INTELLIGENT DESIGN FOR RESILIENT BUILT ENVIRONMENT: the integration of geo and BIM

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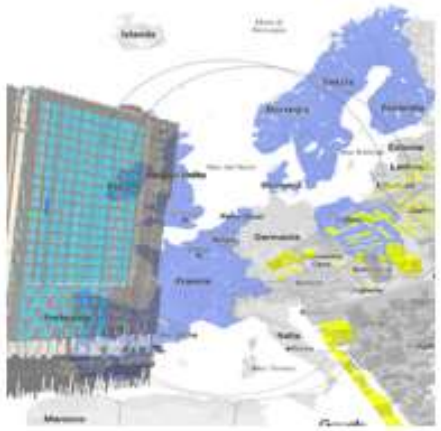
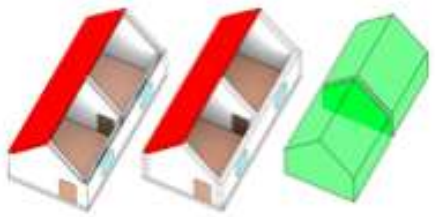
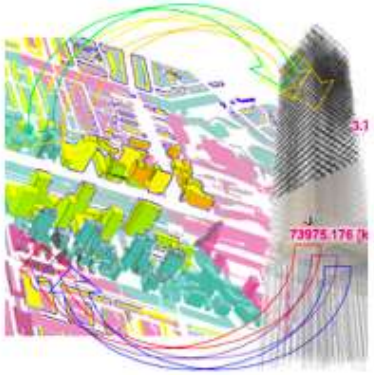


