Attendees

- Pieter Pauwels [Ghent University]
- Markus Rickert [fortiss]
- Alexander Perzylo [fortiss]
- Kris McGlinn [TCD-Adapt]
- Mads Holten Rasmussen [DTU]
- Peter Bonsma [RDF Ltd.]
- Ana Roxin [Univ. Burgundy]
- Anna Wagner [TU Darmstadt]
- François Daoust [W3C]
- Aaron Costin [University of Florida]
- Georg Ferdinand Schneider [Fraunhofer IBP]
- Jun Wang [Curtin University]
- Michel Bohms [TNO]
- Claudio Mirarchi [Polimi]
- Kyriakos Katsigarakis [TUCrete]
- Georgios Lilis [TUCrete]
- Emilio Sanfilippo [LOA]

Excused

- Maxime Lefrançois [Mines Saint-Etienne]
- Gonçal Costa [LaSalle University]
- Odilo Schoch [ETHZurich]

Date and time

- 16/10/2017
- 17:00 CEST

Agenda

1. Presentation by Markus Rickert and Alexander Perzylo about their BREP ontology (geometry subdomain).
2. Discussion about Community Group / Working Group at the W3C

Minutes

1. The BREP ontology (Markus Rickert and Alexander Perzylo).

Presentation:
https://github.com/w3c-lbd-cg/lbd/blob/gh-pages/presentations/geometry/20171016-fortiss-OntoBREP.pdf

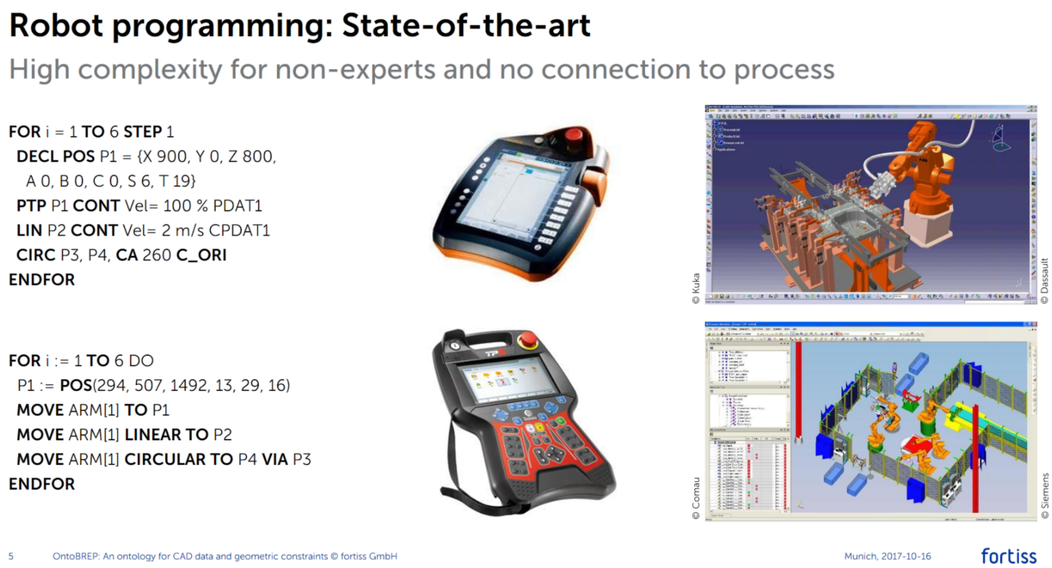
Introduction to Fortiss - Research and transfer institute associated with TUMünich

BREP ontology developed within context of EU project on industrial robotics in mass production: SMERobotics

Unique challenges in robotics for SME due to quick turn around times per contract.

