

Campus FM Technology Association Facilities Geospatial Technologies Showcase

Integrating GIS and IWMS to Create An Effective Space Planning Tool

Presented by

Niels la Cour, Senior Physical Planner

Campus Planning, a division of Facilities and Campus Services

University of Massachusetts Amherst

Umass at a Glance:

- **28,635 Students**
- **1,300 Full Time Faculty**
- **5,000+ Employees**
- **12.5 + Million square feet**
- **200 + Major Buildings (Main Campus)**
- **1,450 Acre Campus**
- **1 FTE GIS Architect in A&F Support Services**
- **Individuals involved from Campus Planning, Design and Construction Management, Physical Plant**

Agenda – The Power of Data Interoperability

- The Pieces of the Puzzle
- The Pursuit of Planning Tools for Decision Support
- Why Data Interoperability (FME)
- Overview of the FME Workbench
- Working Toward Dynamic Data Driven Reports
- Examples of Interoperability and Other Tools

Special Thanks to my colleagues for their contributions:

**Dr. Alexander Stepanov, Jonathan Contract, Lukasz Czarniecki,
Mohamed Abdelaal, Roxanne Verdi, Negar Pourshadi, Lindsay Kenney**



Education Institution Systems (UMA)

Material supply & disposal
7,000 tons of waste (56% recycled) annually

Food Supply
40,000+ meals/day

Energy supply & delivery
\$26M and 2 trillion BTU's in 2013

Finance/Account'g Structures
\$1.03B Revenues, \$1.01B Expenditures

Decision Making Processes
Flagship of System, BOT, 3 unions & public procurement laws

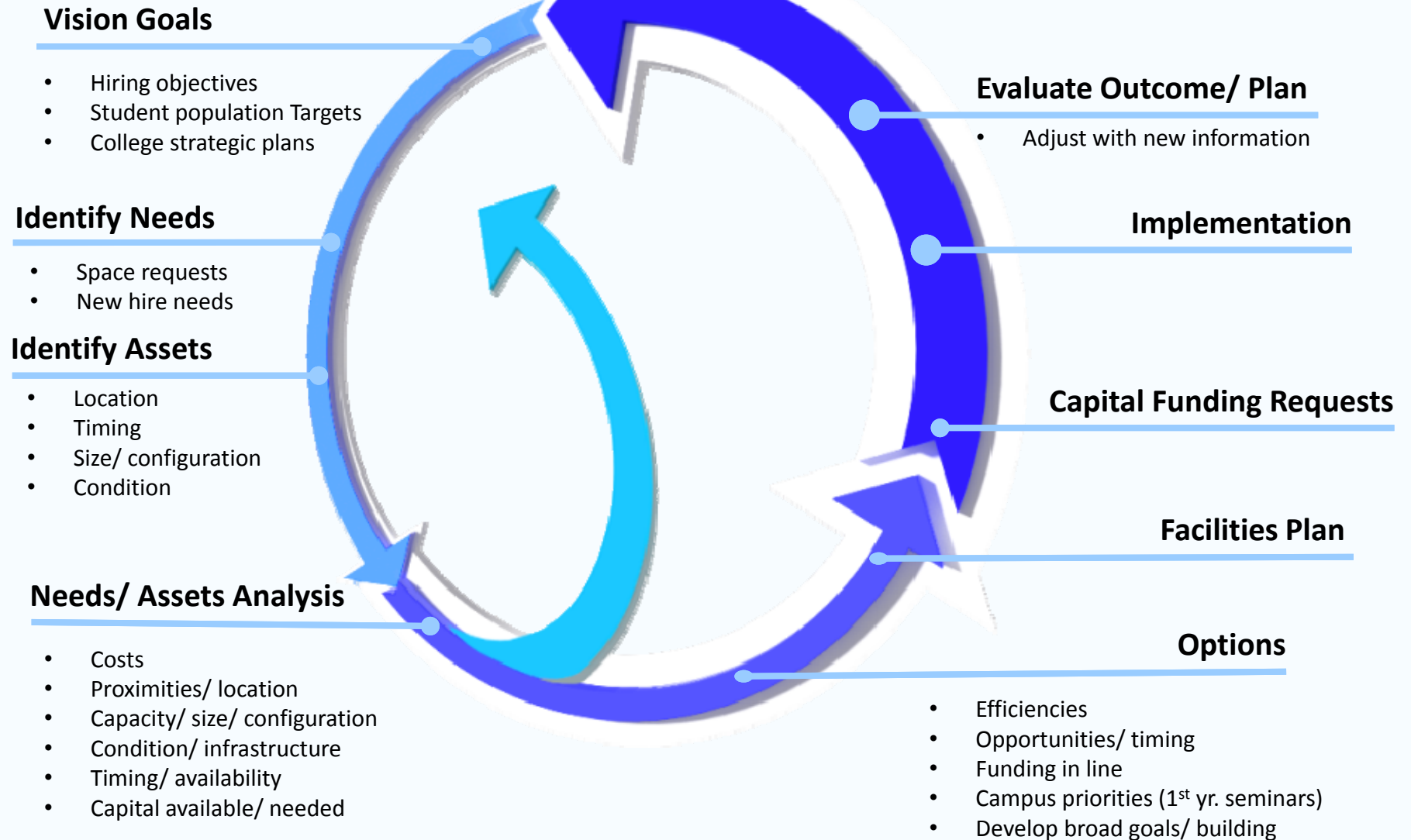
Human Resources
About 35,000 individuals and 14,000 beds

Building Operation & Maint.
\$150M on new construction, DM, renovation & IT

Academic Planning
200+ degree programs, 7,000 course sections/year, 400 classrooms

Campus Planning
12.8M GSF in 388 bldgs (50 heritage)
1,450 acres campus
19 mi roads
27 mi steam
10 mi electricity

Cycle of Planning

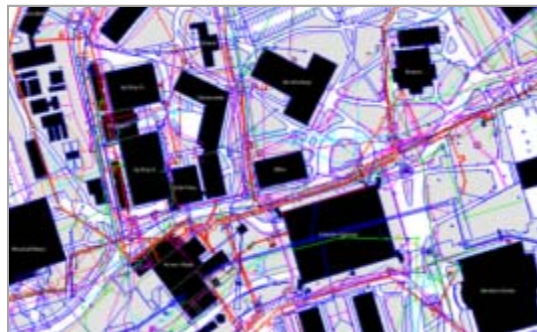
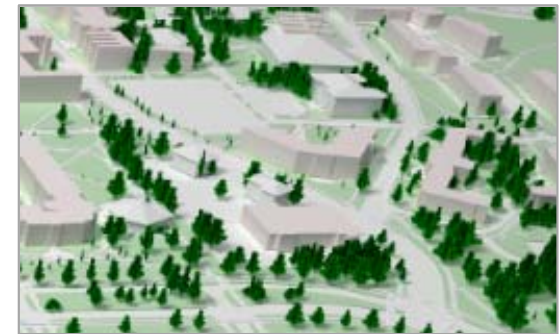


Campus as Systems

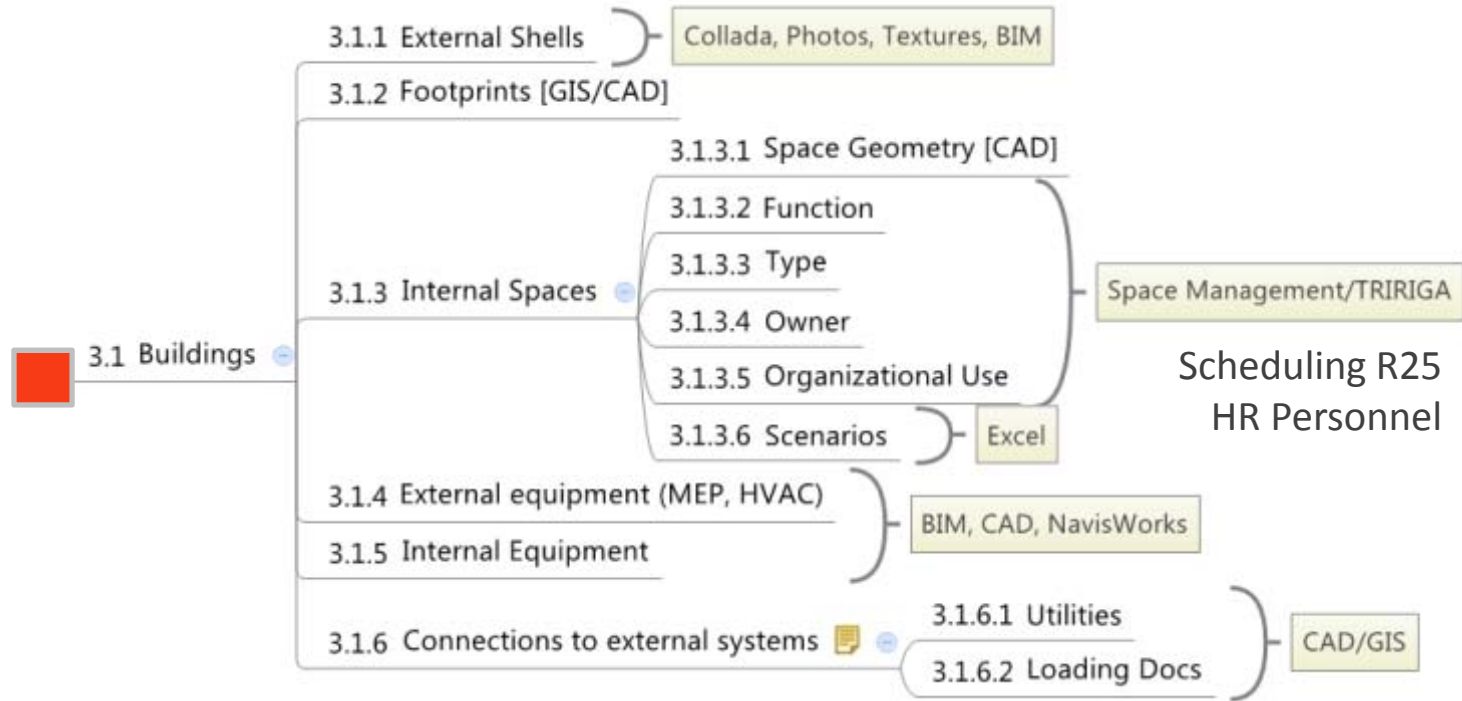
3. Campus as System 📄

- 3.1 Buildings +
- 3.2 Open Space +
- 3.3 Transportation/Transit +
- 3.4 Utilities +
- 3.5 Infrastructure +

