HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES

Building Information Modeling (BIM) and Measuring Techniques

Christian CLEMEN, Robert EHRICH and Christopher VAN ZYL, Germany

Project: As-built survey for BIM

HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES

Copyright for images (BMB GmbH and HTW-Dresden)

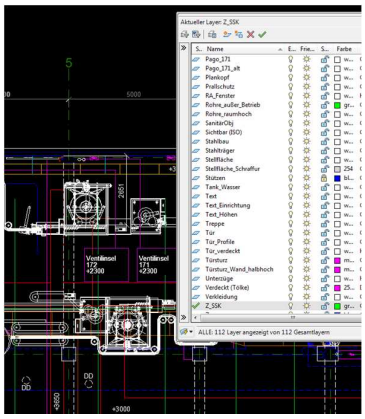
Project: As-built survey for BIM – Step 1

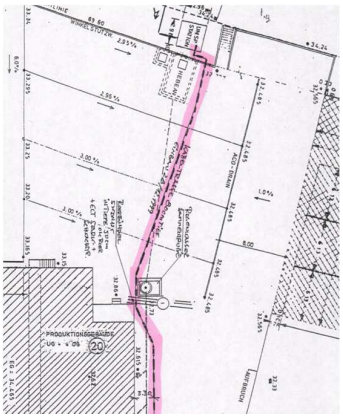
HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN
UNIVERSITY OF APPLIED SCIENCES

Semantic homogenization: Consistent CAD layers in all files.

Digitalization and georeferencing analog and raster data.

Survey: Tacheometry and laser scanning for outside areas





Copyright for images (BMB GmbH, HTW-Dresden, trimble and faro)

Project: As-built survey for BIM – Step 2

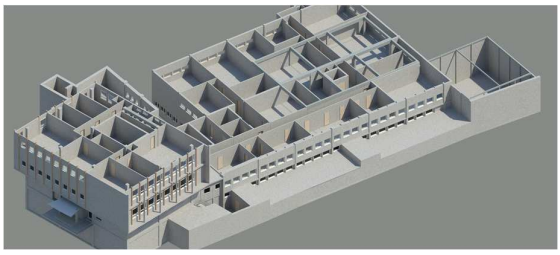
HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN
UNIVERSITY OF APPLIED SCIENCES

What is **NOT** a BIM? [Eastman, p.19]

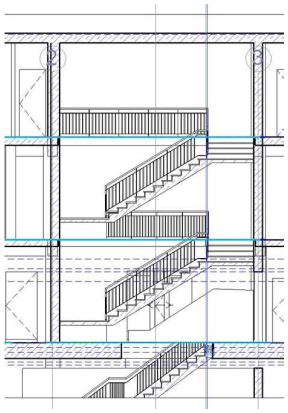
- Models that contain **3D data only** and (or few) object attributes.
- Models with no support of **behavior**. (no parametric intelligence)
- Models that are composed of **multiple 2D CAD reference files** that must be combined to define the building.
- Models that allow changes to dimensions in one view that are not **automatically reflected** in other views.

Eastmann et.al., *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*, 2nd Edition, 2011

Project: As-built survey for BIM – Step 2



BIM - Model



Sections & Views

A	B	C	D
Nr.	Name	Fläche	Umfang
AU-004	Gasübernahme	44.13 m²	26.770
AU-005	Rückstellmuster Laborbereich	34.59 m²	41.800
AU-003	Heizzentrale	34.74 m²	24.355
AU-024	Lager	12.53 m²	17.500
AU-023	Lager	109.89 m²	44.900
AU-021	Lager	4.39 m²	8.990
AU-020	Raum	6.03 m²	11.305
AU-019	Lager	46.65 m²	29.230
AU-022	Lager	39.15 m²	27.185
AU-006	Elektro	8.74 m²	10.545
ELT	Hochspannung BEWAG	19.65 m²	21.405
AU-007	Pumpensumpf	10.56 m²	15.310
AU-008	Lager	71.75 m²	36.915
AU-010	Lager	4.42 m²	8.725
AU-011	Lager Motoren	9.75 m²	13.655
AU-012	WC H	6.93 m²	10.600
AU-013	WC D	6.75 m²	10.475
AU-014	Reinigung	16.28 m²	18.355
AU-015	Lager	56.75 m²	31.700
AU-009	Flur	20.43 m²	28.390
AU-018	Büro	11.78 m²	13.945
AU-017	Werkstatt	155.81 m²	73.055
AU-016	Produktion Linie 100	509.94 m²	99.440
017 - AS95Lg	Lager	11.55 m²	13.960
027	Lager (Laubengang)	144.31 m²	76.745
AU-001	Flur	25.08 m²	41.905
AU-7	Flur	7.82 m²	17.705
UG Kellergeschoss		1483.16 m²	
AS-012	Flur	48.93 m²	74.155
AS-013	Flur	25.96 m²	31.105
AS-014	Raum	36.41 m²	48.620
AS-015	FEO	24.43 m²	20.110
AS-016	Betriebsleitung	28.40 m²	21.515
AS-017	Sekretariat	13.69 m²	15.125
AS-018	GVL-Fällg & Packaging	27.46 m²	21.395
AS-019/020	EEV	46.64 m²	27.725
AS-021	Kaffe-/Teeküche	29.41 m²	19.375
AS-022	Qualitätskontrolle	52.73 m²	29.710
AS-023	Qualitätskontrolle	31.54 m²	26.695
AS-024	Qualitätskontrolle Fußpul	63.78 m²	35.275
AS-025	Qualitätskontrolle Spülpul	27.58 m²	24.000
AS-026	Qualitätskontrolle Microbiologie	48.11 m²	28.850
AS-027	GM-Quibblekontrolle	19.58 m²	18.195
AS-028	GM-Anwatzbereich	32.59 m²	29.675
AS-029	Raum	1.04 m²	4.125
AS-030	Lagerfläsche	83.81 m²	59.835
AS-031	Besprechungsraum	52.74 m²	29.965
AS-032	Besprechungsraum	21.54 m²	19.160
AS-033	Materialmanagement Einlauf	53.51 m²	39.540
AS-034	Büro	36.32 m²	24.115
AS-035	Materialmanagement	27.95 m²	21.465
AS-036	Lager	9.75 m²	12.545