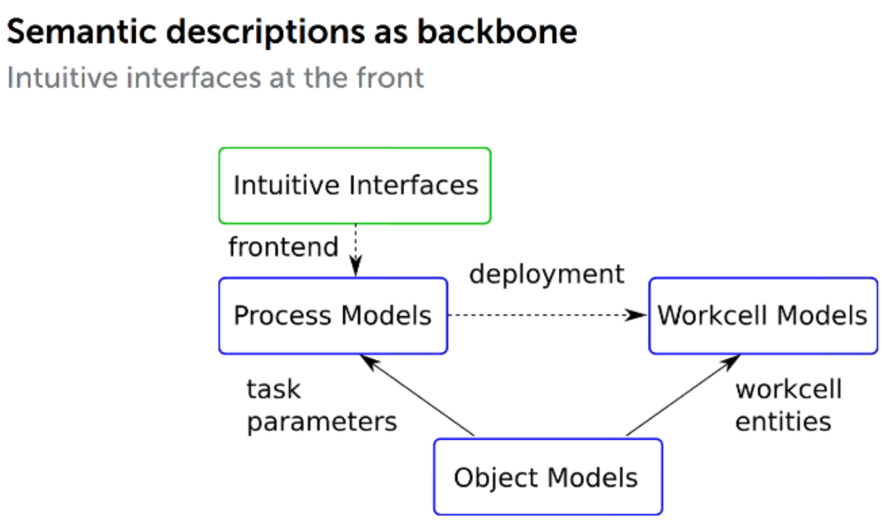
Robot programming complex for non-experts, long training periods.

The main aim is to make this programming a lot faster and more intuitive



Our focus was service robotics, they have goal specific specification, i.e. “get glass of water from kitchen” not explicit set step by step.

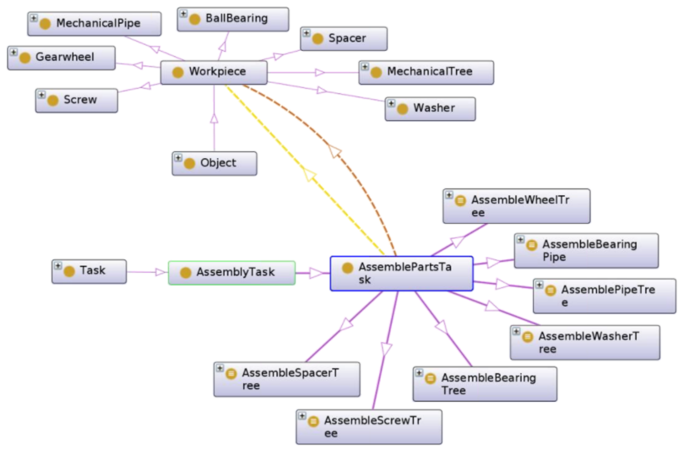
Make use of semantic descriptions with intuitive interfaces at the front end:



Behind the intuitive interfaces (e.g. aimed at welding), a number of process models capture the actual data (CAD and semantics). Intuitive interface is displayed on the right of the below image. This connects to the object model on the left.

Semantic description of processes

Connection of parts and assembly tasks



9 OntoBREP: An ontology for CAD data and geometric constraints © fortiss GmbH Munich, 2017-10-16 fortiss

All objects are semantically described. In doing this, we try to maintain the exact original geometric representation as it was input in the CAD environment, hence the BREP ontology. E.g.:

Bounding box

Width/height/depth

Origin

X/Y/Z axis

Weight

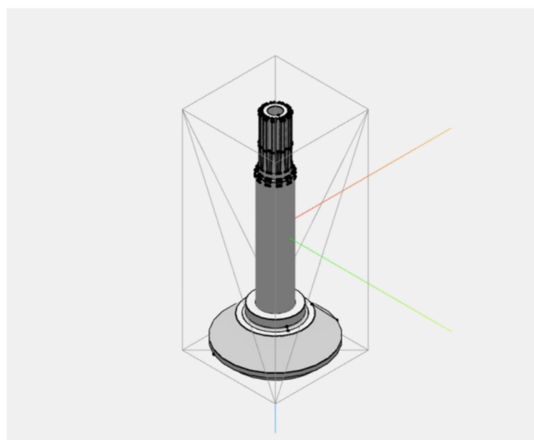
Material properties

Grasp poses

BREP (CAD)

