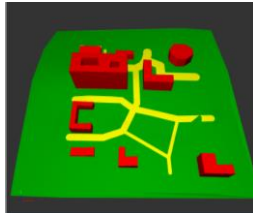
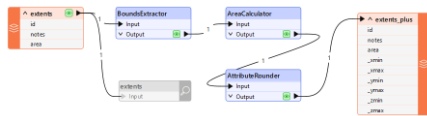


FME Form for beginners



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Last update: 7 September 2024

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Brief overview of FME Form

FME in a nutshell

Readers and writers

Transformers

Data types

Geometry model

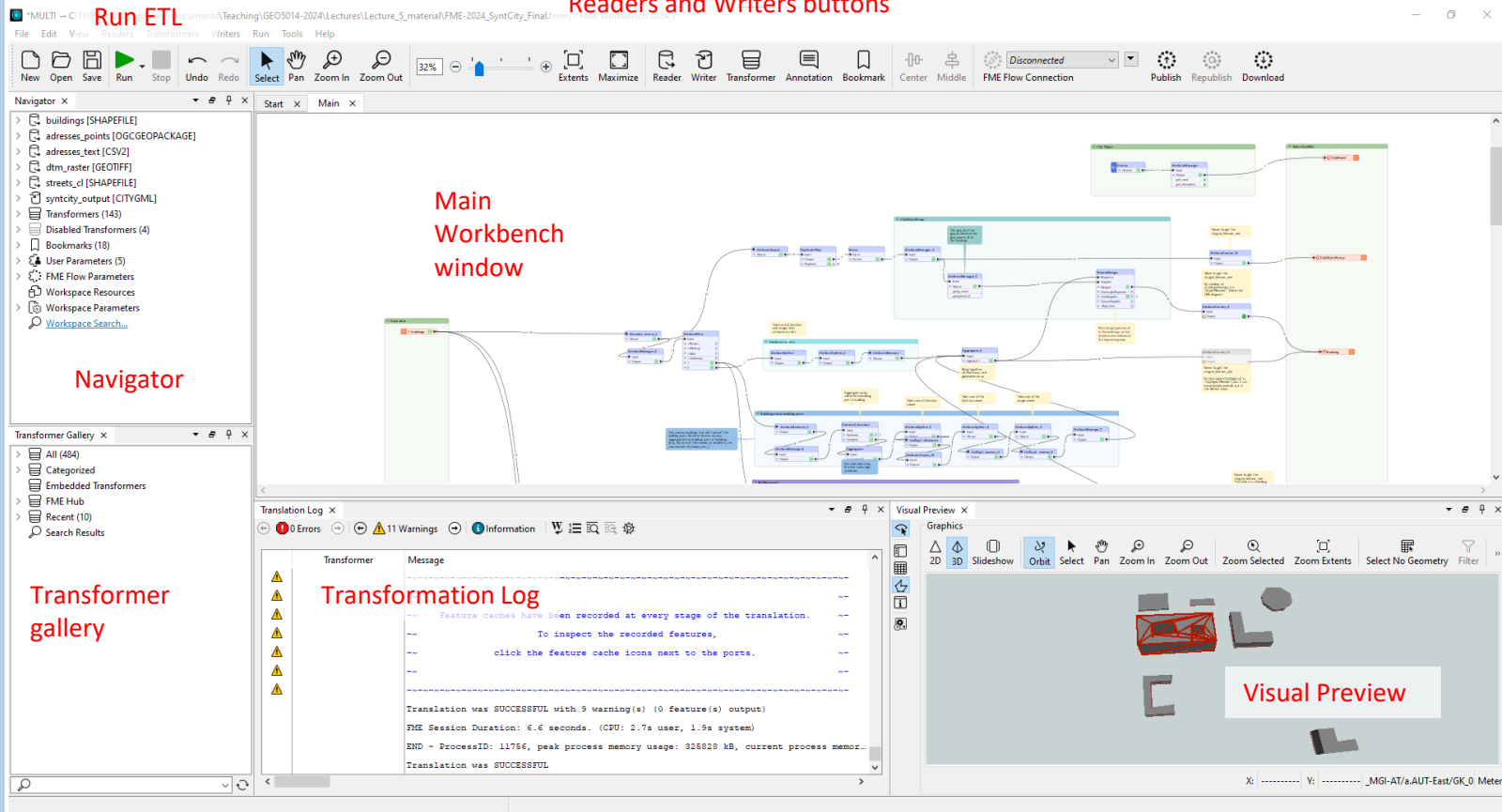
Other stuff

- In a nutshell: FME Form performs spatial data **ETL** (Extract, Transform, Load)
 - https://en.wikipedia.org/wiki/Spatial_ETL
 - In FME jargon: **Reader(s)** → **Transformer(s)** → **Writer(s)**
- Interface areas (see next slides)
 - Workspace
 - Navigator
 - Transformer gallery
 - Translation log (and other views)
 - Menu and toolbar
- Data exploration
 - Visual Preview (in FME Workbench)
 - FME Data inspector (external application)
- Some advanced functionalities (not treated in these slides)
 - Customisation: Create your own transformers
 - Programmability: Python-based transformers can be created
 - Automation: Parent transformers can launch children transformers

FME Form Workbench

Readers and Writers buttons

FME in a nutshell
Readers and writers
Transformers
Data types
Geometry model
Other stuff



The screenshot displays the FME Form Workbench interface. The main workspace shows a complex workflow diagram with various transformers and data sources. The interface includes several panels:

- Navigator:** Located on the left, it lists the project structure, including data sources like buildings, addresses, and dtm, as well as transformers and workspace parameters.
- Transformer Gallery:** Also on the left, it provides a categorized list of available transformers, including FME Hub and recent ones.
- Translation Log:** A panel at the bottom left showing the progress and status of the translation process, including warnings and session duration.
- Visual Preview:** A panel at the bottom right showing a 3D visualization of the data being processed, with a red wireframe model of a building.

Red labels are overlaid on the image to identify key components: "Main Workbench window" points to the central workspace, "Navigator" points to the left panel, "Transformer gallery" points to the bottom-left panel, and "Visual Preview" points to the bottom-right panel.

FME Data Inspector

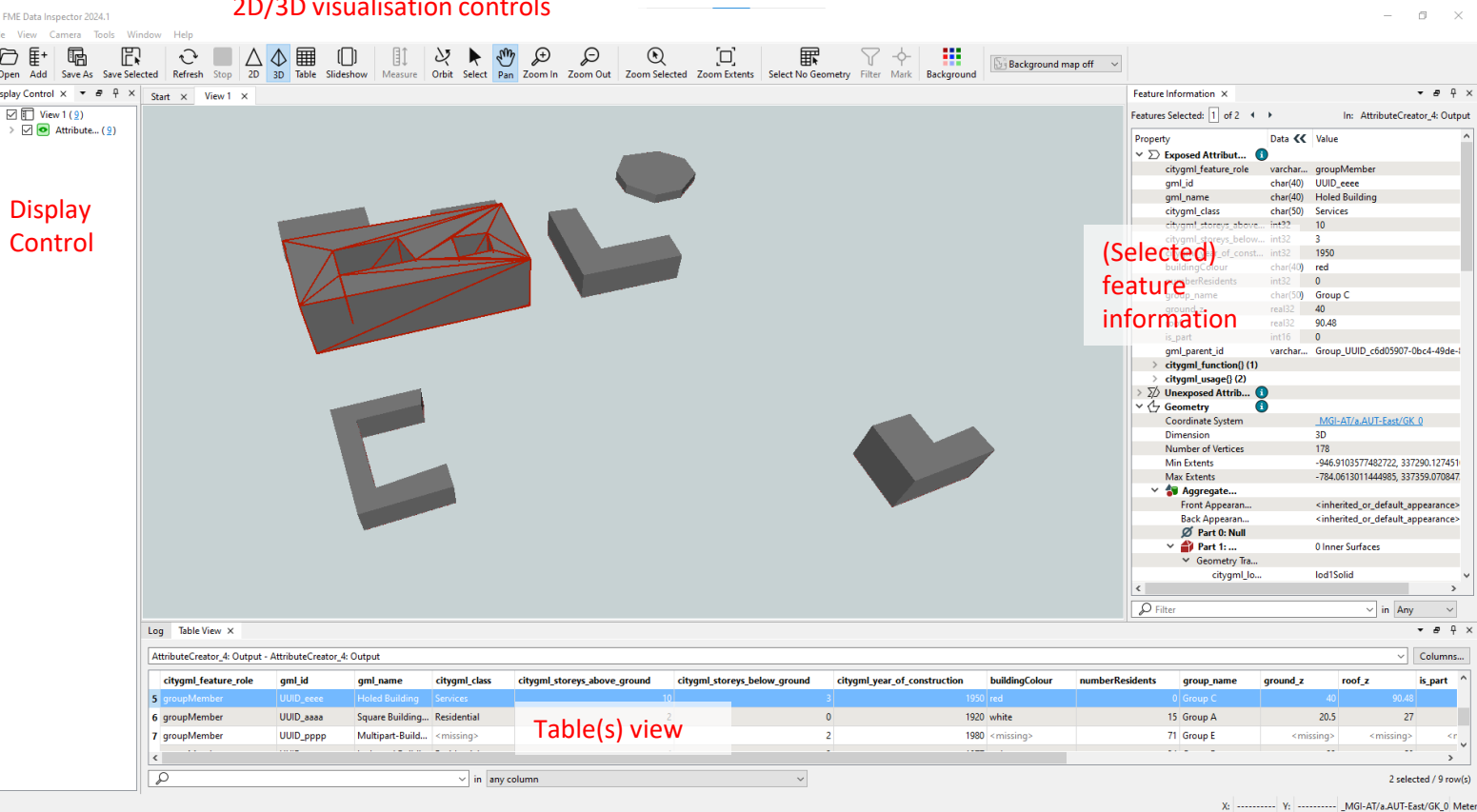
2D/3D visualisation controls

FME in a nutshell
 Readers and writers
 Transformers
 Data types
 Geometry model
 Other stuff

Display Control

(Selected) feature information

Table(s) view



The screenshot shows the FME Data Inspector 2024.1 interface. The main window displays a 3D visualization of building models. A red wireframe box highlights a specific feature. The right-hand pane shows the 'Feature Information' for the selected feature, displaying various attributes such as 'citygml_feature_role', 'gml_id', 'gml_name', 'citygml_class', 'citygml_stores_above_ground', 'citygml_stores_below_ground', 'citygml_year_of_construction', 'buildingColour', 'numberResidents', 'group_name', 'ground_z', 'roof_z', and 'is_part'.

