Example

Building Massing Study

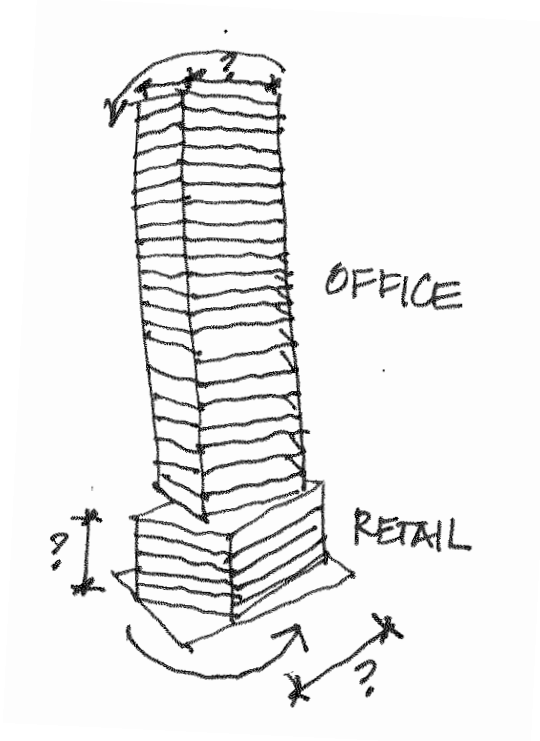
Goals

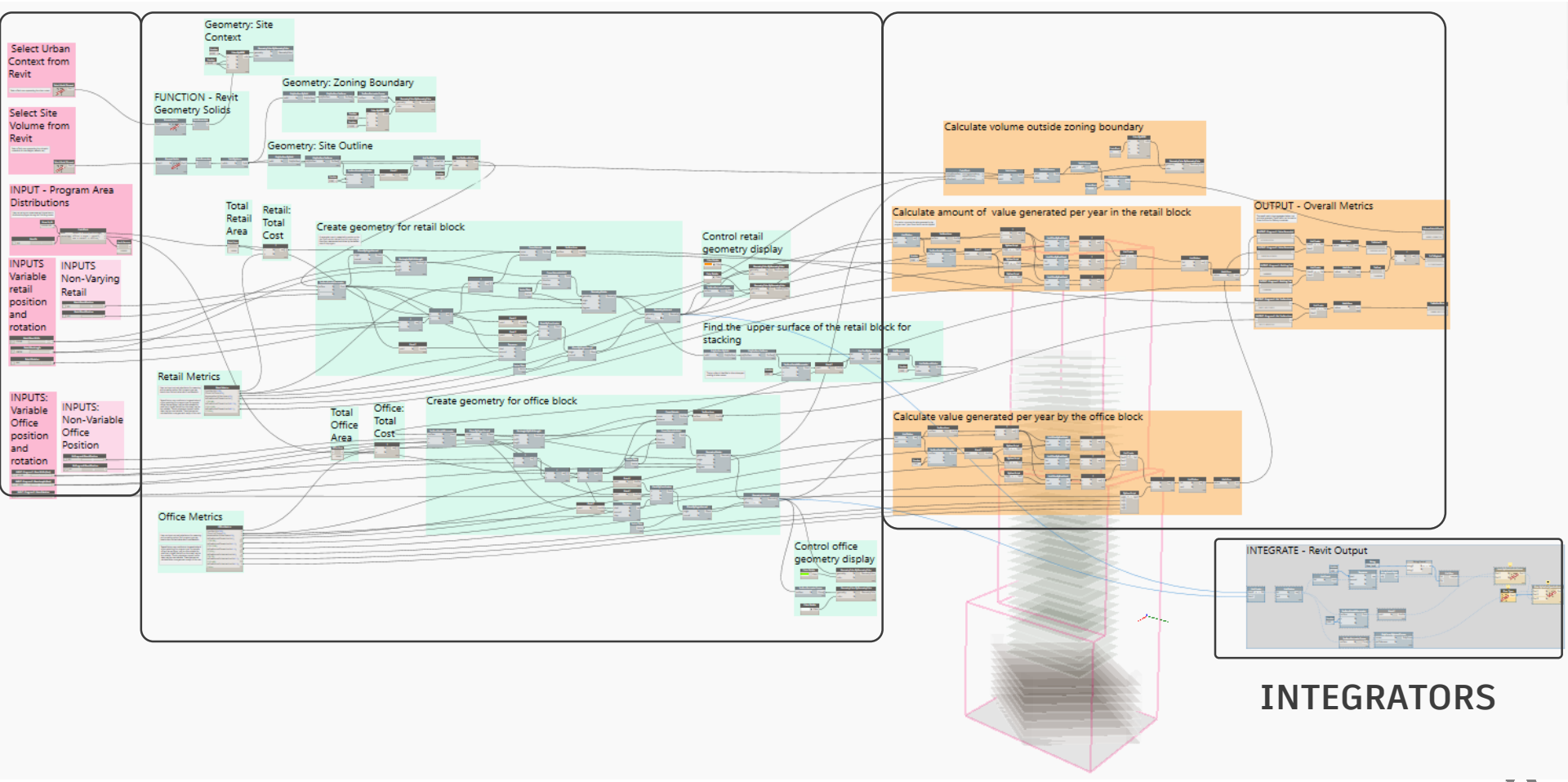
What are we solving for?