EuroSDR GeoBIM



TUD+TU/e GeoBIM



Smart data integration for urban applications

GeoBIM benchmark

UCL

LUND

DIT

University of Ljubljana Faculty of Civil and Geodetic Engineering

isprs

NMCAs

EuroSDR

IGN

Kartverket

AMS Amsterdam Institute for Advanced Metropolitan Solutions

Gemeente Almere

BIM Loket

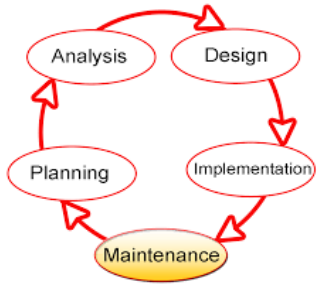
Den Haag

GEONOVUM

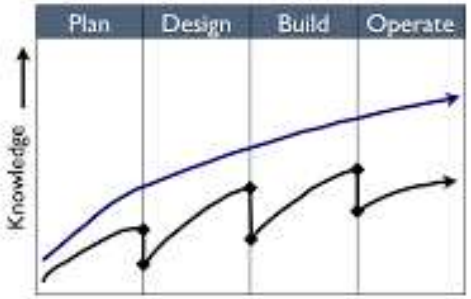
kadaster

Gemeente Rotterdam

GeoBIM integration for intelligent design: our experiences

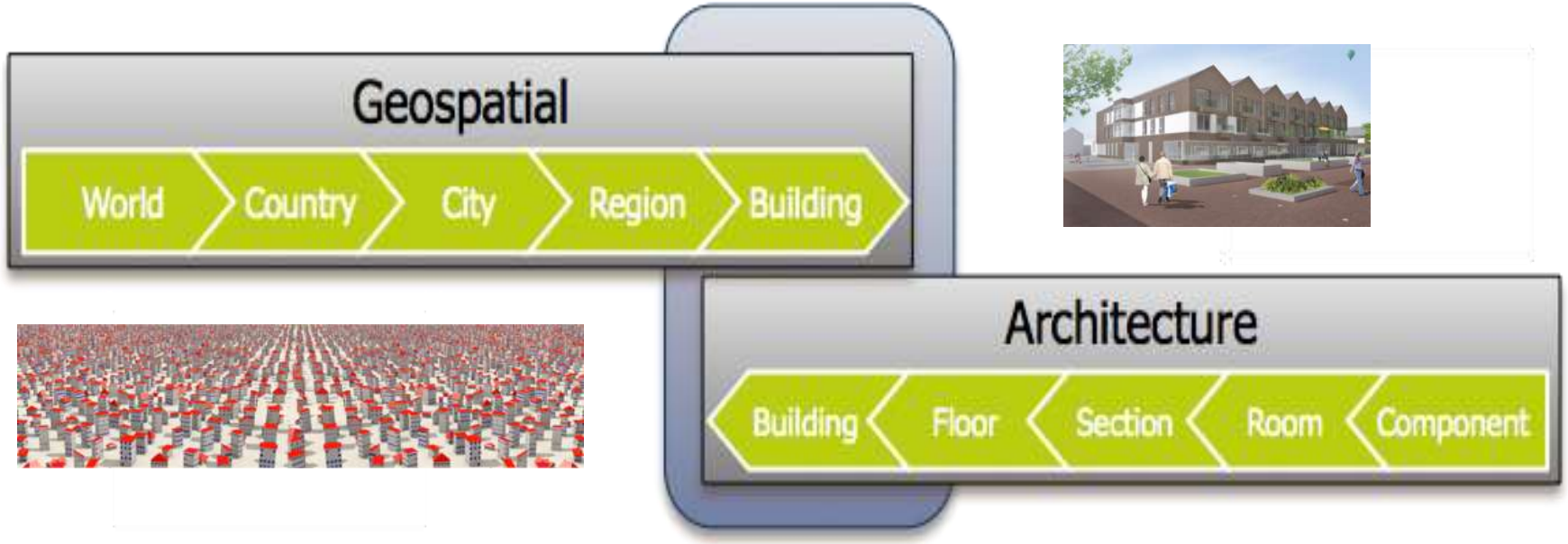


- Good understanding of workflows and required information flows for Object Life Cycles of the built environment (*Intelligent design, Digital Twin, Smart City*)
- And implemented for individual projects and within single software ennvironments
- But beyond projects, ac studies and specific software solutions: data is thrown over the fence, without taking requirements of the next phase into account



- Integration works nice in theory; but in practice we see errors and data losses