The bottom pane shows the 'Table View' of the data, displaying a table with columns corresponding to the attributes shown in the Feature Information pane. The table contains three rows of data, representing different building features.

citygml_feature_role	gml_id	gml_name	citygml_class	citygml_stores_above_ground	citygml_stores_below_ground	citygml_year_of_construction	buildingColour	numberResidents	group_name	ground_z	roof_z	is_part
groupMember	UUID_eeee	Holed Building	Services	10	3	1950	red	0	Group C	40	90.48	
groupMember	UUID_aaaa	Square Building...	Residential		0	1920	white	15	Group A	20.5	27	
groupMember	UUID_pppp	Multipart-Build...	<missing>		2	1980	<missing>	71	Group E	<missing>	<missing>	<f>

Readers & writers

FME in a nutshell

**Readers and
writers**

Transformers

Data types

Geometry model

Other stuff

- Lots of spatial and non-spatial formats
 - https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/Format-List-All.htm
 - E.g. vector: DWG/DXG, shp, txt, csv, Esri Geodatabase, GeoJSON, OBJ, PostgreSQL/PostGIS, R, WMS, WFS, etc...
 - Raster: JPG, GeoTiff, ...
 - CityGML + Application Domain Extensions (ADEs)
 - CityJSON
- **WARNING: There is NO MAGIC!** An FME reader/writer does not “save” you from the need to know the characteristics of a specific format.
But it simplifies life a lot! 😊

Readers & writers

FME in a nutshell

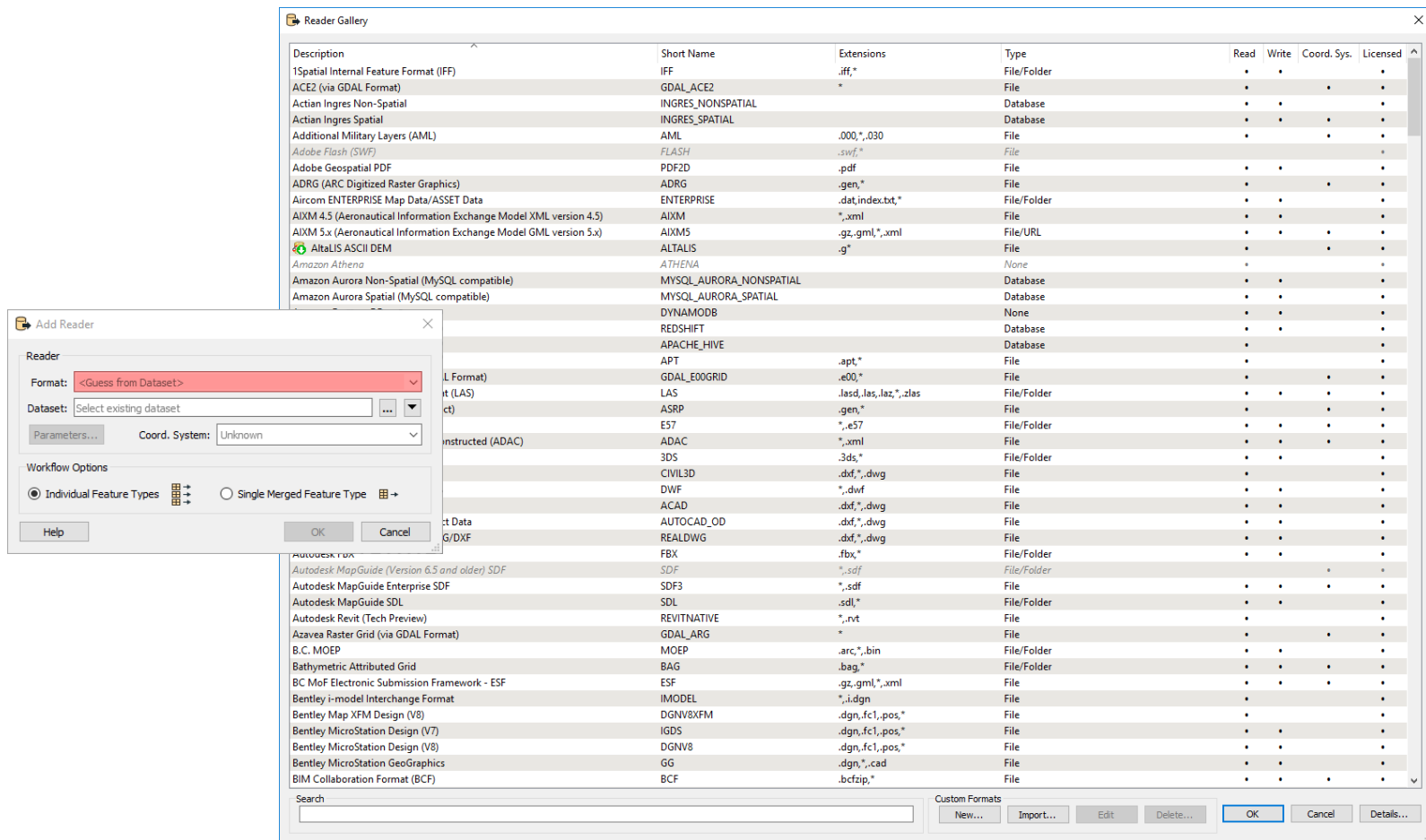
Readers and writers

Transformers

Data types

Geometry model

Other stuff



The image shows the FME Reader Gallery window with a list of readers and an 'Add Reader' dialog box open over it.

Reader Gallery Table:

Description	Short Name	Extensions	Type	Read	Write	Coord. Sys.	Licensed
1Spatial Internal Feature Format (IFF)	IFF	.iff,*	File/Folder	*	*	*	*
ACE2 (via GDAL Format)	GDAL_ACE2	*	File	*	*	*	*
Action Ingres Non-Spatial	INGRES_NONSPATIAL		Database	*	*	*	*
Action Ingres Spatial	INGRES_SPATIAL		Database	*	*	*	*
Additional Military Layers (AML)	AML	.000,*.030	File	*	*	*	*
Adobe Flash (SWF)	FLASH	.swf,*	File	*	*	*	*
Adobe Geospatial PDF	PDF2D	.pdf	File	*	*	*	*
ADRG (ARC Digitized Raster Graphics)	ADRG	.gen,*	File	*	*	*	*
Aircom ENTERPRISE Map Data/ASSET Data	ENTERPRISE	.dat,index.txt,*	File/Folder	*	*	*	*
AIXM 4.5 (Aeronautical Information Exchange Model XML version 4.5)	ADXIM	*.xml	File	*	*	*	*
AIXM 5.x (Aeronautical Information Exchange Model GML version 5.x)	ADXIM5	.gz,gml,*.xml	File/URL	*	*	*	*
AltaLIS ASCII DEM	ALTALIS	.g*	File	*	*	*	*
Amazon Athena	ATHENA		None	*	*	*	*
Amazon Aurora Non-Spatial (MySQL compatible)	MYSQL_AURORA_NONSPATIAL		Database	*	*	*	*
Amazon Aurora Spatial (MySQL compatible)	MYSQL_AURORA_SPATIAL		Database	*	*	*	*
DYNAMODB	DYNAMODB		None	*	*	*	*
REDSHIFT	REDSHIFT		Database	*	*	*	*
APACHE_HIVE	APACHE_HIVE		Database	*	*	*	*
APT	APT	.apt,*	File	*	*	*	*
GDAL_E00GRID	GDAL_E00GRID	.e00,*	File	*	*	*	*
LAS	LAS	.lasd,.las,.laz,*.zlas	File/Folder	*	*	*	*
ASRP	ASRP	.gen,*	File	*	*	*	*
E57	E57	*.e57	File/Folder	*	*	*	*
ADAC	ADAC	*.xml	File	*	*	*	*
3DS	3DS	.3ds,*	File/Folder	*	*	*	*
CIVIL3D	CIVIL3D	.dxf,*.dwg	File	*	*	*	*
DWF	DWF	*.dwf	File	*	*	*	*
ACAD	ACAD	.dxf,*.dwg	File	*	*	*	*
AUTOCAD_OD	AUTOCAD_OD	.dxf,*.dwg	File	*	*	*	*
REALDWG	REALDWG	.dxf,*.dwg	File	*	*	*	*
FBX	FBX	.fbx,*	File/Folder	*	*	*	*
SDF	SDF	*.sdf	File/Folder	*	*	*	*
SDF3	SDF3	*.sdf	File	*	*	*	*
SDL	SDL	.sdl,*	File/Folder	*	*	*	*
REVITNATIVE	REVITNATIVE	*.nvt	File	*	*	*	*
GDAL_ARG	GDAL_ARG	*	File	*	*	*	*
MOEP	MOEP	.arc,*.bin	File/Folder	*	*	*	*
BAG	BAG	.bag,*	File/Folder	*	*	*	*
ESF	ESF	.gz,gml,*.xml	File	*	*	*	*
IMODEL	IMODEL	*.idgn	File	*	*	*	*
DGNV8XFM	DGNV8XFM	.dgn,.fc1,.pos,*	File	*	*	*	*
IGDS	IGDS	.dgn,.fc1,.pos,*	File	*	*	*	*
DGNV8	DGNV8	.dgn,.fc1,.pos,*	File	*	*	*	*
GG	GG	.dgn,*.cad	File	*	*	*	*
BCF	BCF	.bcfzip,*	File	*	*	*	*

