

Machine tool data management problem

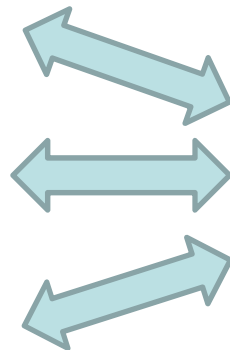
Today development of manufacturing systems involves:

- Duplication of data in different application systems
- Interpretation of ambiguous and inconsistent data
- Difficulties to share and communicate data
- Time-consuming data collection and data re-creation
- Deficient verification and validation
- Expensive data archiving

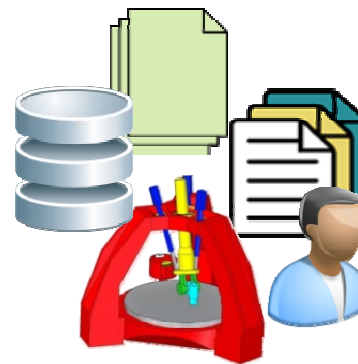


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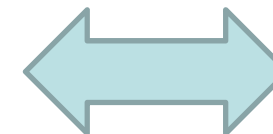
Investment
Factory design
Process planning
Maintenance



Document centered



Verification



Validation



Model based data management

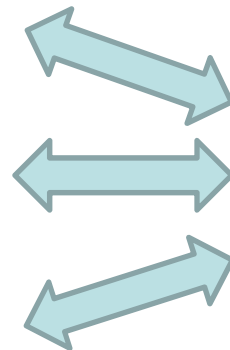
Digital factory key components:

- Coherent, consistent and consolidated data
- Concepts, semantics
- Contexts, views, domains
- Software and hardware independent data
- Support for cross application work



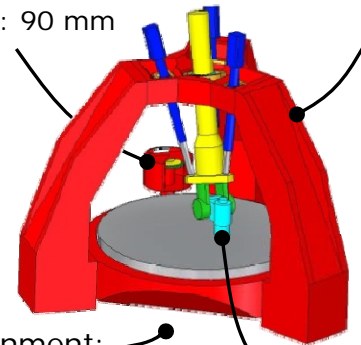
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Investment
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Tool magazine:
size: 12 tools
max tool Ø: 90 mm

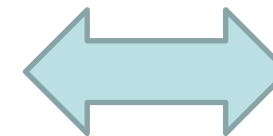
Column:
Color: RAL 2002



Environment:
max noise: 85 dB(A)
max vibrations: 0,3 m/s²
max radiation: 0,5 µT

Spindle:
max rpm: 18000
interface: HSK-A

Verification

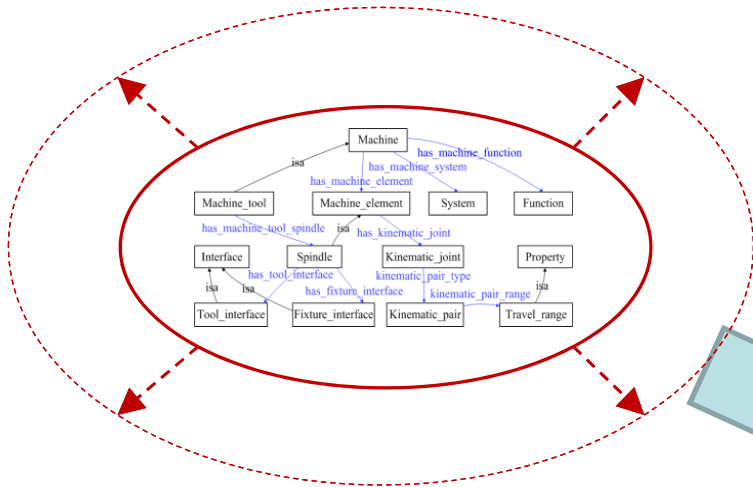


Validation

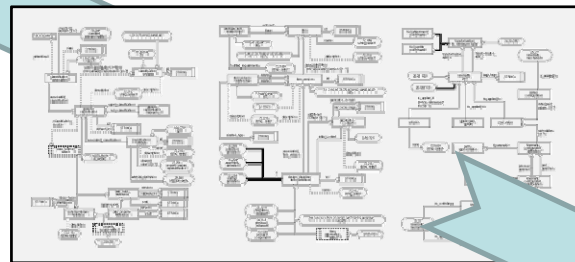


Modeling method requirement

Stable and standardized data model also capable of representing future machine tool designs.