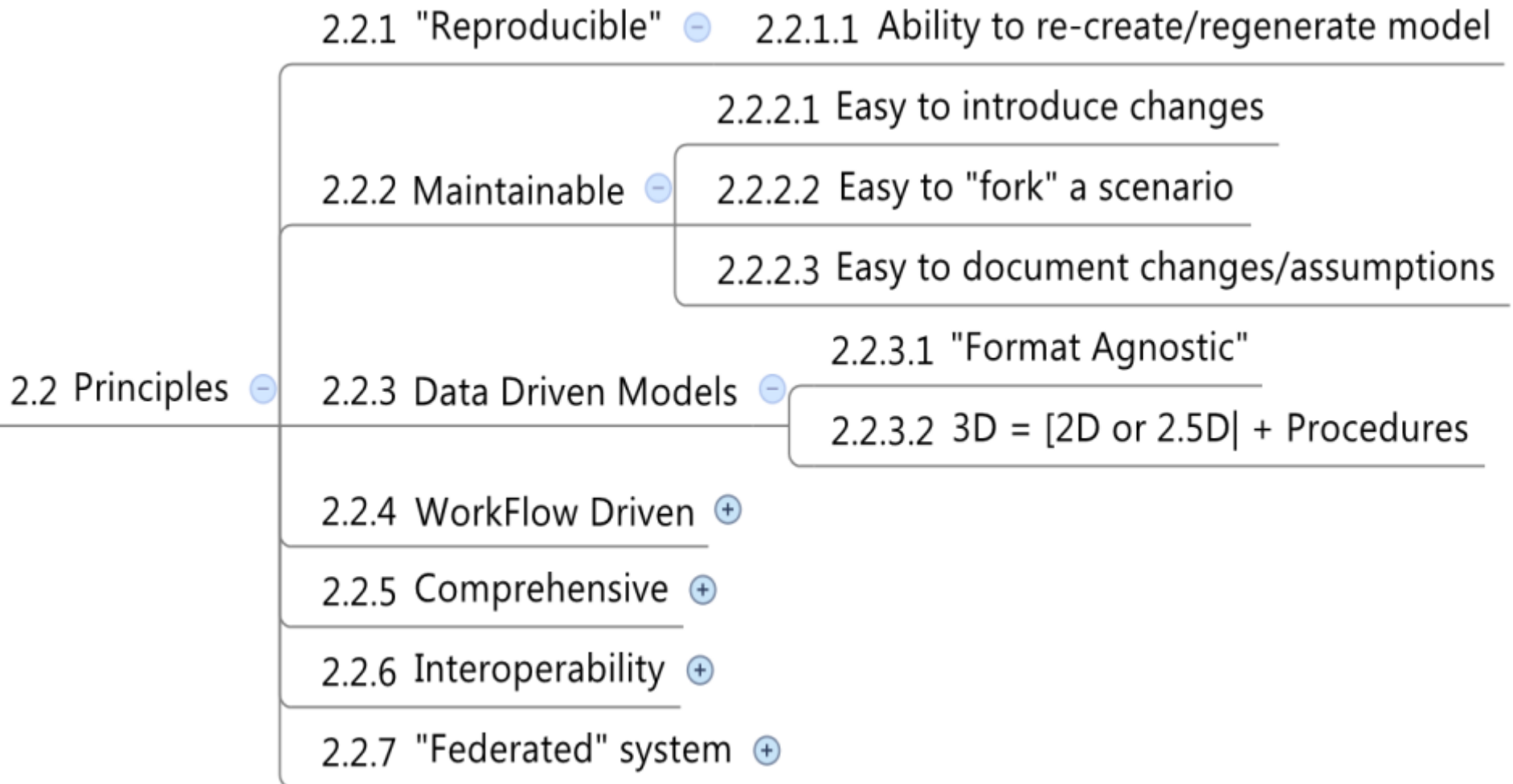
Education
Research
Operations



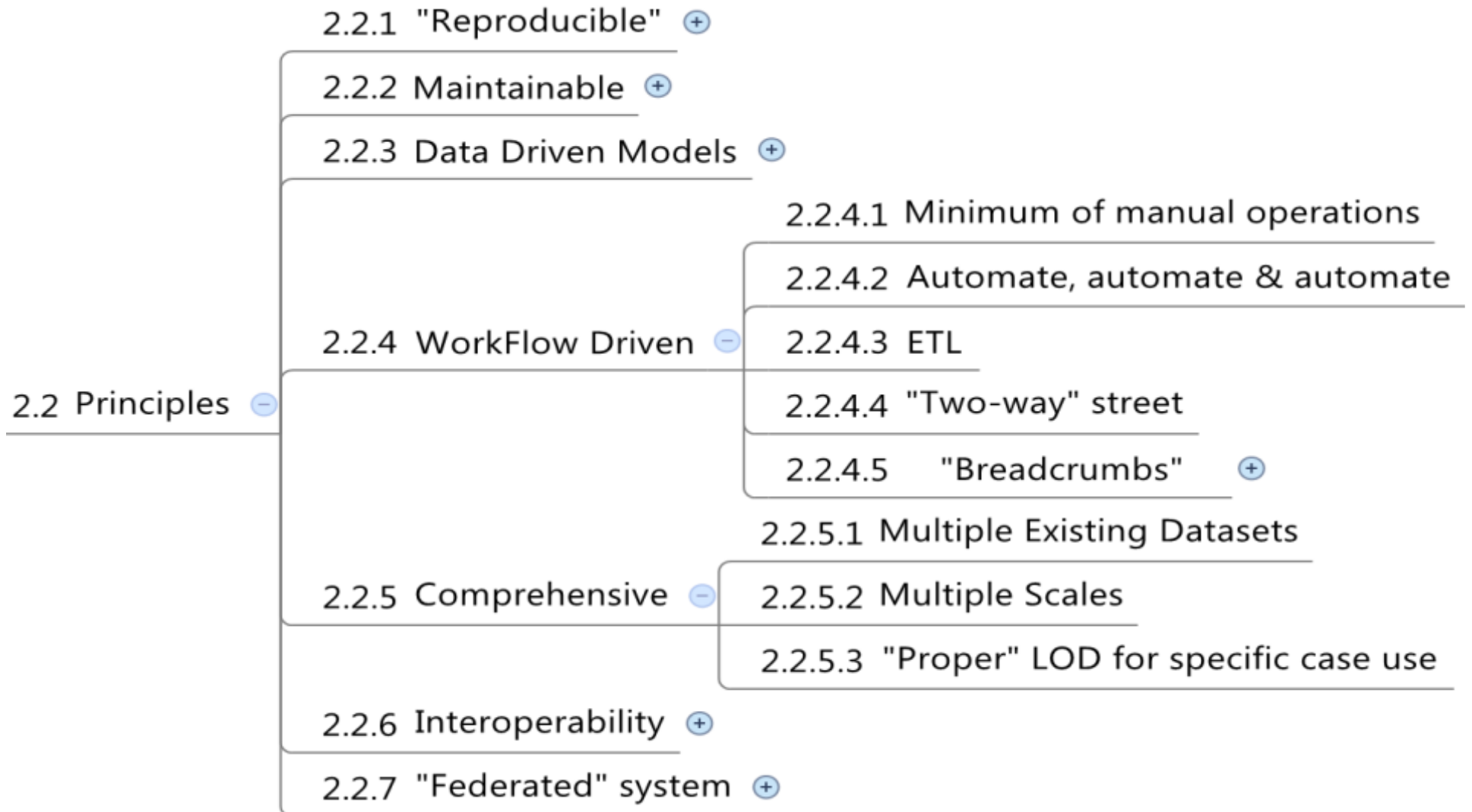
Campus as Systems: Buildings



Principles of integration

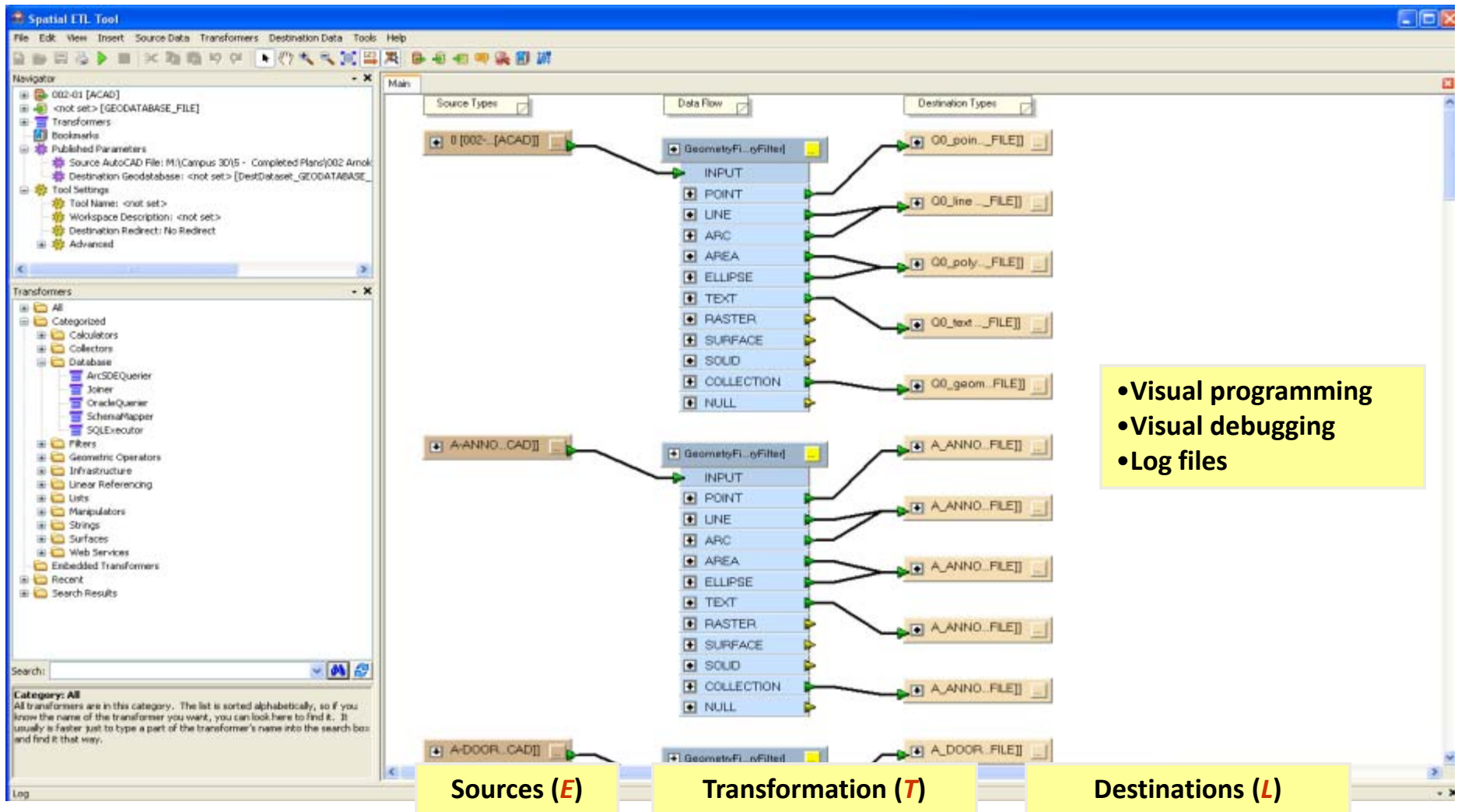


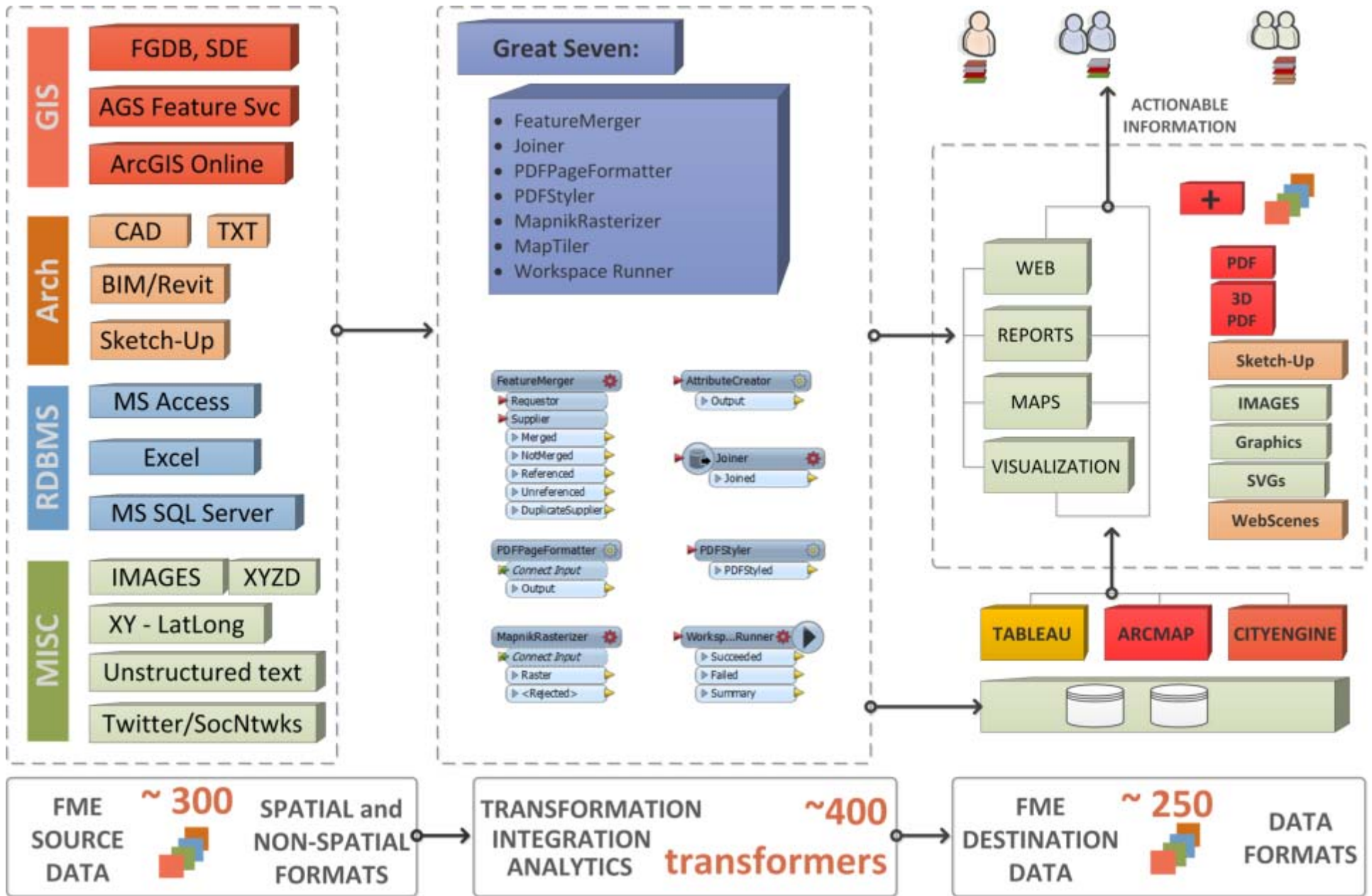
Principles of integration



Data InterOperability WorkBench

Support for more than 300 data formats



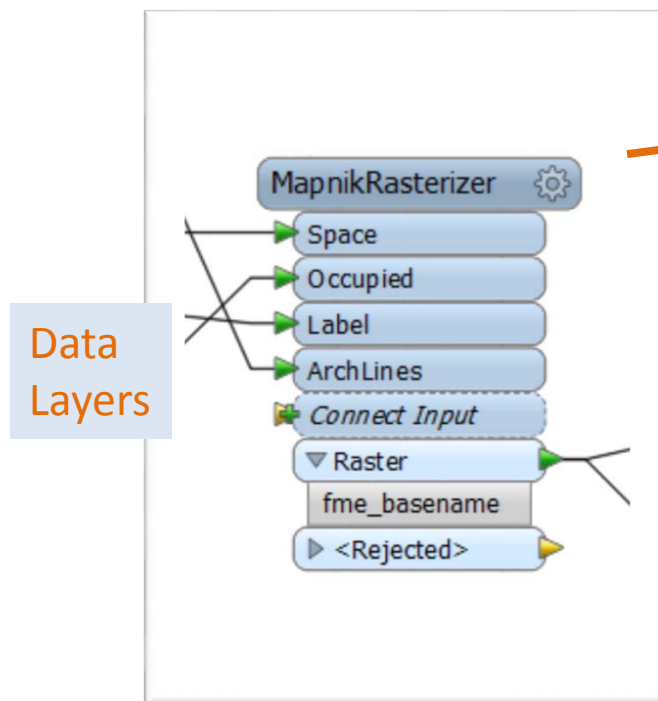


“Reporting functionality”: Mapnik Rasterizer

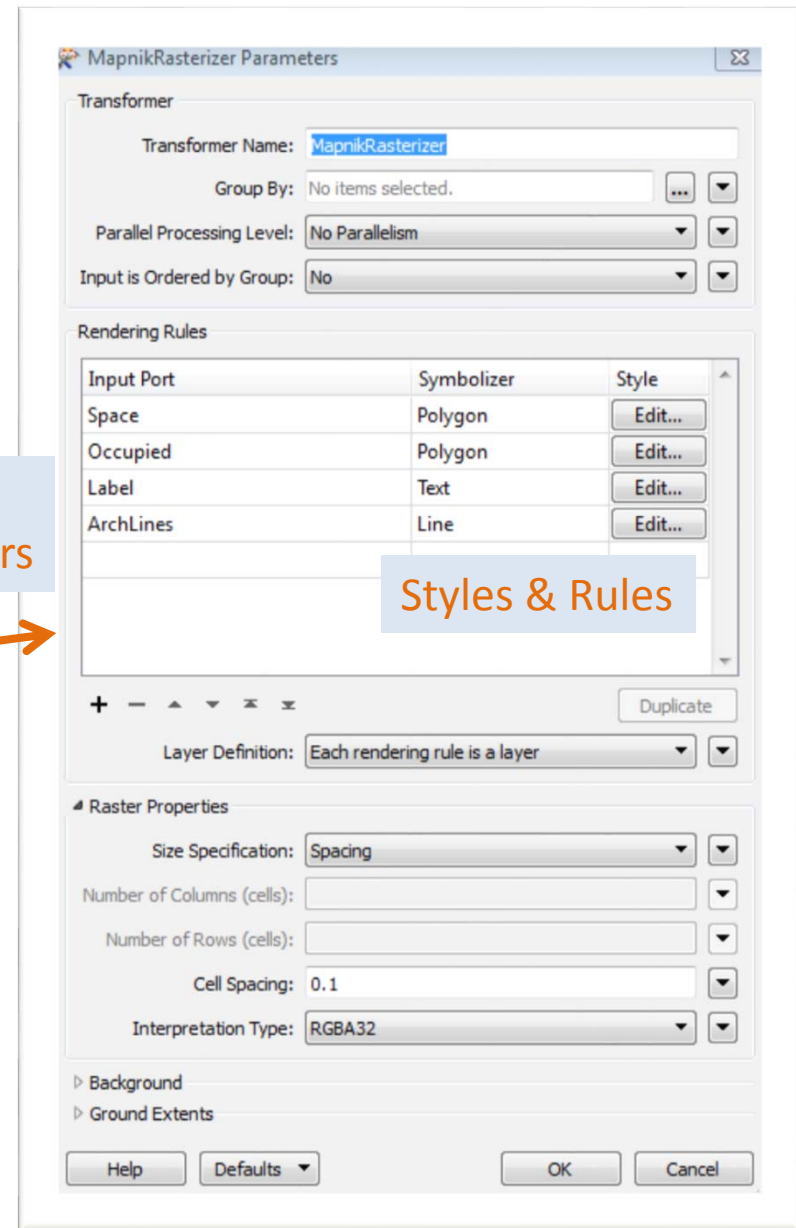
GUI interface to powerful open-source
<http://mapnik.org>

Defines “rules” for rendering

- Highly customizable rendering engine
- Automation of high quality ‘maps’
- Pre-render components of reports



Data Layers



Styles & Rules

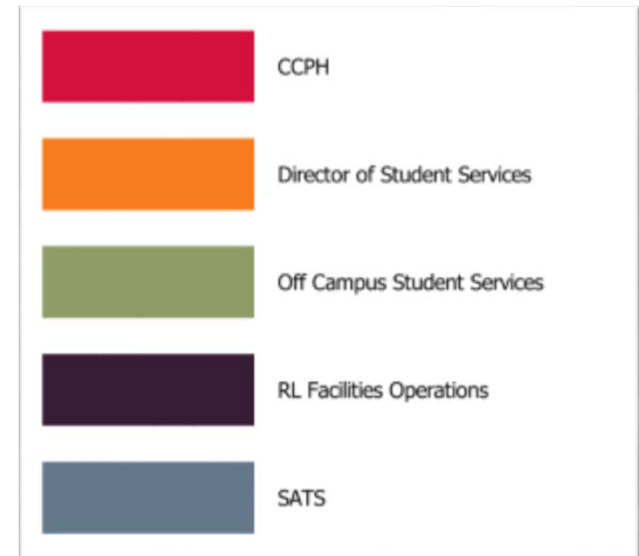
“Reporting functionality”: Mapnik Rasterizer

GUI interface to powerful open-source
<http://mapnik.org>

Defines “rules” for rendering

An approach to automate ‘cartography’ tasks

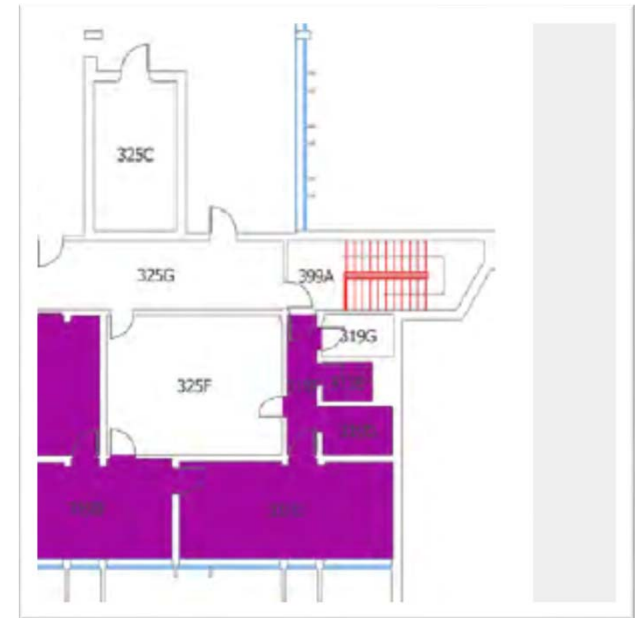
2D/data, 3D data, labels, diff geometries