Polygon triangulation

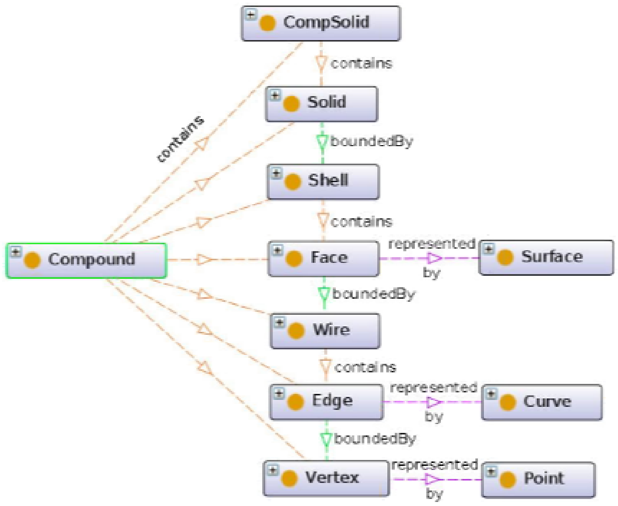
...

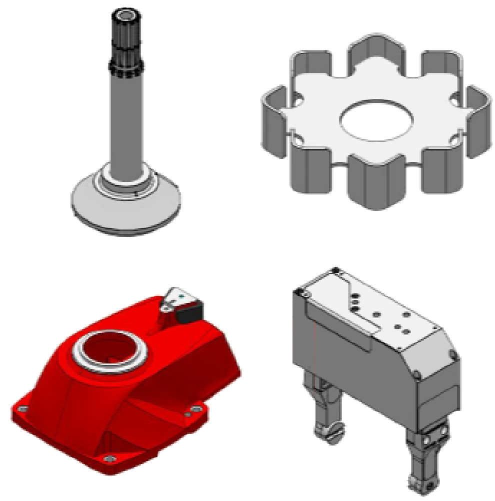


10 OntoBREP: An ontology for CAD data and geometric constraints © fortiss GmbH Munich, 2017-10-16 fortiss

BREP Representation (BREP)

A compound can contain a number of solid elements, for example a CompSolid, which in itself contains a number of other geometric elements (solids, shells, faces, wires and so forth).



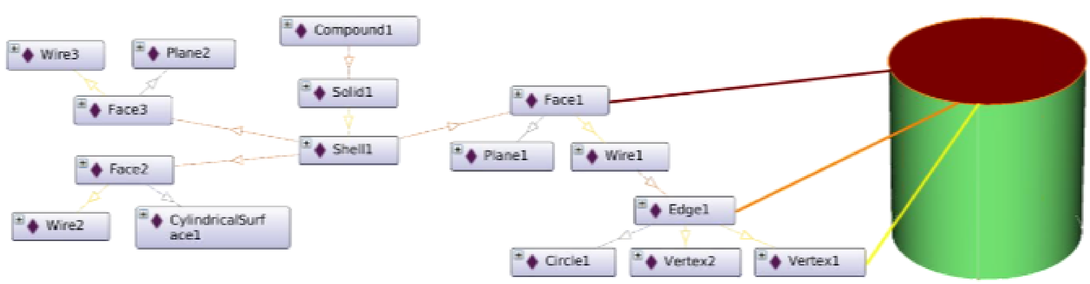


OntoBREP uses OWL, provides taxonomy of topological and geometric entities, properties, i.e. topological relations and geometric parameters.

OntoBREP

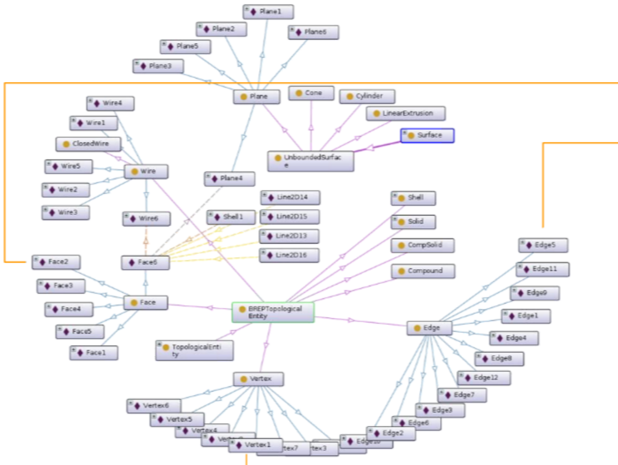
Semantic description language for CAD data