Extendable model of machine tool concepts

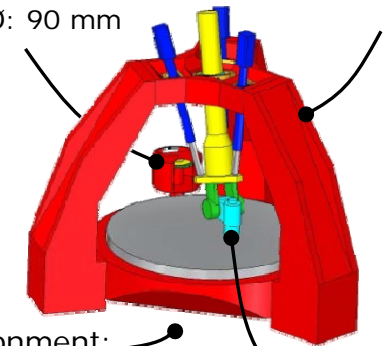


Product generic data model

Defined machine tool concepts applied on a product generic data model.

Tool magazine:
size: 12 tools
max tool Ø: 90 mm

Column:
Color: RAL 2002

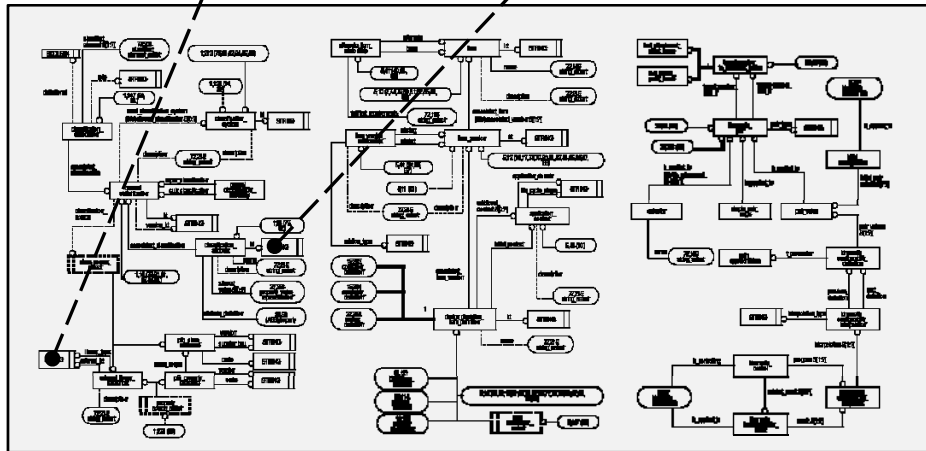
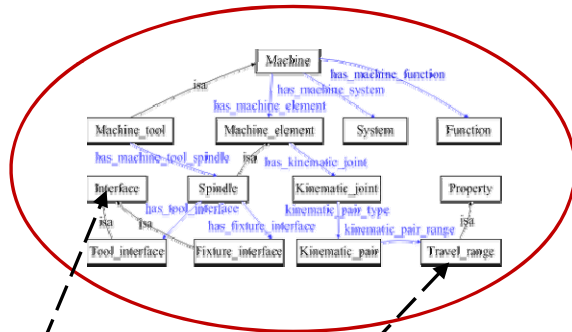


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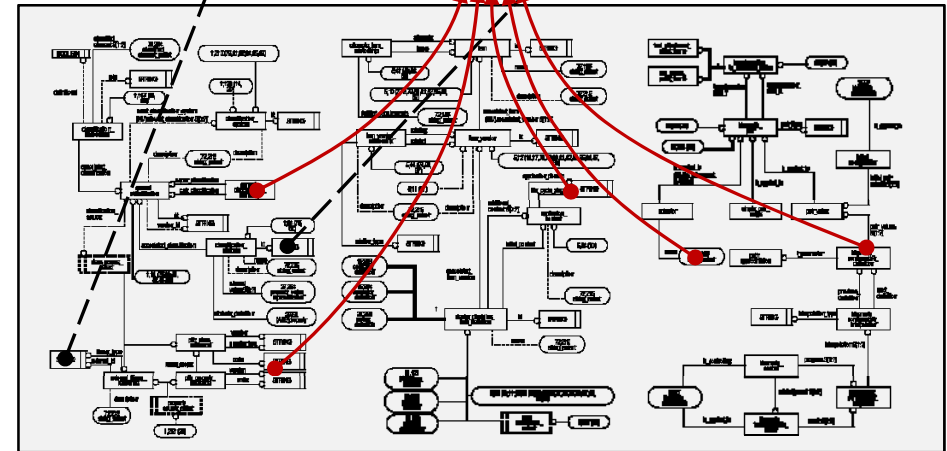
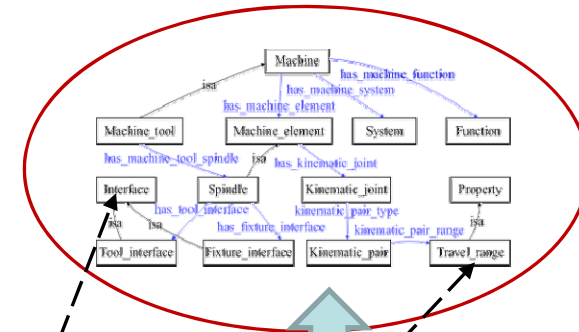
Spindle:
max rpm: 18000
interface: HSK-A

