Open BIM for infrastructure: Recent standardisation efforts

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Prof. Dr. Gianluca Dell'Acqua (UniNa) and Prof. Dr. Andrej Tibaut (UM)
BIM is a process of structuring the information of an AECO project from inception onward.

BIM facilitates design, construction, operation and maintenance by creating reliable bases for decision making.
Why Standards?

“Great things happen when the World agrees.”
Standards for Infrastructure

Exchange scenario in a Road Project

Adapted from: BuildingSMART: Requirement Analysis Report IFCRoad, WP2
Open BIM

WHY?

OPEN STANDARDS
- IFC
- MVD and IDM
- bsDD
- CoBie
- BCF
- OGC
- gbXML
- BIMXML
- PDF

Smart Business Decision
Platform Independent and Vendor Neutral
Wide implementation
Flexibility and choice, for global market success and fair competition
Strategic
Facilitators for innovation
End-to-end solutions
Meeting customer requirements today and in the future
Why IFC?

Industry Foundation Classes
Neutral, open file format specification

The IFC specification is developed and maintained by buildingSMART International as its "Data standard"

Intended to describe Architecture, Engineering, Construction and Operations (AECO) data
IFC is an open ISO standard supported by the industry, promoted by buildingSMART

- ISO 16739-1:2018
  Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries -- Part 1: Data schema

- ISO 12006-3:2007
  Building construction -- Organization of information about construction works -- Part 3: Framework for object-oriented information

- ISO 29481-2:2012
  Building information models -- Information delivery manual -- Part 2: Interaction framework
Complete detailed representation of road projects in IFC is still missing...
IFC for Road Projects
Material for review available from **May 17, 2019**

"IFC Road Expert Panel: Draft Conceptual Model"

**May 31, 2019**

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
OBJECTIVE

- Extending the IFC data model into the domain of roads by describing the **semantics and geometry for roads**

FOCUS

- Developing a **conceptual model** for the upcoming extension of IFC into the domain of roads
A unique hierarchical spatial breakdown of the project

Each component belongs uniquely to one element in this breakdown

Grouping of physical parts, composed for a common purpose or function or to provide a service

A physical part may belong to many functional elements

Hierarchical composition of physical parts

Each part belongs directly or indirectly to an element in the spatial structure

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
Spatial Structure:

Spatial (project) structure

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
IFC Road conceptual model: Taxonomy, Associations, Definitions

Functional Structure:

General physical (building) elements

ISO 6707-1:2017
Buildings and civil engineering works
-- Vocabulary -- Part 1: General terms

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
Example ROAD: Alternative ways to model

1. Pavement not decomposed into parts (courses)
   - Geometric representation using `SectionedSolidHorizontal`
   - Material association using `MaterialProfileSet`

2. Pavement decomposed in 2 parts (courses as Fill)
   - Geometric representation using `SectionedSurface`
   - Material association using `MaterialProfileSet`

   - Geometric representation using `OpenCrossProfileDef`
   - Material association using `MaterialProfileSet`

   - Geometric representation using `SectionedSolidHorizontal`
     - Material association using single `Material` for each `Fill`
     - Material association using single `Material` for each `Fill`

   - Geometric representation using `OpenCrossProfileDef`
     - Material association using single `Material` for each `Fill`

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
Modelling the Road

Pavement not decomposed into parts (courses)

Geometric representation using **SectionedSolidHorizontal**
Material association using **MaterialProfileSet**

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
Pavement not decomposed into parts (courses)

Geometric representation using proposed `SectionedSurface` and `OpenCrossProfileDef`
Material association using `MaterialProfileSet`

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
Modelling the Road

Pavement decomposed in 2 parts (courses as Fill)

Geometric representation using **SectionedSolidHorizontal**

Material association using single **Material** for each **Fill**

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Modelling the Road

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
Modelling the Road

Pavement decomposed in 2 parts (courses as Fill)

Geometric representation using proposed GeometricCurveSet

Material association using single Material for each Fill

Adapted from: BuildingSMART: IFC Road Expert Panel WP3: Conceptual Model Report
Procedural / Generative / Algorithmic / Parametric Modelling

```plaintext
32  rotate = "both"; // [clockwise, counterclockwise, both]
33  height_building = height_tower * 0.1;
34  height_topslab = thbr / 10;
35  height_baseslab = thbr / 10;
36  height_column = thc / 10;
37  height_basement = thbr / 10;
38  
39  /* module for single column generation */
40  /* columns */
41  
42  for (i=0; i<nsp-1; i++) {
43      /* base slab */
44      translate([0, 0, -height_baseslab/2])
45      cylinder(h=height_baseslab, r=radius+height_column);
46  
47      /* massive building */
48      translate([0, 0, height_baseslab/2])
49      cylinder(h = height_building, r1 = radius-2*height_column, r2 = 0)
50      (radius-height_column)*0.80);
51      
52      /* shaft: cylinder with height, radius, */
53      translate([0, 0, height_baseslab/2+height_building])
54      cylinder(h = height_building+height_baseslab, r=(radius-2*
55        height_column)*0.3, $fn=4);
56      
57      /* lookout top slab */
58      translate([0, 0, height_tower-0.9 - height_topslab / 2])
59      cylinder(h=height_topslab, r=radius-height_topslab);
60      
61      /* top-1 slab */
62      translate([0, 0, height_tower - height_topslab / 2])
63      cylinder(h=height_topslab, r=radius-height_topslab);
64  
65  // eof
```

Adapted from: UM Vinarium Project
Procedural / Generative / Algorithmic / Parametric Modelling

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```plaintext
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41  /* module for single column generation */
42  void module_columns(ang, h, r) {
43
44  for (i=[0:nsp-1]) {
45   /* base slab */
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54  /* shaft: cylinder with height, radius */
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64     cylinder(h=height_topslab, r=radius+height_topslab);
65
66  // eof
67  }
68  }
69
```

Adapted from: UM Vinarium Project
Thank you for the attention!