



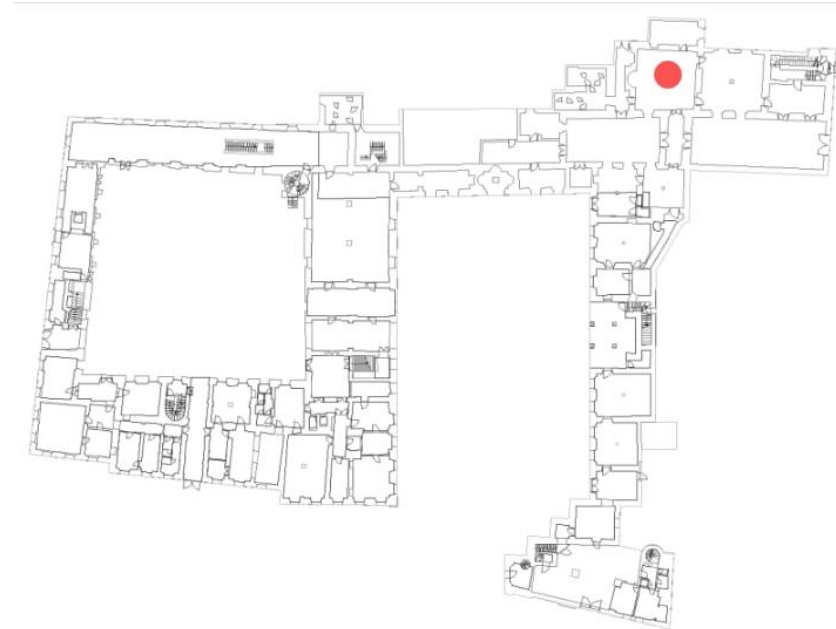
Aufbereitungsstrategien digitaler Datengrundlagen (CAD und PDF) für ArcGIS Indoors am Beispiel CampusMap der Universität Salzburg




Digital Twin Workshop
Esri User Conference Austria - powered by SynerGIS
23. Oktober 2025
Manfred Mittlböck

CampusMap: Status quo?

- -> Goals
 - orientation & navigation
 - (blue dot outdoors and *in* the building)
 - Connection to public transport information
 - accessibility information
 - security management
 - support for room booking
 - connection with existing data services (e.g. Plusonline room management)
 - Safety & fire protection training
 - identification & commitment for students and staff
 - public relations
 - (e.g. discovery tours with 360° images)



- BERG12
- BEV_Kataster
- CHU1
- EBMÖ
- FRA1
- GET21
- H34
- HAR4
- I79G
- I79P
- JAK1
- JAK2
- JAK2A
- JAK6
- JAK8
- KAP3
- KAP4
- KAP5
- KG17
- MB2A
- OH1
- PF6
- RES1
- RU42
- SC49
- SH16
- SH18
- UNI1
- UNI7
- UNIP
-  readme.txt



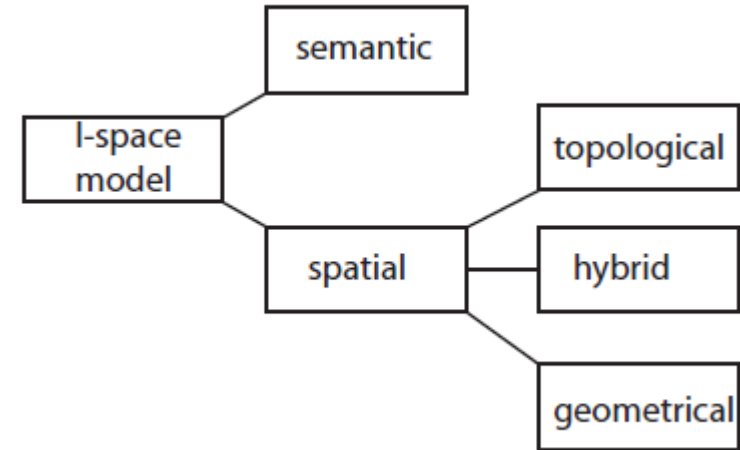
Digital Campus Map

Defining indoors?

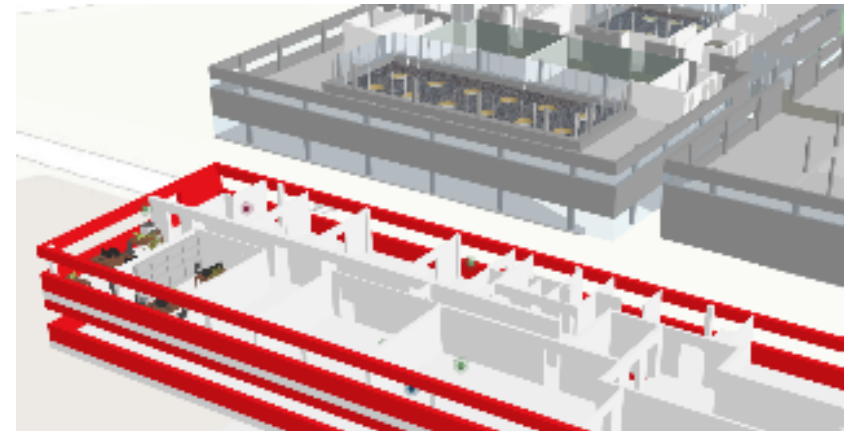
- Walton & Worboys 2009/11
 - Criteria for indoor-space
 - Built space
 - Enclosed
 - Large-scale
 - > Top level taxonomy of indoor space models

Li 2008:

- „the natures of indoor space are determined by the constraints of architectural components, such as **doors, corridors, floors, walls, and stairs**”