Reference to used concepts

Data model with interface to externally defined concepts. (e.g. PLCS and ISO 13399)



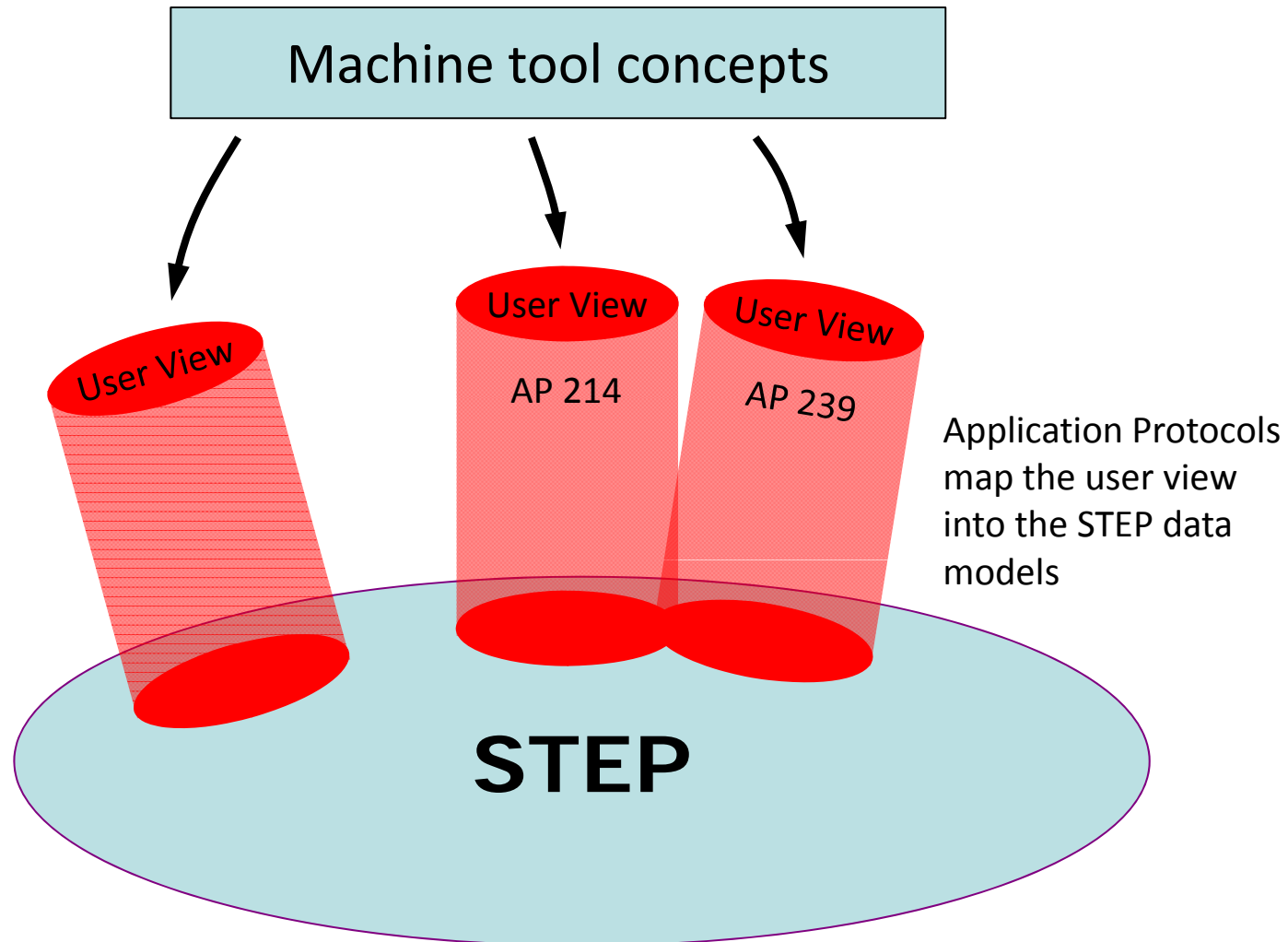
Modeling method where externally defined concept also can be used at all entity attributes