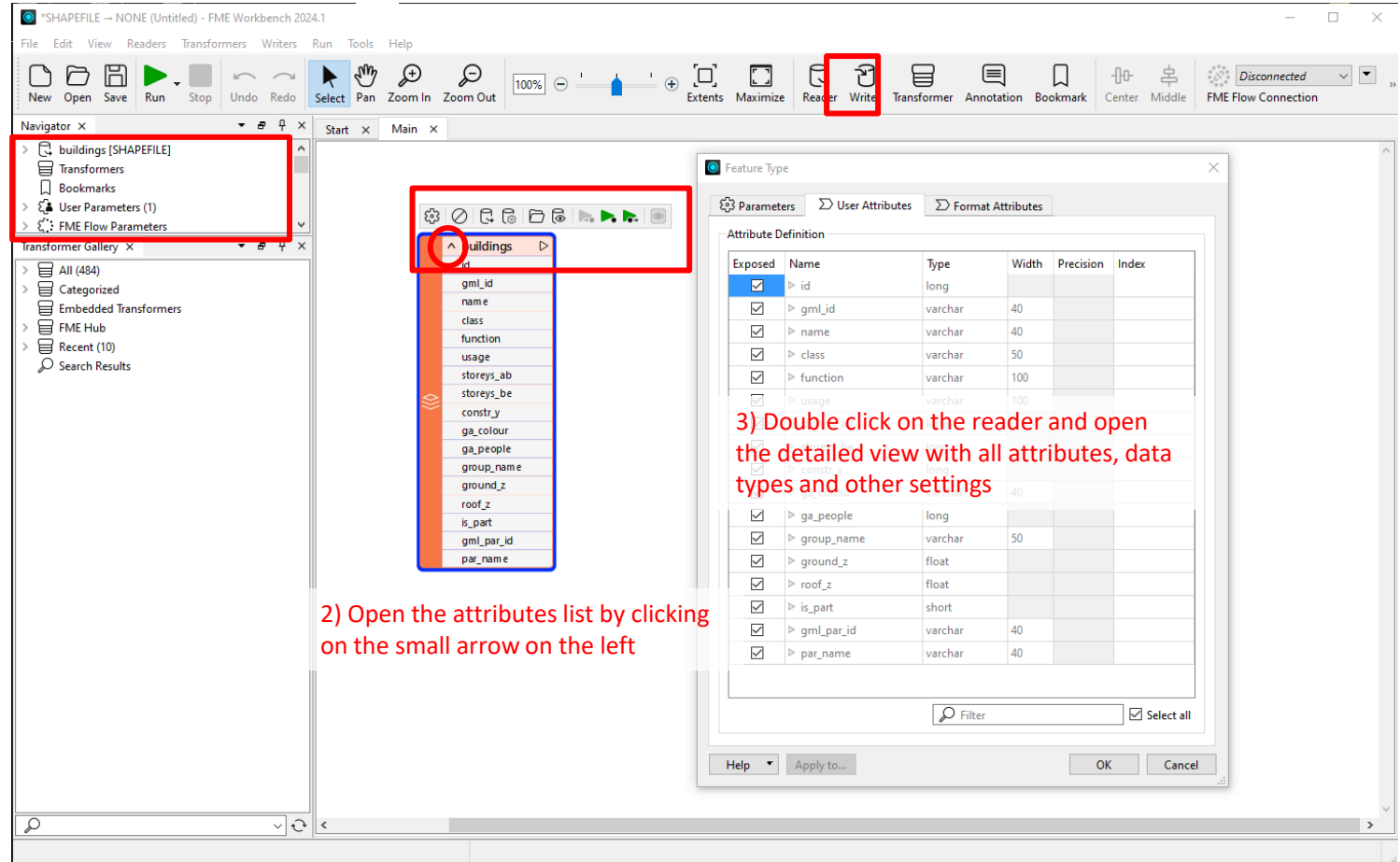
Add Reader Dialog:

- Format: <Guess from Dataset>
- Dataset: Select existing dataset
- Parameters... (button)
- Coord. System: Unknown
- Workflow Options:
 - ☒ Individual Feature Types
 - ☐ Single Merged Feature Type
- Buttons: Help, OK, Cancel

Reader(s)

- 1a) Click the reader button and select the reader depending on format, OR
- 1b) Type the reader format (e.g. SHAPEFILE) in the workbench area, OR
- 1c) Drag and drop the file in the workbench area

FME in a nutshell
Readers and writers
 Transformers
 Data types
 Geometry model
 Other stuff



The screenshot shows the FME Workbench 2024.1 interface. The top toolbar has the 'Reader' button highlighted with a red box. The left pane shows the 'Navigator' with 'buildings [SHAPEFILE]' selected, also highlighted with a red box. The right pane shows the 'Attribute Definition' dialog box, which is open for the 'buildings' reader. The dialog box has tabs for 'Parameters', 'User Attributes', and 'Format Attributes'. The 'Format Attributes' tab is active, showing a table of attributes with checkboxes for 'Exposed', 'Name', 'Type', 'Width', 'Precision', and 'Index'. The 'Exposed' column has checkboxes for 'id', 'gml_id', 'name', 'class', 'function', 'usage', 'storeys_ab', 'storeys_be', 'constr_y', 'ga_colour', 'ga_people', 'group_name', 'ground_z', 'roof_z', 'is_part', 'gml_par_id', and 'par_name'. The 'Name' column has values like '> id', '> gml_id', '> name', '> class', '> function', '> usage', '> storeys_ab', '> storeys_be', '> constr_y', '> ga_colour', '> ga_people', '> group_name', '> ground_z', '> roof_z', '> is_part', '> gml_par_id', and '> par_name'. The 'Type' column has values like 'long', 'varchar', 'float', 'short', and 'long'. The 'Width' column has values like 40, 50, 100, and 40. The 'Precision' column has values like 40, 50, 100, and 40. The 'Index' column has values like 40, 50, 100, and 40. The 'Attribute Definition' dialog box is also highlighted with a red box. Below the dialog box, the 'buildings' attribute list is shown, with a small arrow on the left highlighted with a red box. The attribute list includes 'gml_id', 'name', 'class', 'function', 'usage', 'storeys_ab', 'storeys_be', 'constr_y', 'ga_colour', 'ga_people', 'group_name', 'ground_z', 'roof_z', 'is_part', 'gml_par_id', and 'par_name'.

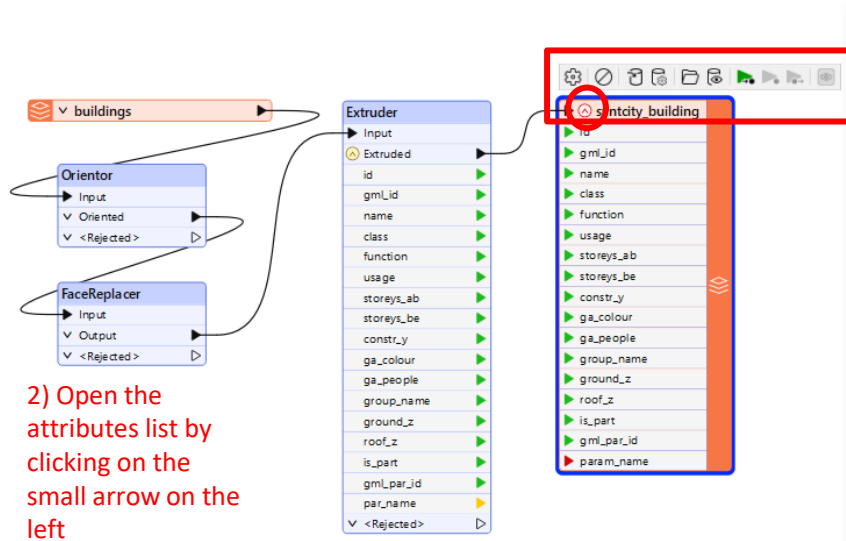
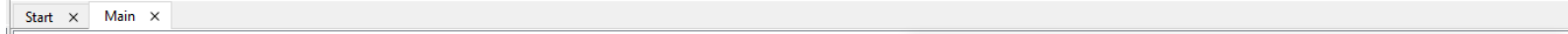
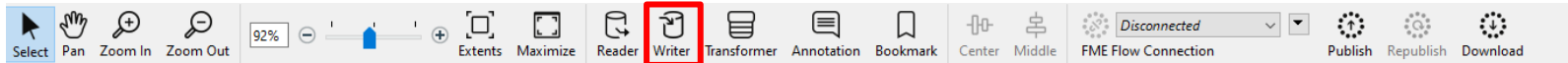
2) Open the attributes list by clicking on the small arrow on the left

3) Double click on the reader and open the detailed view with all attributes, data types and other settings

Exposed	Name	Type	Width	Precision	Index
☒	> id	long			
☒	> gml_id	varchar	40		
☒	> name	varchar	40		
☒	> class	varchar	50		
☒	> function	varchar	100		
☒	> usage	varchar	100		
☒	> storeys_ab	long	40		
☒	> storeys_be	long	40		
☒	> constr_y	long	40		
☒	> ga_colour	long	40		
☒	> ga_people	long			
☒	> group_name	varchar	50		
☒	> ground_z	float			
☒	> roof_z	float			
☒	> is_part	short			
☒	> gml_par_id	varchar	40		
☒	> par_name	varchar	40		

Writer(s)

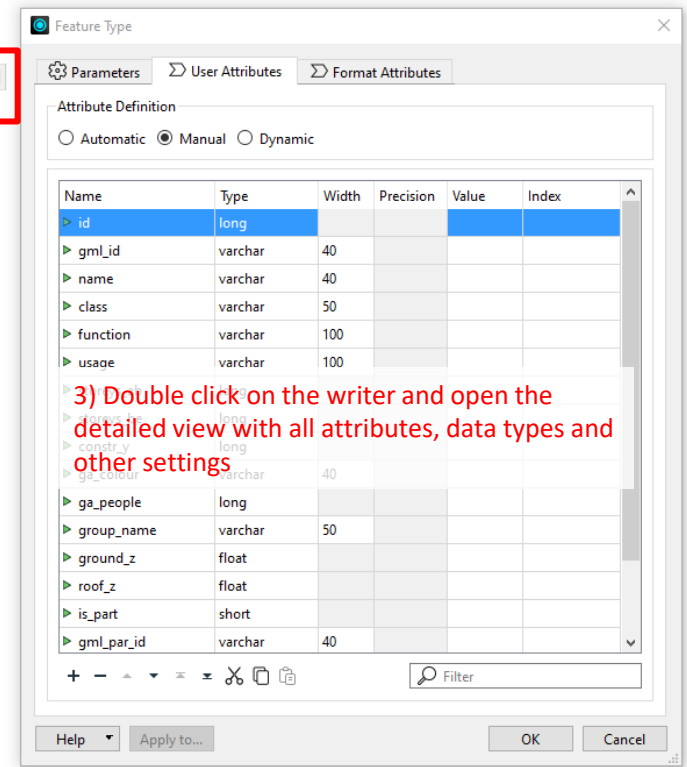
- 1a) Click the writer button and select the reader depending on format, OR
- 1b) Type the writer format (e.g. SHAPEFILE) in the workbench area