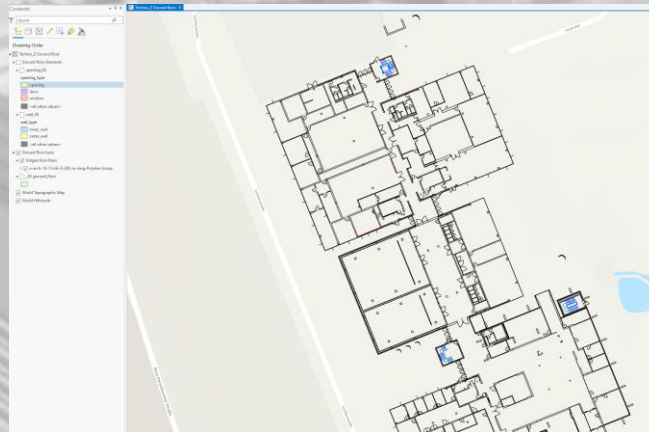
Top level taxonomy of indoor space models (Walton, 2011)





Digital Campus Map

Defining important indoor objects



Footprint

- 3D-Properties: height
- Other properties: ID, floor number

Wall

- Subtype: inner/outer
- 3D-Properties: height
- Other properties: ID, floor number

Opening

- Subtype: window/door/opening
- 3D-Properties: lower height, upper height, total height
- Other properties: ID, floor number

Rooms

- 3D-Properties: height
- + Vertexes for doors
- Other properties: ID, floor number

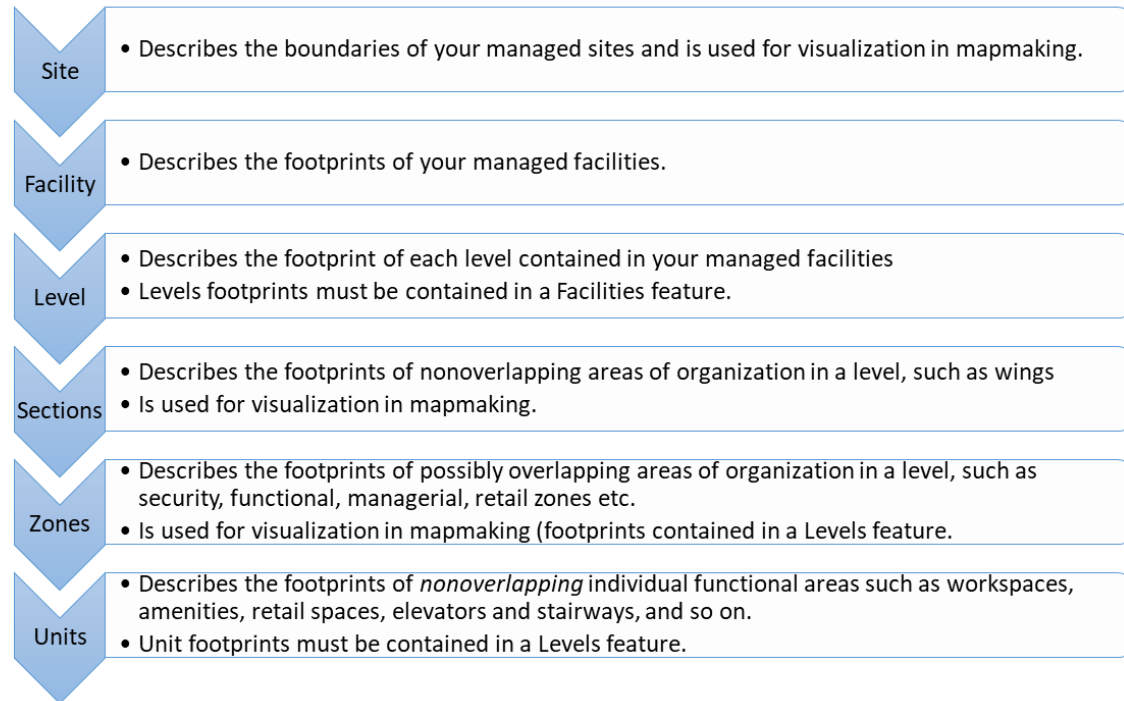
Stair

- 3D-Properties: height, number of stairs
- Other properties: ID, floor number from, floor number to

Indoor Mapping Models

ArcGIS Indoors Information Model (AIIM)