Support for xAP (cross Application Protocol) work



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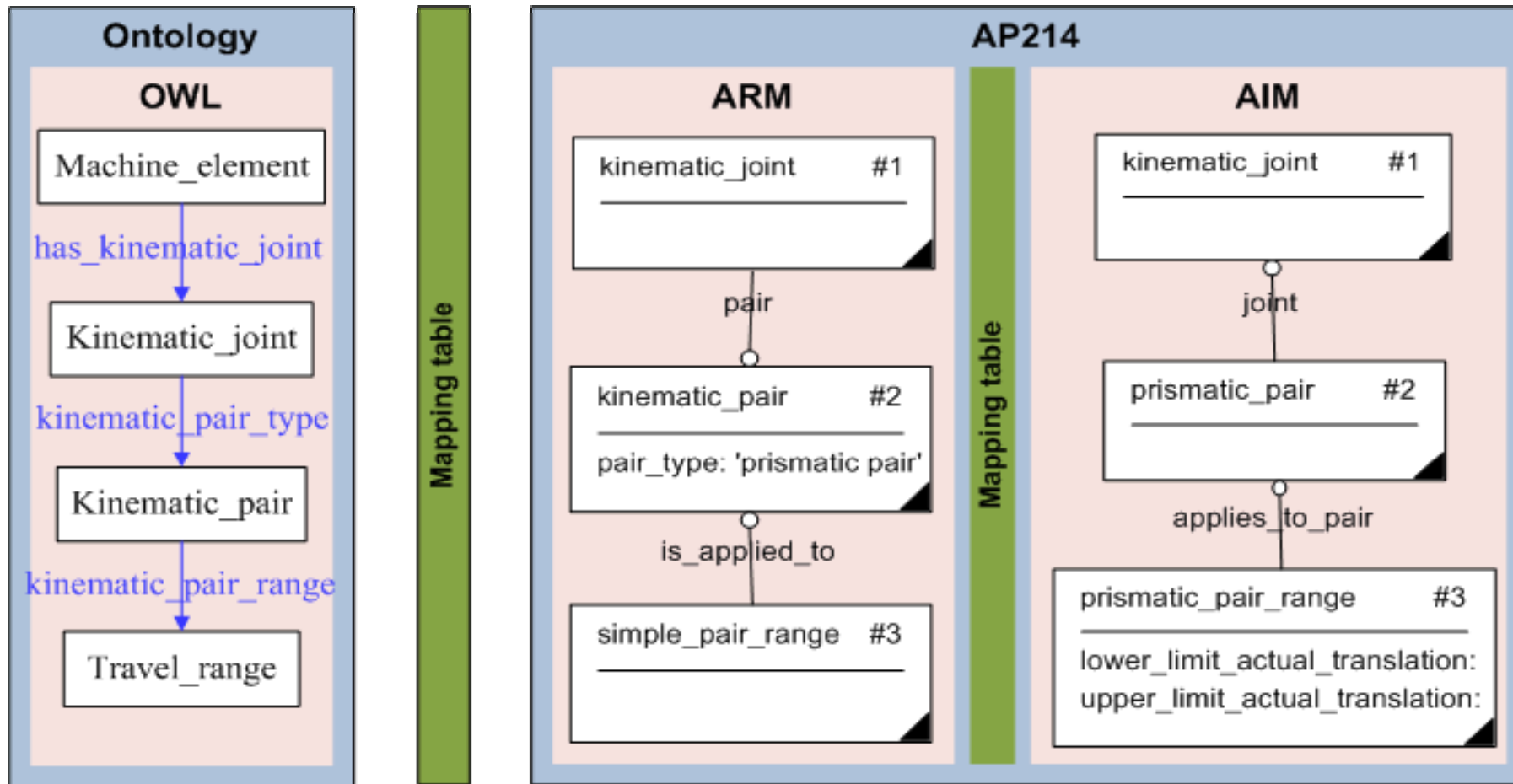


[Figure upper part complemented, original by Howard Mason, Chairman, ISO TC184 SC4.]