Tables

```
    </PolyLoop>
  </PlanarGeometry>
</Surface>
<Surface id="wu-1307" surfaceType="Air">
  <Name>3D-AU-009-AU-009-I-0-1307</Name>
  <AdjacentSpaceId spaceIdRef="wp-AU-009-Flur">
  </AdjacentSpaceId>
  <AdjacentSpaceId spaceIdRef="wp-AU-009-Flur">
  </AdjacentSpaceId>
  <RectangularGeometry>
    <Azimuth>270.000000</Azimuth>
    <CartesianPoint>
      <Coordinate>30.182966</Coordinate>
      <Coordinate>13.578726</Coordinate>
      <Coordinate>-0.250000</Coordinate>
    </CartesianPoint>
    <Tilt>90.000000</Tilt>
    <Height>0.250000</Height>
    <Width>0.392500</Width>
  </RectangularGeometry>
  <PlanarGeometry>
    <PolyLoop>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.186226</Coordinate>
        <Coordinate>-0.250000</Coordinate>
      </CartesianPoint>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.186226</Coordinate>
        <Coordinate>0.000000</Coordinate>
      </CartesianPoint>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.578726</Coordinate>
        <Coordinate>0.000000</Coordinate>
      </CartesianPoint>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.578726</Coordinate>
        <Coordinate>-0.250000</Coordinate>
      </CartesianPoint>
```

Specialized Data

CAD vs. BIM: Impact on as-built surveying

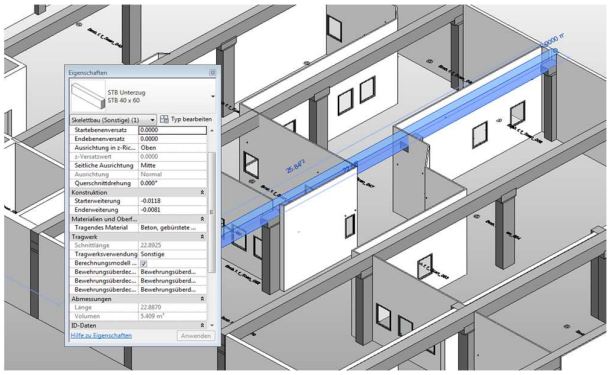
1. **Semantics**
2. **Geometry**
3. **Technical Project Management**

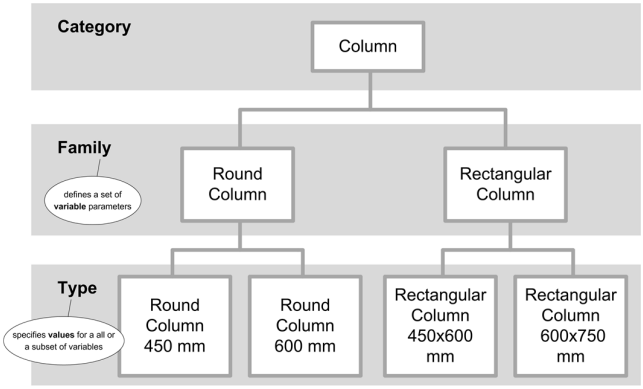
HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES

Semantic Modeling
(product model)

Working Method:

- identification and specification of new types (e.g. doors, windows)
- data acquisition includes semantics (columns, beam)
- with BIM, CAD-"drawing" becomes real modeling.





HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES

Parametric Object Modeling

- **Rule based** control (e.g. windows must not overlap each other)
- Semantic object definition is strictly **linked to geometry** with the set of parameters.

Working Method:

1. Specification of **object type**
2. Enter **measured dimensions** and specify topological relations (graphically)
3. **Conflicts** are reported immediately. Model is always consistent.