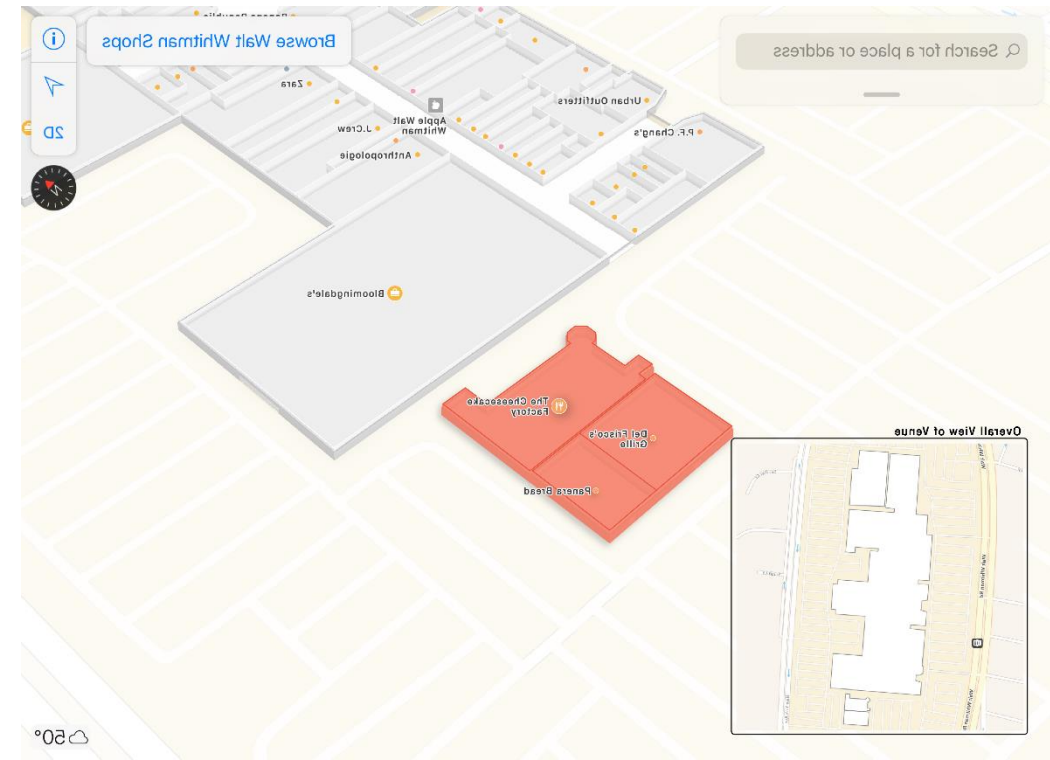
- The Indoors feature dataset consists of two different types of feature classes:
 - represent indoor information and those representing tracking and indoor positioning restrictions.
- Indoors data model comprises of
 - Feature Hierarchy of Sites
 - Routing Netzwerk Dataset
 - POIs
 - Events
 - Tracking Zones (for geofencing)
 - Dead Zones
 - Details (lines)
- Network feature classes
 - Landmarks
 - Pathways
 - Transitions (routing between levels)



Indoor Mapping Models

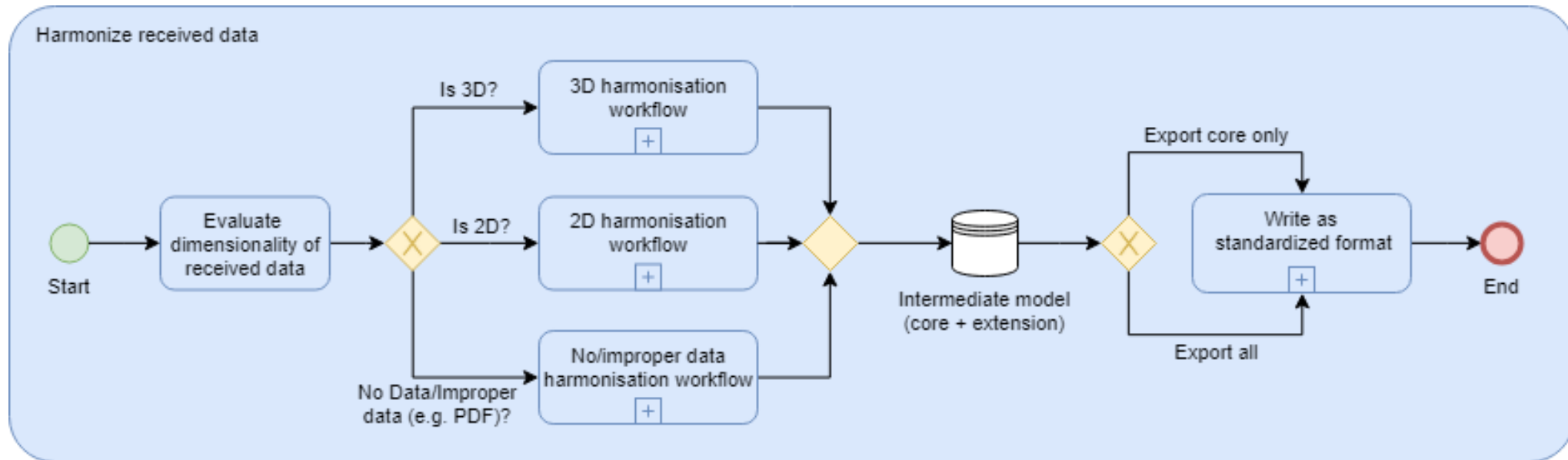
OGC Indoor Mapping data Format

- provides a generalized, yet comprehensive model for any indoor location, providing a basis for orientation, navigation and discovery.
 - <https://docs.ogc.org/cs/20-094/index.html>
- Developed by Apple -> OGC Standard
 - Indoor Mapping Data Format (IMDF) show users with fully-customized indoor maps of venues around the world, such as stadiums, airports, and campuses

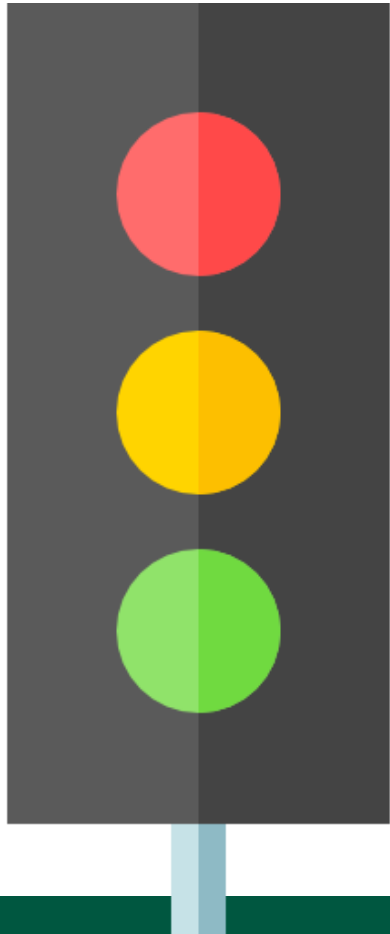


Source (2021): <https://docs.ogc.org/cs/20-094/Building/index.html>

Generalized CAD to GIS Integration workflow



Digital Campus Map - CAD-Layer evaluation



Only .pdf plans available.  **re-digitization**

Getreidegasse 21, Jakob Haringer Straße 2, Kapitelgasse 3, Otto Holzbauerstr. 1-3, Schlossallee 49