<https://owenpowell.wordpress.com/>



Safe Software



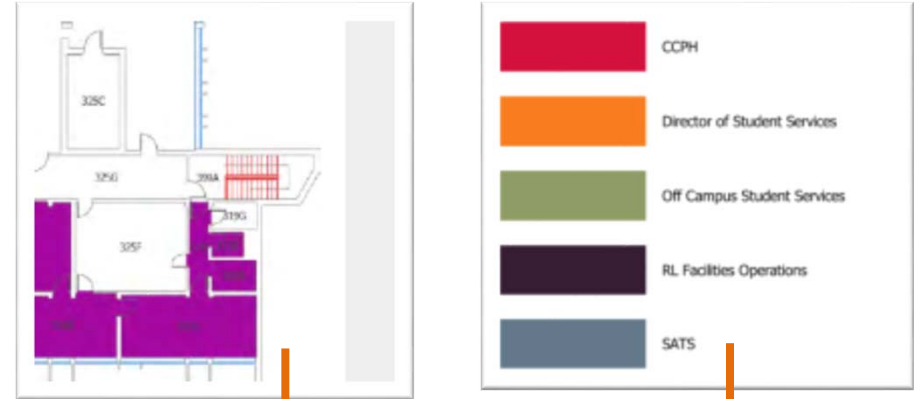
Rendering report **components**

“Reporting functionality”: PDF Page Formatter

GUI interface to *create* and *populate* PDF Documents/Reports via *templates*

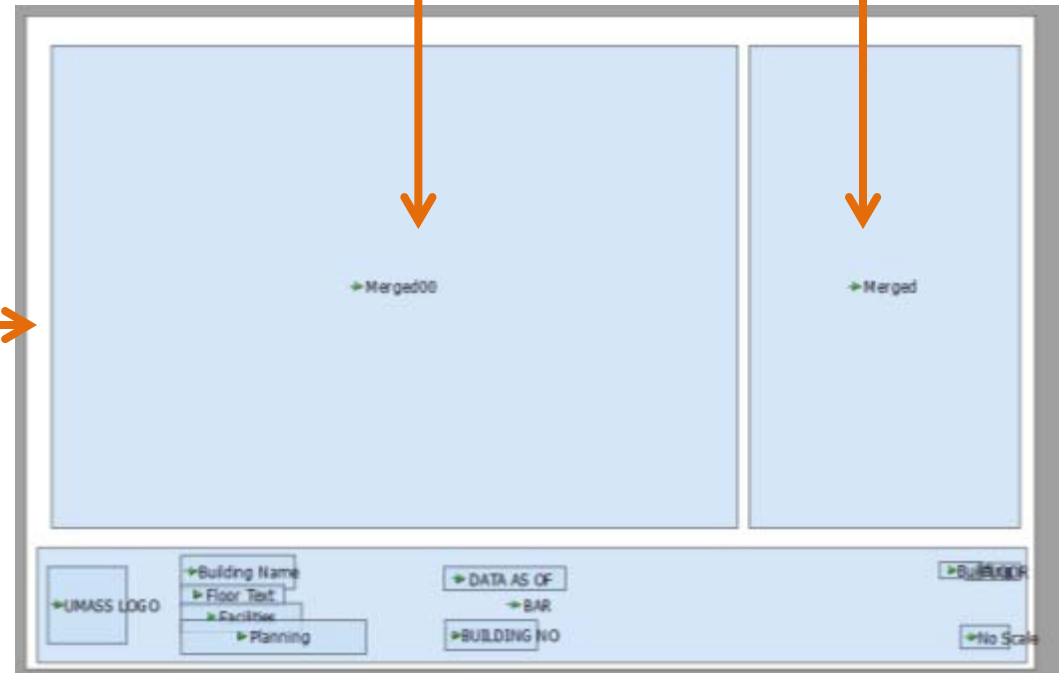
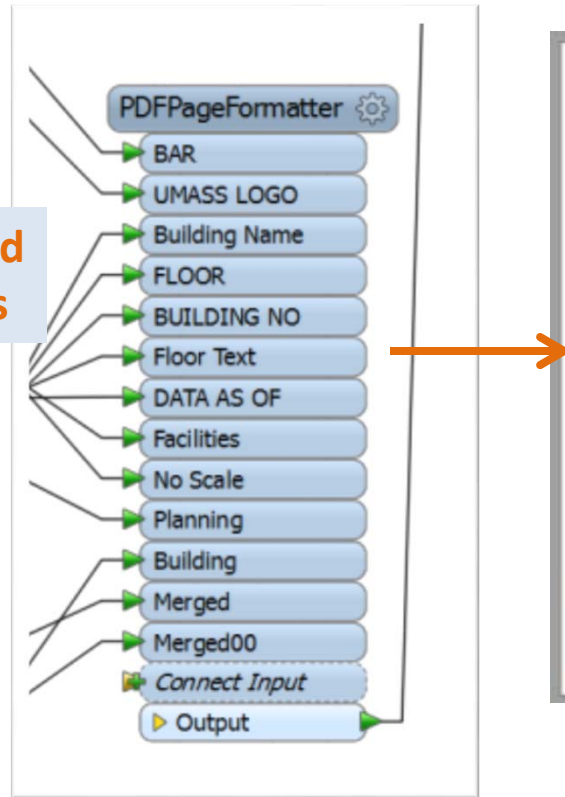
Defines “rules” for PDF templates

Highly customizable rendering engine



Pre-rendered components

Data Layers



PDF report template

“Reporting functionality”: PDF Page Formatter

GUI interface to *design* templates

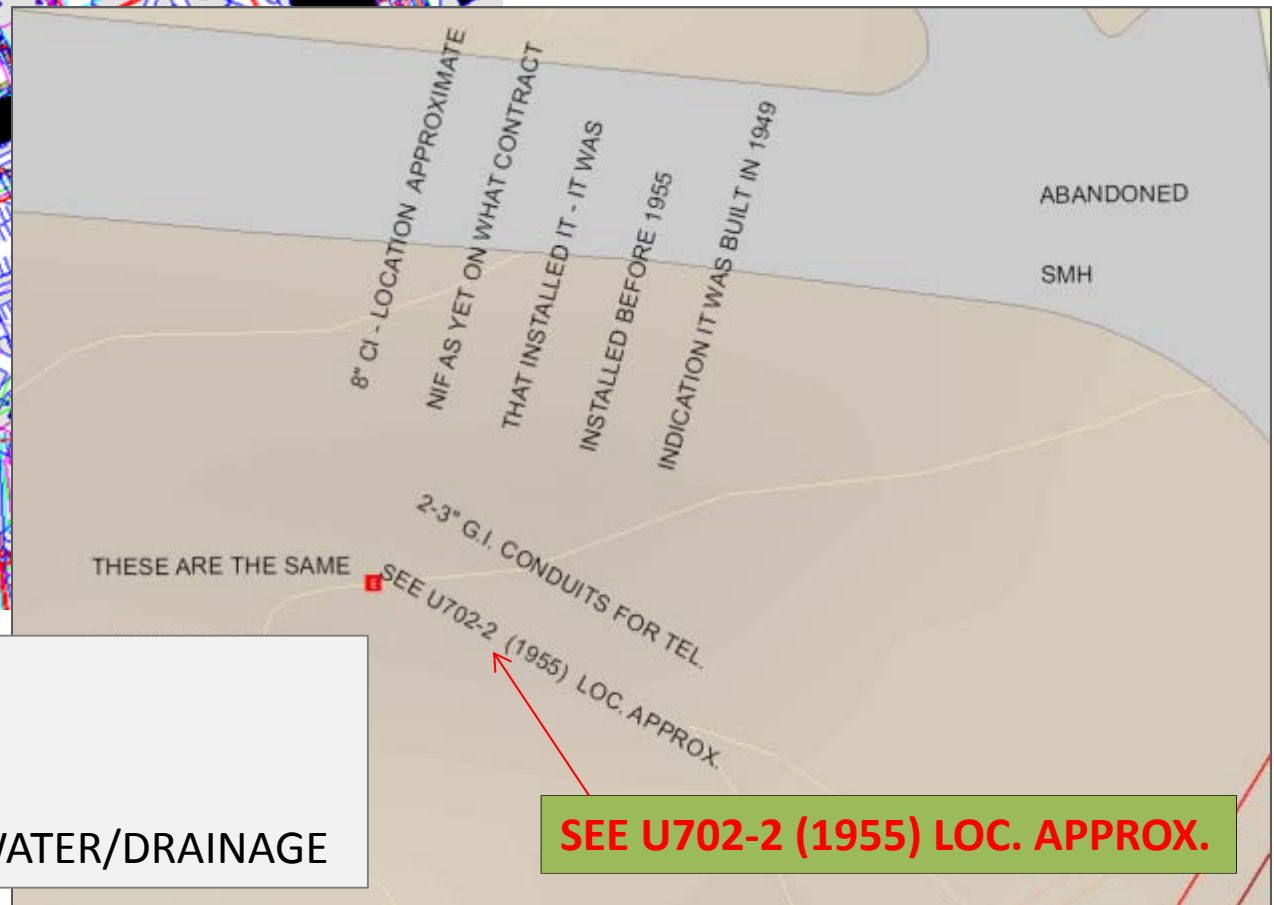
Pre-rendered components

Data Layers

“Placeholders”

PDF report template – define placeholders for components

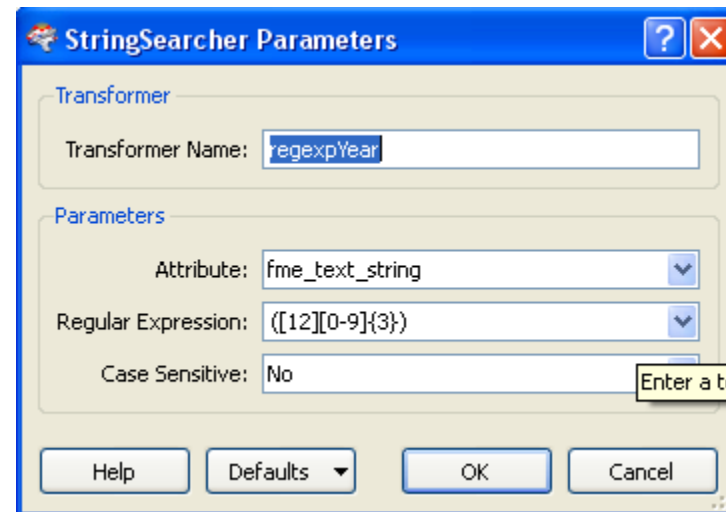
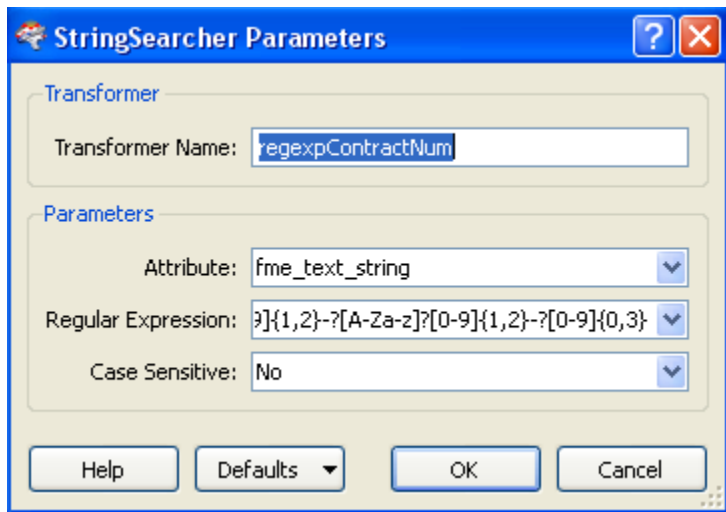
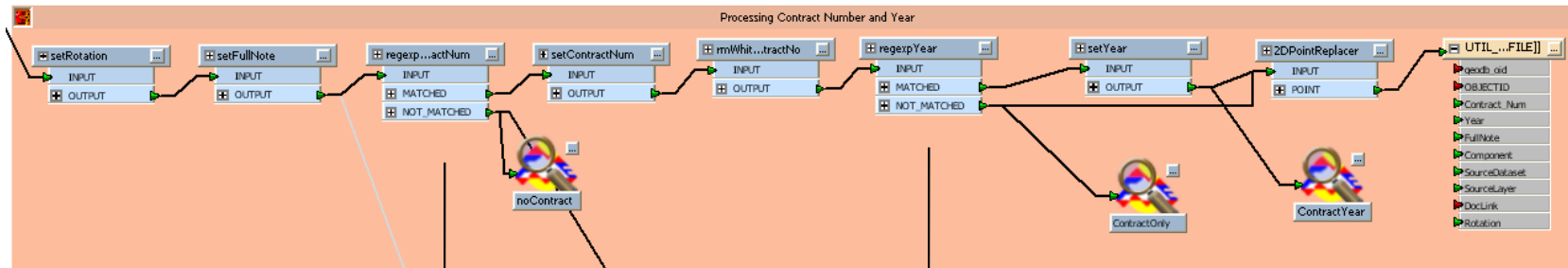
EXTRACTING TEXT INFORMATION



6,000 notes
30 year of experience
Period 1940s – current
4 layers: STEAM/ELECTRIC/WATER/DRAINAGE

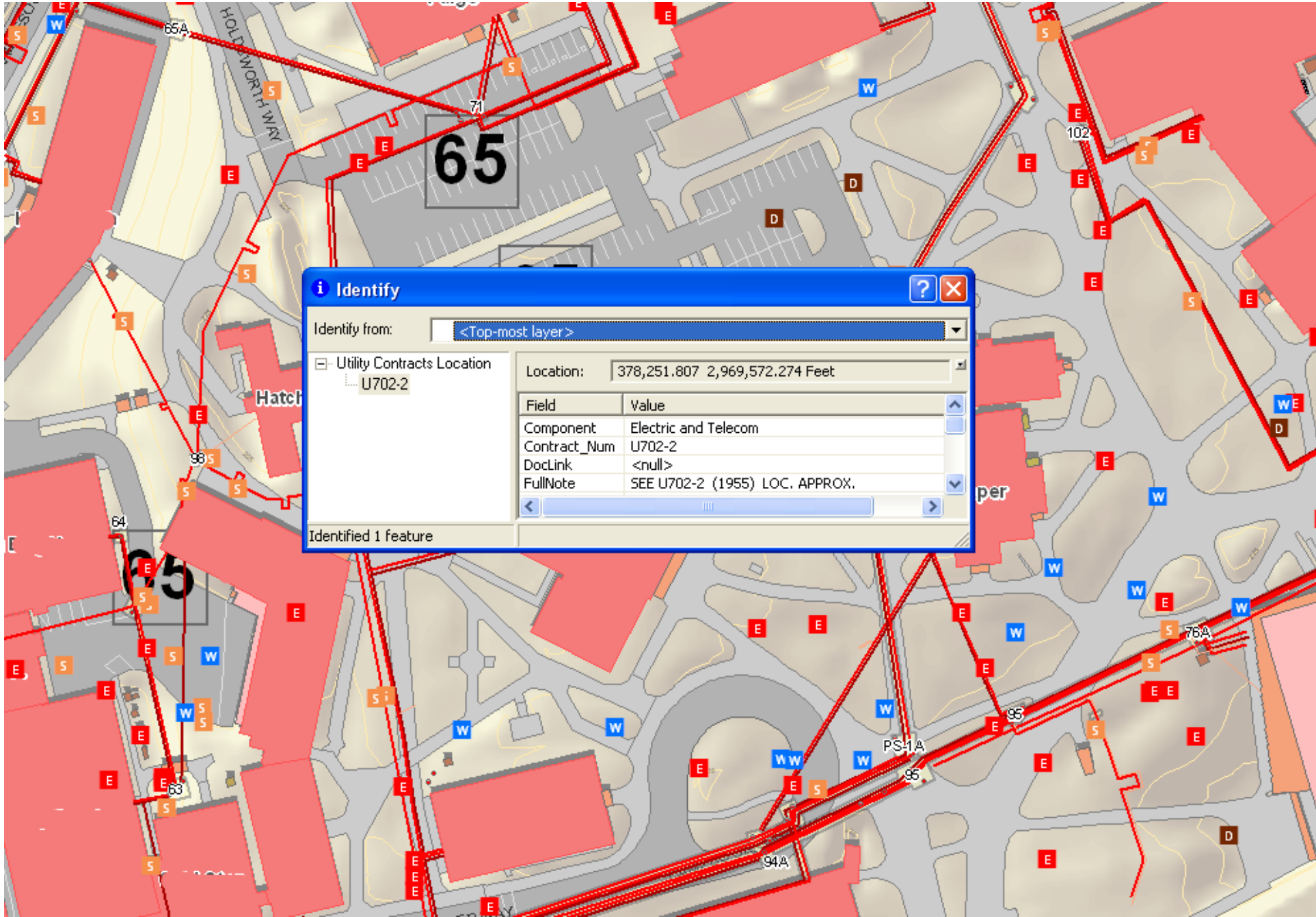
SEE U702-2 (1955) LOC. APPROX.