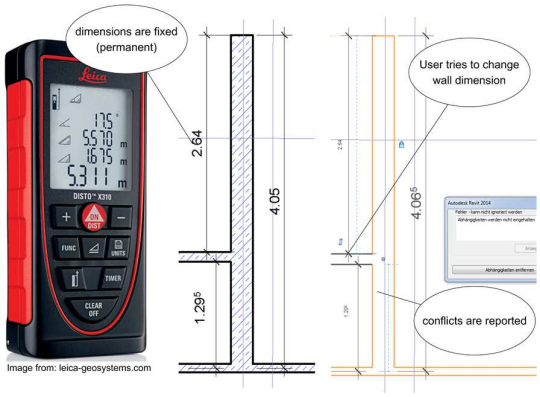
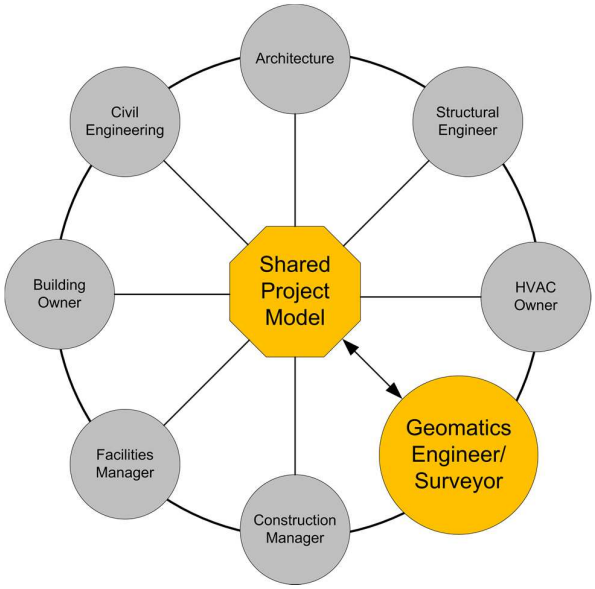


Image from: leica-geosystems.com

Drawback: Geometric variations are not easy to model. Better use CAD for historic buildings.

Technical Project Management



Goal
- consistent model
- automatically updated views

Way of working
- *check-in* surveying results
- *check-out* for stake-out and model update (changes)

Prerequisites
- nonredundant object modelling
- associated data and rules

1. **Tacheometry**
2. **Laser scanning (point cloud)**
3. **Laser scanning (registered scan view)**

Tacheometry (3D-buildung survey)

HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES

1. **Polar Survey** with point codes
   - Consistent spatial reference
   - Code (Window, Wall, Fence,…)

2. **Constraints** and **Fitting**
   - planar (points in plane)
   - rectangular (wall-ceiling, wall-wall)

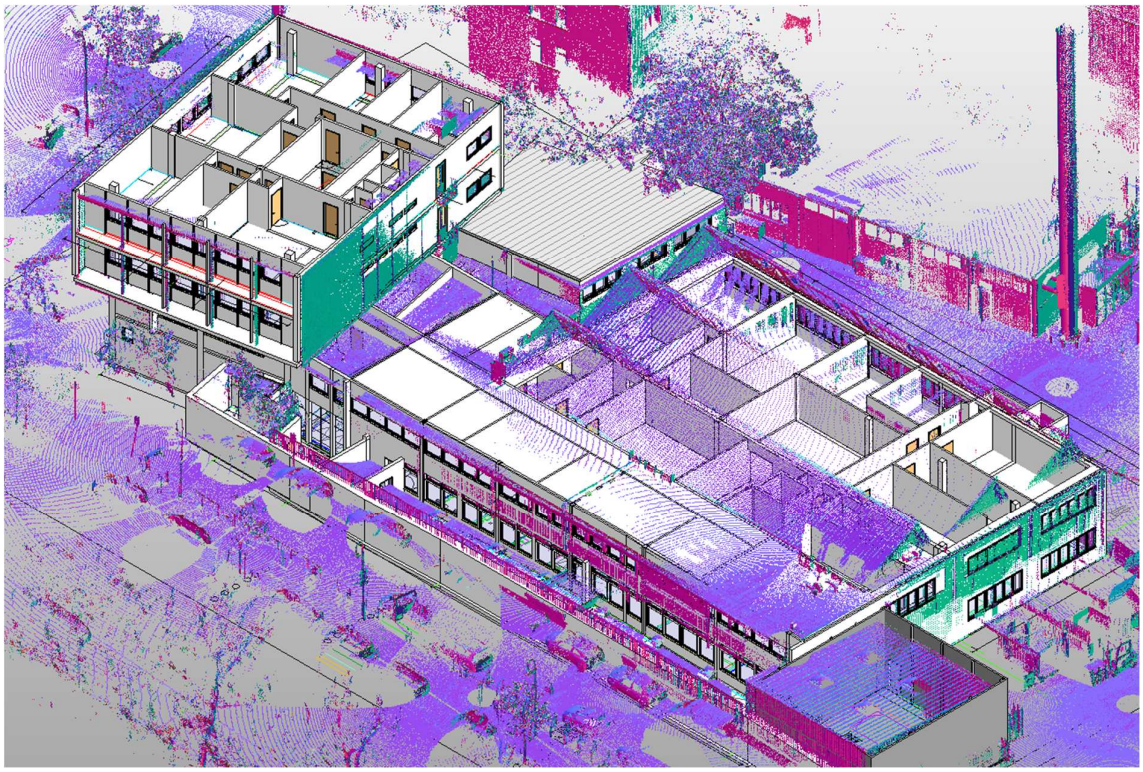
3. **Derivation** of building element **parameters**
   - Directly measured or
   - COGO / CAD pick off

