About Aibel

- Aibel AS is a leading supplier of services related to oil, gas and renewable energy
- Around 4,000 employees
- More than a hundred years of proud history
- A global company with roots in Norway
Company overview

• Annual turnover of approximately 10 billion NOK – among Norway’s 100 largest companies
• Long term maintenance and modifications contracts
• Present on half of the offshore installations and 4 onshore terminals in Norway
• Deliver new platforms and modules
• Successfully entered into offshore wind market
Managing Complex Requirements

- Types
- Geometry
- Pressure classes
- Fire classes
- Explosion ratings
- Materials
- Certificates
- Manufacturers
- Revisions
- +++

Cost Estimates
Material Catalogs
Interchangeability
Efficiency
Digitalization
Reuse
Data Exchange
Master Data
Automation
The Material Master Data (MMD) Ontology

- Expressed in OWL 2.0
- Modular: 230+ ontology modules
  - Imports public ontologies whenever possible: SKOS, PAV, ++
- Focus on classes (T-box) rather than individuals (A-box)
- Three primary sources:
  - Protégé/Turtle files
  - Excel-/database tables
  - Programmatically generation
- Focus on reasoning:
  - Consistency checks
  - DL queries

Key Figures

| Axioms | 1.840.769 |
| Logical axioms | 535.512 |
| Declaration axioms | 106.674 |
| Class count | 98,133 |
| Object property count | 135 |
| Data property count | 723 |
| Individual count | 20,412 |
| SubClassOf | 505,376 |
| EquivalentClasses | 745 |
| DisjointClasses | 27 |
| AnnotationAssertion | 1,198,266 |

DL expressivity ~ SHOIQ

The World's Largest Industrial Ontology…?
Annotations: ASME B16.5 Pipe Flange NPS 1 1/2 CL150 Weld Neck Raised Face

- rdfs:comment [type xsd:string]
  Design article weights are calculated using the same formula as on actual wall thickness and density

Abbreviation [type xsd:string]
F:\N

CAD Description - Geometry [type xsd:string]
FGW CL150 RF

Description: ASME B16.5 Pipe Flange NPS 1 1/2 CL150 Weld Neck Raised Face

Equivalent To

SubClass Of
- "ASME B16.5 Pipe Flange NPS 1 1/2 CL 150"
- "has Flange Hub" some "ASME B16.5 Weld Neck Flange Hub"
- "has Flanged End" some "ASME B16.5 Raised Face Flange Face NPS 1 1/2 CL 150"
- "has Pipe End" some "ASME B16.5 NPS 1 1/2 Butt welding end"
- "Metal Volume Based on Geometry dm^3 value" 0.333"^xsd:double
- "Pipe Flange Weld Neck"
- "Raised face height mm value" 2.0"^xsd:double
- "Specified Length Through Hub mm value" 60.0"^xsd:double
- "Specified Outside Diameter of Flange mm value" 125.0"^xsd:double
- "Specified Thickness of Flange mm value" 15.9"^xsd:double
- "Surface Area_dm^2 value" 3.13"^xsd:double
- "Wall Thickness Base for Metal Volume mm value" 3.68"^xsd:double

General class axioms
The MMD System

HermiT
OWL 2 Reasoner Service

Oracle 12 Database
+ Spatial & Graph

Ontology Development

Protégé

Bulk Creation of Design Articles & Products

Export to Engineering, CAD & ERP

Linked Data Publishing and DL Queries

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Gains

- Data quality (elimination of duplicates)
- Material catalogs containing only valid components
- Reduced ordering of incorrect components
- Basis for decision support/automation
- Basis for semantic Digital Twin
Pains

• Reasoning performance (HermiT classification currently takes ~20 minutes)
• Reasoning over ontology & huge number of individuals
• Interface/abstraction between ontology and software
• Specification/extraction of ontology subsets
• Temporal reasoning/lifecycle considerations
Contact Information

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