CAD-plans with extensive need of revision  **definition of custom semi-automated import strategies where applicable, or re-digitization**

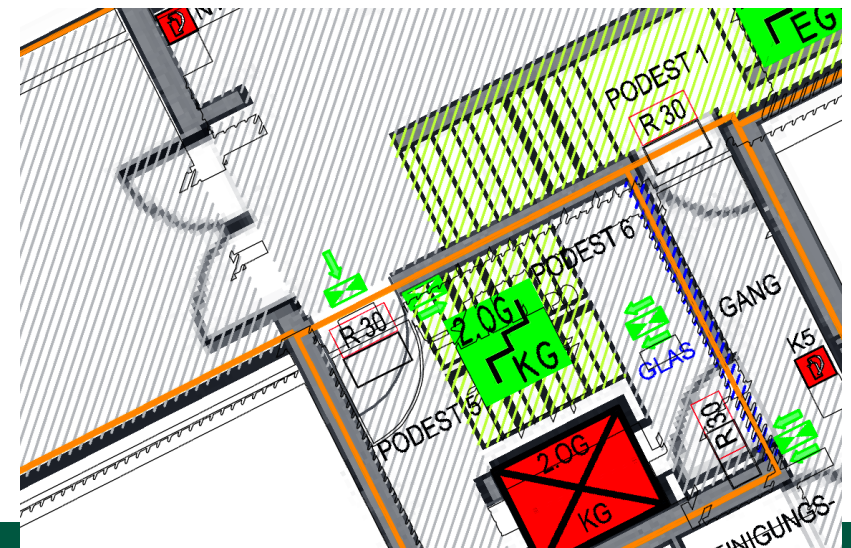
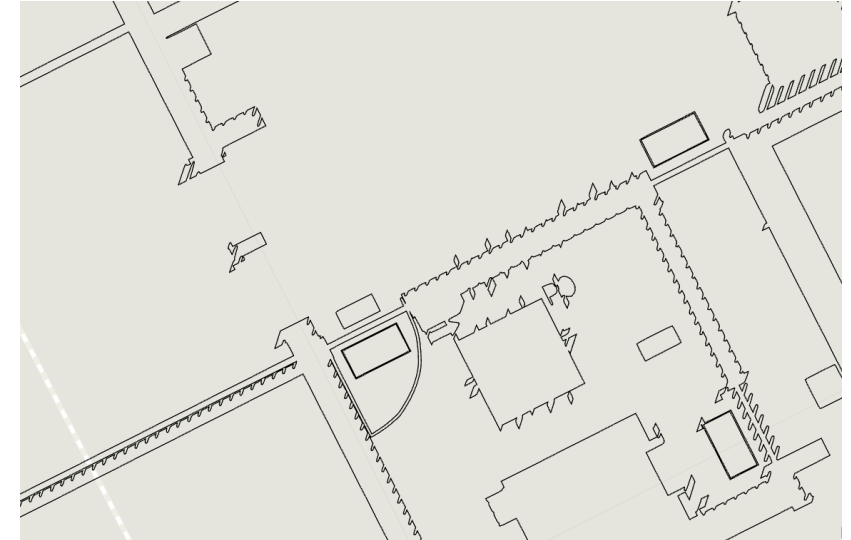
Bergstr. 12, Franziskanergasse 1, Ignaz-Harrer Str. 79G, 79P, Jakob Haringer Str. 1, 2A, 6, 8, Mönchsberg 2, 2A, Rudolfskai 42, Sigmund-Haffner Gasse 16, 18, Universitätsplatz 7

CAD-plans according to (partly) ON A-6241  **minor adoptions and semi-automated translation to GIS.**

Churfürstr. 1, Erzabt Klotz Str. 1, Hellbrunnerstr. 34, Kaigasse 17, Kapitelgasse 4-6, 5-7, Universitätsplatz 1

.pdf2CAD

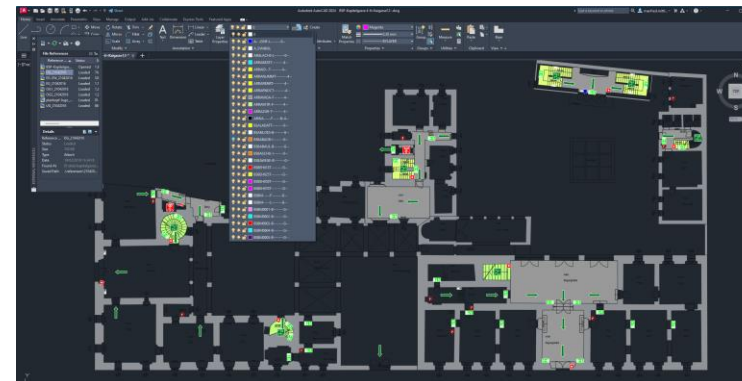
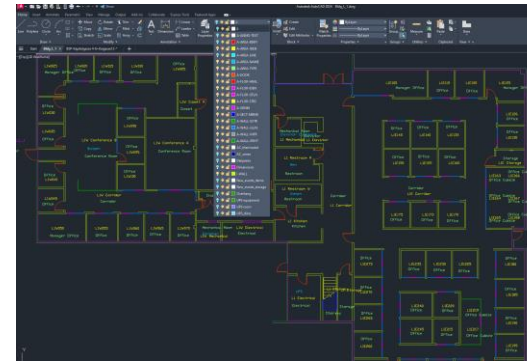
- Steps
 - evaluate .pdf
 - optional convert: to .tif
 - georeference .pdf/.tif
- Option 1: vectorize raster source
 - enhance contrast
 - convert to vector
- Option 2 digitize from raster