2) Open the attributes list by clicking on the small arrow on the left

4) Check the attribute connections between the writer and the last transformer

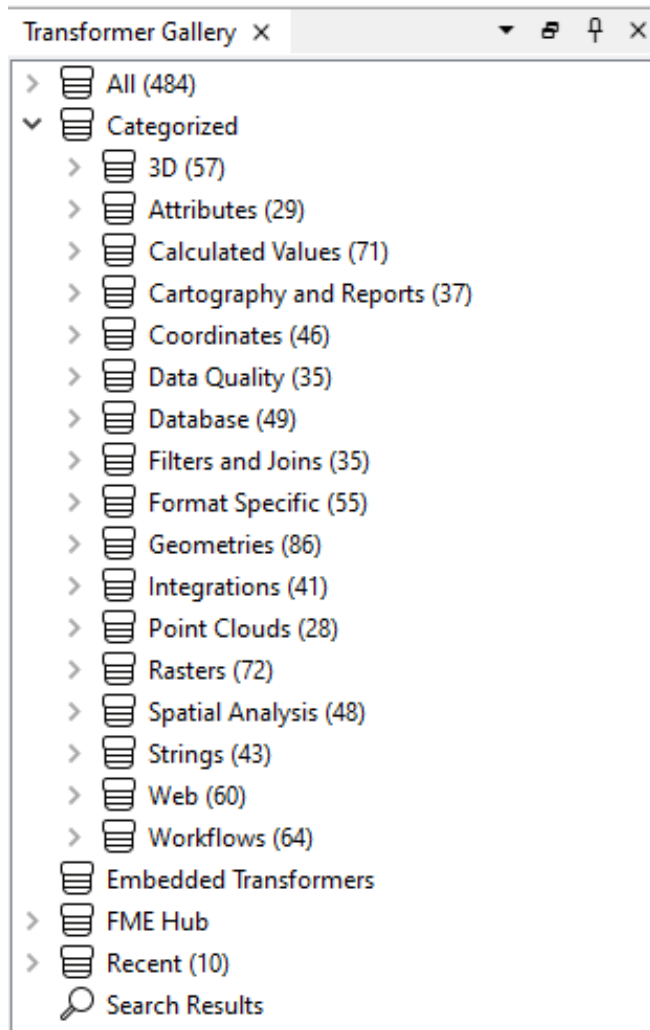
- Green: attribute is mapped and will be written
- Yellow: attribute is not mapped, needs to be connected manually (e.g. ground_z to ground_z_v)
- Red: attribute without correspondence; it will be written, but will remain empty



3) Double click on the writer and open the detailed view with all attributes, data types and other settings

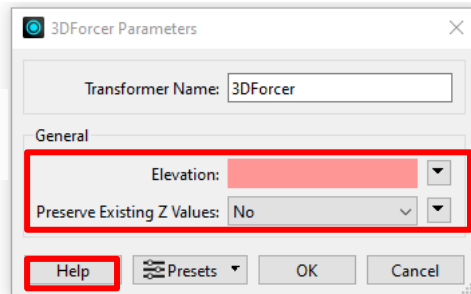
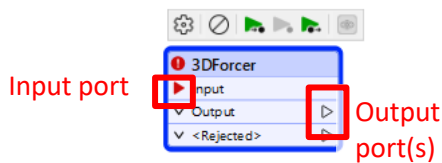
Transformer(s)

- A transformer... *transforms* data! 😊
- Circa 500 transformers, thematically classified
- In general, transformers work sequentially (FIFO = First In, First out)
- Possibility to interface to e.g. Python
- Possibility to define/create your own transformer
- If you feel lost: use the help!

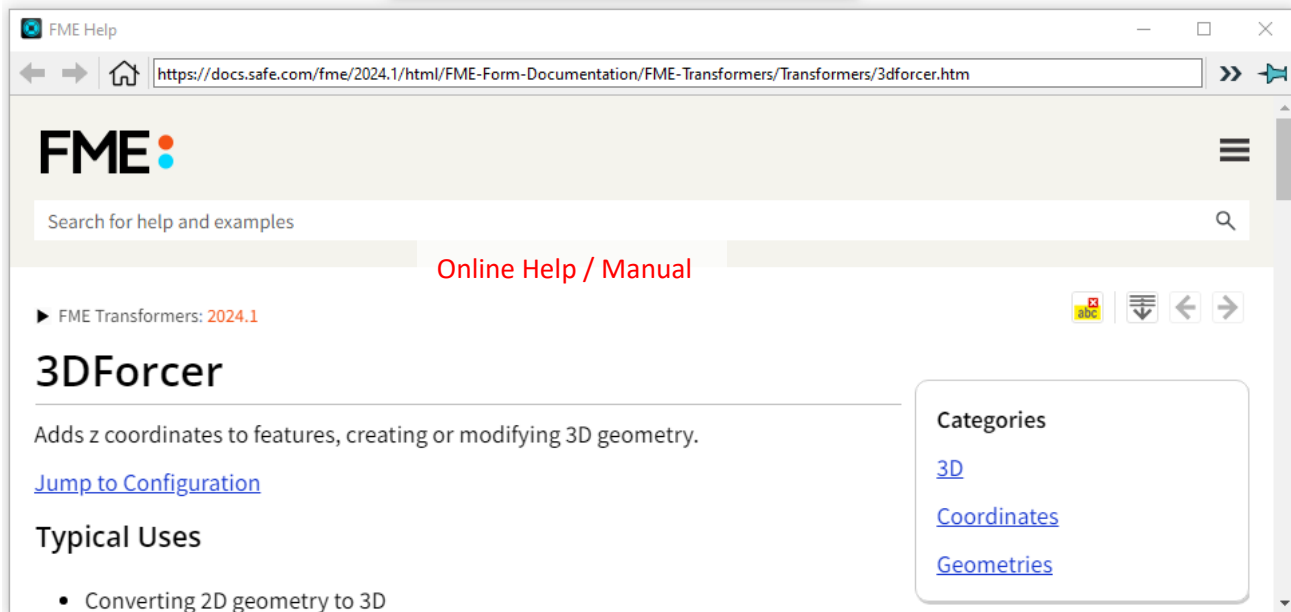


Transformer(s)

- 1a) Double click on the transformer name in the Transformer gallery, OR
- 1b) Drag and drop the transformer from the Transformer gallery into the workbench area OR
- 1c) Directly type the transformer name (e.g. 3Dforcer) in the workbench area



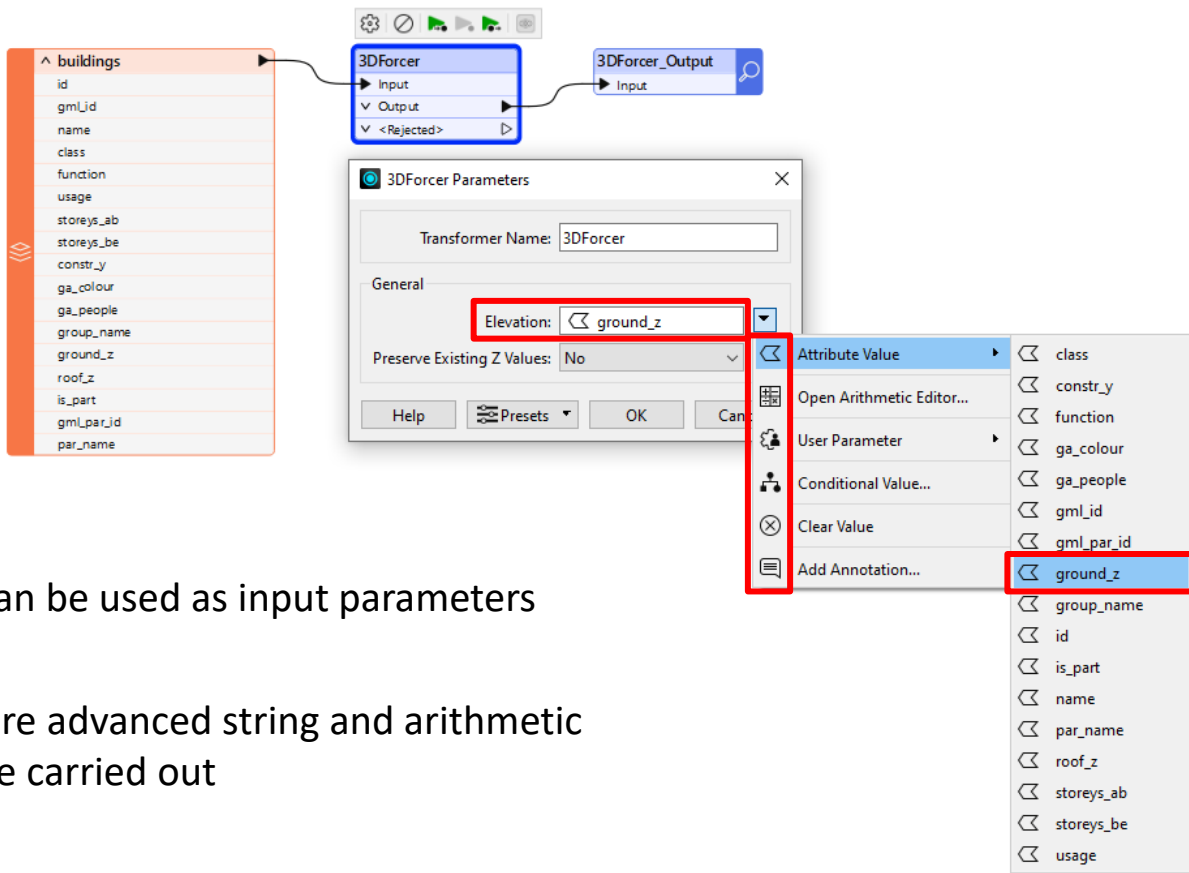
Transformer
Parameters



Online Help / Manual

Transformer(s)