4. CAD **to BIM**
   - Sematics from layer
   - Object geometry frompoints and lines

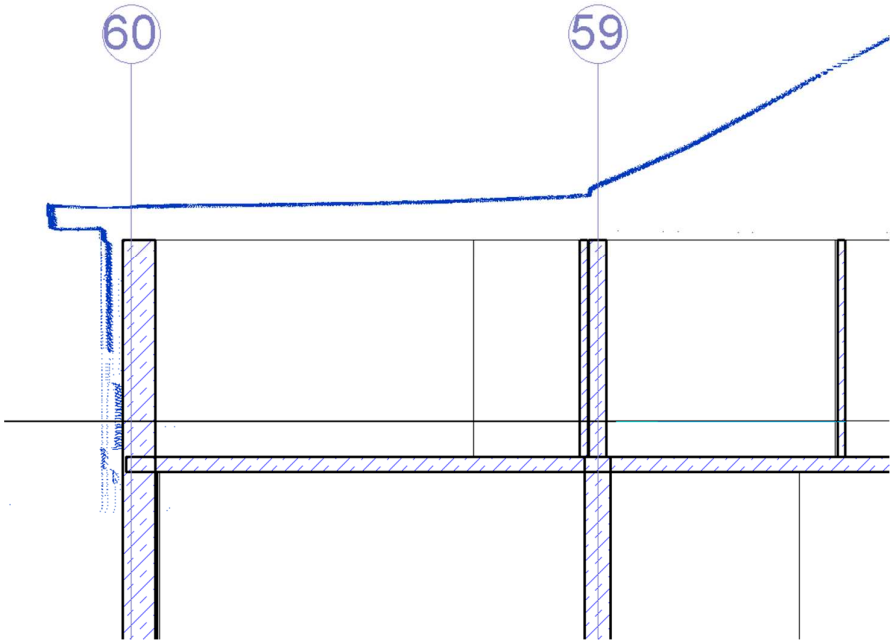
- **! BIM-site model** imports point coordinates directly and generates DTM.

Laser scanning - point cloud (1/4)

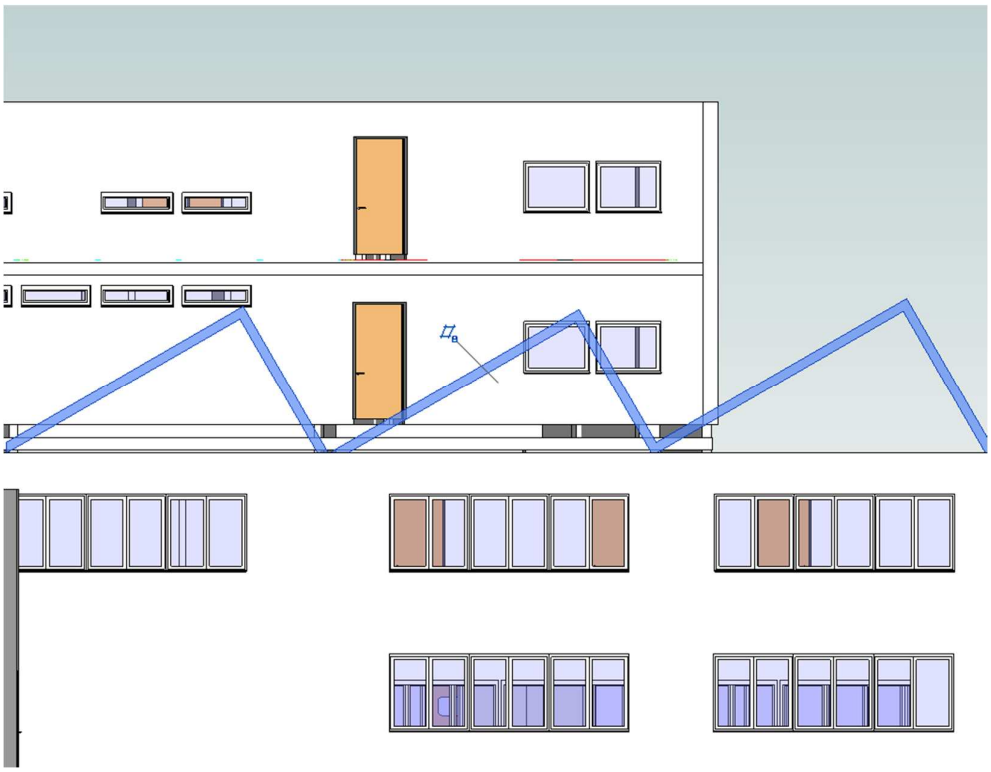
HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES



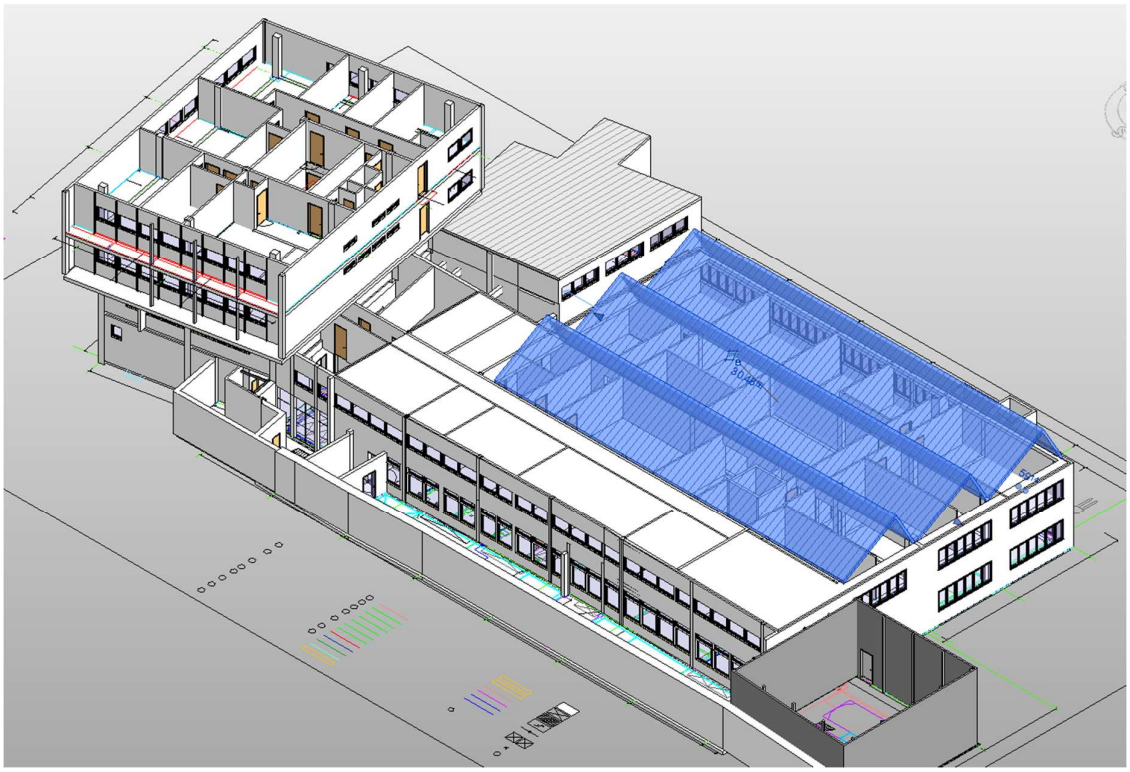
Laser scanning - point cloud (2/4)



Laser scanning - point cloud (3/4)



Laser scanning - point cloud (4/4)