EXTRACTING TEXT INFORMATION



Regular expressions allows one to do advance search for patterns (learn once, re-use everywhere)

We use the same approach to extract utility attributes from CAD annotation layers



Browser Address Bar: `http://spweb/utilities/Documents/For...?FilterField1=UMA_Number&FilterValue1=`

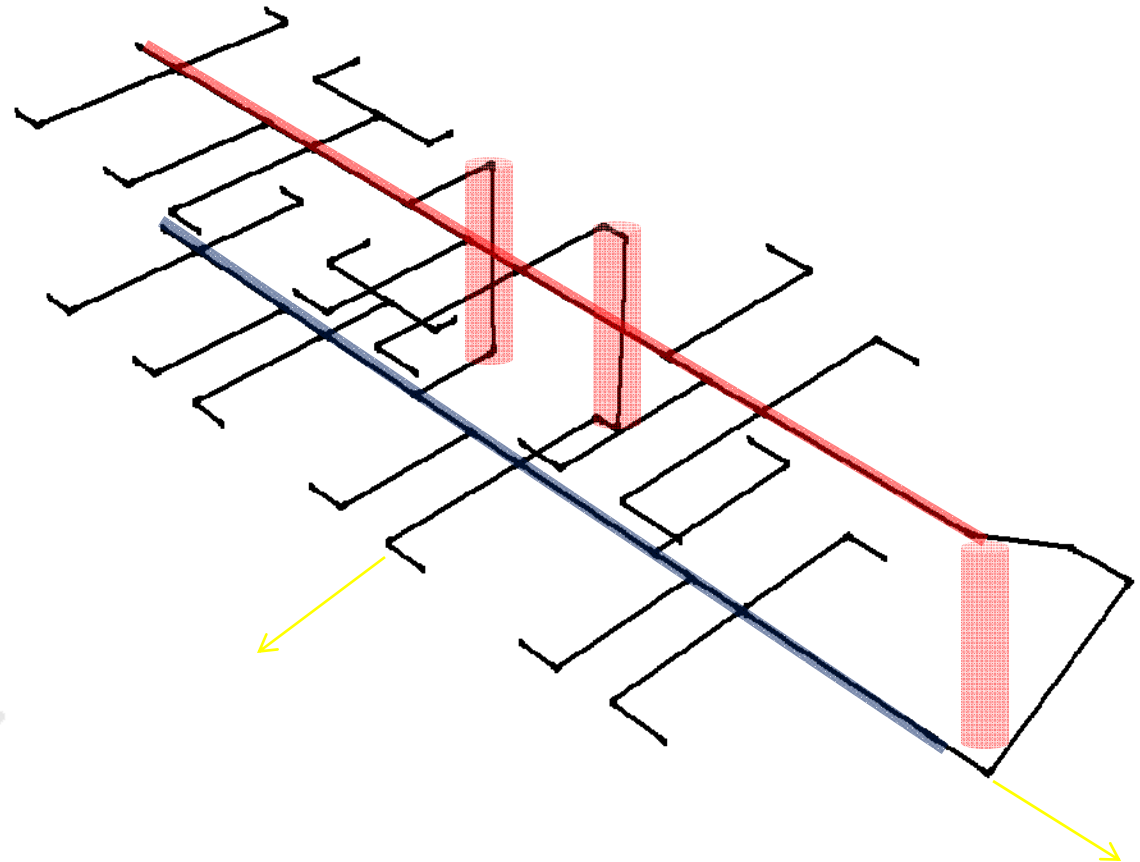
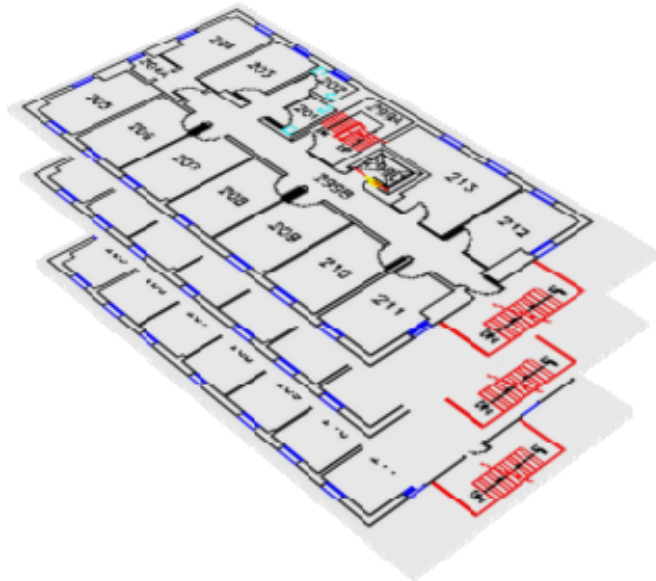
Name	UMA_Number
E01	U63-7-6
E02	U63-7-6
H01	U63-7-6
H02	U63-7-6
H03	U63-7-6
H04	U63-7-6
Title Sheet	U63-7-6

Windows Picture and Fax Viewer: E02[1].tif - Windows Picture and Fax Viewer

Map Labels: SW-19A

Browser Footer: FP&CP SharePoint v3.1.1 AppGeo Save Map as Image

Implementing Rectilinear Steiner Minimal Trees



- Space Assignment
- Location/Allocation
- User/Space Interaction
- 2D/3D Routing
- Evacuation Planning
- Accessibility

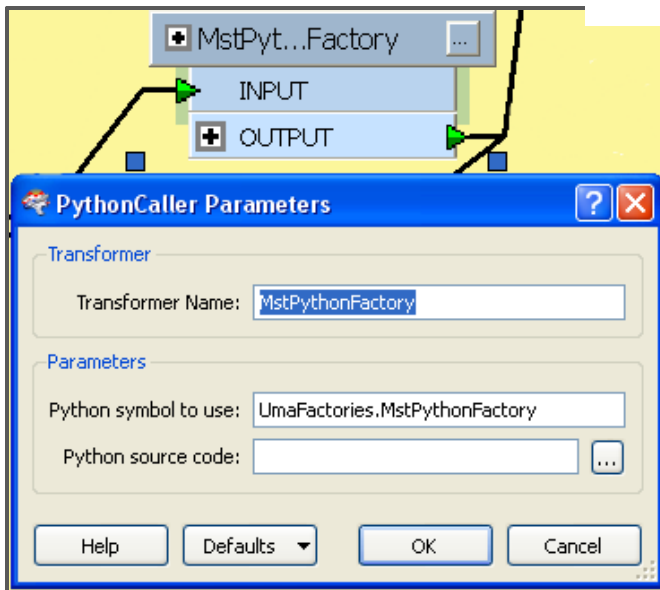
Implementing Rectilinear Steiner Minimal Trees

```
import pyfme
import networkx as nx

class MstPythonFactory( object ):
    def __init__( self ):
        self.edge_counter = 0
        self.logger = pyfme.FMELogfile()
        self.logger.log( "MST Factory was initialized ...", 1)
        self.G = nx.Graph()
        self.logger.log( 'NX Graph was initialized', 1 )

    def input( self, feature ):
        self.edge_counter += 1
        self.logger.log( 'Processing feature ' + str( self.edge_counter ),
            self.edgeID = feature.getAttribute('mstEdgeID')
            self.startNodeID = feature.getAttribute('mstStartNodeID')
            self.endNodeID = feature.getAttribute('mstEndNodeID')
            self.edgeLength = feature.getAttribute('mstEdgeLength')
            self.edgeNodes = str( self.startNodeID ) + '_' + str( self.endNodeID )
            #
            self.G.add_edge( self.startNodeID, self.endNodeID, weight = self.ed

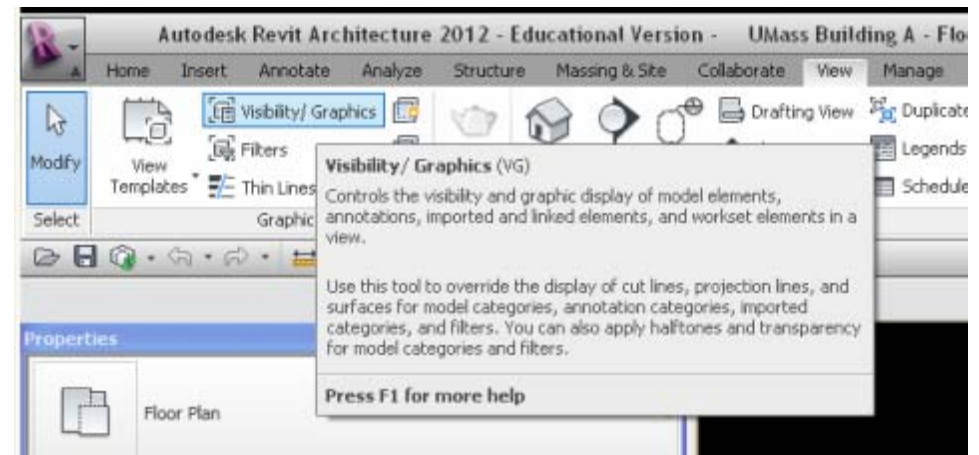
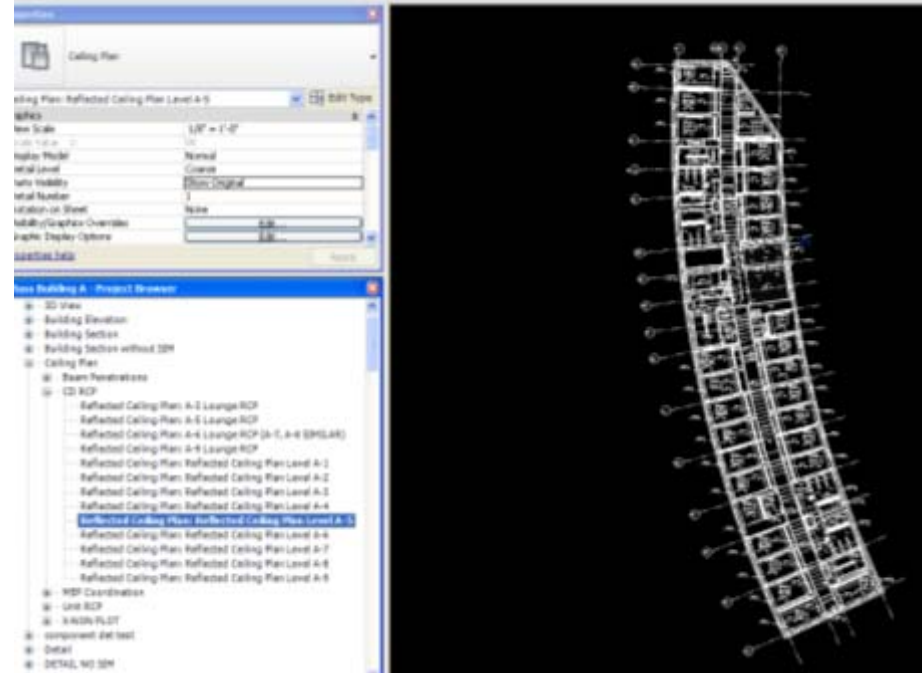
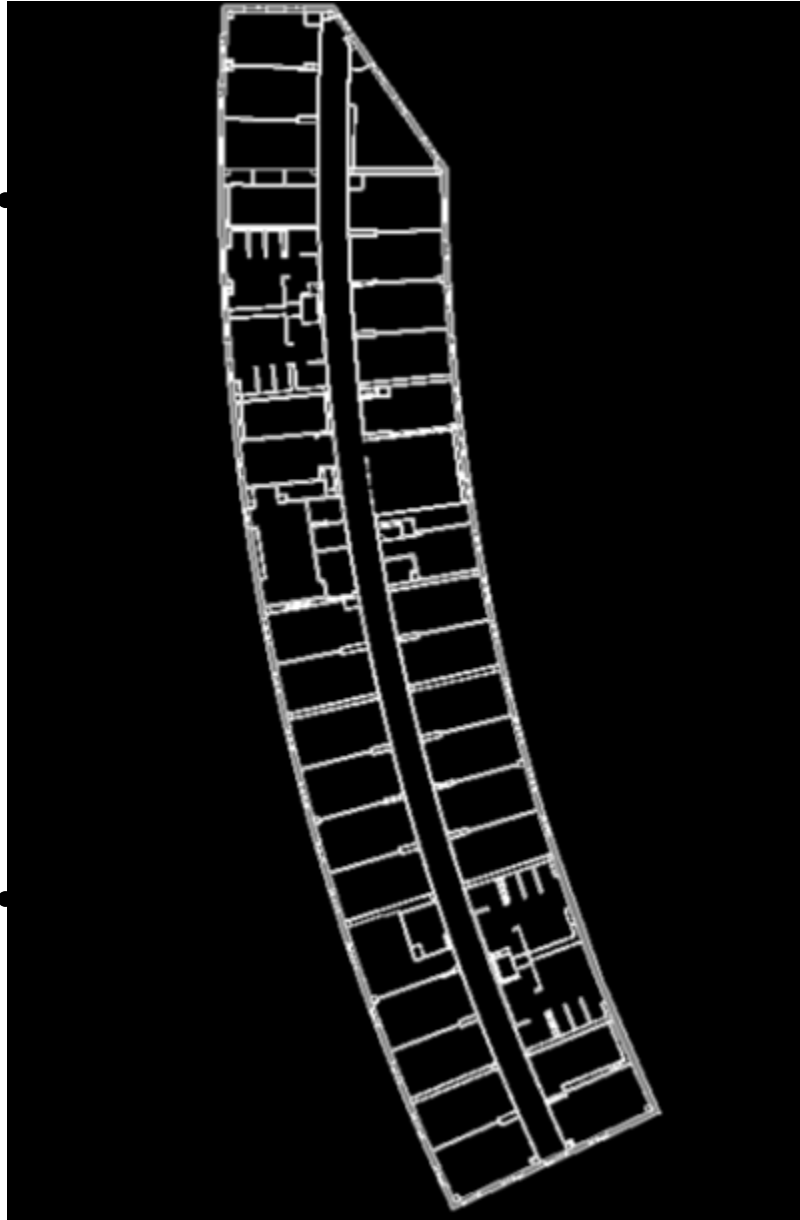
    def close( self ):
        self.logger.log( 'Close method for MstPythonFactory ->
            self.mst = nx.kruskal_mst( self.G )
```



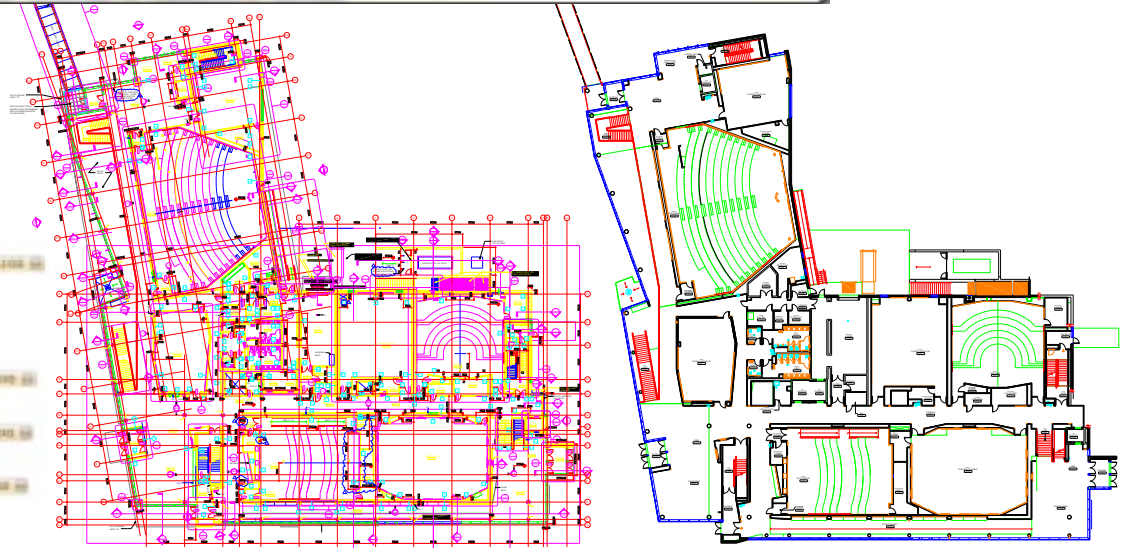
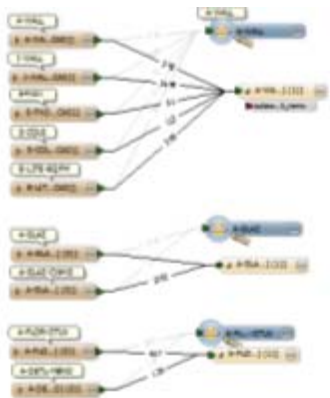
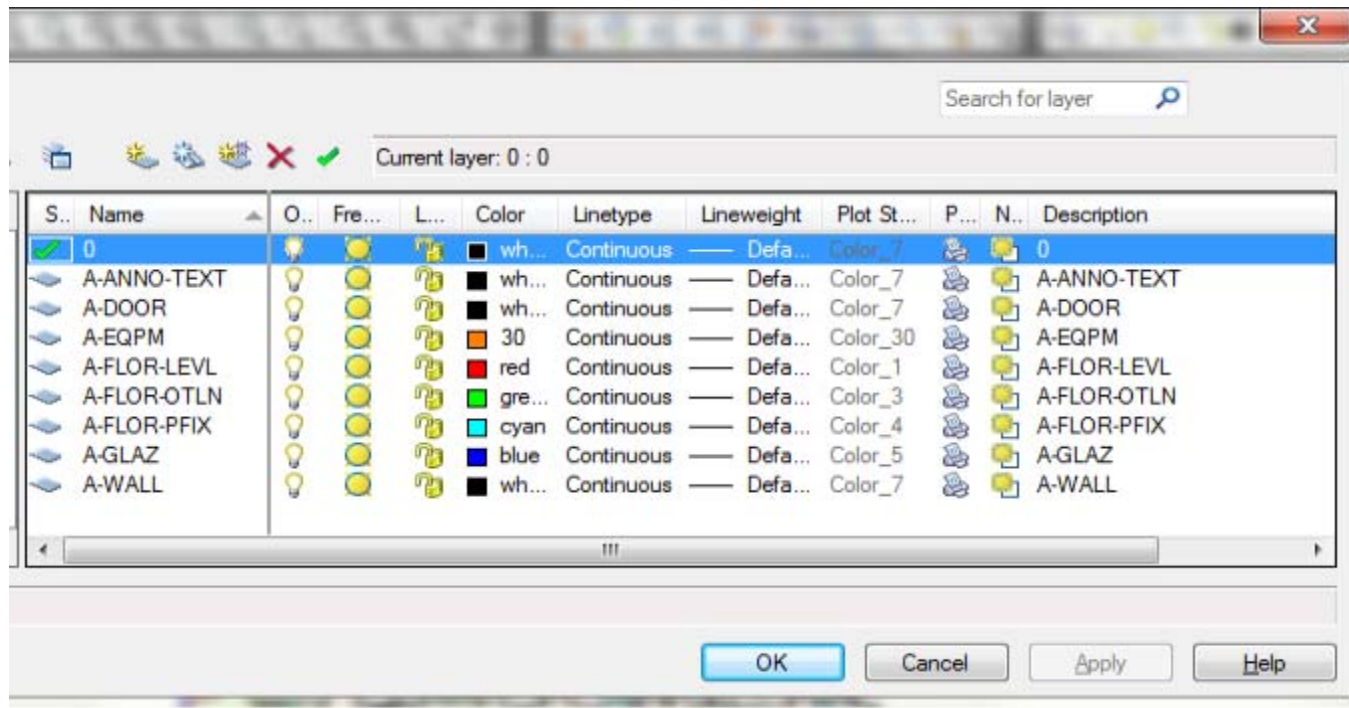
21 rows of code to implement MST transformer