Rod to Campus Map

Current approaches for indoor representation

- Architecture-Engineering-Construction – AEC:
 - Worldwide - Building Information Modelling (BIM) with Industry foundation classes (IFC)
 - US: A/E/C CAD Standard
 - Austria: National Standards for building plan documentation
 - CAD/BIM Standard ON A6241-1
- GIS
 - OGC Indoor GML
 - OGC Indoor Mapping Data Format (IMDF)
 - ESRI ArcGIS Indoors Information Model



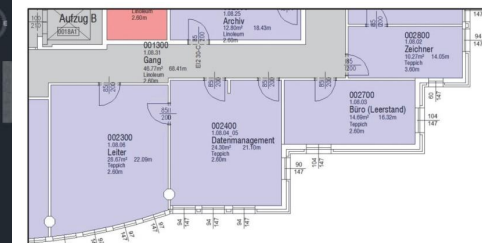
A/E/C CAD Standard

Release 4.0

July 2009



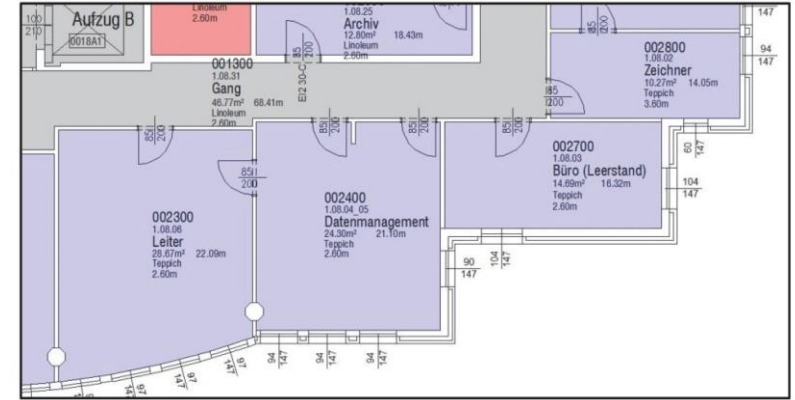
The A/E/C CAD Standard is compliant with Version 4.0 of the U.S. National CAD Standard. The A/E/C CAD Standard contains supplemental materials and DxD specific requirements not addressed in the U.S. National CAD Standard.





Building plans in Austria CAD/BIM Standard ON A6241-1

- DIGITALE GEBÄUDEDOKUMENTATION
 - ÖNORM A 6241-Teil 1
 - Example: B.2.4.3 Raumblock Übergabepläne CAD
 - AR_RA_RAUMBLOCK
 - RAUM_ID
 - RAUM_NUMMER
 - RAUM_BEZEICHNUNG
 - DATUM_AUFNAHME

