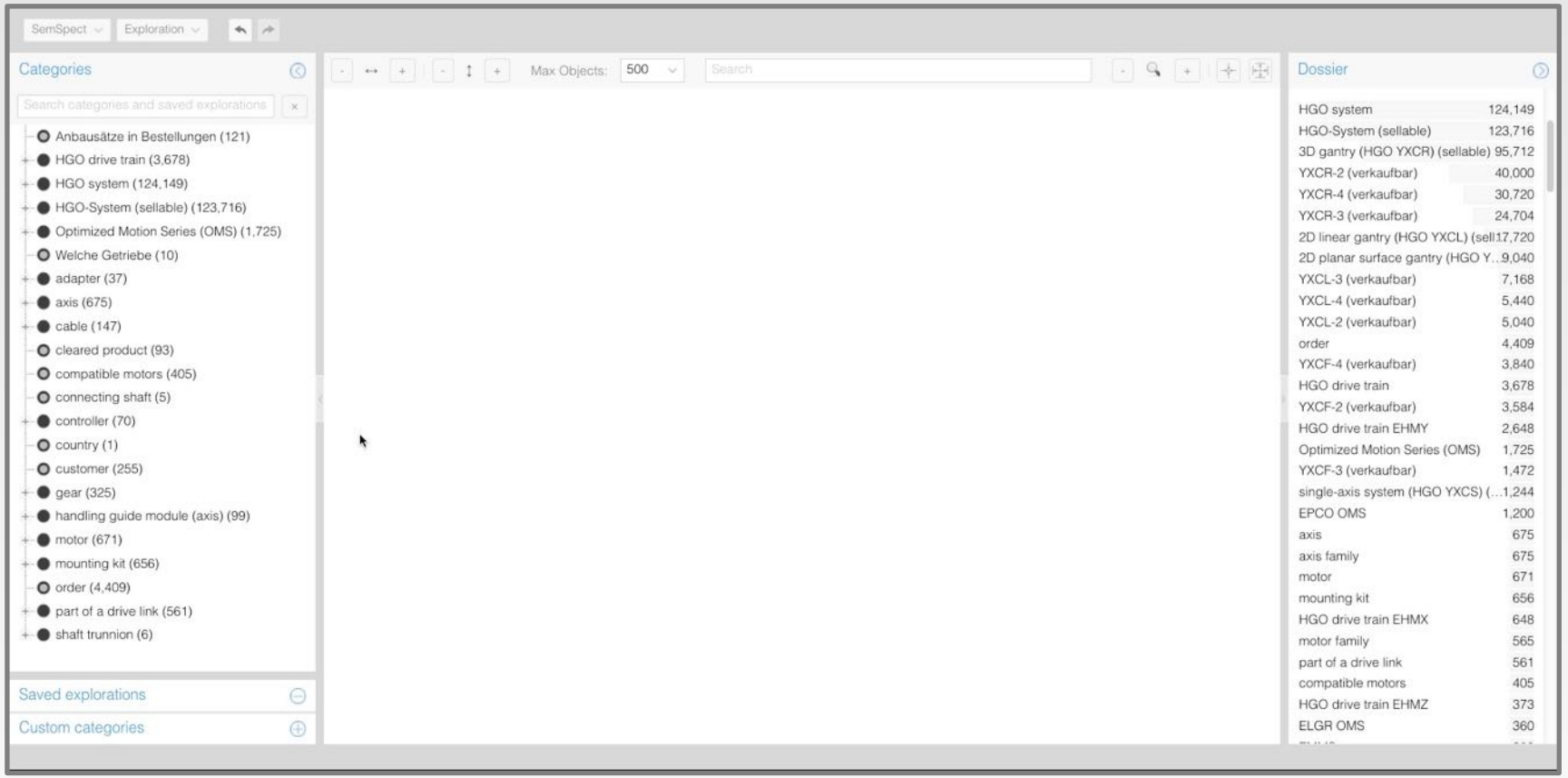
OWL 2 RL

Drive Train Demo Configurator



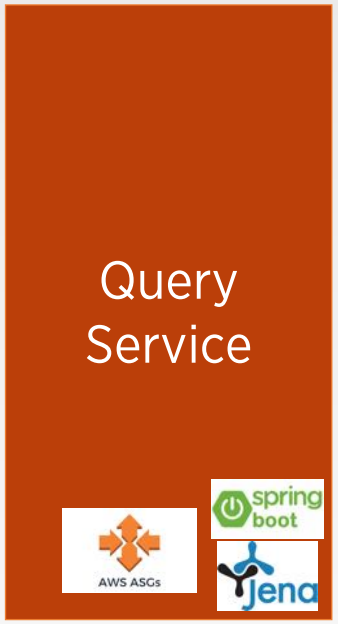
Capturing Automation Systems with KGs

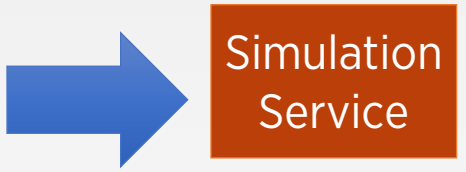


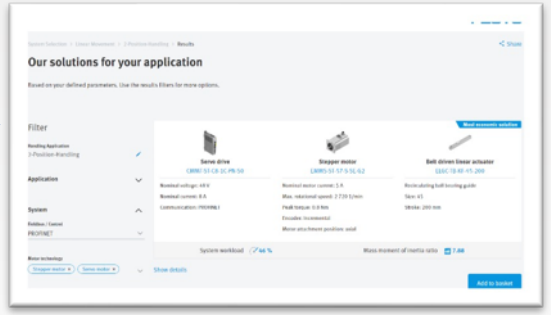

SemSpect
Exploration
Categories
Search categories and saved explorations
Anbausätze in Bestellungen (121)
HGO drive train (3,678)
HGO system (124,149)
HGO-System (sellable) (123,716)
Optimized Motion Series (OMS) (1,725)
Welche Getriebe (10)
adapter (37)
axis (675)
cable (147)
cleared product (93)
compatible motors (405)
connecting shaft (5)
controller (70)
country (1)
customer (255)
gear (325)
handling guide module (axis) (99)
motor (671)
mounting kit (656)
order (4,409)
part of a drive link (561)
shaft trunnion (6)
Saved explorations
Custom categories
Max Objects:
500
Search
Dossier
HGO system 124,149
HGO-System (sellable) 123,716
3D gantry (HGO YXCR) (sellable) 95,712
YXCR-2 (verkaufbar) 40,000
YXCR-4 (verkaufbar) 30,720
YXCR-3 (verkaufbar) 24,704
2D linear gantry (HGO YXCL) (sell 17,720
2D planar surface gantry (HGO Y… 9,040
YXCL-3 (verkaufbar) 7,168
YXCL-4 (verkaufbar) 5,440
YXCL-2 (verkaufbar) 5,040
order 4,409
YXCF-4 (verkaufbar) 3,840
HGO drive train 3,678
YXCF-2 (verkaufbar) 3,584
HGO drive train EHMY 2,648
Optimized Motion Series (OMS) 1,725
YXCF-3 (verkaufbar) 1,472
single-axis system (HGO YXCS) (… 1,244
EPCO OMS 1,200
axis 675
axis family 675
motor 671
mounting kit 656
HGO drive train EHMX 648
motor family 565
part of a drive link 561
compatible motors 405
HGO drive train EHMZ 373
ELGR OMS 360