4 rows to solve Minimum Spanning Tree sub-problem using NetworkX (LANL) (<http://networkx.lanl.gov/>)

Export Revit Plans to CAD and Modified in FME



FME Identifies Layers to Export and Attributes



Floor , Building and Document Data

Administration ☰

- Organization Hierarchy ☰
- Property ☰
- Buildings ☰
- Rooms ☰
- Spaces ☰
- Organization Hierarchy ☰
- Locations ☰
- Departments ☰
- Employees ☰

Administration Reports ☰

- UMASS Crystal Reports ☰
- Report By Space ☰
- Space Details ☰
- Rooms in Draft Status ☰
- Buildings - Floors - Rooms ☰
- Buildings - Floors - Rooms ☰
- Manage Employees ☰

Buildings Floors Rooms

ID	Name	Status
628	358 North Pleasant	Active
702	93 Fearing House	Active
137	Abbattoir Slaughter House	Active
354	Adams, John House	Active
355	Adams, John Q. House	Active
229	Administration Building	Active

Name	Gross Measured Area	Capacity	Headcount	Status
01	7484 square-feet	53	0	Active
02	3103 square-feet	29	0	Revision In Progress

Room	Current Use Space Class	Area	Capacity	Headcount	Organization Name	Room ID	Status
201	Inactive	218 square-feet	0	0	UMass Extension	0201	Active
202	Inactive	113 square-feet	1	0	UMass Extension	0202	Active
203	Inactive	109 square-feet	1	0	UMass Extension	0203	Active
204	Inactive	228 square-feet	0	0	UMass Extension	0204	Active
205	Rest Room	22 square-feet	0	0	General Building	0205	Active
205A	Rest Room	78 square-feet	0	0	General Building	0205A	Active
207	Inactive	106 square-feet	1	0	UMass Extension	0207	Active
208	Inactive	224 square-feet	0	0	UMass Extension	0208	Active
209	Meeting Room	331 square-feet	20	0	UMass Extension	0209	Active

Room and Space Data

Space : 131 - TRIRIGA - Windows Internet Explorer


Space : 131

General Graphic Details Notes & Documents System Work Flow Instance Includes Associations Audit Actions

(Required): General Information for this Space.

General

ID Status Revision In Progress

* Name Image 

Description

Hierarchy Path

Space Alias

Space Measurements

Area square-feet

Current Use Space Classification [Find](#) | [Clear](#)

* Used for Space Class Roll Up

* Current Use Space Class Current Use Space Class ID

Occupancy

Headcount Occupancy Status		d. Capacity	<input type="text" value="192"/>
Org Occupancy Status	Occupied	Code Capacity	<input type="text" value="0"/>
Chargeback Status	Vacant	e.Shared Capacity Factor	<input type="text" value="1"/>
a.Headcount (Primary)	0	f.Emergency Capacity	<input type="text" value="0"/>
b.Headcount (Other)	0	g.Overflow Capacity	<input type="text" value="0"/>
c. Seats Allocated	192	Total Planning Capacity (d * e)	2066.7384
Headcount Percent Occupied (a / d)	0	Total Emergency Capacity (f * e)	0
Headcount Remaining Vacant (d - a)	192	Total Overflow Capacity (g * e)	0
Org Percent Occupied (c / d)	1	j. Planned Vacancy	0
h. Org Remaining Vacant (d - c)	0	k. Adjusted Remaining Vacant (h - i) + j	0
i. Planned Occupancy	0		

Local intranet 100%

Room and Space Data on Floorplans

Home > Space > Manage Space > Space Manager

Print Open In New Window Add to Bookmarks My Bookmarks

Close X

(Required): Select an action to assign or unassign people, assets, and/or organizations on selected spaces. Use the floor plan to view and/or select space(s).

Select an Action

Action: Unassign Occupancy Organizations

Show confirmation before updating space(s):

Location of the Space(s)

Building: Life Science Laboratories

Floor: 05

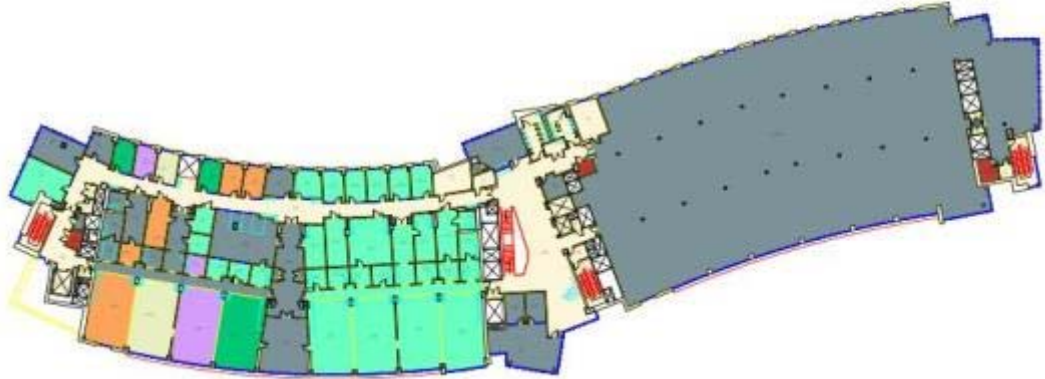
Select Organization(s) to Unassign Occupancy from Space(s) Refresh Floor Plan with Selected Organizations

Export 8 total found Apply Filters Clear Filters Show: 10

Type	ID	Name	Hierarchy Path
Department	ADPT041400	Biochemistry & Molecular Bio.	\Organizations\University of Massachusetts - Amherst\Academic Affairs\College of Natural Sciences\Biochemistry & Molecular Bio.
Department	ADPT040100	Biology	\Organizations\University of Massachusetts - Amherst\Academic Affairs\College of Natural Sciences\Biology
Department	ADPT041100	Microbiology	\Organizations\University of Massachusetts - Amherst\Academic Affairs\College of Natural Sciences\Microbiology
Department	ADPT010400	Veterinary & Animal Sciences	\Organizations\University of Massachusetts - Amherst\Academic Affairs\College of Natural Sciences\Veterinary & Animal Sciences
Department	ADPT090600	Chemical Engineering	\Organizations\University of Massachusetts - Amherst\Academic Affairs\Engineering\Chemical Engineering
Department	ADPT699900	CIO	\Organizations\University of Massachusetts - Amherst\Information Technologies\Information Technologies\CIO
Department	ADPTUM9910	General Building	\Organizations\University of Massachusetts - Amherst\Not Assigned\Not Assigned\General Building

Floor Plan - Space(s) for selected Organization(s) Unassign Occupancy Organizations

Menu Life Science Laboratories\05



Room and Space Data in Reports

Home > UMass Space Reports

General Reports

Please select a form: 2. Department Space Occupancy Profile

Showing page 1 of 2

Go to page:

Department Space Occupancy Profile

Learning Resource Center (ADPT694000)

Floor	Room	Use Code	Use Type	Area (Sq. Ft.)	Stations	Occupants
DuBois (417)						
10						
	1001	310	Office	82	1	Cameron Holden
	1002	310	Office	353	1	Lin Tang
	1003	315	Office Srv	42	0	
	1004	312	Grad Student Office	42	1	John Ramos
	1005	411	Closed Carrel	24	1	
	1006	411	Closed Carrel	25	1	
	1007	411	Closed Carrel	24	1	
	1008	411	Closed Carrel	25	1	
	1009	411	Closed Carrel	24	1	
	1010	411	Closed Carrel	25	1	
	1011	455	Study Srv	91	0	
	1012	411	Closed Carrel	24	1	
	1013	411	Closed Carrel	25	1	
	1014	411	Closed Carrel	24	1	
	1015	411	Closed Carrel	25	1	
	1016	411	Closed Carrel	24	1	
	1018	310	Office	47	1	
	1019	315	Office Srv	48	0	
	1020	240	Computer Lab	785	18	Laurie Simmons
	1021	312	Grad Student Office	47	1	Anna Habib
	1022	310	Office	48	1	
	1024	411	Closed Carrel	25	1	
	1025	411	Closed Carrel	24	1	
	1026	411	Closed Carrel	25	1	
	1027	411	Closed Carrel	24	1	
	1029	455	Study Srv	91	0	

Adobe Acrobat Reader DC

File Edit View Window Help

Home Tools Document

2 / 2

Sign In

Department Space Occupancy Profile

Learning Resource Center (ADPT694000)

Room	Area	Use Type	Stations	Occupants	...
DuBois (417)					
1001	82	Office	1	Cameron Holden	
1002	353	Office	1	Lin Tang	
1003	42	Office Srv	0		
1004	42	Grad Student Office	1	John Ramos	
1005	24	Closed Carrel	1		
1006	25	Closed Carrel	1		
1007	24	Closed Carrel	1		
1008	25	Closed Carrel	1		
1009	24	Closed Carrel	1		
1010	25	Closed Carrel	1		
1011	91	Study Srv	0		
1012	24	Closed Carrel	1		
1013	25	Closed Carrel	1		
1014	24	Closed Carrel	1		
1015	25	Closed Carrel	1		
1016	24	Closed Carrel	1		
1018	47	Office	1		
1019	48	Office Srv	0		
1020	785	Computer Lab	18	Laurie Simmons	
1021	47	Grad Student Office	1	Anna Habib	
1022	48	Office	1		
1024	25	Closed Carrel	1		
1025	24	Closed Carrel	1		
1026	25	Closed Carrel	1		
1027	24	Closed Carrel	1		
1029	91	Study Srv	0		

Page 1 of 2

General

Survey Help

Reports

Submit Survey

Save

Save & Close

x

ICR Space Survey

(Required): General Information for this Survey Project.

General

Status Active

* Name Test survey for bio1 - MPG 4

Description

* Survey Due Date 01/01/2014

Survey Submitted By

Survey Recipients

Find | Remove

Export | 1 total found

Show: 10

<input type="checkbox"/>	Department Name	Role	Last Name	First Name
<input type="checkbox"/>	Biology	Survey Recipient	bio1	bio1

Step 1: Review the Rooms Below for Accuracy

Related Reports -Select- Space Surveys for Project

Export | 3 total found | Apply Filters | Clear Filters | Show More Filters

Show: 50

Color	Survey Status	Building Name	Floor Name	Space	Area	Not My Room
		<input type="text" value="Contains"/>	<input type="text" value="Contains"/>	<input type="text" value="Contains"/>		
	Completed	Clark Hall	01	10		
	Active	Clark Hall	01	10		
	Active	Clark Hall	01	10		

Survey Submission :

Print ? Hel

Continue x

(Required): Log details.

Step 2: List Any of your Department Rooms that are Missing

List Missing Rooms

General

* Name Test Survey Project_071712_1

Description I certify that to the best of my knowledge and belief all of the information in this Space Survey is correct. I also understand that failure to report completely and accurately may result in the incorrect collecting of department space information.

Submitted By DepartmentContact2, DepartmentContact2 - BRG014

Submit Survey

Save

Save & Close

x

Continue x

Room and Space Data in the Survey

The screenshot displays the IBM TRIRIGA Space Survey Portal. The interface includes a top navigation bar with 'Home', 'My Reports', 'Space', and 'Space Survey Portal'. Below this is a breadcrumb trail 'Home > Space Survey Administrator' and utility links for 'Personalize', 'Open In New Window', 'Add to Bookmarks', and 'My Bookmarks'.

The main content area is divided into several sections:

- Surveys By Status:** A summary table showing the count of surveys in different stages.

Status	Count
Acceptance In Progress	24.0
Accepted	107.0
Active	13.0
Retired	6.0
- Space Survey Help:** A list of links for 'Functional Activity (A21) Space Use Definitions', 'Space Use Class Descriptions', 'Survey Recipient Manual', 'FAQs on Activity (A21) Coding for Space Survey', and 'FAQs on General Space Survey'.
- Notifications:** A list of recent notifications with checkboxes, dates, and subjects.

<input type="checkbox"/>	Date	Subject
<input type="checkbox"/>	05/22/2015 08:28:07	Space Change Request - Change Request Submitted
<input type="checkbox"/>	05/22/2015 08:24:40	Space Change Request - Change Request Submitted
<input type="checkbox"/>	05/21/2015 14:07:40	Space Survey Project [HFA Dean Space Survey 03/24/2015] has been submitted.
<input type="checkbox"/>	05/19/2015 11:18:56	Space Survey Project [Art Space Survey 03/24/2015] - Room Removal Requested
<input type="checkbox"/>	05/19/2015 11:14:47	Space Survey Project [Art Space Survey 03/24/2015] - Room Removal Requested
<input type="checkbox"/>	05/19/2015	Space Survey Project [Art Space Survey
- Buildings Floors Rooms:** A table listing building details.

ID	Name	Status
628	358 North Pleasant	Active
661	661 - Operations - Missing Building	Active
702	93 Fearing House	Active
137	Abattoir Slaughter House	Active
354	Adams, John House	Active
355	Adams, John Q. House	Active
229	Administration Building	Active
679	Ag Engineering Annex A	Active
680	Ag Engineering Annex B	Active
387	Agricultural Engineering Building Central	Active
- Space Surveys:** A table listing active and in-progress surveys.

<input type="checkbox"/>	Color	Status	Survey Name	Department Name	Survey Create Date	Survey Due Date	Created By
<input type="checkbox"/>	Yellow	Acceptance In Progress	Theater Space Survey 03/23/2015	Theater	03/23/2015	04/10/2015	Negar Pourshadi
<input type="checkbox"/>	Yellow	Acceptance In Progress	Dean School of Engineering Space Survey 03/23/2015	Dean School of Engineering	03/23/2015	04/17/2015	Negar Pourshadi
<input type="checkbox"/>	Yellow	Acceptance In Progress	Math & Stats Space Survey 03/23/15	Mathematics & Statistics	03/23/2015	05/01/2015	Roxanne Verdi
<input type="checkbox"/>	Red	Active	Kinesiology Space Survey 03/23/2015	Kinesiology	03/23/2015	04/17/2015	Negar Pourshadi
<input type="checkbox"/>	Red	Active	Biology Space Survey 03/23/2015	Biology	03/23/2015	05/01/2015	Negar

Interim Steps: SharePoint Helps Illustrate Campus Space Use, Organization and Viewing of Drawings

UMass Space Management News and Announcements Complexes Related Sites ▾ Floorplan Map Advanced Content ▾ Tririga ▾

Building Lookup

Name ID

News and Announcements

Life Science Laboratories (LSL) 9/26/2013 2:44 PM
by Verdi Roxanne

The LSL is on-line! Floor plans and data are now available.