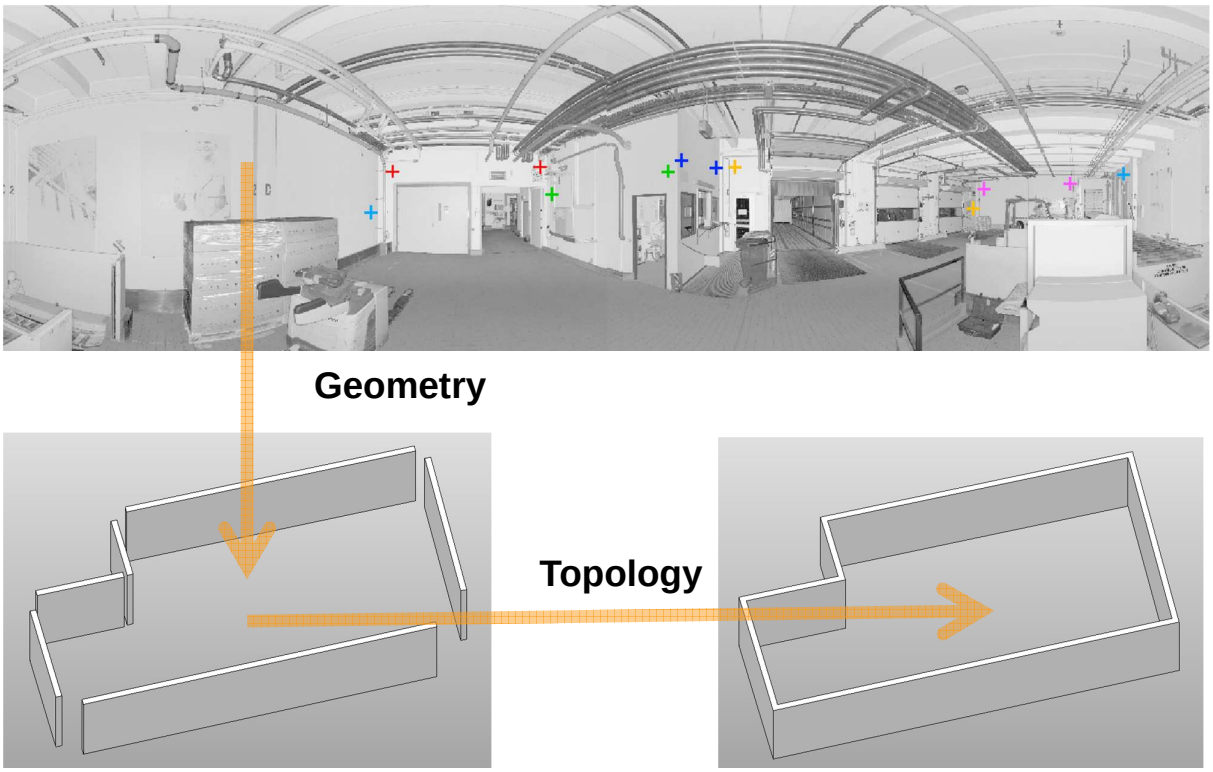
BIM and Measuring Techniques

1. Tacheometry
2. Laser scanning (point cloud)
3. **Laser scanning (registered scan view)**

   (Software: VirtuSurv by kubit)