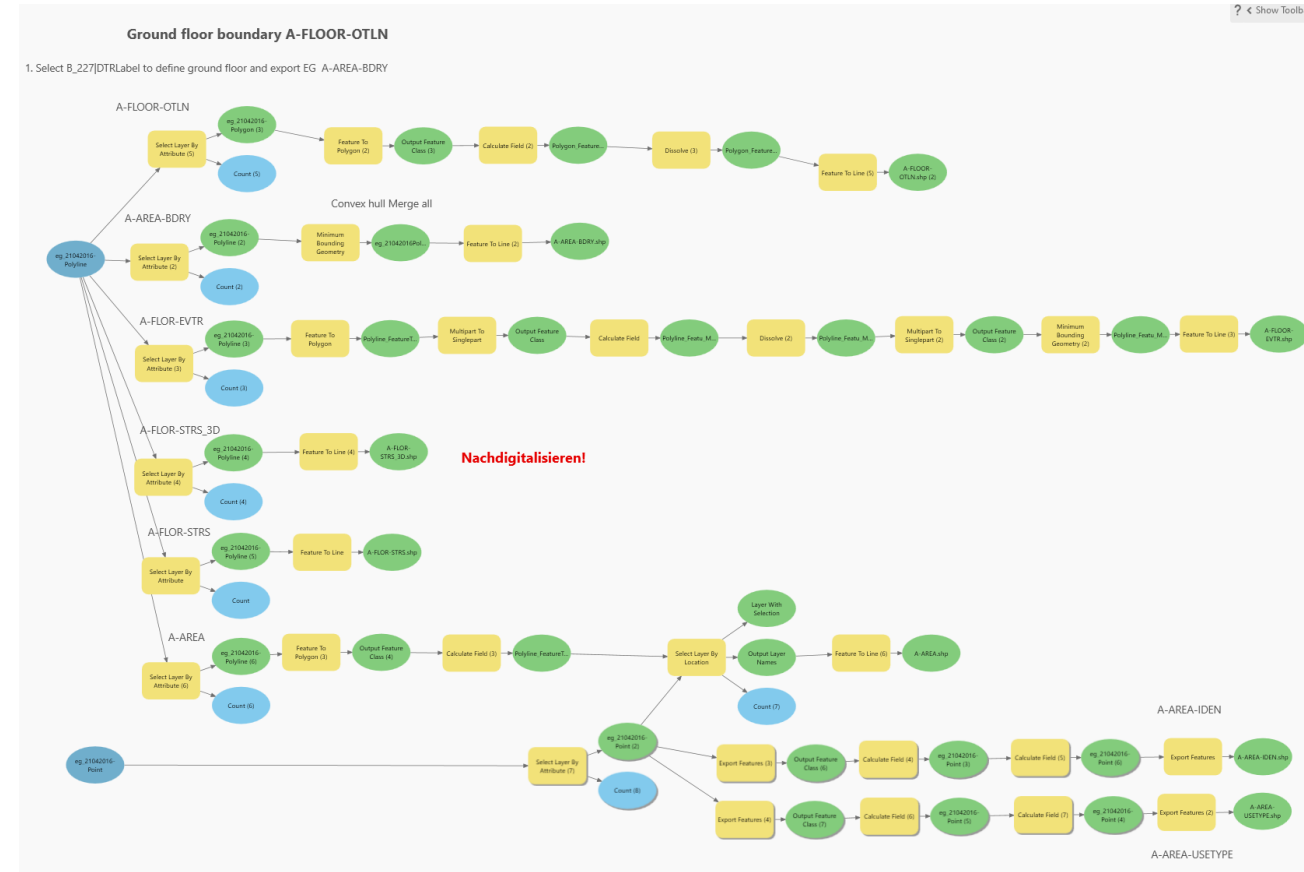


Layer	Element	Inhalt_Verwendungszweck
ARRAUBEZT	Raum	Verwaltungs- Nutzungseinheit, Wohnung
ARRAZUR-T	Raum	Verwaltungs- Nutzungseinheit, Wohnung
ARRAZUR-T	Raum	zu Raum ID-Nummer
ARRAZUR-T	Raum	zu Raum ID-Nummer
ARRAZURAT	Raum	zu Raum ID-Nummer – Außen
ARRAZURAT	Raum	zu Raum ID-Nummer – Außen
ARRAZURIT	Raum	zu Raum ID-Nummer – Innen
ARRAZURIT	Raum	zu Raum ID-Nummer – Innen
ARRAZWDET	Raum	abgehängte Decke
ARRAZWDET	Raum	abgehängte Decke

Abbildung: Wertekatalog ÖNORM A6241-1 – Layer BIG

Semi-automated transformation ON 6241-1 -> Simplified US-Cad 4.0

- One time georeferencing
- Definition of a transformation for ON 6241-1 -> US-Cad 4.0
 - -> integration to GIS using ArcGIS Indoor Information Model
 - Can be later used for semi-automated geometry updates



Digital Campus Map Semantics

United States National CAD Standard (NCS)

Layer name	Geometry or entity type	Description
A-AREA-BDRY	Closed polyline	Closed polylines features representing room boundaries.
A-AREA-USETYPE	Text	Text describing the unit's use type. This layer can be mapped to the Unit layer's USE_TYPE field.
A-AREA-IDEN	Text	Room numbers or identifications. This layer can be mapped to the Unit layer's UNIT_ID field.
A-COLS	Polyline	Columns (S-COLS)
A-DOOR	Polyline	Doors
A-FLOR-OTLN	Closed polyline	Closed polyline features representing level boundaries.
A-FLOR-EVTR	Polyline	Elevator cars and equipment
A-FLOR-STRS	Polyline	Stair treads, escalators, and ladders
A-FLOR-Cutout	Polyline	Floor cutout staircase
A-FURN	Polyline	Furniture
A-GLAZ	Polyline	Windows, curtain walls, and glazed partitions - indoor & outdoor
A-WALL	Polyline	General walls
A-WALL-GLAZ	Polyline	Generall glas walls
A-WALL-PHRT	Polyline	General partial height walls
I-WALL	Polyline	Interior walls (A-WALL-INTR)

Mapping of ON A-6241 layers to US-CAD 4.0 requirements

Layer Önorm	Beschreibung	Indoors Layer	Kap 4-6	H34
Wände				
ARWATR---D-----4--	Wände tragend (bei NAWI als niedrige Wände angegeben)	A-AREA-BDRY, A-WALL-PRHT	ja	ja
ARWATR---L-----4--	Wände tragend	A-AREA-BDRY, A-FLOR-OTLN A-WALL	ja	ja
ARAL-----L-----4--	Sonderelement -Nur für Übernahme von Zeichnungselementen auf Layer H_L27 aus Altplänen	A-WALL, (A-FLOR-EVTR)	ja	ja
ARDESPRU-V-----4--	Deckensprung	A-ROOF-LEVL	nein	ja
ARWANT---L-----4--	Wände - nicht tragend	A-AREA-BDRY, A-WALL	ja	ja
ARWANTSA-L-----4--	Wände Leichtwand, Sanitärtrennwand	A-AREA-BDRY, A-WALL	ja	
ARWB-----L-----4--	Wände Fassade	A-FIOR-OTLN	ja	ja
B_227IDTR	Trakt - Polyline, Stockwerkumriss	A-FIOR-OTLN	ja	ja
B_227IDTRI	Trakt - Abzugspolylinie - Innere Traktbegrenzung	A-FIOR-OTLN	ja	nein (eg)
Z_009	Raumpolyline	A-AREA-BDRY	ja	ja
Z_109	Abzugspolyline, an Türposition	A-AREA-BDRY, A-DOOR	ja	ja
Z_109I	Rauminself, Säulen, etc	A-AREA-BDRY, S-COLS	ja	ja
Treppen				
ARTRHLAU-D-----4--	Darstellung aller nicht bereits auf anderen Layern dargestellten Stufen, Geländer u. Handläufe	A-FLOR-STRS	ja	ja
ARTR-----V-----4--	alle nicht sichtbar darzustellenden Bauteile - z.B. Stiegen des Stockwerks darüber	A-FLOR-STRS	ja	ja
ARTR-----D-----4--	Umriß, Kante d. An- u. Austrittstufen, Podestkanten, Bruchlinie bei Rampen, Stiegen und Rampen	A-FLOR-STRS	ja	ja
Z_109MRG	Polyline Stiege	A-FLOR-STRS	ja	ja
Türen				
OUT27	Türstock	A-DOOR	ja	ja
AROTSTUR-V-----4--	Türsturz	A-DOOR	ja	ja
AROT-----L-----4--	Öffnungen – Türen und Durchgänge (Teilweise auch für Fensteröffnungen verwendet, z.B. NAWI)	A-DOOR	ja	ja
Fenster				
AROF-----L-----4--	Öffnungen -Fenster	A-GLAZ	ja	ja
AROFEINF-B-----4--	Fenstermaße BxH und Simshöhe	A-GLAZ-TEXT	ja	ja
Raumbezeichnung				
B127N	Architekten-Raumnummer	A-AREA-IDEN	ja	ja
B_227Z	Verwendung, Raumbezeichnung	A-AREA-USETYPE	ja	ja