Geo data and BIM data: Often overlap is highlighted



BIM

Differences

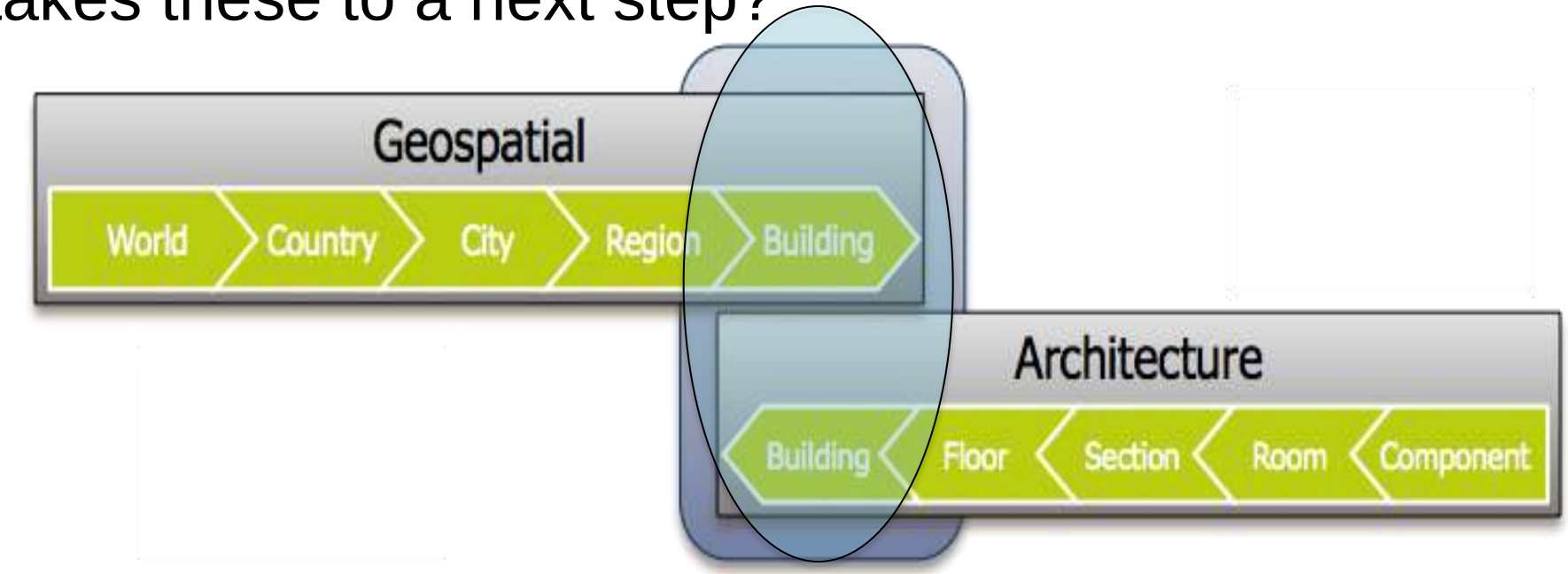
Geo

Digital plan for design & construction + data management for project sites	Data is source for spatial analysis
Dominated by industry	Dominated by government
Sharing data is complex (copyrights). Supplier does not per se benefit	Sharing data is common good. Both supplier and user benefit
Added values of open standards less prominent	Standards are required and shared interest
Validation in context of individual software	Focus on data flows within Spatial Data Infrastructure (data quality, validation)
Geometry is designed; volumetric objects	Measured geometry Brep (surfaces)
LoD: Single house contains 1000 elements; highly detailed	Less detailed

TU Delft

GeoBIM solutions for intelligent design for resilient built environment: **what next?**

- Many studies, pilots, projects have shown potentials. How to takes these to a next step?

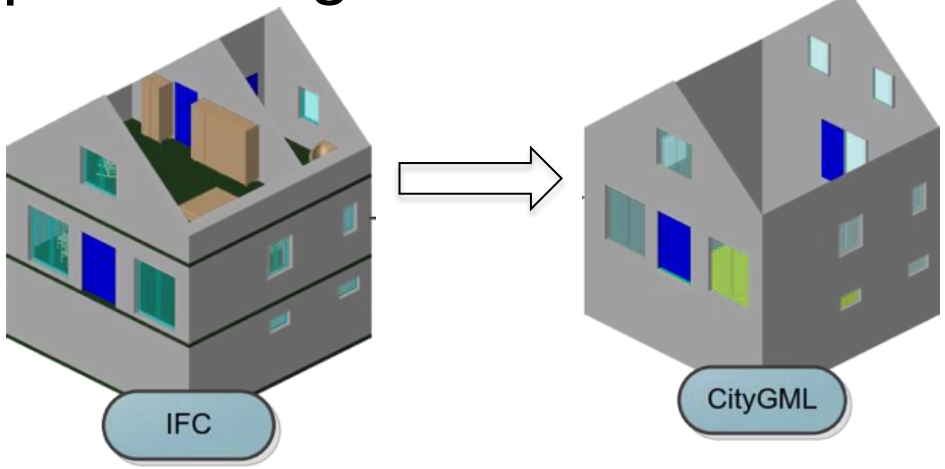


- Where do both domains touch? And how can we organize alignment and integration at this boundary?

Next steps for GeoBIM solutions

1. Understand how BIM-data is needed in Geo-applications and vice versa (i.e. materials for energy transition or information to check regulations). Real case studies

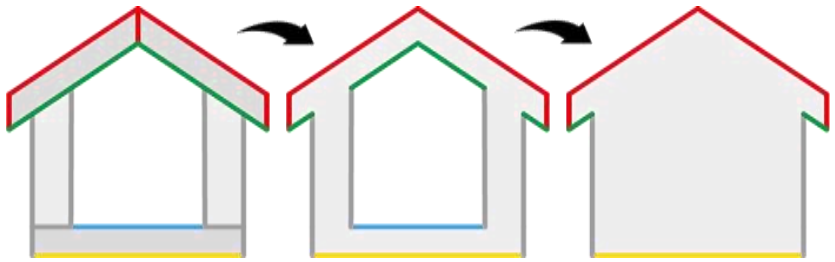
2. How to develop meaningful conversion between Geo and BIM?



Model with high detail and many objects (all volumes; mostly modelled with parametrized geometries)

One object as closed volume; no “thick” walls

Next steps continued



Donkers et al, 2016

3. Develop (application) profiles for open standards to limit modelling possibilities

   Georeferencing; geometrical valid objects; model geo-concepts in BIM (rooms; hallways; outer shells); use of specific classes