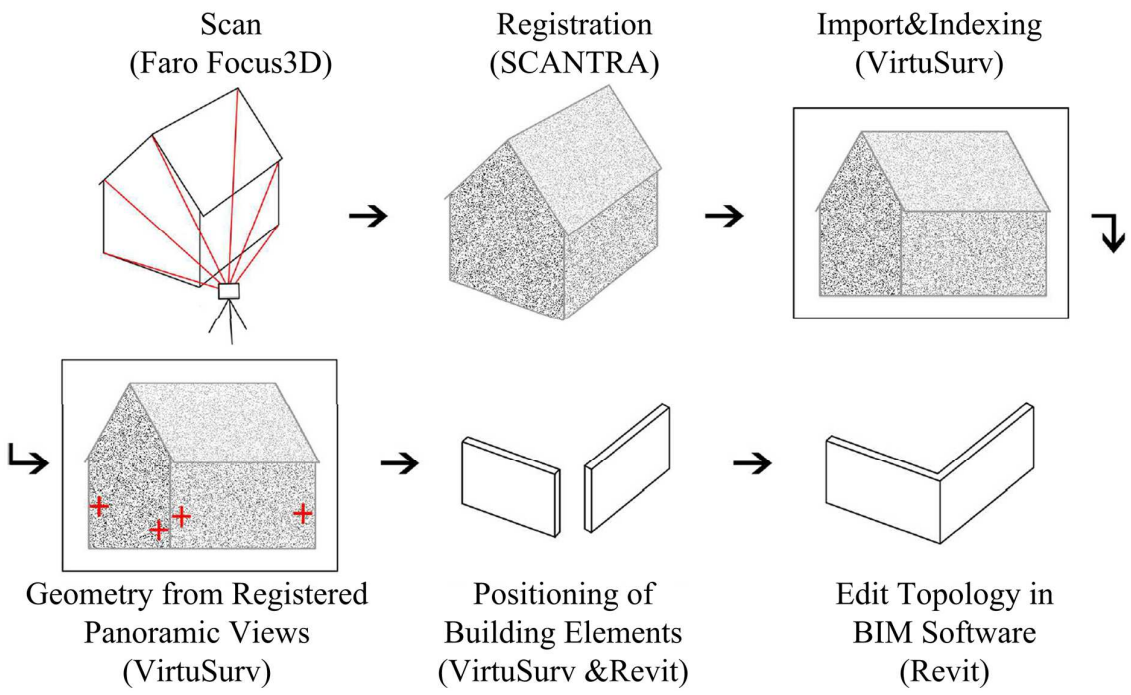
Laser scanning - registered scan view

HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES

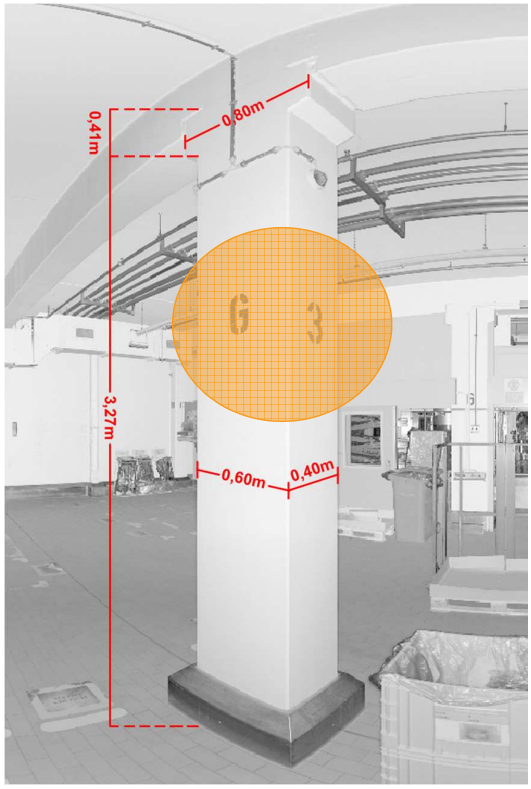


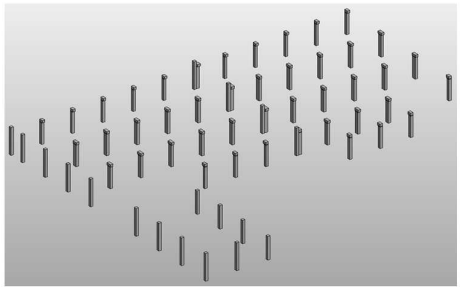
Laser scanning - registered scan view

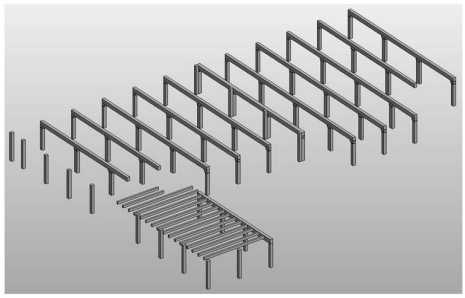
HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES



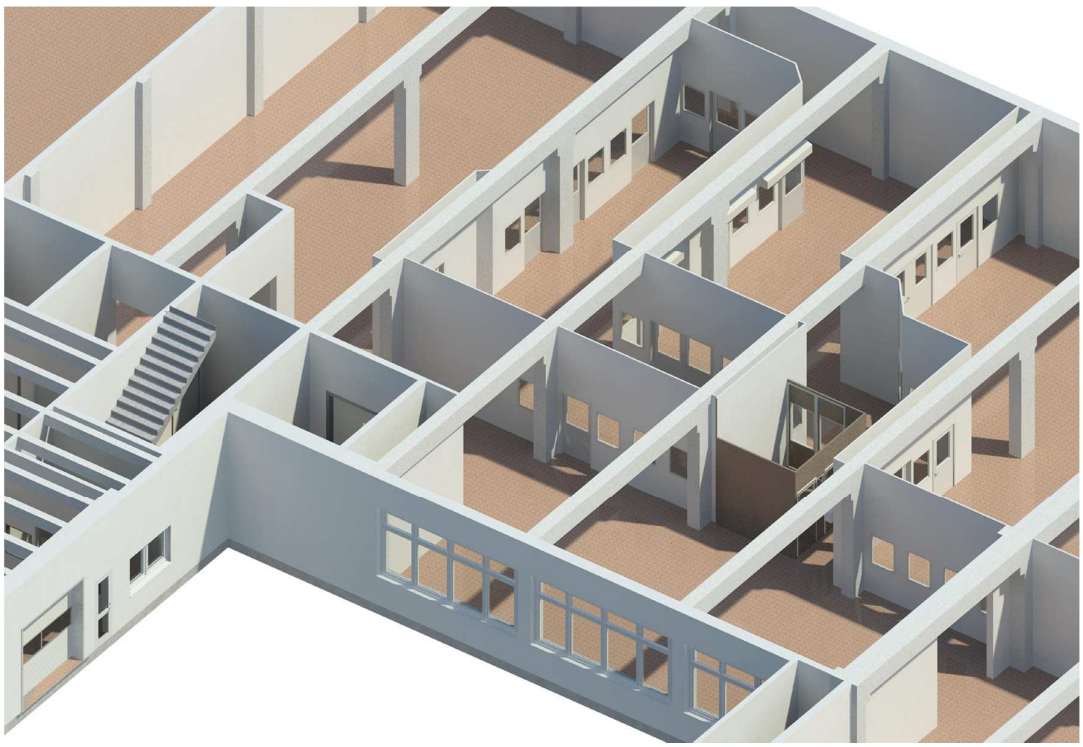
Laser scanning - registered scan view



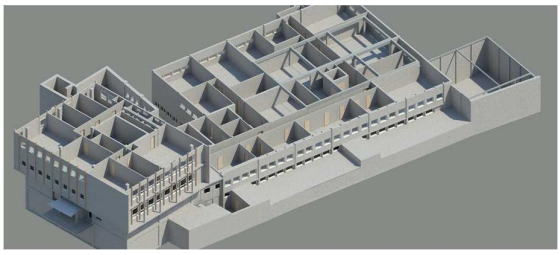




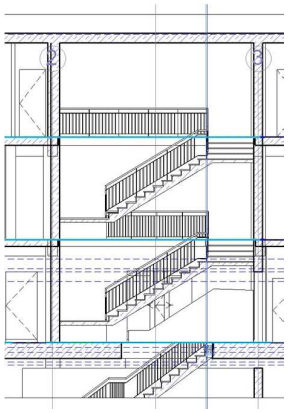
Laser scanning - registered scan view



HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES



BIM - Model



Sections & Views

A	B	C	D
Nr.	Name	Fläche	Umfang
AU-004	Gasübergabestation	44.13 m²	26.770
AU-005	Rückstellhalter Laborbereich	34.59 m²	41.850
AU-003	Heizzentrale	34.74 m²	24.355
AU-024	Lager	12.53 m²	17.500
AU-023	Lager	109.89 m²	44.960
AU-021	Lager	4.39 m²	8.990
AU-020	Raum	6.03 m²	11.305
AU-019	Lager	46.65 m²	29.230
AU-022	Lager	39.15 m²	27.185
AU-006	Elektro	8.74 m²	10.545
ELT	Hochspannung BEWAG	19.65 m²	21.405
AU-007	Pumpensumpf	10.56 m²	15.310
AU-008	Lager	71.75 m²	36.915
AU-010	Lager	4.42 m²	8.725
AU-011	Lager Motoren	9.75 m²	13.655
AU-012	WC H	6.93 m²	10.600
AU-013	WC D	6.75 m²	10.475
AU-014	Reinigung	16.28 m²	18.355
AU-015	Lager	56.75 m²	31.700
AU-009	Flur	20.43 m²	28.390
AU-018	Büro	11.70 m²	13.945
AU-017	Werkstatt	155.81 m²	73.005
AU-016	Produktion Linie 100	509.94 m²	99.440
017 - AS95Lø	Lager	11.55 m²	13.960
027	Lager (Laubengang)	144.31 m²	76.745
AU-001	Flur	25.08 m²	41.905
AU-7	Flur	7.82 m²	17.705
UG Kellergeschoss		1483.16 m²	
AS-012	Flur	49.93 m²	74.155
AS-013	Flur	25.96 m²	31.105
AS-014	Raum	36.41 m²	48.620
AS-015	FEO	24.43 m²	20.110
AS-016	Betriebsleitung	28.40 m²	21.515
AS-017	Sekretariat	13.69 m²	15.125
AS-018	Gill-Fällig & Packaging	27.46 m²	21.395
AS-019/020	EDV	46.64 m²	27.725
AS-021	Kaffe-/Teeküche	29.41 m²	19.075
AS-022	Qualitätskontrolle	52.73 m²	29.710
AS-023	Qualitätskontrolle	31.54 m²	28.695
AS-024	Qualitätskontrolle Fußpul	63.78 m²	35.275
AS-025	Qualitätskontrolle Spülpul	27.58 m²	24.600
AS-026	Qualitätskontrolle Microbiologie	48.11 m²	28.850
AS-027	Gill-Quibblekontrolle	19.58 m²	18.195
AS-028	Gill-Anwaltsbereich	32.59 m²	29.675
AS-029	Raum	1.04 m²	4.135
AS-030	Lagerfläsche	83.81 m²	59.835
AS-031	Besprechungsraum	52.74 m²	29.965
AS-032	Besprechungsraum	21.54 m²	19.160
AS-033	Materialmanagement Einlauf	53.51 m²	39.540
AS-034	Büro	36.32 m²	24.115
AS-035	Materialmanagement	27.95 m²	21.465
AS-036	Lager	9.75 m²	12.545

Tables

```
    </PolyLoop>
  </PlanarGeometry>
</Surface>
<Surface id="wu-1307" surfaceType="Air">
  <Name>3C-AU-009-AU-009-I-0-1307</Name>
  <AdjacentSpaceId spaceIdRef="wp-AU-009-Flur">
  </AdjacentSpaceId>
  <AdjacentSpaceId spaceIdRef="wp-AU-009-Flur">
  </AdjacentSpaceId>
  <RectangularGeometry>
    <Azimuth>270.000000</Azimuth>
    <CartesianPoint>
      <Coordinate>30.182966</Coordinate>
      <Coordinate>13.578726</Coordinate>
      <Coordinate>-0.250000</Coordinate>
    </CartesianPoint>
    <Tilt>90.000000</Tilt>
    <Height>0.250000</Height>
    <Width>0.392500</Width>
  </RectangularGeometry>
  <PlanarGeometry>
    <PolyLoop>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.186226</Coordinate>
        <Coordinate>-0.250000</Coordinate>
      </CartesianPoint>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.186226</Coordinate>
        <Coordinate>0.000000</Coordinate>
      </CartesianPoint>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.578726</Coordinate>
        <Coordinate>0.000000</Coordinate>
      </CartesianPoint>
      <CartesianPoint>
        <Coordinate>30.182966</Coordinate>
        <Coordinate>13.578726</Coordinate>
        <Coordinate>-0.250000</Coordinate>
      </CartesianPoint>
```

Specialized Data

Conclusion

HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN UNIVERSITY OF APPLIED SCIENCES

- BIM will **not replace CAD.** But BIM is getting very important, also for as-built surveys.
- **Real BIM:**
  - object oriented **product** model
  - **parametric** modeling
  - **shared** product model
- Conventional CAD-**surveying techniques** are to be adapted to the BIM-method**.**

Contact

HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN
UNIVERSITY OF APPLIED SCIENCES

Prof. Dr. - Ing. **Christian Clemen**
Fachgebiet CAD und Virtual Reality / Chair of CAD and Virtual Reality
Fakultät Geoinformation / Faculty of Geoinformation
HTW Dresden / Dresden University of Applied Sciences

Friedrich-List-Platz 1
D-01069 Dresden
Germany
Raum/Office: Z 726 (Zentralgebäude/Main building)
Tel: +49 351 462-3199
Fax: +49 351 462-2191
E-Mail: christian . clemen (at the) htw - dresden. de