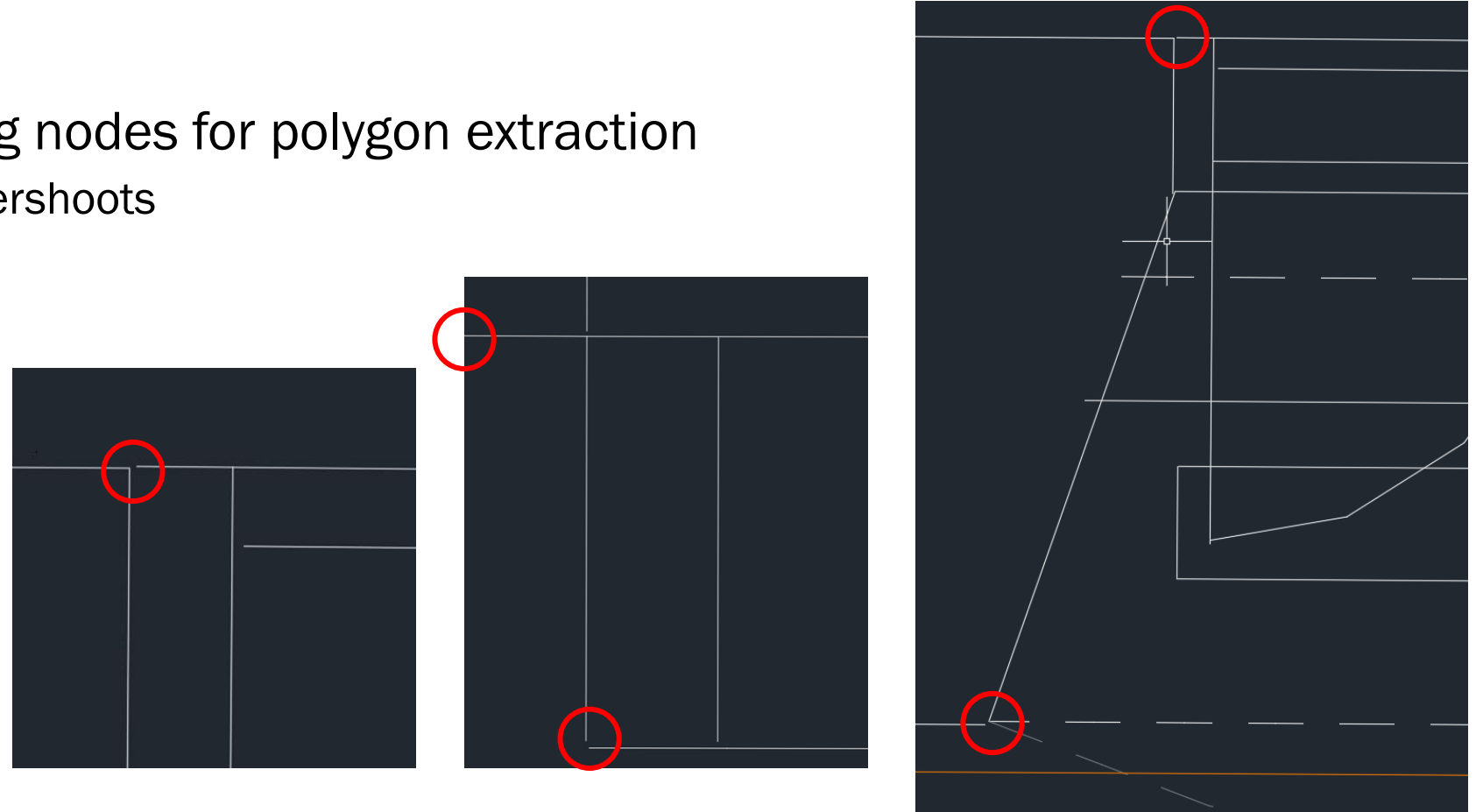
Digital Campus Map – CAD building plans – CAD BIG CAD (leveraging ON-A6241) - inventory

FRA1	Philosophie	Altstadt/Innenstadt	Franziskanergasse	1	Salzburg	Katholisch-Theologische Gesellschaftswissenschaftliche Fakultät	Fakultät,	Ja
H34	Freisaal	Naturwissenschaftliche Fakultät	Hellbrunner Straße	34	Salzburg	Natur- und Lebenswissenschaftliche Gesellschaftswissenschaftliche Fakultät	Fakultät,	Ja

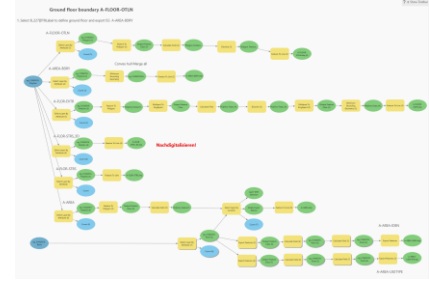
Gebäude	Kriterium	Beschreibung
H34	Layer-Namensstandard	größtenteils BIG
FRA1	Layer-Trennung logisch	Ja (Ausnahme Stiegen, Layer Umrahmung nicht einheitlich)
FRA1	Stockwerksinformationen klar	Pläne nach Stockwerke getrennt
FRA1	Türen	Teilweise Türrahmen von Türe zu trennen
FRA1	Stiegen	Mit Umrahmung (Z_109MRG), Stufen nur Linie, erste Stufe unterschiedlicher Layer
FRA1	Fenster	Evtl. Trennung Glasscheibe von Fensterrahmen nötig (Beide AROF-----L-----4-Layer)