Mapping table between concepts and application protocols

Concepts	AP214	AP239
Machine_element (Spindle)	Item, Alt1: Specific_item_classification.classification_name = 'Spindle' Alt2: General_classification, External_library_reference.id = 'Spindle'	Part, Classification_assignment, External_class.name = 'Spindle'
Kinematics (Travel_range)	Simple_pair_range, General_property.property_type = 'Travel_range'	Assigned_property, Classification_assignment, External_class.name = 'Travel_range'
Dimension_property (Length)	Alt1: Length_size_dimension Alt2: General_property.property_type = 'Length'	Assigned_property, Classification_assignment, External_class.name = 'Length'

Implementation to AIM conformance



Basis of case study

STEP, system neutral information models

- ISO 10303-214, generic standard for mechanical products (so far the only Application Protocol including kinematic representation)
- Machine tool is one type of product



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Machine tool information

- Functional
- Requirement
- Behaviour (thermal, damping etc.)

STEP AP214 property building blocks



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Property determination

- calculated
- **designed**
- estimated
- measured
- required

Value

- number
- string
- value list
- **value limit**
 - maximum
 - minimum

Unit

- **SI units**
- derived units
- conversion units

Properties relation

- decomposition
- **dependency**
- hierarchy
- peer
- substitution

Value relation

- decomposition
- **dependency**
- equivalence
- substitution

Identifier

- **name**
- id
- version

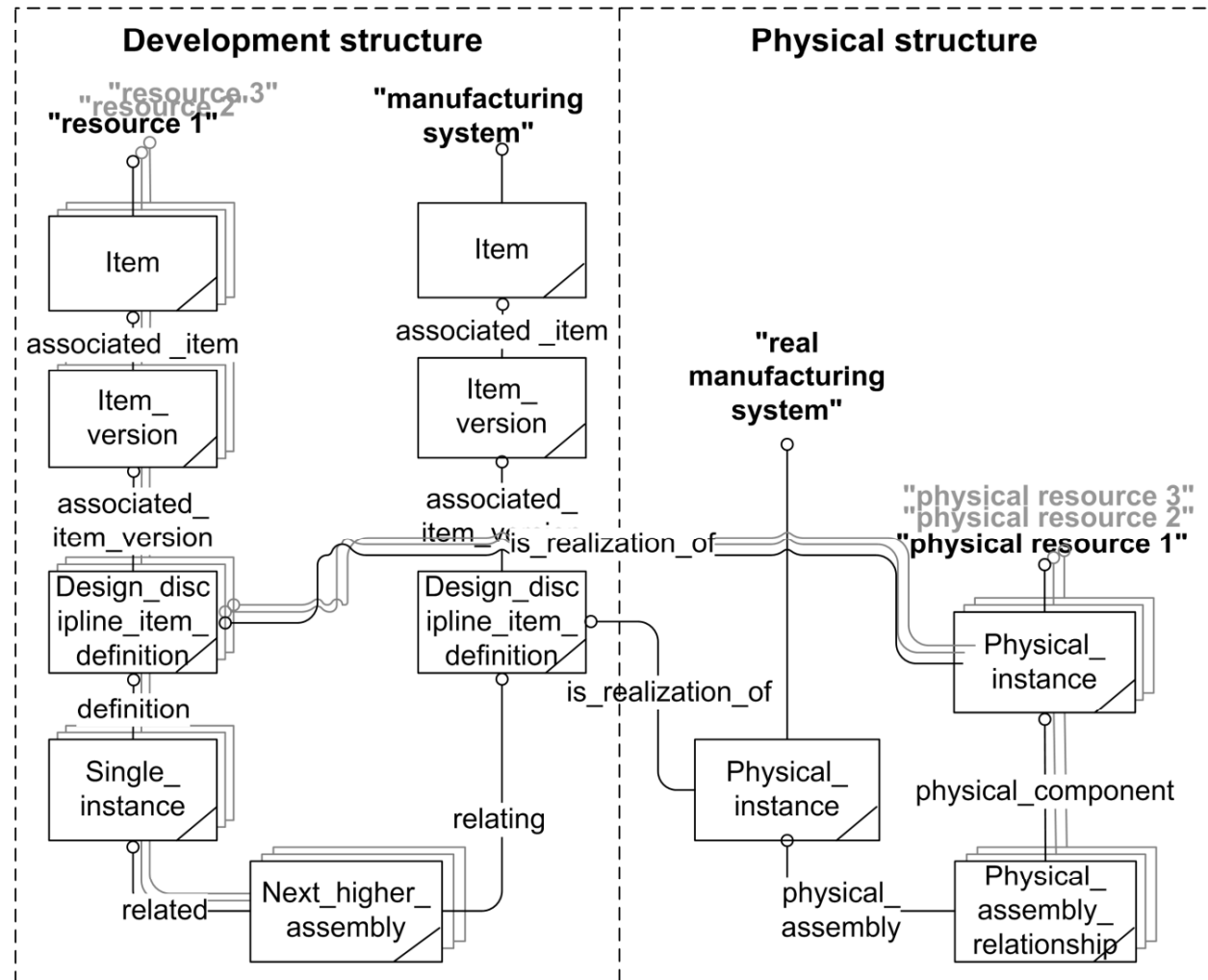
Combined it can represent e.g.:

Designed maximum spindle motor torque value in Nm unit is dependent on the spindle speed.

STEP AP214 product lifecycle



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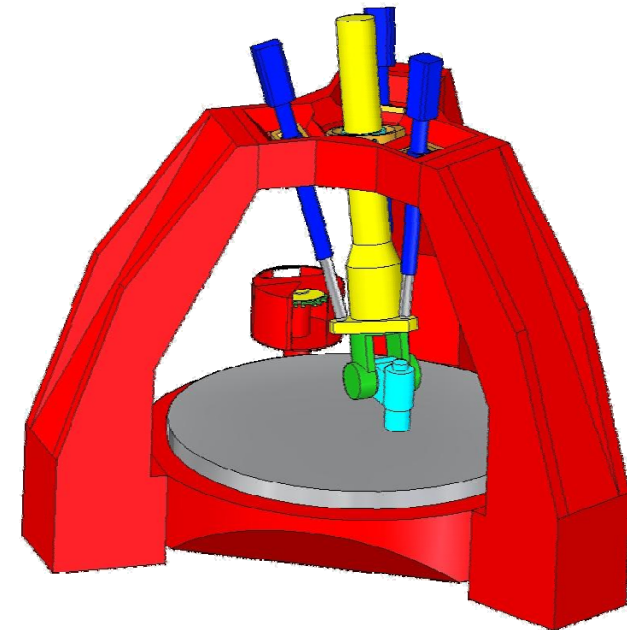
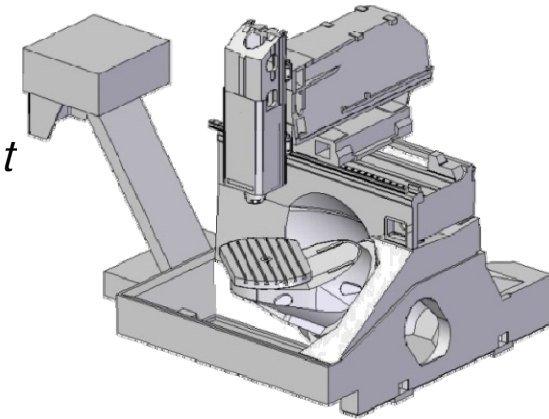


[Fig. source: A. von Euler-Chelpin, KTH, PhD thesis]

Machine tool data model in STEP AP214

Used functionality:

- Machine tool element classification (derived from the ontology)
 - Terminology
 - Element relations
e.g. *table* is a type of *mechanical machine element*
- Kinematics, e.g.
 - Joint placement and type
 - Axis direction
 - Travel range
- Properties, e.g.
 - Spindle speed, max. [rpm]
 - Feed rate, max. [mm/min]
 - Acceleration, max. [mm/min²]
 - Jerk, max. [mm/min³]
- Interfaces, e.g.
 - Cutting tool placement and type
 - Fixture placement and type



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