[\(More Announcements...\)](#)

[Click here to subscribe to News and Announcements](#)

Reports

Building Reports

[Building List](#)
[Building - Room By Room](#)
[Building - Room By Room - All Details](#)


Department Reports

[Department Space By Executive Area and MBU](#)
[Department Space - All Details](#)

People Reports

[Occupants By Building](#)
[Occupants By Department](#)
[PIs By Building](#)
[PIs By Department](#)

Whitmore Hall



Whitmore Reports

[Building at a Glance](#)

[Building - Room By Room](#)

[Building - Room By Room - All Details](#)

[PIs by Building](#)

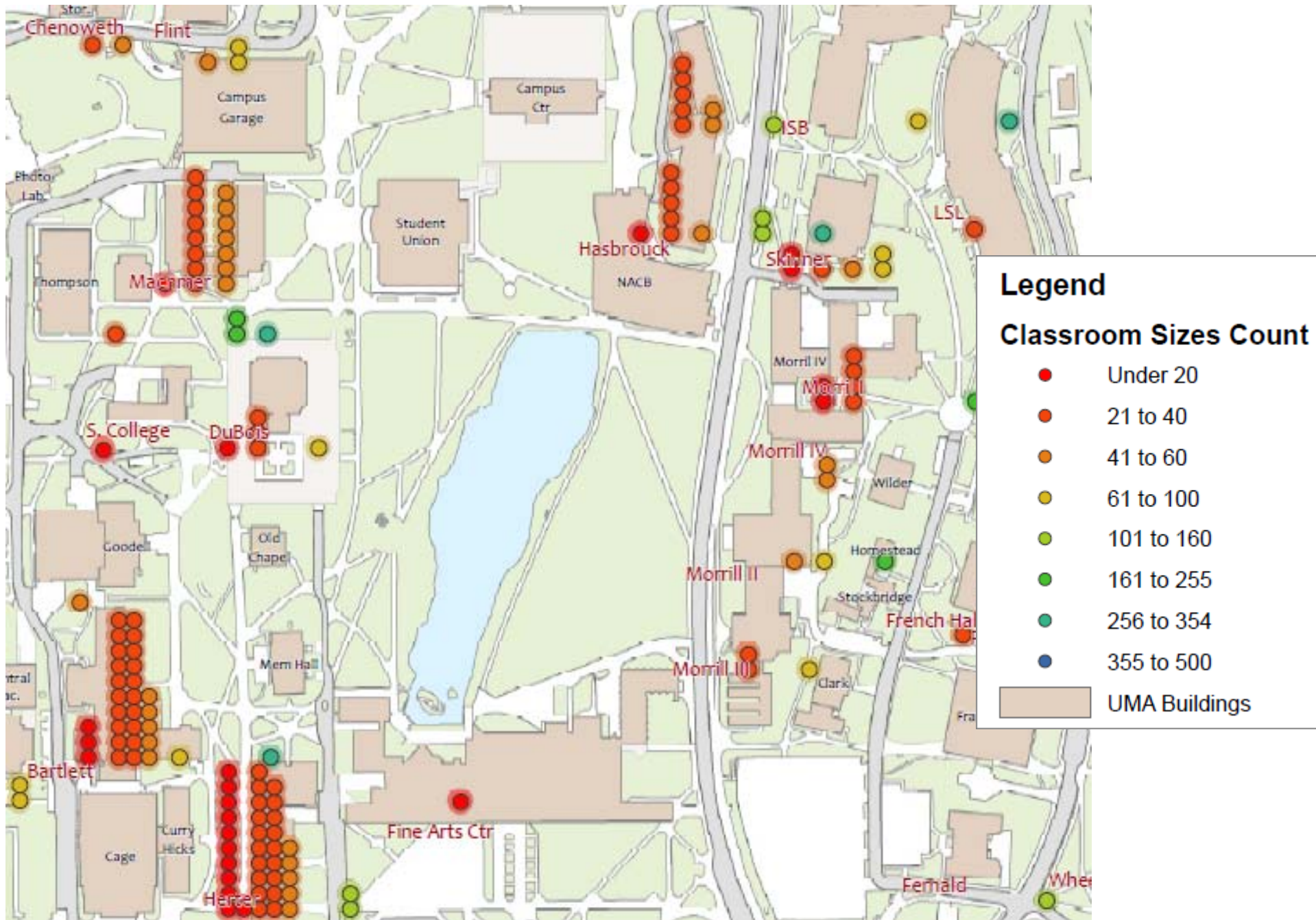
Floorplans (DWG)

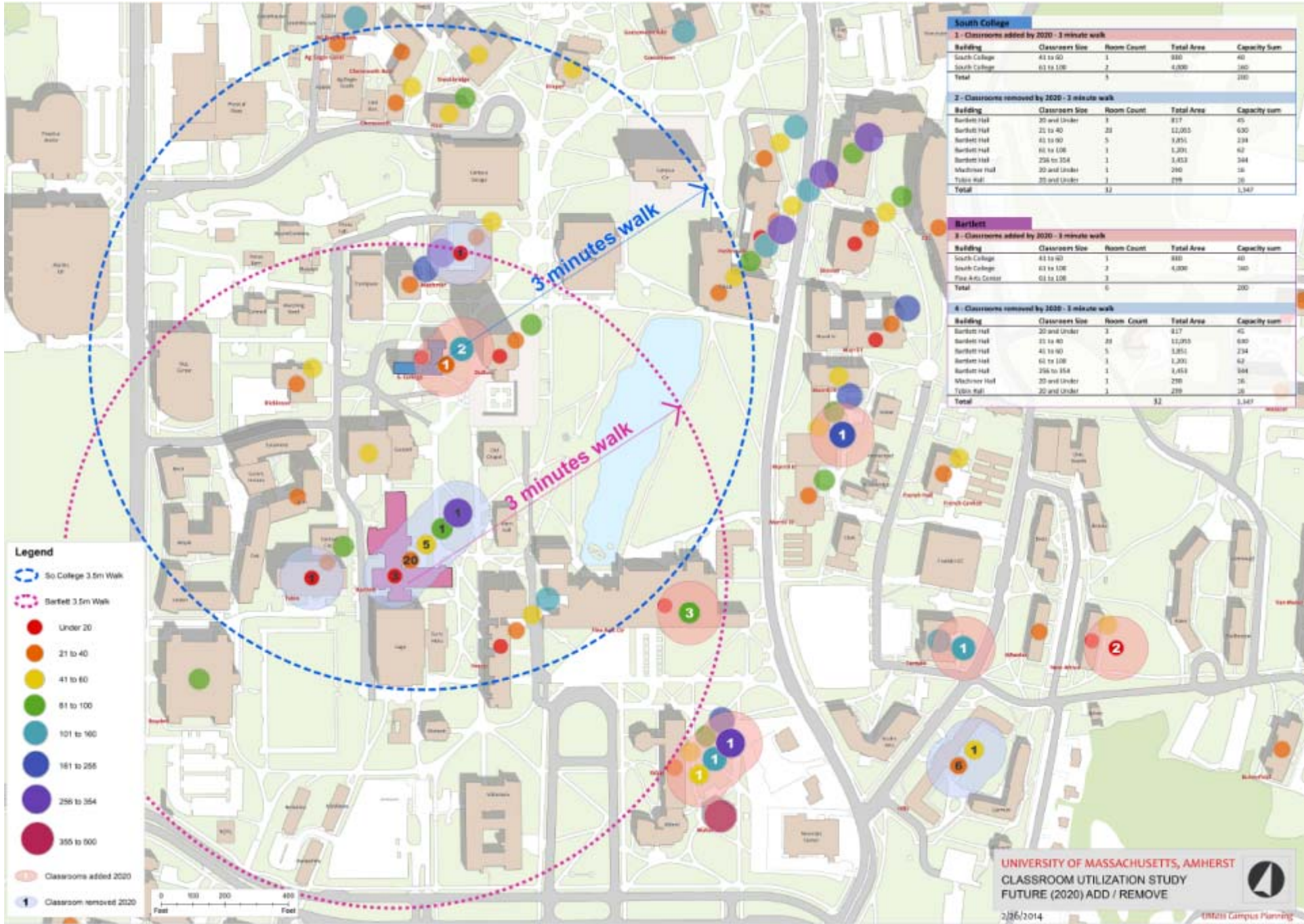
Name	Floor	<input type="checkbox"/> Checked Out To	Version
388-01	01		8.0
388-02	02		7.0
388-03	03		6.0
388-BT	BT		4.0

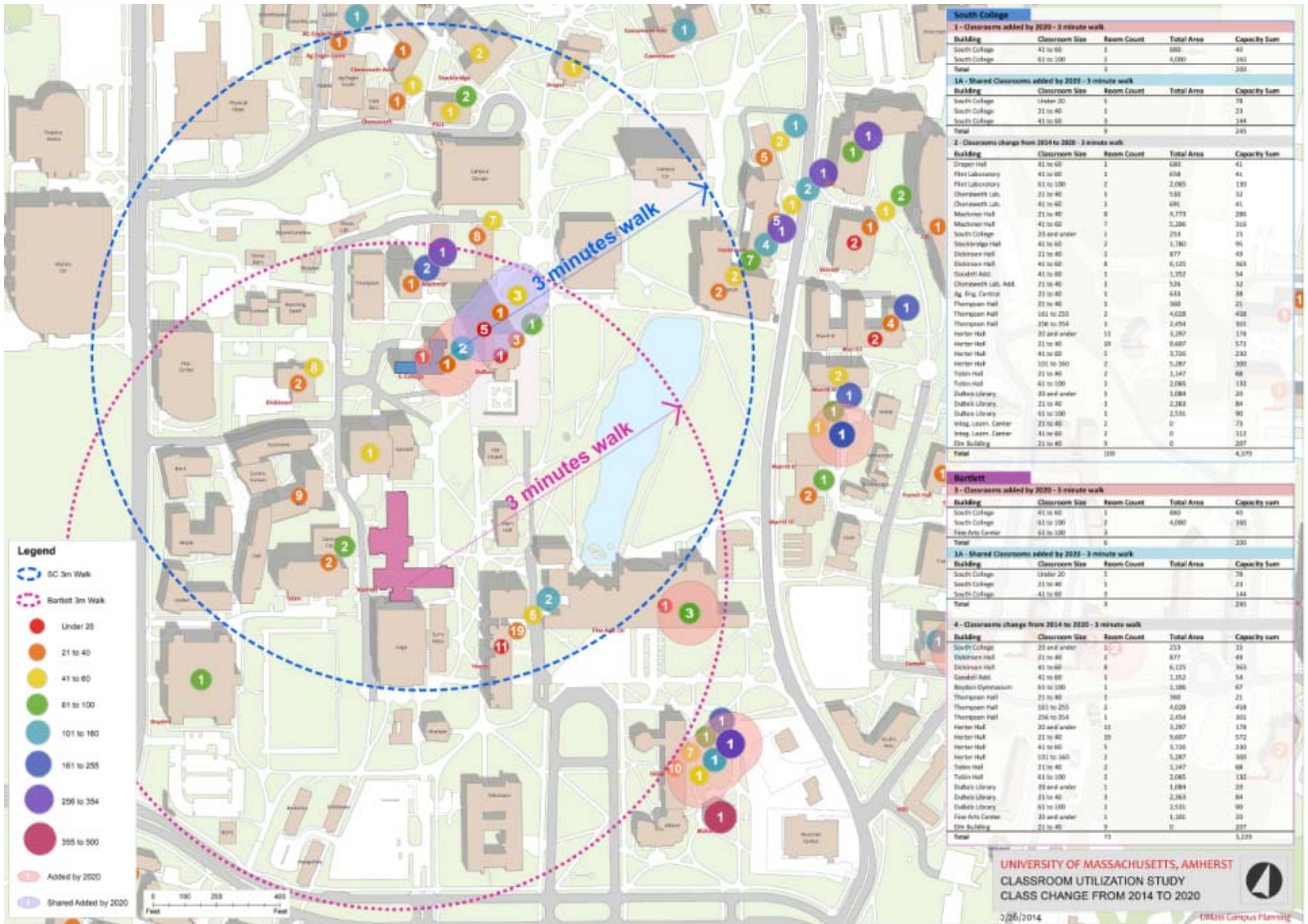
[+ Add document](#)

Floorplans (PDF)

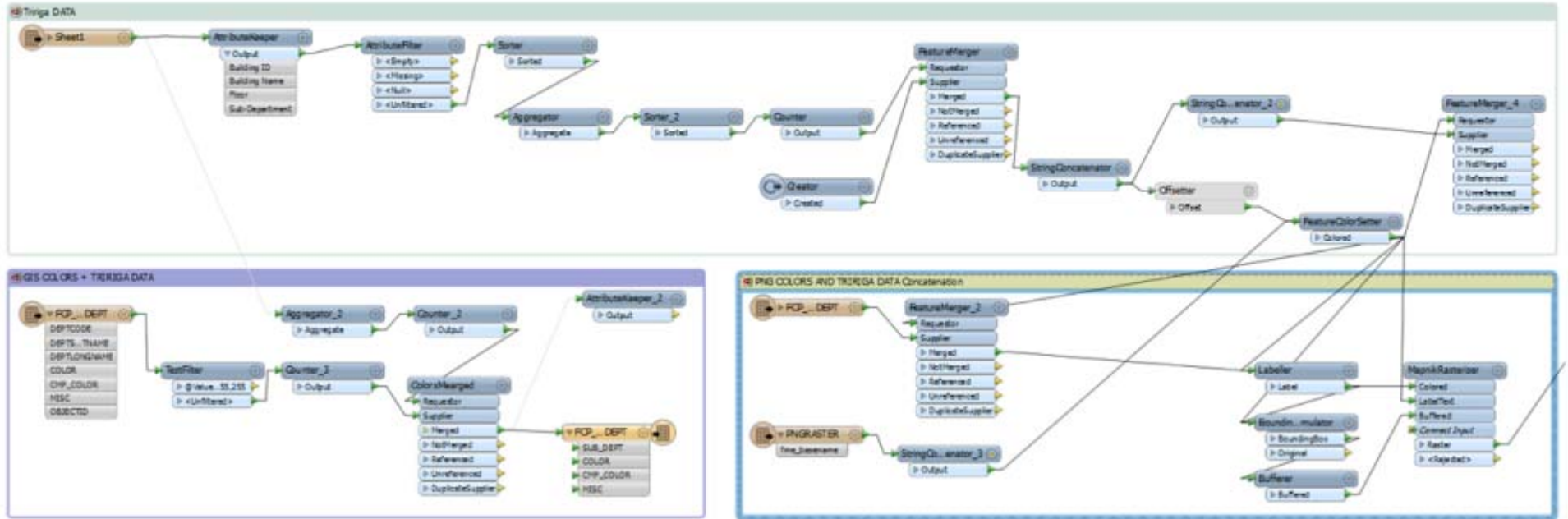
Name	Floor	Modified	Building ID
388-01	01	9/17/2013 8:21 AM	388
388-02	02	9/17/2013 8:22 AM	388
388-03	03	9/17/2013 8:22 AM	388