Digital Campus Map CAD Layer evaluation

- CAD main error
 - Handling dangling nodes for polygon extraction
 - Overshoots, undershoots

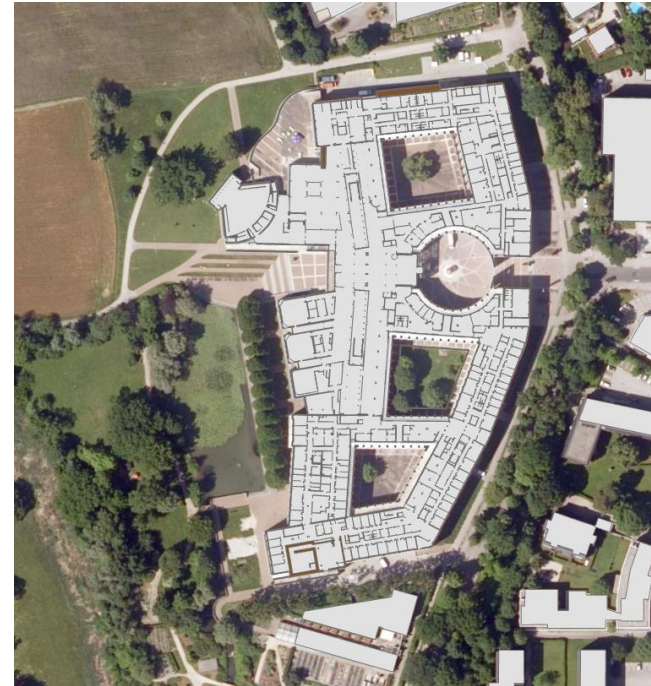
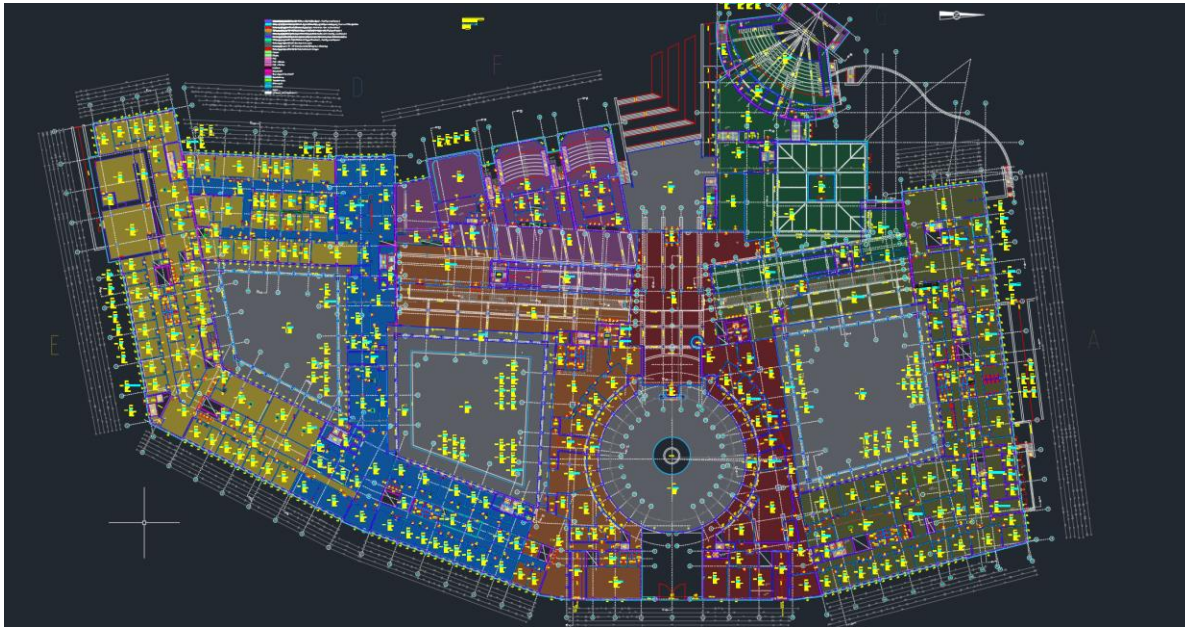


Strategy Freisaal: CAD lines => GIS objects



CAD plan H34 EG (lines) –
ON 6241-1

GIS Plan: walls & windows H34 (objects)



Learnings in evaluating digital CAD building plans for the University Salzburg

- Completeness
 - For most of the university buildings (>85%), digital building plan data is available in technical CAD exchange format .dwg or .dxf from Autodesk
 - For the other buildings .pdf plans are available
- Validity
 - The CAD is >75% closely aligned or conformant to the Austrian building documentation standard ON_A 6142.
 - Most datasets are provided by the Bundesimmobiliengesellschaft – BIG, these datasets are either conformant to ON_A 6142 or semantically very close
 - CAD plans from other providers do usually follow custom data specifications
- Consistency
 - CAD content is usually available in a consistent level for the different floors of buildings
- Accuracy
 - Some CAD datasets have complex plan references which are difficult to handle for GIS import
- Integrity
 - Digitization accuracy and errors (e.g. dangling node) are reduced when the data model is in accordance to the ON_A 6142 standard

Thank you!