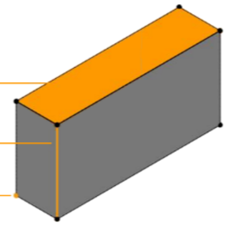
- Using the Web Ontology Language (OWL)
- Taxonomy of topological and geometric entities
- Properties, i.e., topological relations and geometric parameters



Complete example: Cuboid

Representation of geometry information



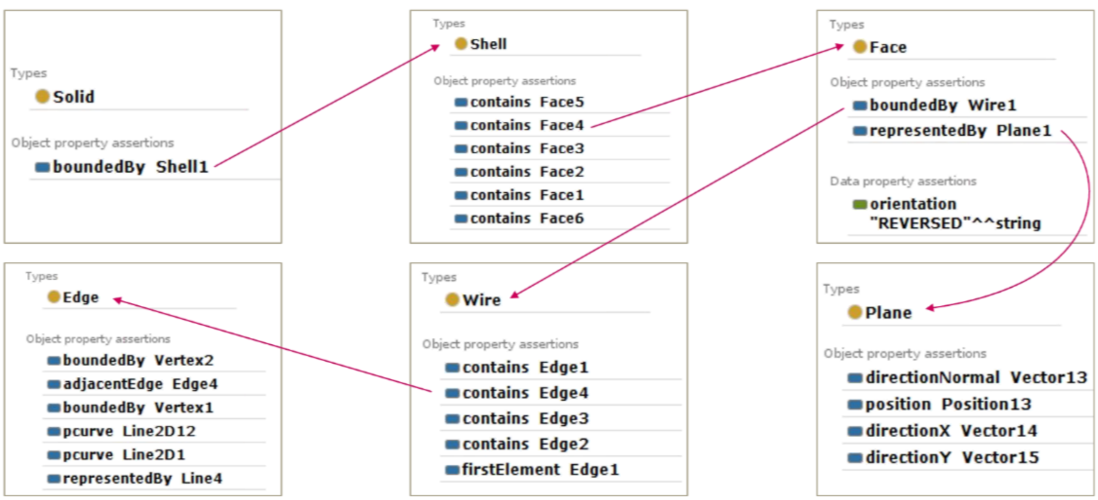


BREP representation of an object with surfaces, edges, points (with unique IDs)

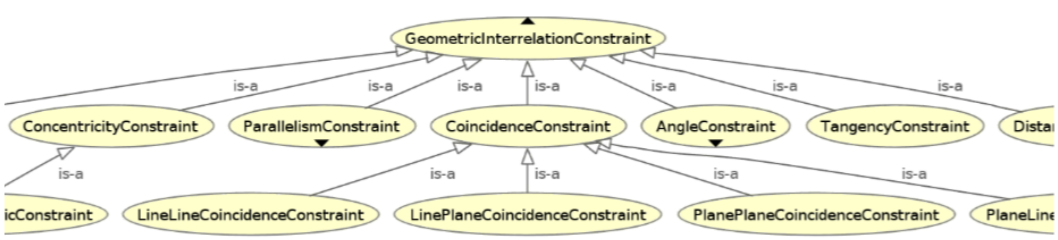
Access to mathematical elements (e.g., axis, radius) of circles, cylinders etc. for linking