4. Validation

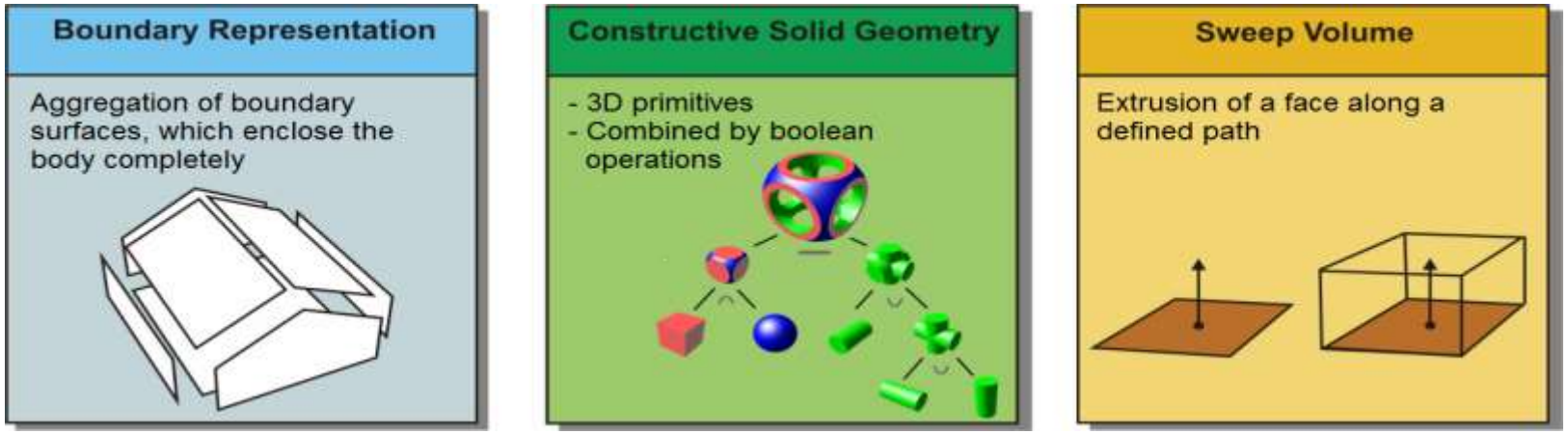
5. Better support for open standards: in practice IFC files vary a lot in their structure and classes used, even in one file

6. How to share data while accounting for copy rights

7. How to organize “trust” for sharing BIM data (who is responsible?)

Next steps continued

8. Align differences in geometrical paradigma's



explicit representation

implicit representation
(need to be discretised to be manipulated with GIS objects)

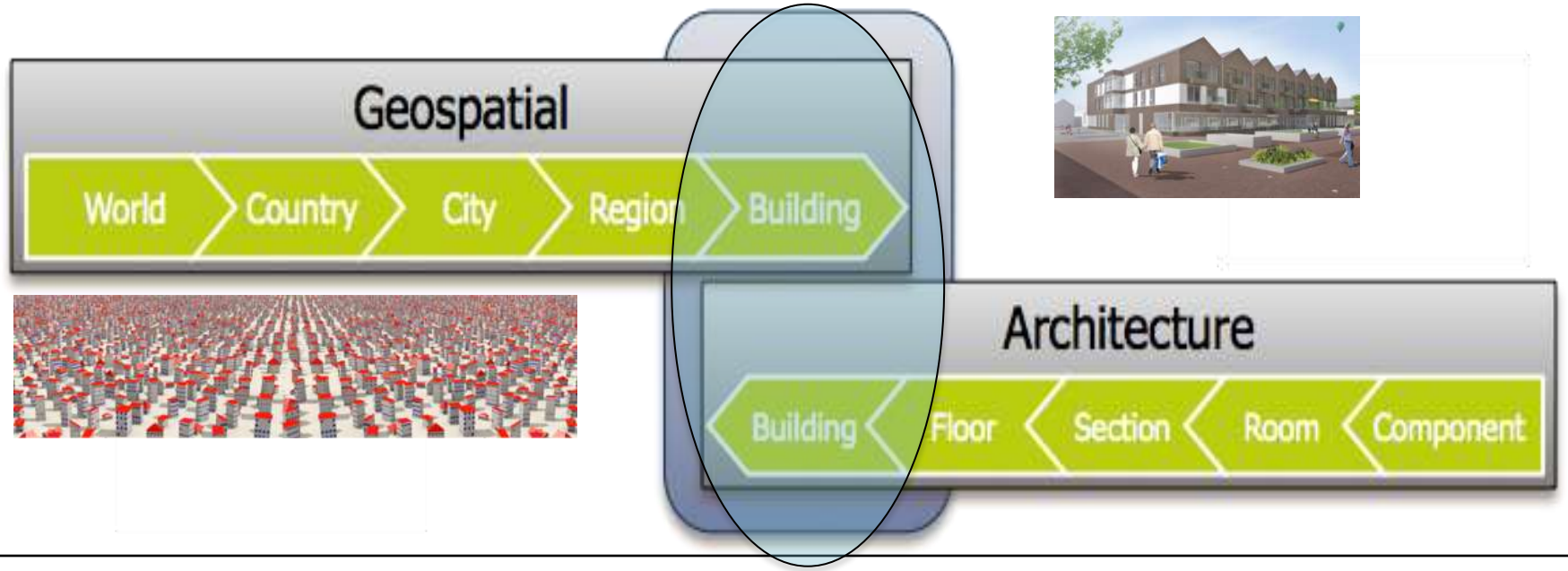
3D GIS

Figure adapted from Kolbe and Plümer (2004)