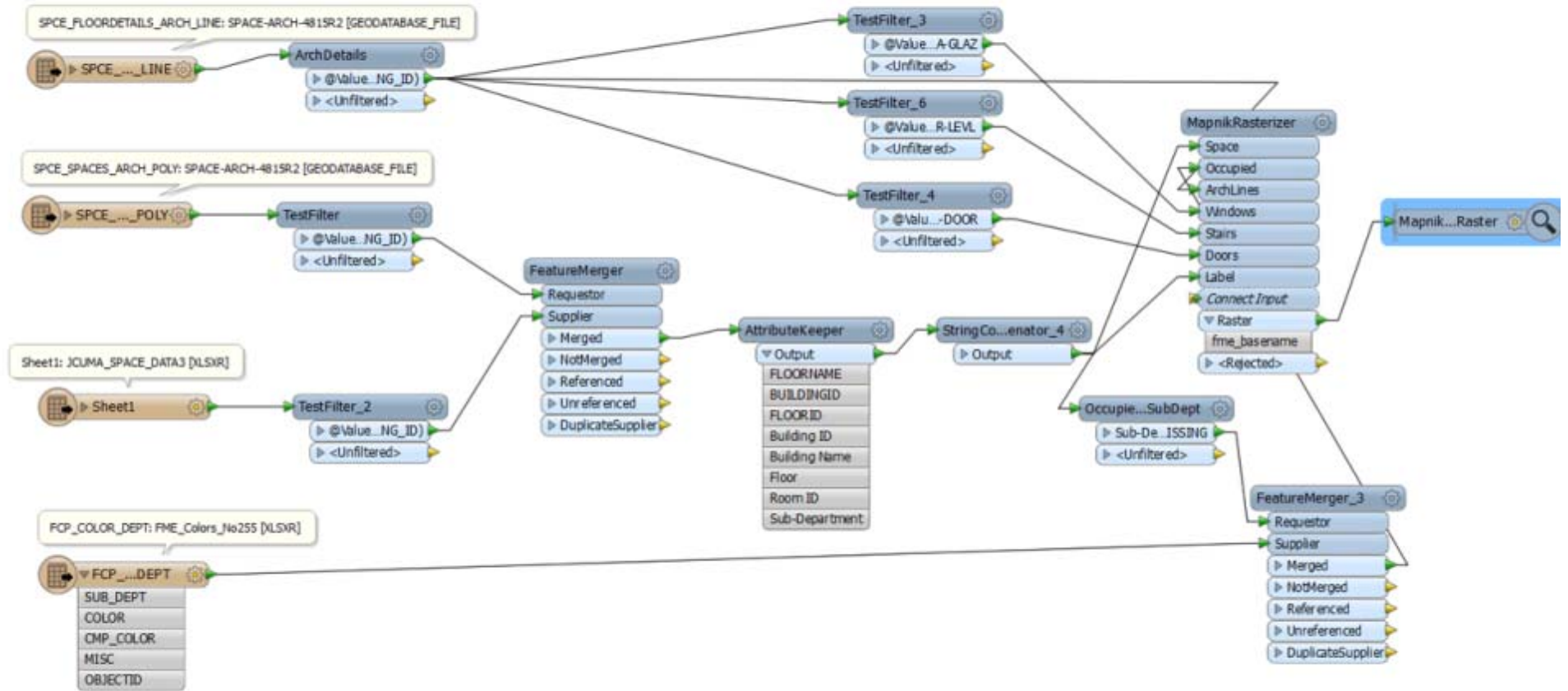




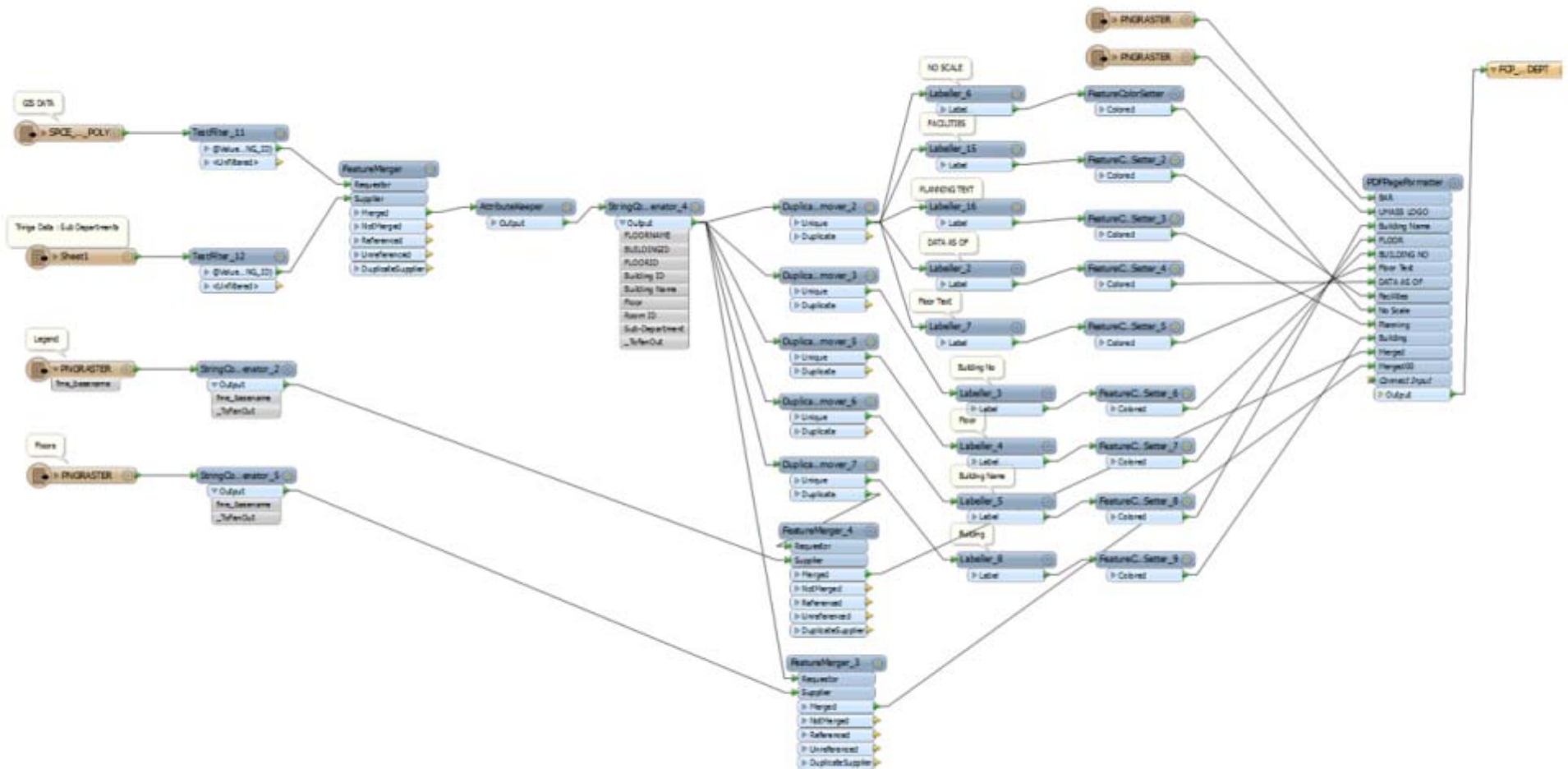
Data Driven Reports - Legend



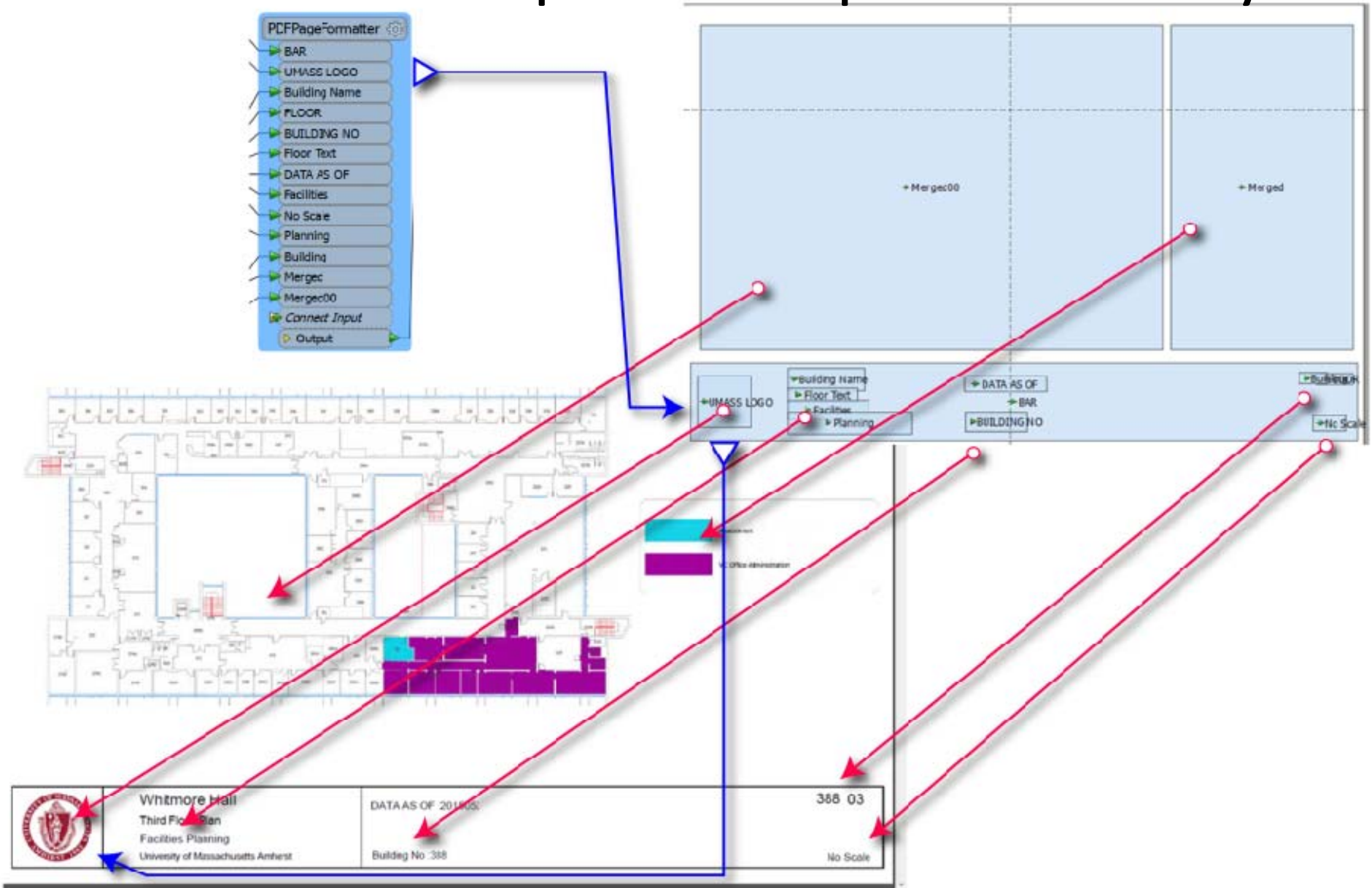
Data Driven Reports - Floorplans



Data Driven Reports – Data Assembly




Data Driven Reports – Report Assembly



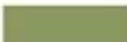




Data Driven Reports – Report Assembly



	<p>Whitmore Hall Third Floor Plan Facilities Planning University of Massachusetts Amherst</p>	<p>DATA AS OF :201505: Building No :388</p>	<p>388 03 No Scale</p>
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	CCH	686 NAF
	Director of Student Services	232 NAF
	Off Campus Student Services	128 NAF
	RL Facilities Operators	785 NAF
	SAS	1,577 NAF



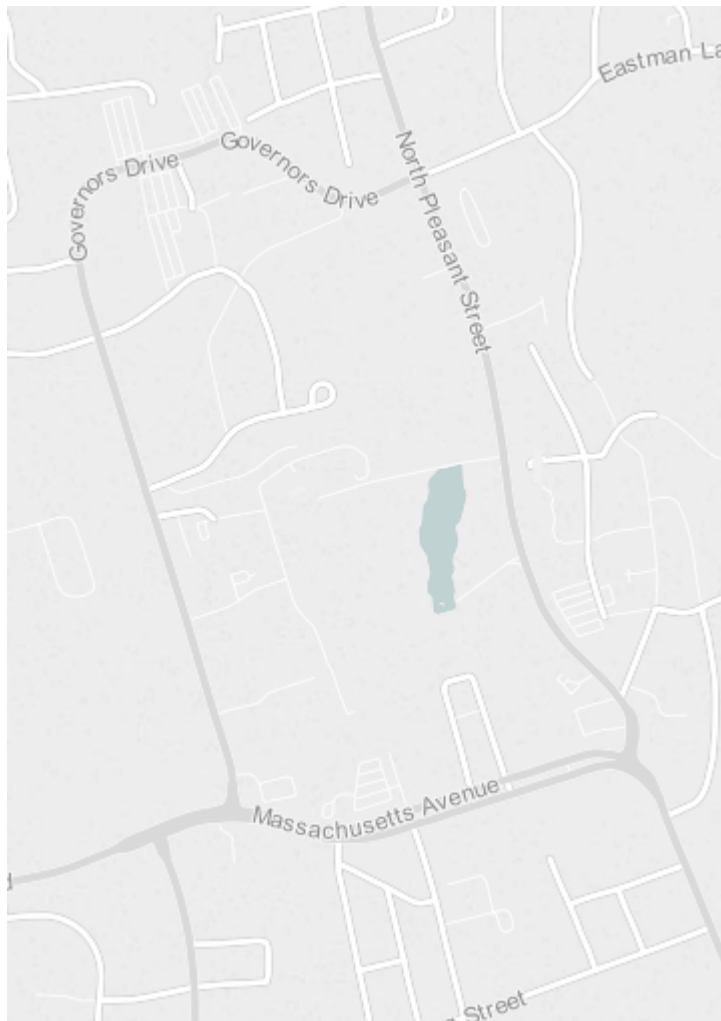
Berkshire House
 First Floor
 Campus Planning
 University of Massachusetts Amherst

Inventory as of : June 11 2015

Building No : 007

007 - 01

No Scale



Default Tableau map (service)

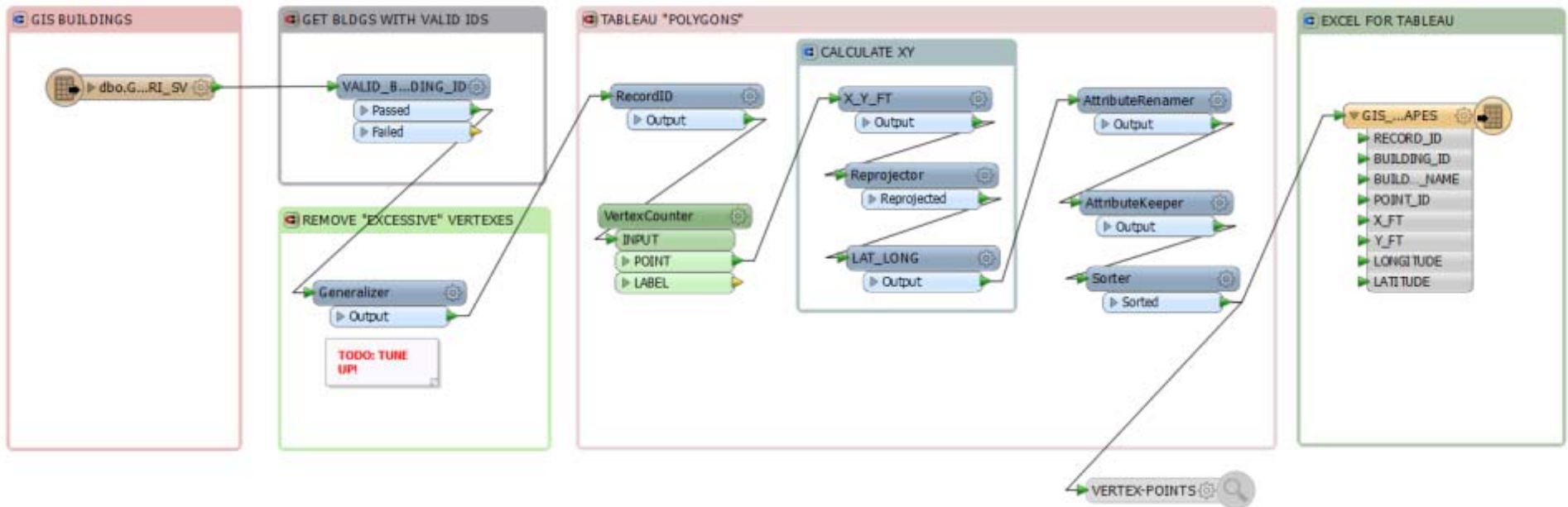


UMass-Amherst GIS map (+ 200 Buildings)

How can we approach reporting on building level with Tableau?

- a) How to bring GIS Building footprints into Tableau shapes
- b) How to bring centroids of Buildings as X/Y (lat/long) into Tableau

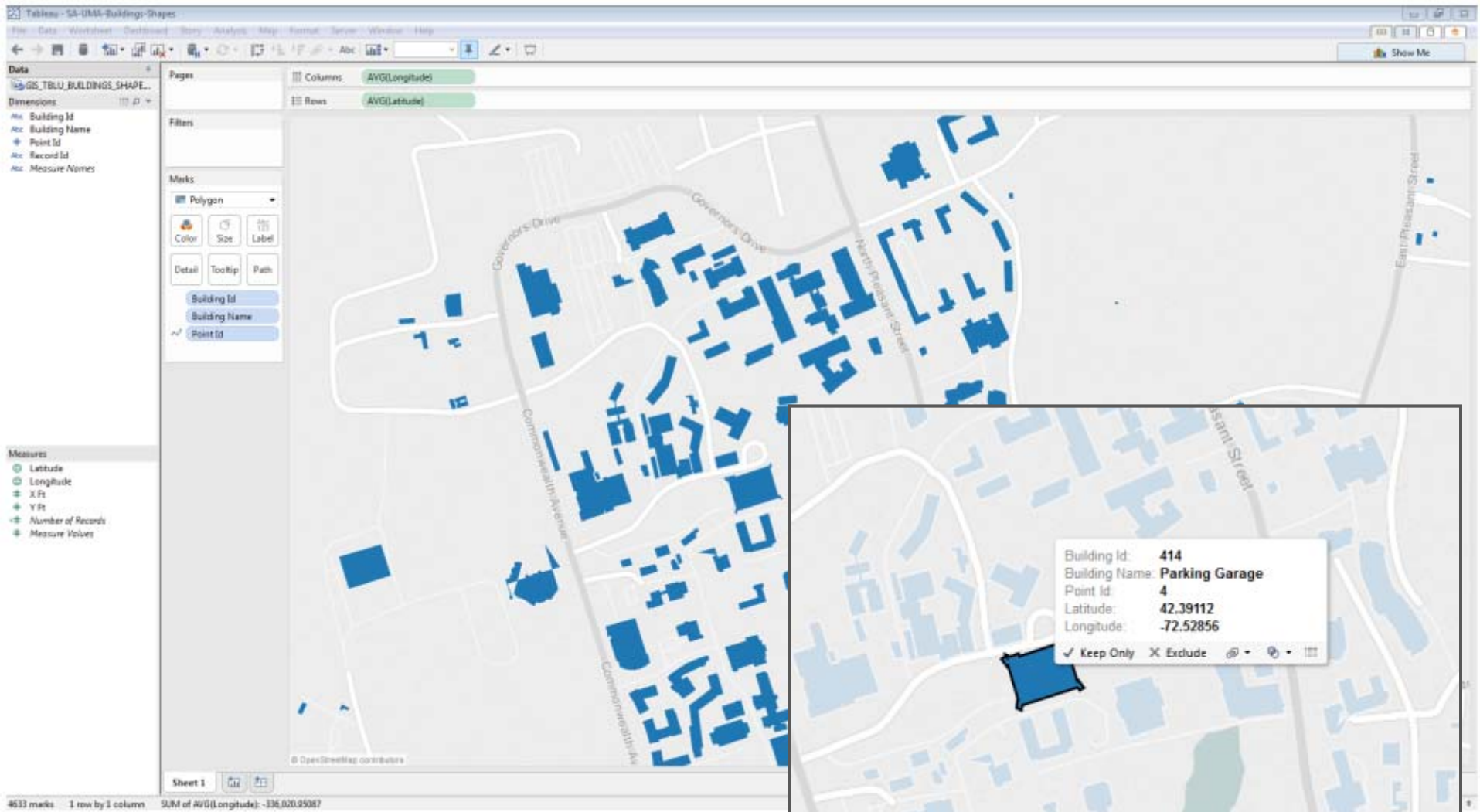
Example of simple FME workflow to bring any polygon/line GIS geometry into Tableau