Semantic description of CAD data

The cuboid step-by-step

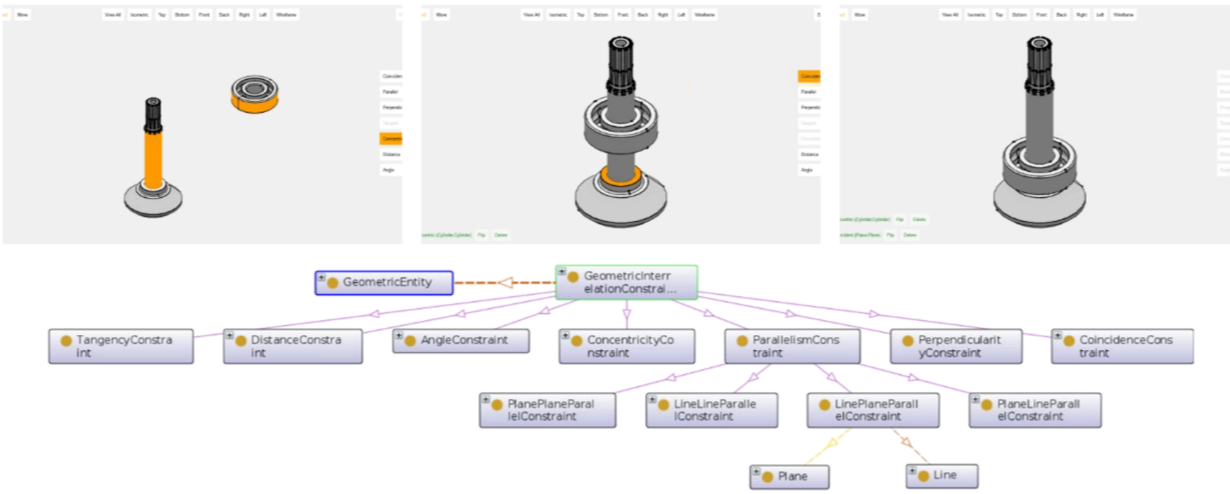


Besides taxonomies for topological and geometric entities, we also worked towards representing geometric interrelation constraints. This allows to specify relative poses of a robot (arm grasping, assembly positions, …).



Description of geometric constraints

Example: Assembly of parts



An implementation has been done using the Open Cascade (OCC) kernel, a Java wrapper for OCC and the OWL API:

Automatic conversion to OntoBREP formalism

Import of STEP and IGES models

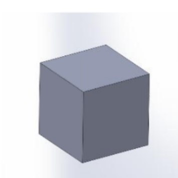
Conversion tool utilizing

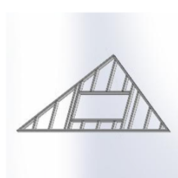
- OpenCascade (OCC) CAD kernel
- JNI-based Java wrapper for OCC
- OWL API

Quantitative Evaluation

- Conversion time
- Load time in Sesame triple store (OWLIM)

Model	*Converting STEP*	*Loading OWL in Sesame*	
	time in ms	*time in ms*	*axioms per ms*
CUBE	365	25	57.2
FRAME	805	343	77.0
ROTOR	1018	704	60.9


cube


frame


rotor

STEP files can thus be parsed using this implementation; after which the application populates the BREP ontology automatically. Quantitative evaluations have been done of conversion times and file sizes, using a cube, frame and rotor geometry (see below image).

Model	*Number of topological BREP entities*								
	Ve [a]	*Ed* [b]	*Fa* [c]	*Wi* [d]	*Sh* [e]	*So* [f]	*CS* [g]	*Co* [h]	*Total*
CUBE	8	12	6	6	1	1	0	1	35
FRAME	152	228	114	114	19	19	0	1	647
ROTOR	270	405	153	155	9	9	0	1	1002

[a]Vertex [b]Edge [c]Face [d]Wire [e]Shell [f]Solid [g]CompSolid [h]Compound

Number of OWL axioms							
C [i]	*OP* [j]	*DP* [k]	*I* [l]	*CA* [m]	*OPA* [n]	*DPA* [o]	*Total*
15	12	17	206	206	281	694	1431
16	12	17	3915	3915	5358	13186	26419
19	12	18	6068	6068	8342	22314	42841