BIM

In conclusion

- More knowledge and solutions needed on boundary of both domains
- Specifically on how used in practice, in open environments taking into account differences in both domains



https://3d.bk.tudelft.nl/projects/geobim-benchmark/

Thank you!

For more information, visit 3D.bk.tudelft.nl

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GeoBIM integration often studied via IFC-CityGML interoperability and conversion

Industry Foundation Classes

IfcActuatorType
IfcAirTerminalBoxType
IfcAirTerminalType
IfcAirToAirHeatRecoveryType
IfcAlarmType
IfcAnnotation
IfcBeam
IfcBoilerType
IfcBuildingElementPart
IfcBuildingElementProxy
IfcBuildingStorey
IfcCableCarrierFittingType
IfcCableCarrierSegmentType
IfcCableSegmentType
IfcChillerType
IfcCoilType
IfcColumnType
IfcCompressorType
IfcCondenserType
IfcControllerType
IfcCooledBeamType
IfcCoolingTowerType
IfcCovering
IfcCurtainWall
IfcDamperType
IfcDistributionChamberElementType
IfcDistributionControlElement
IfcDistributionElement
IfcDistributionFlowElement
IfcDoorType
IfcDuctFittingType
IfcDuctSegmentType
IfcDuctSilencerType
IfcElectricApplianceType
IfcElectricFlowStorageDeviceType
IfcElectricGeneratorType
IfcElectricHeaterType
IfcElectricMotorType
IfcElectricTimeControlType
IfcElementAssembly

IfcEnergyConversionDevice
IfcEvaporativeCoolerType
IfcEvaporatorType
IfcFanType
IfcFastenerType
IfcFilterType
IfcFireSuppressionTerminalType
IfcFlowController
IfcFlowFitting
IfcFlowInstrumentType
IfcFlowMeterType
IfcFlowMovingDevice
IfcFlowSegment
IfcFlowStorageDevice
IfcFlowTerminal
IfcFlowTreatmentDevice
IfcFooting
IfcFurnishingElement
IfcFurnitureType
IfcGasTerminalType
IfcHeatExchangerType
IfcHumidifierType
IfcJunctionBoxType
IfcLampType
IfcLightFixtureType
IfcMechanicalFastenerType
IfcMemberType
IfcMotorConnectionType
IfcOpeningElement
IfcOutletType
IfcPile
IfcPipeFittingType
IfcPipeSegmentType
IfcPlateType
IfcProtectiveDeviceType
IfcPumpType
IfcRailing
IfcRamp
IfcReinforcingBar
IfcReinforcingMesh

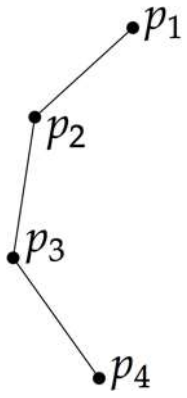
IfcRoof
IfcSanitaryTerminalType
IfcSensorType
IfcSite
IfcSlab
IfcSpace
IfcSpaceHeaterType
IfcStackTerminalType
IfcStair
IfcSwitchingDeviceType
IfcSystemFurnitureElementType
IfcTankType
IfcTransformerType
IfcTransportElementType
IfcTubeBundleType
IfcUnitaryEquipmentType
IfcValveType
IfcWall
IfcWasteTerminalType
IfcWindowType

1000+ in total

Many more IFC geometric classes than GML (point, curve, surface and solid)

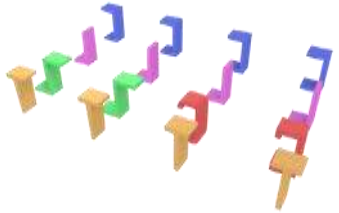
Curves/wires

IfcCircle
IfcEllipse
IfcLine
IfcEdge
IfcOrientedEdge
IfcEdgeLoop
IfcPolyLoop
IfcPolyline
IfcCompositeCurve
IfcTrimmedCurve