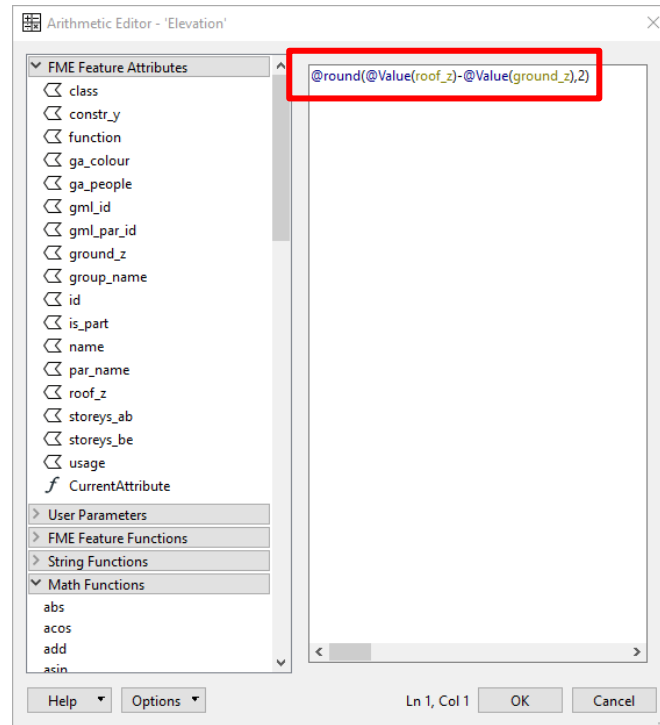
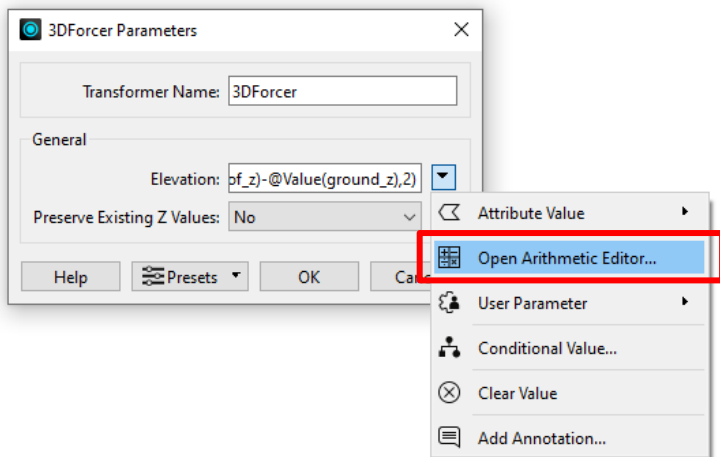
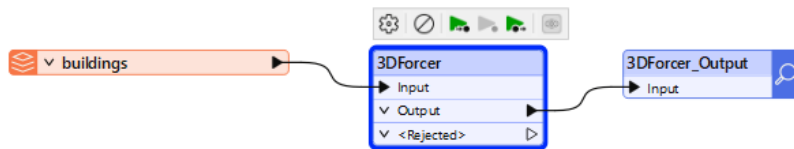
FME in a nutshell
 Readers and writers
Transformers
 Data types
 Geometry model
 Other stuff



The screenshot illustrates the configuration of the 3DForcer transformer in FME. On the left, a list of attributes for the 'buildings' dataset is shown, including 'id', 'gml_id', 'name', 'class', 'function', 'usage', 'storeys_ab', 'storeys_be', 'constr_y', 'ga_colour', 'ga_people', 'group_name', 'ground_z', 'roof_z', 'is_part', 'gml_par_id', and 'par_name'. The 'ground_z' attribute is highlighted. In the center, the '3DForcer' transformer is shown with its 'Input' and 'Output' ports. To the right, the '3DForcer Parameters' dialog is open, showing the 'Transformer Name' as '3DForcer'. The 'Elevation' field is set to 'ground_z', and the 'Preserve Existing Z Values' is set to 'No'. A dropdown menu is open, showing a list of attributes with 'ground_z' selected.

- Attribute fields can be used as input parameters
- Alternatively, more advanced string and arithmetic operations can be carried out

Transformer(s)



- Alternatively, more advanced string and arithmetic operations can be carried out

Data types

- For **non-spatial data** FME Form *generally* takes care of automatically choosing the correct type (integer, string, date, Boolean, etc.)
- Data is dealt with as tabular data, generally associated to geometries
- Transformers are available for most typical alphanumeric data operations
- For time/date formats, you may have to use transformers to adapt them (e.g. **DateTimeConverter**)

FME in a nutshell
Readers and writers
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Data types: lists

- Lists are denoted by a pair of curly brackets (“{}”)
 - E.g. *name_of_list*{}
- Lists can contain attributes associated to each item. A period (“.”) denotes them
 - E.g. *trees*{*.name*}, *trees*{*.species*}, etc.
- It is good habit to prefix lists with an underscore (“_”)
 - E.g. *_trees*{}
- Further info:
 - https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_Desktop/!List_Attribute_s/Understanding-List-Attributes.htm

Data types: spatial data

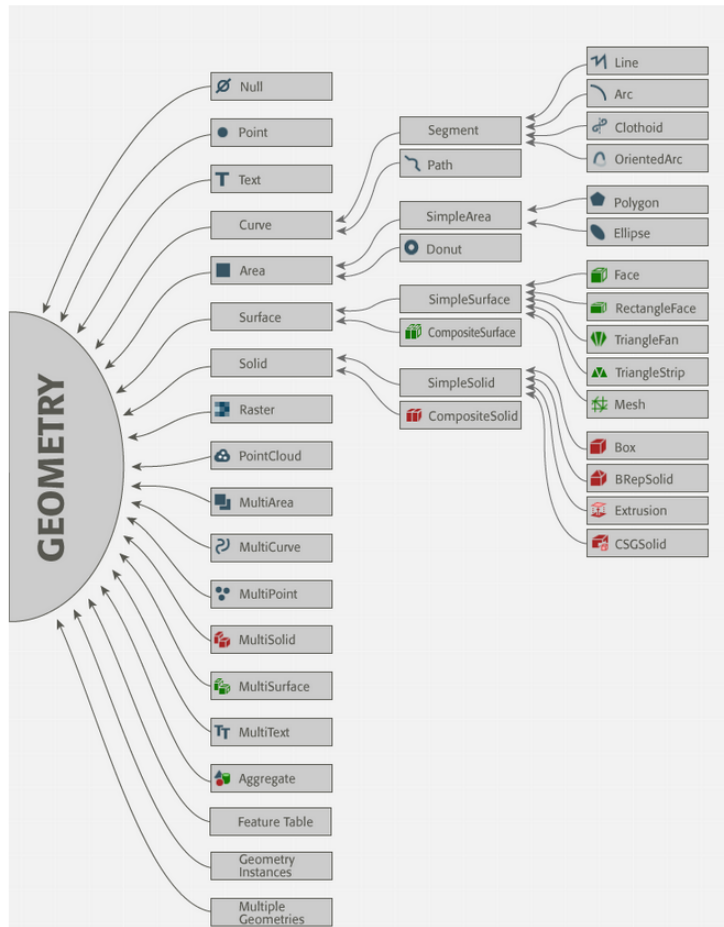
FME in a nutshell
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- For **spatial data**, FME has its own internal geometry model. All geometries are mapped to/from it
 - https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_Desktop/!FME_Geometry/FME_Geometry_Model.htm
- It is rather intuitive, however with some peculiar semantics
 - **Area**: a 2D polygon with or without holes is called a “Donut” or a “SimpleArea”, respectively
 - **Surface**: a 3D geometry (simple or composite) that is made of 3D entities (Face, RectangleFace, ... Mesh) and has a surface normal
- Examples of series of geometrical transformations could be:
 - donut -> face -> multisurface
 - polygon -> face -> composite surface -> Brep-solid
- **WATCH OUT:** A “classical” 3D polygon can be many things in FME!
- Geometries can have “internal” attributes called *geometry traits*
 - E.g. they are needed for CityGML

FME Geometry Model

FME provides a comprehensive geometry model that includes everything from the simplest geometry to the most complex.

Click on a geometry class for more information.