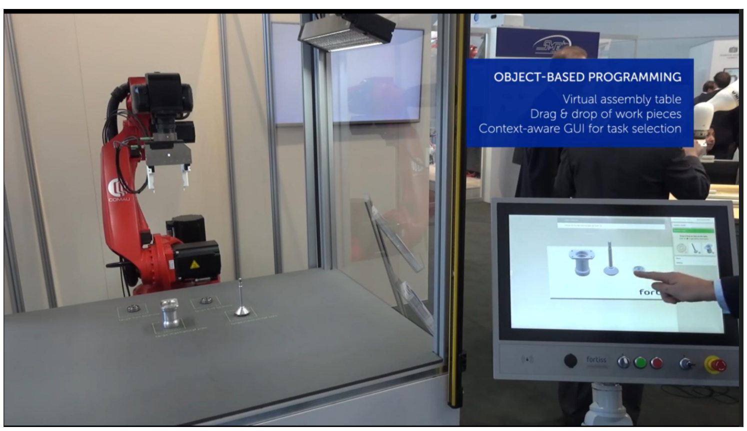
[i]Class [j]Object property [k]Data property [l]Individual [m]Class assertion [n]Object property assertion [o]Data property assertion


cube

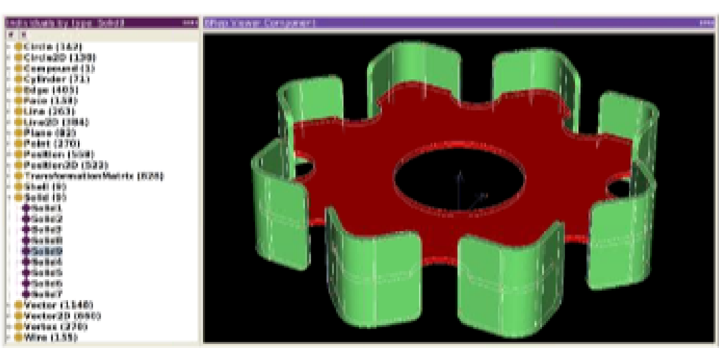

frame


rotor

Example implementations have been presented on various occasions, focusing a lot on the intuitive interface for programming a robot:



An open source release is available in github (partial): https://github.com/ontobrep. This project includes an OWL ontology and a SWIG project for generating Java bindings for the OpenCascade library (C++).



Questions:

1) Pieter: how is the order of elements handled?
   We indicate which is the first Edge 1, which in turns specifies the following edge. This keeps going, thus creating order.

2) Giorgios: how are inner boundaries connected?
   It depends on the orientation of the wire (if CCW, it is considered as a whole).
3) Peter: how is the transformation from STEP handled? Are the geometric constraints exported to STEP?
   No, only in Catia or SolidWorks. Could be done by writing a plugin for Catia / SolidWorks.
4) Michel: how would it relate to CSG geometries? Some shapes could be more efficiently represented with CSG instead of BREP?
   An extension to CSG is envisaged, along with the mappings CSG->BREP and vice-versa.
5) Michel: could BREP on the fly be generated (like triang. from brep) ?
   could be.
6) Michel: is it a generic BREP (how related to “ISO STEP Part 21’s BREP and bSI IFC’s BREP)?
   Based on OpenCascade

Github - https://github.com/ontobrep

2. Discussion about Community Group / Working Group at the W3C
W3C - consortium, so members decide together and develop standards (approved by members).

A community group doesn’t require W3C membership, and gives quite some freedom. A working group, on the other hand, needs something that is scoped enough to become a candidate for standardisation. It has a different context: W3C membership is required, the scope has to be very strictly specified (with regard to certain patent policies). The deliverables need to be met, so the scope needs to be very realistic.

Ideas:

- Restrict our scope to 1 or 2 deliverables - keep in mind efficiency
- 5% paid membership
- Groups with 10 active participants are ok
- Then create a WG - think of finding support among other W3C members (20-25 W3C members have to express support for the WG to be created)

Interest Groups is more of a Steering Committee

- For geometries at the W3C, we should consider discussing with the Spatial Data on the Web Interest Group - https://w3c.github.io/sdw/jwoc/

Previous minutes

https://docs.google.com/document/d/1do2nyz1FcRaj-o0dQ1MbtMKlUGeXfbR_PzhvtinyaO8/edit#

Next Calls

Monday, 30th of October during bSI London, 5PM CET