Festo Electric Motion Sizing

$$m_{max_i}^{drvTrn} = \frac{i^{gear} \cdot \left(M_{max}^{mot} - M_{fric_{stat}}^{gear} - M_{fric_{stick}}^{gear} - M_{fric_{torque}}^{gear} \cdot M_{still}^{mot}\right) - M_{fric}^{coup}}{a_{com}^{ax} \cdot M_{fric}^{coup} \cdot \left(a_{max}^{app} + |sin(\alpha^{app})| \cdot g \cdot \left(1 + F_{fric_{24}}^{cyl}\right)\right)}$$
$$\frac{-2 \cdot F_{fric_{24}}^{cyl} - 2 \cdot a_{com}^{ax} \cdot M_{fric}^{coup}}{a_{max}^{app} + |sin(\alpha^{app})| \cdot g \cdot \left(1 + F_{fric_{24}}^{cyl}\right)}$$
$$- \frac{F_{fric_{24}}^{cyl} \cdot \left(m_{load}^{app} + m_{piston}^{cyl} + m_{piston}^{ax} + (m_{rod}^{cyl} + m_{rod}^{ax}) \cdot s_{total}^{app}\right) \cdot g \cdot |sin(\alpha^{app})|}{a_{max}^{app} + |sin(\alpha^{app})| \cdot g \cdot \left(1 + F_{fric_{24}}^{cyl}\right)}$$
$$- \left(m_{piston}^{cyl} + m_{piston}^{ax} + (m_{rod}^{cyl} + m_{rod}^{ax}) \cdot s_{total}^{app}\right) \quad (3.57)$$

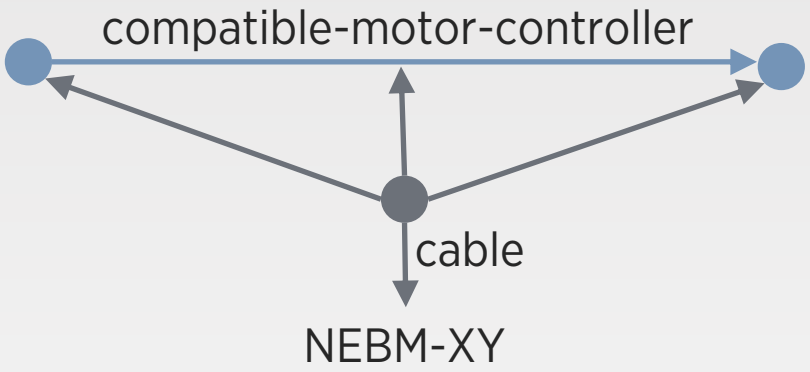




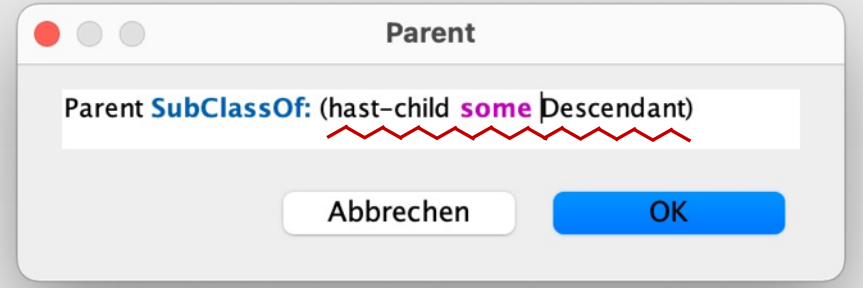


Technical Lessons Learned

- RDF Reification sometimes is necessary



- Carefully check you language fragment: OWL 2 RL > SWRL > Datalog



- Real-world may require negation (NAF) + existentials (skolems) + aggregation

```
deptAvgSalary[?d,?z] :-
  Department[?d],
  AGGREGATE( worksFor[?x,?d],
             salary[?x,?s] ON ?d BIND AVG(?s) AS ?z) .
```

Conceptual Lessons Learned And Wrap-Up

- Understand and know the use-case: the type of queries that are asked frequently
- Invest in your KG model – it pays of in the end (it creates added value)
- Use standards (Cypher, RDF, OWL, SPARQL, R2RML, SHACL, SHEX, ...)

Knowledge Graph Technology and Reasoning:

- Increases data quality a lot
- Brings data and knowledge together:
  - declarative and understandable
  - exchangeable and independent from specific tools
  - flexibility