Faces

- IfcArbitraryClosedProfileDef
- IfcArbitraryProfileDefWithVoids
- IfcRectangleProfileDef
- IfcRoundedRectangleProfileDef
- IfcRectangleHollowProfileDef
- IfcTrapeziumProfileDef
- IfcCircleProfileDef
- IfcCircleHollowProfileDef
- IfcEllipseProfileDef
- IfcFace



IfcCShapeProfileDef
IfcLShapeProfileDef
IfcIShapeProfileDef
IfcTShapeProfileDef
IfcUShapeProfileDef
IfcZShapeProfileDef
IfcDerivedProfileDef

Volumetric shapes

- IfcExtrudedAreaSolid
- IfcExtrudedAreaSolidTapered
- IfcConnectedFaceSet
- IfcCsgSolid
- IfcBlock
- IfcBooleanResult
- IfcSphere
- IfcRectangularPyramid
- IfcRightCircularCylinder
- IfcRightCircularCone
- IfcTriangulatedFaceSet
- IfcHalfSpaceSolid

Abstract shapes

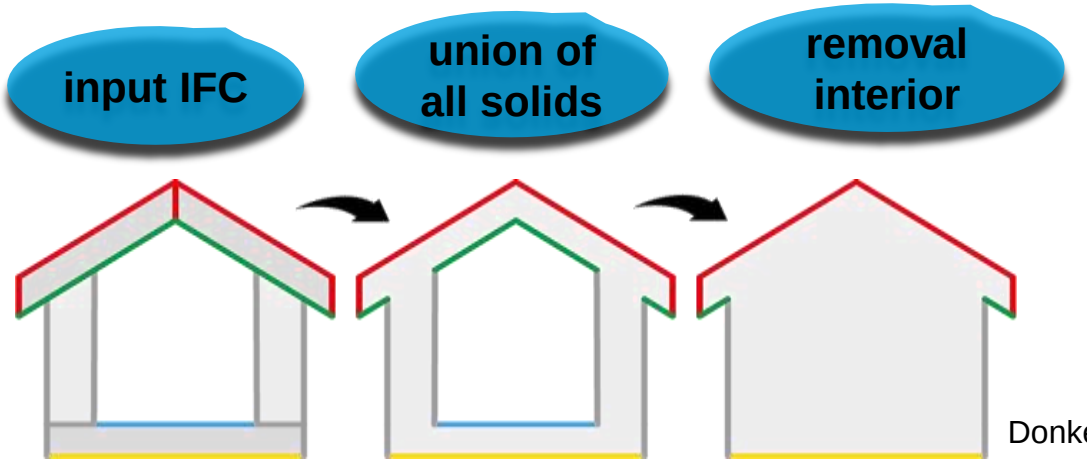
IfcRepresentation
IfcGeomatricSet
IfcShellBasedSurfaceModel
IfcManifoldSolidBrep
IfcMappedItem
IfcFaceBasedSurfaceModel

IFC versus GIS Geometry

IFC -> CityGML
Not just conversion of geometry

For a house:

IFC -> CityGML of a building



Donkers et al, 2016

ISPRS Int. J. Geo-Inf. **2018**, *7*(8), 311; https://doi.org/10.3390/ijgi7080311

Processing BIM and GIS Models in Practice: Experiences and Recommendations from a GeoBIM Project in The Netherlands

Ken Arroyo Ohori [1,*], Abdoulaye Diakité [2], Thomas Krijnen [3], Hugo Ledoux [1] and Jantien Stoter [1]

Conversion IFC<-> CityGML; works nice in theory and on clean models, but in practice

- IFC files vary a lot in their structure and classes used, even in one file

- IFC models contain errors because lack of support in mainstream software

(Note that also Geo-data may have issues)

GeoBIM solutions for smart city applications require…..

- Solutions to reconstruct valid IFC (incl validation)
- Correct georeferencing of BIM models
- Stop throwing data over the fence and “wait” for successful automated conversion solutions
- Better understanding of BIM needs in GIS
- GIS-prepared IFC data and v.v.

Only then can academic solutions become successful in practice

Euro Spatial Data Research (EuroSDR) GeoBIM project

- Lantmateriet Sweden
- GUGiK Poland
- NLS, Finland
- Kartverket, Norway
- ADSE, Denmark
- Kadaster, NL
- Swisstopo, Switzerland
- Ordnance Survey, UK
- Ordnance Survey, Ireland
- IGN, France
- ICGC, Catalonia

Use case 1:
From design to construction

Use case 2:
Lifecycle support in AM

Thank you!

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For more information, visit 3D.bk.tudelft.nl

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