Understanding FME Geometry

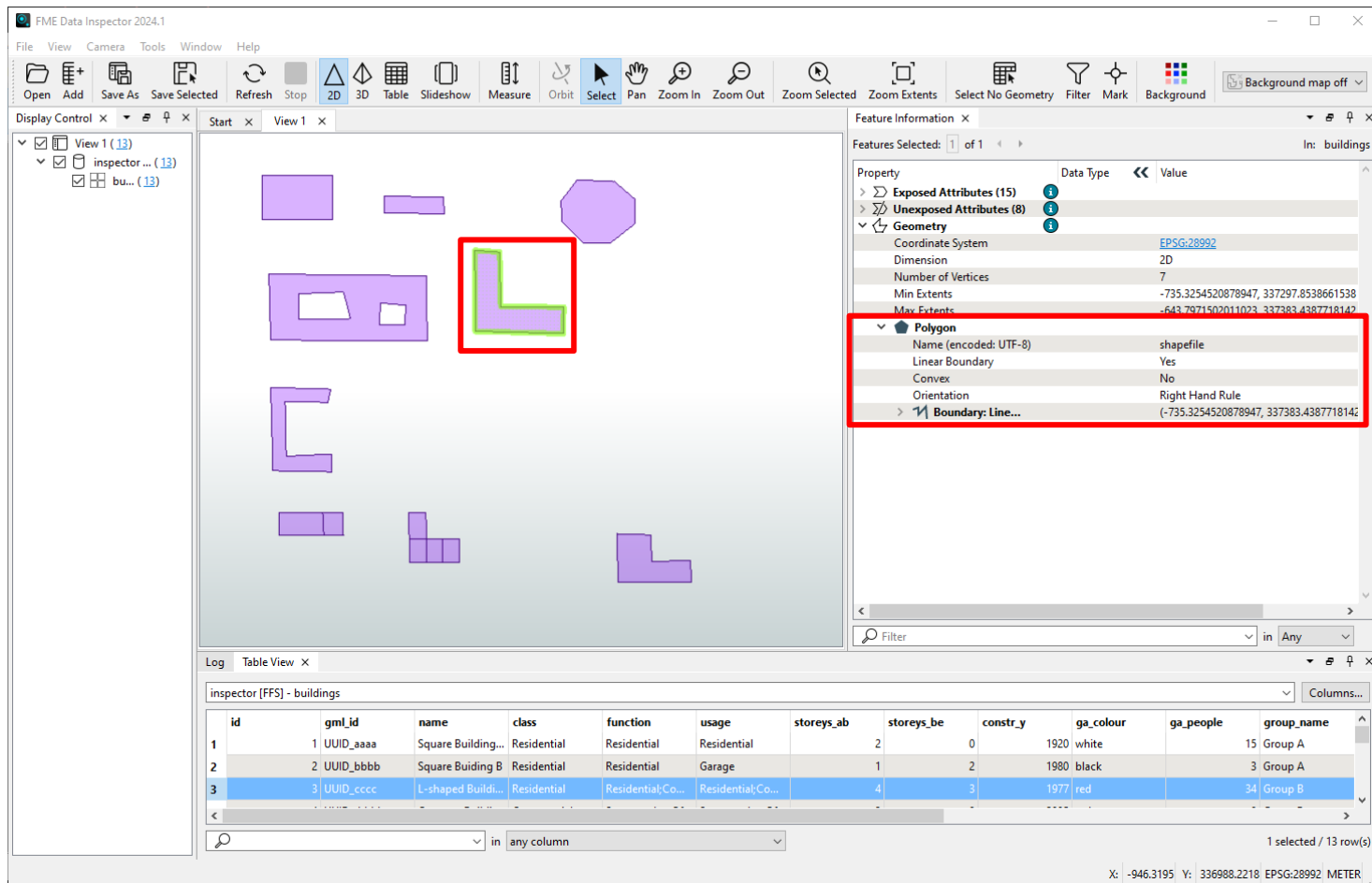
Geometry Concepts
FME Geometry Model
Nulls (IFMNull)
Points (IFMEPoint)
Text (IFMEText)
Curves (IFMECurve)
Segments (IFMESegment)
Paths (IFMEPath)
Areas (IFMEArea)
Simple Areas (IFMESimpleArea)
Donuts (IFMEDonut)
Surfaces (IFMESurface)
Simple Surfaces (IFMESimpleSurface)
Composite Surfaces (IFMECompositeSurface)
Solids (IFMESolid)
Simple Solids (IFMESimpleSolid)
Composite Solids (IFMECompositeSolid)
Rasters (IFMERaster)
Point Clouds (IFMEPointCloud)
Multis
Aggregates (IFMEAggregate)
Feature Tables (IFMEFeatureTable)
Geometry Definitions and Instances
Multiple Geometries

Geometry model

- How to check which geometry data type is used?
- One possibility is to open the **Data Inspector**, select the geometry and check in the Feature Information tab. At the end, you will see the geometry type and the associated geometry traits (if any)
- The hierarchy and the nested geometries will be shown, too.
- See next slides for examples

Geometry model

FME in a nutshell
 Readers and writers
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Feature Information

Features Selected: 1 of 1 In: buildings

Property	Data Type	Value
> Exposed Attributes (15)		
> Unexposed Attributes (8)		
> Geometry		
Coordinate System	EPSG:28992	
Dimension	2D	
Number of Vertices	7	
Min Extents		-735.3254520878947, 337297.8538661538
Max Extents		-643.79715020111023, 337383.4387718142
> Polygon		
Name (encoded: UTF-8)	shapefile	
Linear Boundary	Yes	
Convex	No	
Orientation	Right Hand Rule	
> Boundary: Line...		(-735.3254520878947, 337383.4387718142)

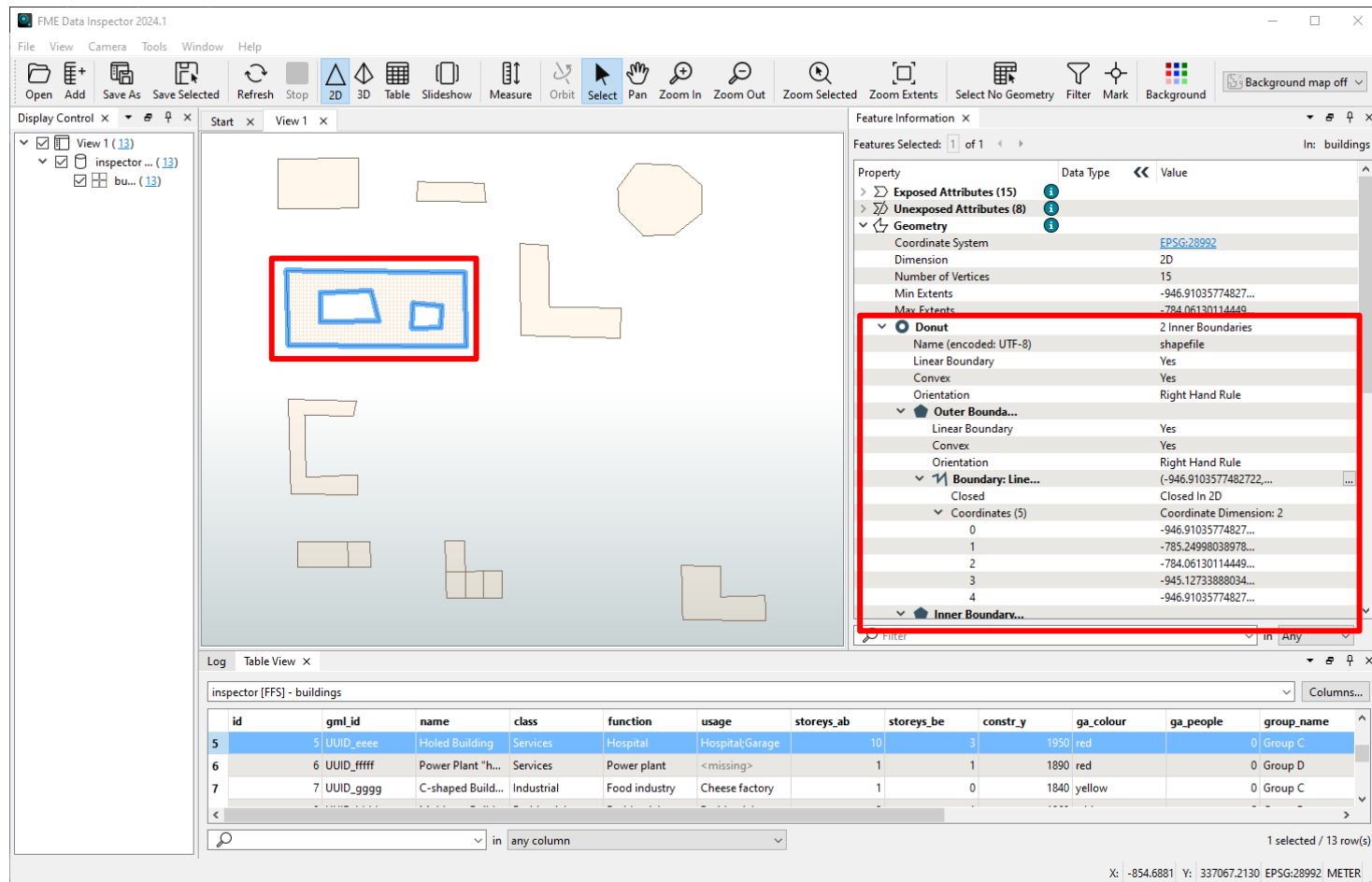
id	gml_id	name	class	function	usage	storeys_ab	storeys_be	constr_y	ga_colour	ga_people	group_name
1	1 UUID_aaaa	Square Building...	Residential	Residential	Residential	2	0	1920	white	15	Group A
2	2 UUID_bbbb	Square Building B	Residential	Residential	Garage	1	2	1980	black	3	Group A
3	3 UUID_cccc	L-shaped Buildi...	Residential	Residential/Co...	Residential/Co...	4	3	1977	red	34	Group B

1 selected / 13 row(s)

X: -946.3195 Y: 336988.2218 EPSG:28992 METER

Geometry model

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Feature Information

Features Selected: 1 of 1 In: buildings

Property Data Type Value

- > Exposed Attributes (15)
- > Unexposed Attributes (8)
- > Geometry
 - Coordinate System EPSG:28992
 - Dimension 2D
 - Number of Vertices 15
 - Min Extents -946.91035774827...
 - Max Extents -784.06130114449...
 - Donut
 - 2 Inner Boundaries
 - Name (encoded: UTF-8) shapefile
 - Linear Boundary Yes
 - Convex Yes
 - Orientation Right Hand Rule
 - Outer Boundary...
 - Linear Boundary Yes
 - Convex Yes
 - Orientation Right Hand Rule
 - Boundary: Line... (-946.9103577482722..., ...)
 - Closed Closed In 2D
 - Coordinates (5) Coordinate Dimension: 2
 - 0 -946.91035774827...
 - 1 -785.24998038978...
 - 2 -784.06130114449...
 - 3 -945.12733888034...
 - 4 -946.91035774827...
 - Inner Boundary...