Author: A.V.S
Date: Nov 24
Purpose: to create Tableau Shape for Buildings
HISTORY:

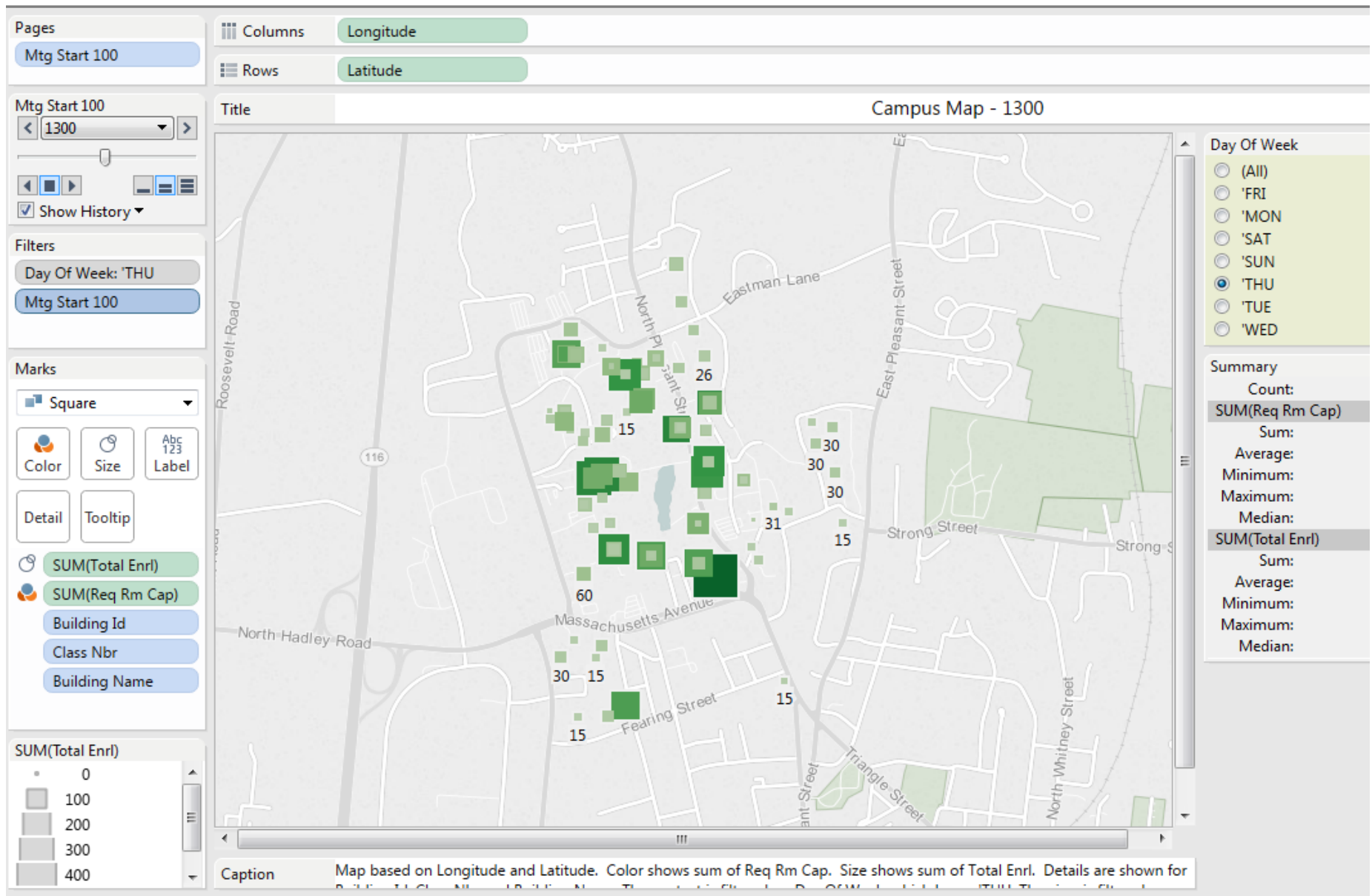
Converts BUILDINGS footprints from GIS representation to SQL Table which represents a line by storing shape_id, point sequence and lat/long.

Most complex part is "VertexCounter" transformer
Available as a free custom transformer from FME Store ...
Programming time = 0.



Building Footprints in Tableau.

Now it's ready to be connected with data tables and to run analytics



FME converts Building Footprints to centroids (Polygons -> X/Y centroid -> Lat/Lon):
 Student distribution at 10am on Thursday (Fall 2013)



Morrill Science Center IV
 Basement
 Campus Planning
 University of Massachusetts Amherst

Inventory as of : June 18 2015

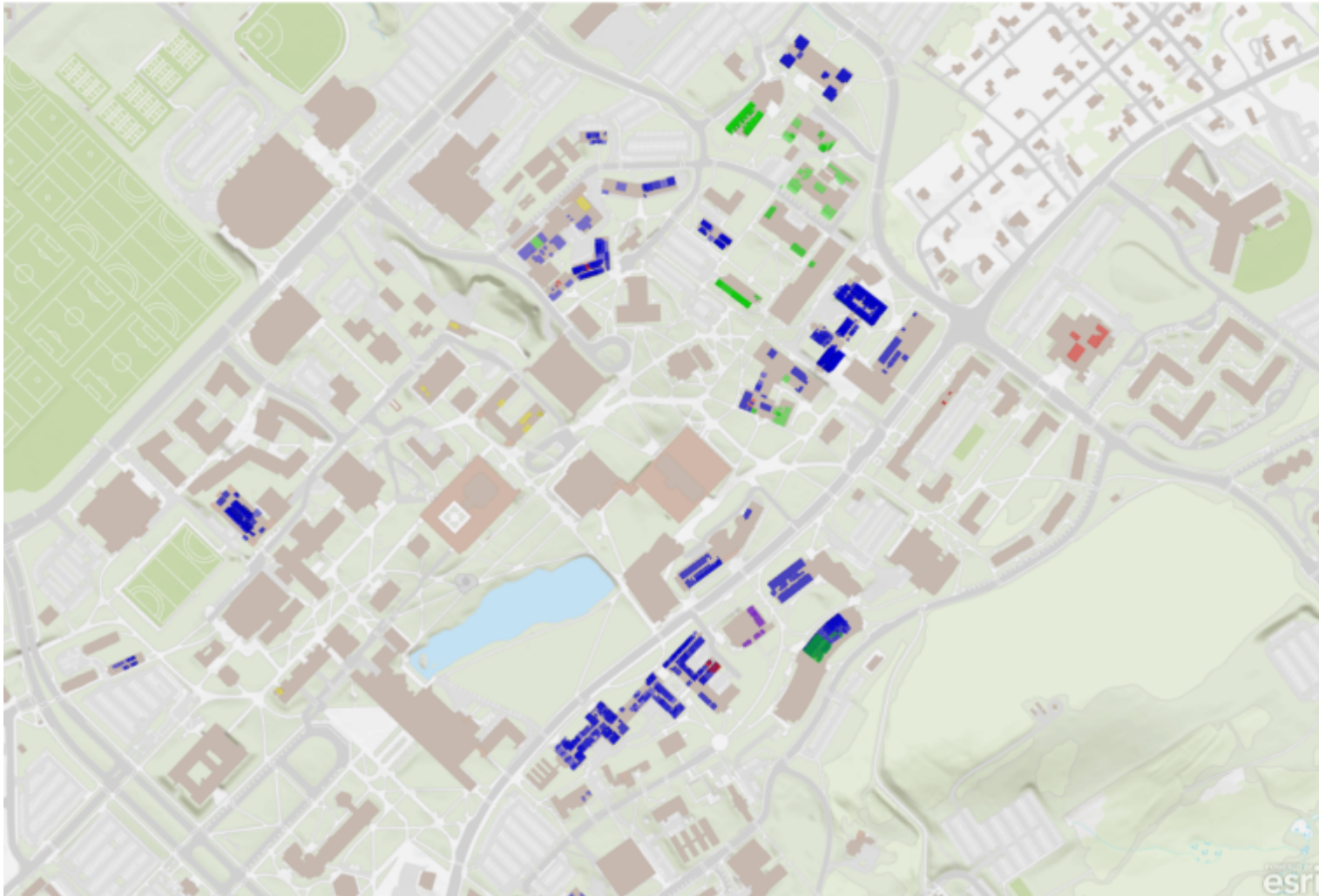
Building No : 347

347 - B

No Scale

Campus Planning v.1.2

SHARE HELP ARCGIS ONLINE



Layers



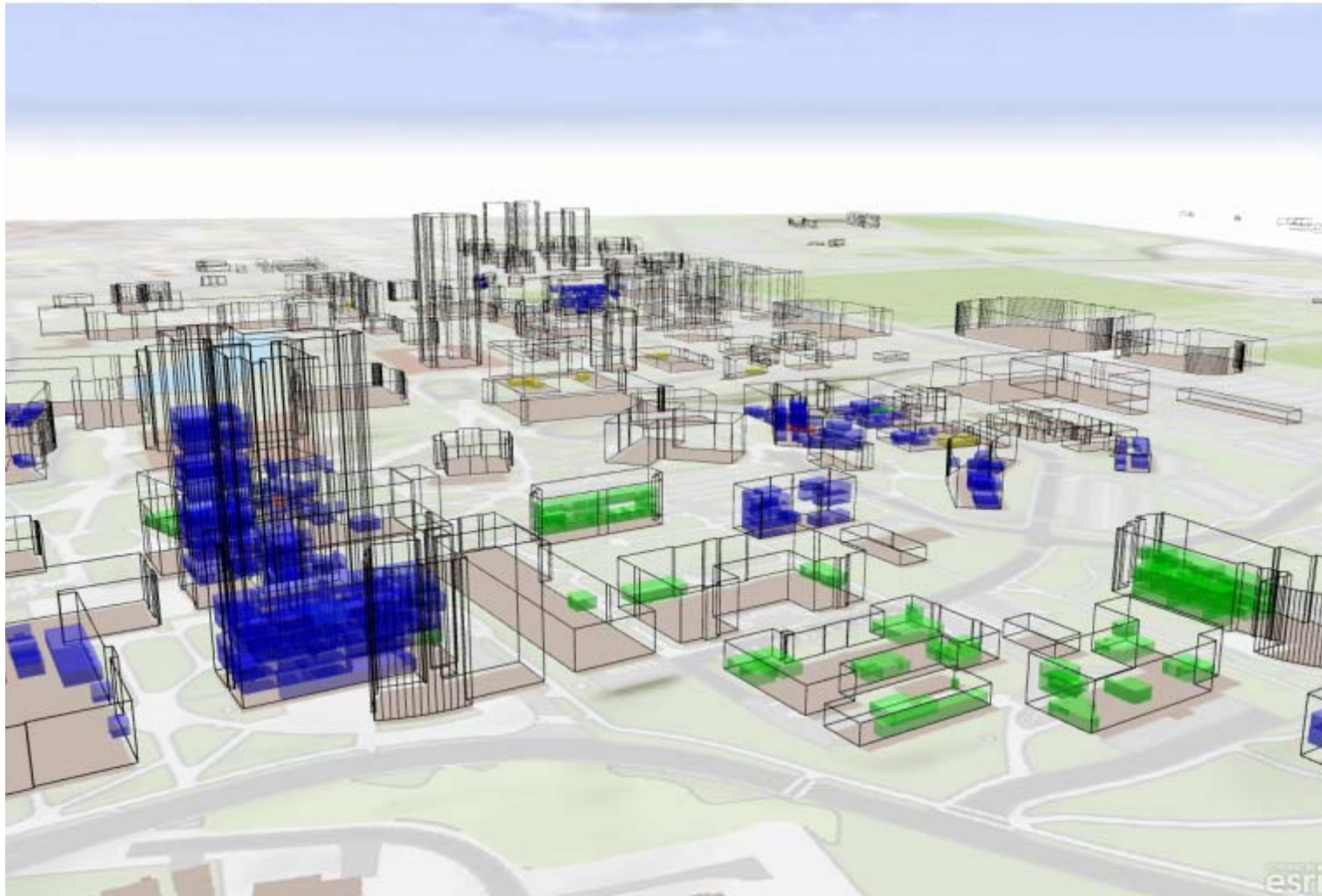
Buildings



College

- CollegeofNaturalSciences
- Engineering
- SocialBehavioralSciences
- PublicHealth-HealthScience
- CollegeofNursing
- College

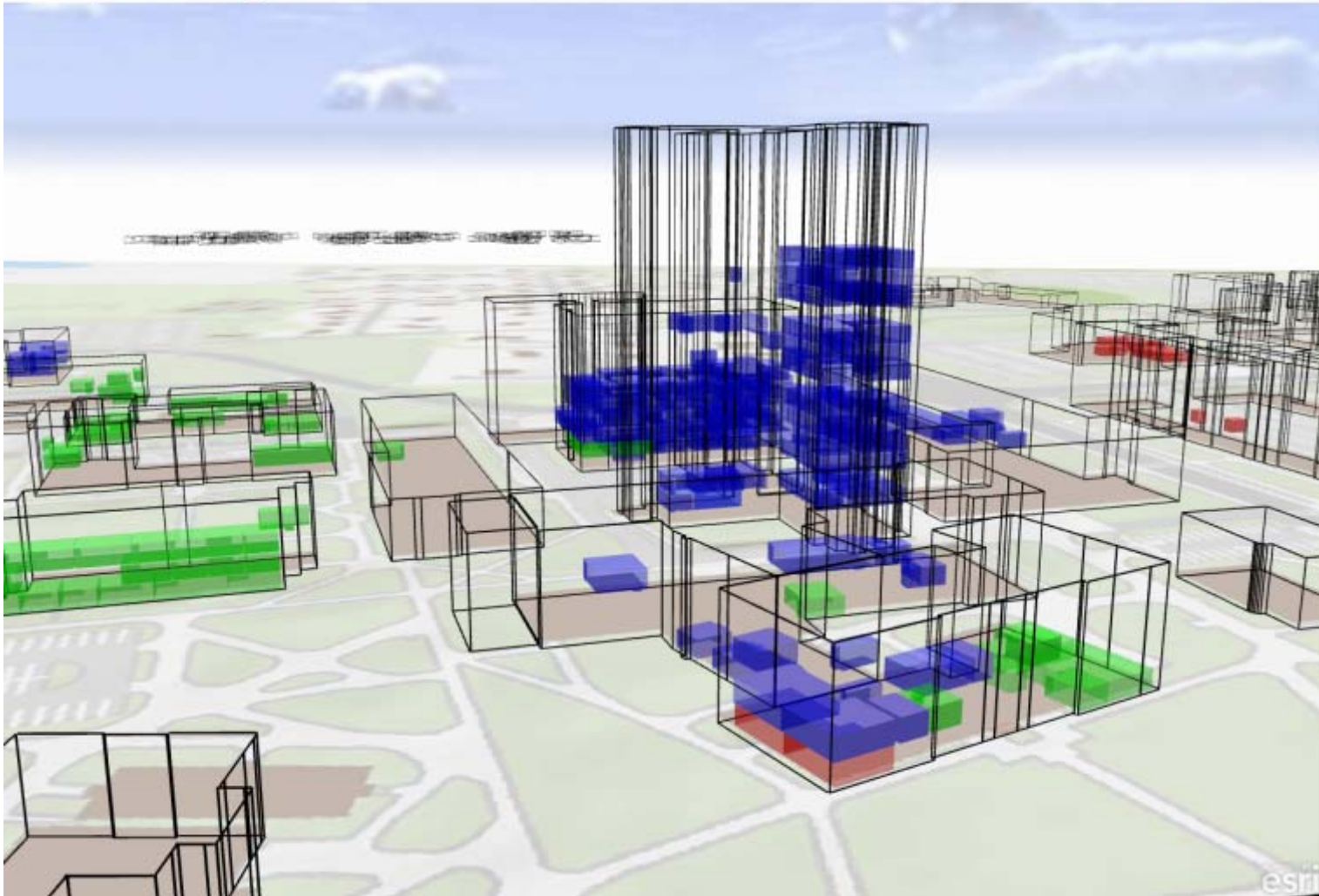




Information

Shape 1742

Attributes	
ADPCodes	ADPT090700
BUILDINGID	614
BuildingName	Conte Polymer Research Center
Department	Polymer Science & Engineering
Floor	06
MBU	College of Natural Sciences
NetArea	642
ROOMNAME	B662
SpaceClassID	250
SpaceClassName	NCL Lab
SpaceClassSeriesID	200
YearAcquired	1995



Information

Shape 1907

Attributes

ADPCodes	ADPT070100
BUILDINGID	502
BuildingName	Lederle Graduate Research Center Addition
Department	Computer Science
Floor	02
MBU	College of Natural Sciences
NetArea	1177
ROOMNAME	213
SpaceClassID	250
SpaceClassName	NCL Lab
SpaceClassSeriesID	200
YearAcquired	1973



Layers



Buildings



College

- CollegeofNaturalSciences
- Engineering
- SocialBehavioralSciences
- PublicHealthHealthScience
- CollegeofNursing
- College



GIS@UMASS

It's the Data Stupid