Table View

Log inspector [FFS] - buildings

id	gml_id	name	class	function	usage	storeys_ab	storeys_be	constr_y	ga_colour	ga_people	group_name
5	5 UUID_eeee	Holed Building	Services	Hospital	Hospital;Garage	10	3	1950	red	0	Group C
6	6 UUID_ffff	Power Plant "h...	Services	Power plant	<missing>	1	1	1890	red	0	Group D
7	7 UUID_gggg	C-shaped Build...	Industrial	Food industry	Cheese factory	1	0	1840	yellow	0	Group C

1 selected / 13 row(s)

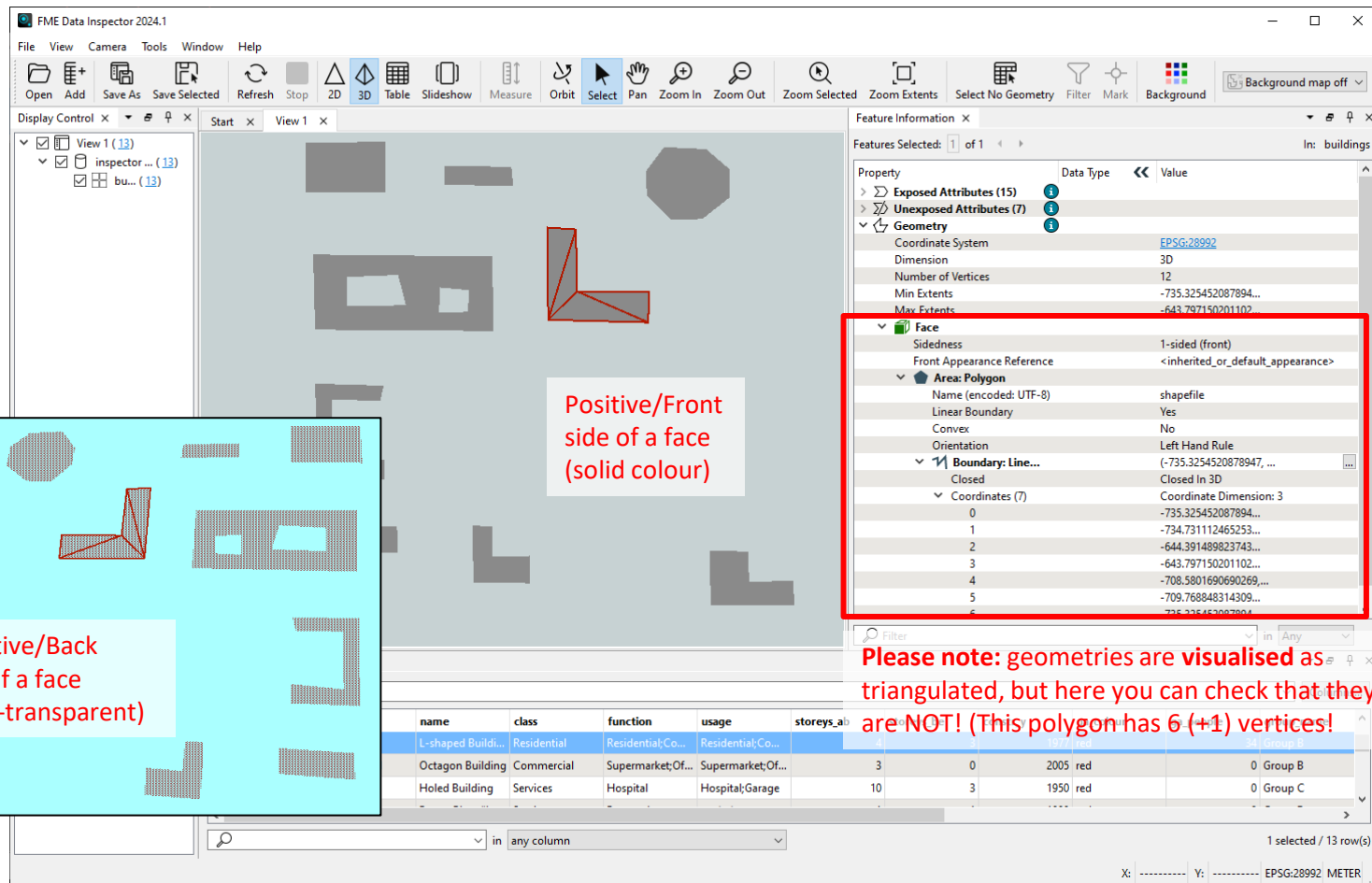
X: -854.6881 Y: 337067.2130 EPSG:28992 METER

Geometry model

- *Polygons* and *donuts* are 2D geometry types
- To transform them into 3D entities, in general they must become (3D) *faces*
 - You can use the **FaceReplacer** transformer, after (optionally) forcing them to 3D using a **3DForcer** transformer
- Faces have the additional property of having a positive and negative *side* (wrt. the surface normal vector)
 - You may have to check the orientation with the **Orientor** transformer
- The two sides of a face are visualised differently in FME:
 - Solid-colour for the positive/front side of the surface
 - Semi-transparent surface for the negative/back side
 - **Watch out!** When visualised, the triangulation does **not** affect the real geometry. It is only for visualisation purposes (unless you are working with triangular geometries!)

Geometry model

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Positive/Front side of a face (solid colour)

Negative/Back side of a face (semi-transparent)

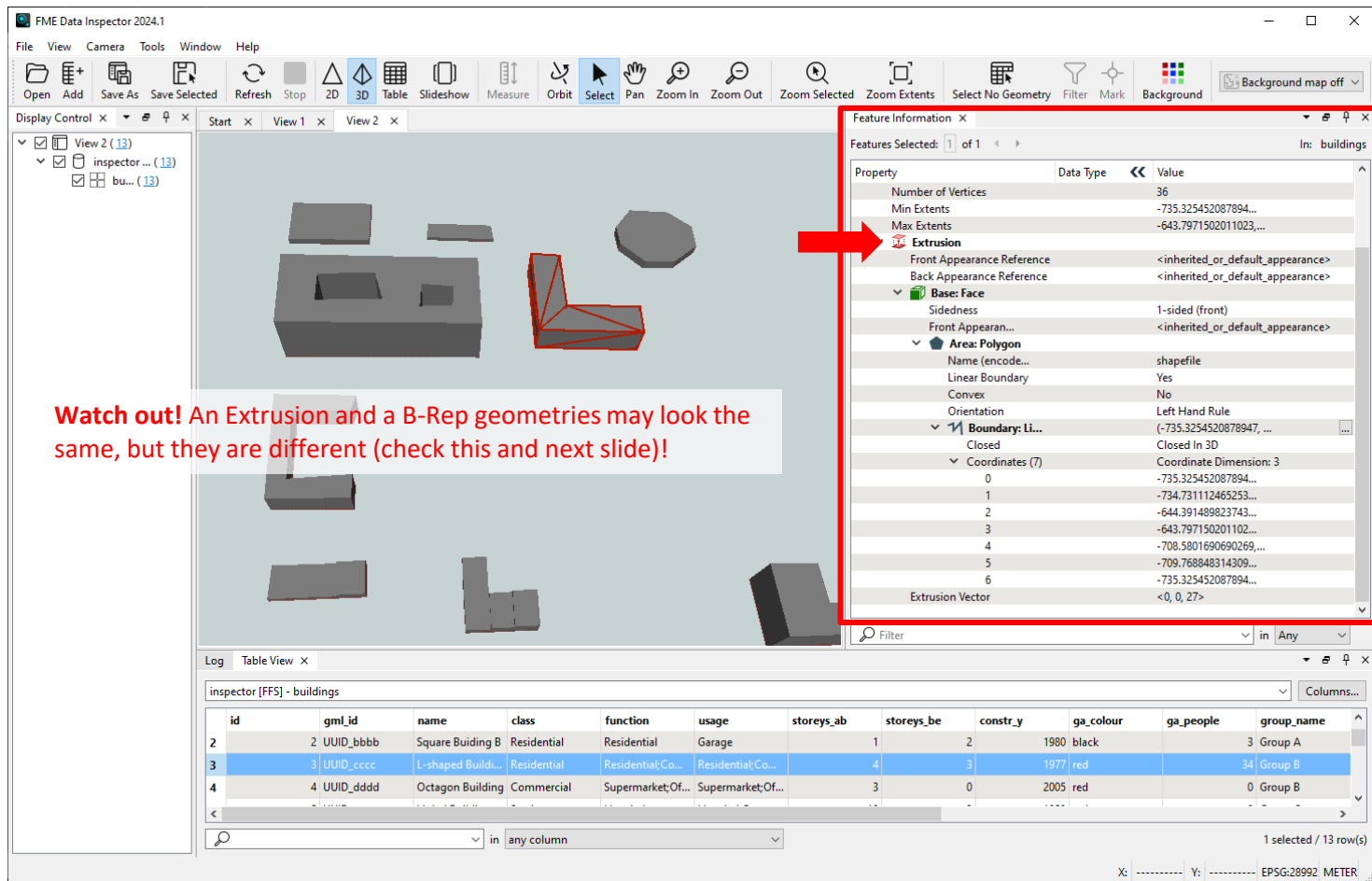
Please note: geometries are visualised as triangulated, but here you can check that they are NOT! (This polygon has 6 (+1) vertices!)

name	class	function	usage	storeys_ab	4	0	2005	red	0	Group B
L-shaped Buildi...	Residential	Residential/Co...	Residential/Co...							
Octagon Building	Commercial	Supermarket;Of...	Supermarket;Of...	3	0	2005	red	0	Group B	
Holed Building	Services	Hospital	Hospital;Garage	10	3	1950	red	0	Group C	

Geometry model

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Watch out! An Extrusion and a B-Rep geometries may look the same, but they are different (check this and next slide)!



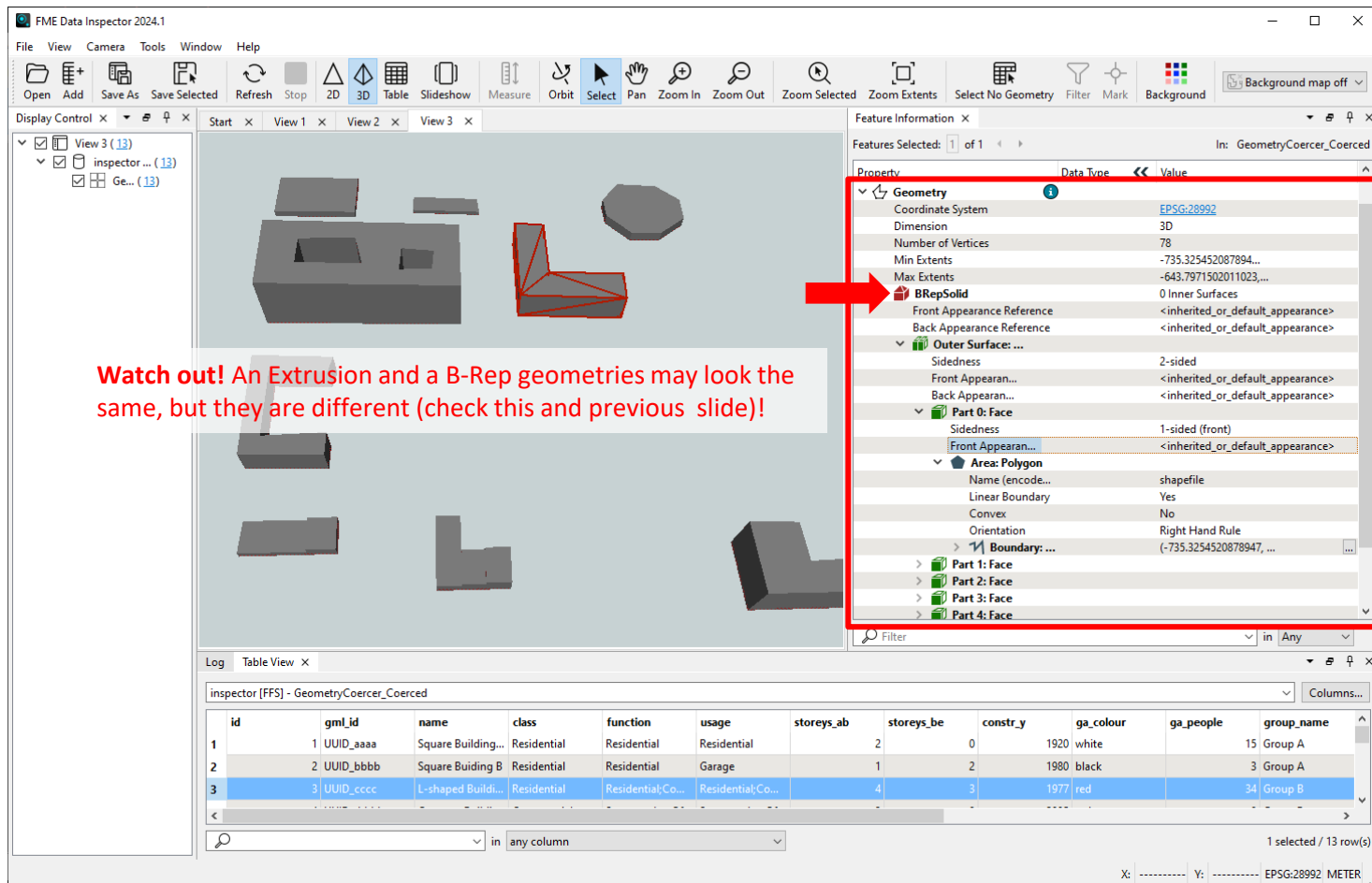
The screenshot shows the FME Data Inspector 2024.1 interface. The main 3D view displays several building models. A red arrow points from a text box to the Feature Information panel on the right, which is currently showing the properties of an 'Extrusion' feature. The panel lists various properties such as 'Number of Vertices', 'Min Extents', 'Max Extents', 'Extrusion', 'Base: Face', 'Area: Polygon', and 'Boundary: Li...'. The 'Extrusion' property is highlighted, showing its 'Front Appearance Reference' and 'Back Appearance Reference' as '<inherited_or_default_appearance>'. The 'Area: Polygon' property is also expanded, showing its 'Name', 'Linear Boundary', 'Convex', 'Orientation', and 'Boundary: Li...' properties. The 'Boundary: Li...' property is further expanded, showing its 'Closed' status and 'Coordinates (7)'. The 'Extrusion Vector' is shown as '<0, 0, 27>'. Below the 3D view, the 'Table View' shows a table of building data with columns for 'id', 'gml_id', 'name', 'class', 'function', 'usage', 'storeys_ab', 'storeys_be', 'constr_y', 'ga_colour', 'ga_people', and 'group_name'. The table contains three rows of data, with the second row highlighted in blue.

id	gml_id	name	class	function	usage	storeys_ab	storeys_be	constr_y	ga_colour	ga_people	group_name
2	2 UUID_bbbb	Square Building B	Residential	Residential	Garage	1	2	1980	black	3	Group A
3	3 UUID_cccc	L-shaped Building...	Residential	Residential/Co...	Residential/Co...	4	3	1977	red	34	Group B
4	4 UUID_dddd	Octagon Building	Commercial	Supermarket/Of...	Supermarket/Of...	3	0	2005	red	0	Group B

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Watch out! An Extrusion and a B-Rep geometries may look the same, but they are different (check this and previous slide)!



The screenshot shows the FME Data Inspector 2024.1 interface. The main 3D view displays a building model with a red wireframe overlay on a specific part. The Feature Information panel on the right provides detailed properties for the selected geometry, which is a BRepSolid.

Feature Information Panel:

- Geometry**
 - Coordinate System: EPSG:28992
 - Dimension: 3D
 - Number of Vertices: 78
 - Min Extents: -735.325452087894...
 - Max Extents: -643.7971502011023...
 - BRepSolid**
 - Front Appearance Reference: <inherited_or_default_appearance>
 - Back Appearance Reference: <inherited_or_default_appearance>
 - Outer Surface: ...**
 - Sidedness: 2-sided
 - Front Appearance: <inherited_or_default_appearance>
 - Back Appearance: <inherited_or_default_appearance>
 - Part 0: Face**
 - Sidedness: 1-sided (front)
 - Front Appearance: <inherited_or_default_appearance>
 - Area: Polygon**
 - Name (encode...): shapefile
 - Linear Boundary: Yes
 - Convex: No
 - Orientation: Right Hand Rule

The bottom panel shows a table view of the data:

id	gml_id	name	class	function	usage	storeys_ab	storeys_be	constr_y	ga_colour	ga_people	group_name
1	1 UUID_aaaa	Square Building...	Residential	Residential	Residential	2	0	1920	white	15	Group A
2	2 UUID_bbbb	Square Building B	Residential	Residential	Garage	1	2	1980	black	3	Group A
3	3 UUID_cccc	L-shaped Buildi...	Residential	Residential/Co...	Residential/Co...	4	3	1977	red	34	Group B

Geometry model

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- You can transform geometries from one type to another using, for example, the **GeometryCoercer** transformer
 - Beware: not all transformation combinations are possible
 - Beware: geometries might *look* the same, but they are implicitly different (see previous slides)
 - Both look like 3D extrusions, but they can be modelled as MultiSurface objects, or BRepSolids, or Extrusions
- The **Aggregator/Deaggregator** transformers allow to group/ungroup geometries (and, more in general, features)
 - Handy transformer to go from "simple" geometries to **multi**-geometries.
- The **GeometryFilter** allows to select specific geometry types
- The **GeometryValidator** allows to check the validity and automatically repair (some) errors of geometries

Other stuff

Common transformers:

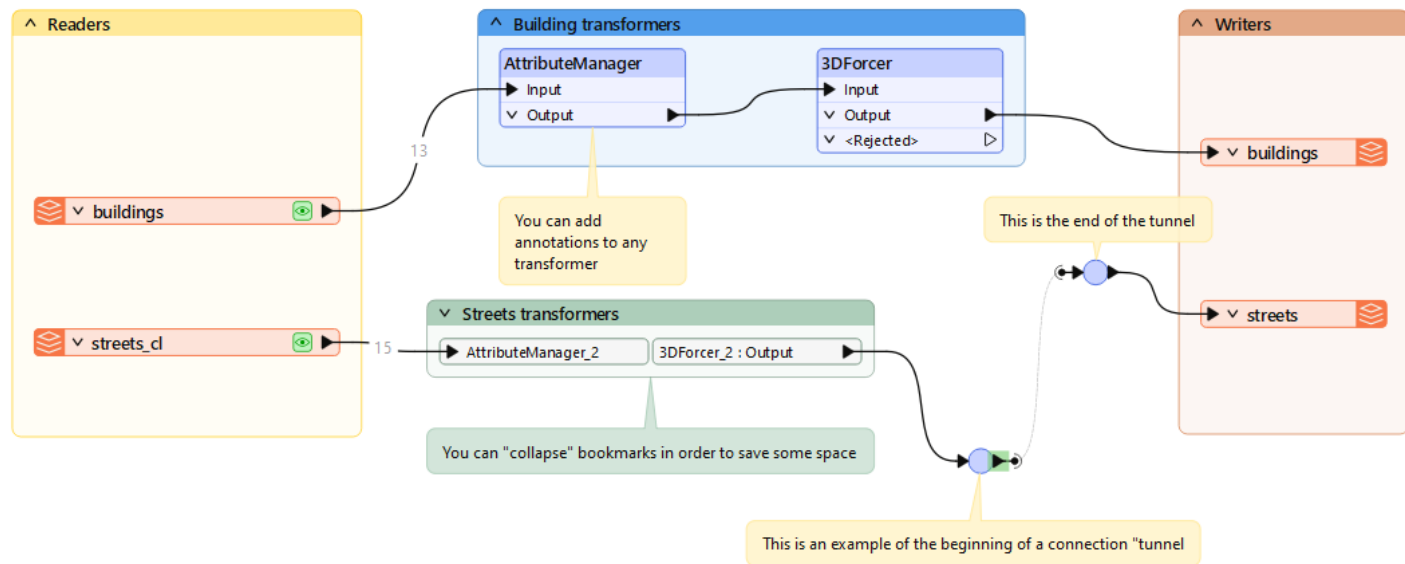
- AttributeCreator, AttributeRemover, AttributeKeeper, AttributeRenamer
- AttributeManager
- Sorter
- AttributeFilter
- Tester
- FeatureMerger

- GeometryValidator, GeometryRemover
- GeometryCoercer
- GeometryFilter
- 2DForcer, 3DForcer, Extruder
- FaceReplacer, Orientor
- GeometryPropertySetter, GeometryPropertyRemover

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Other goodies

- You can group transformers using **Bookmarks**
- You can attach **annotations** to each transformer, and to bookmarks, too
- You can change the **shape of the connection lines**
- You can create "**tunnels**" in the connections
- ...and much more!





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