- Retail and office distribution and configuration for a building on an urban site.

- Variable Inputs:
  1. Ratio retail to office
  2. Program block size
  3. Program block rotation

- Goals:
  1. Minimize zoning envelop overlap
  2. Minimize cost
  3. Maximize total value per year




INPUTS
GENERATORS
EVALUATORS
Select Urban Context from Revit
Select Site Volume from Revit
INPUT - Program Area Distributions
INPUTS Variable retail position and rotation
INPUTS Non-Varying Retail
INPUTS: Variable Office position and rotation
INPUTS: Non-Variable Office Position
Geometry: Site Context
FUNCTION - Revit Geometry Solids
Geometry: Zoning Boundary
Geometry: Site Outline
Total Retail Area
Retail: Total Cost
Create geometry for retail block
Control retail geometry display
Find the upper surface of the retail block for stacking
Retail Metrics
Total Office Area
Office: Total Cost
Create geometry for office block
Office Metrics
Control office geometry display
Calculate volume outside zoning boundary
Calculate amount of value generated per year in the retail block
OUTPUT - Overall Metrics
Calculate value generated per year by the office block
INTEGRATE - Revit Output
INTEGRATORS

Autodesk Revit 2019 - STUDENT VERSION - BuildingMasser-UrbanContext2019.rvt - 3D View: {3D}

Type a keyword or phrase

Sign In

File | Architecture | Structure | Steel | Systems | Insert | Annotate | Analyze | Massing & Site | Collaborate | View | Manage | Add-Ins | Modify

Modify | Select

Materials | Object Styles | Snaps | Project Information | Project Parameters | Shared Parameters | Global Parameters | Transfer Project Standards | Purge Unused | Project Units

Settings

Structural Settings | MEP Settings | Panel Schedule Templates | Additional Settings

Location | Coordinates | Position

Project Location

Design Options | Add to Set | Pick to Edit | Main Model

Design Optio

Properties

3D View

3D View: {3D} | Edit Type

Graphics

View Scale	1" = 80'-0"
Scale Value 1:	960
Detail Level	Medium
Parts Visibility	Show Original
Visibility/Graphics Overri...	Edit...
Graphic Display Options	Edit...
Discipline	Coordination
Show Hidden Lines	By Discipline
Default Analysis Display S...	None
Sun Path	

Extents

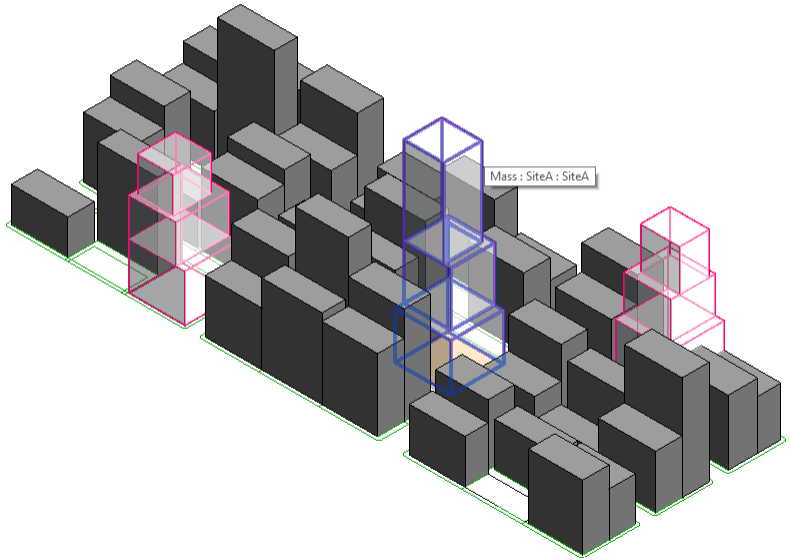
Crop View	
Crop Region Visible	
Annotation Crop	

Properties help | Apply

Project Browser - BuildingMasser-UrbanContext2019.rvt

- Views (all)
  - Floor Plans
    - Level 1
    - Level 2
    - Site
  - Ceiling Plans
    - Level 1
    - Level 2
  - 3D Views
  - Elevations (Building Elevation)
    - East
    - North
    - South
    - West
- Legends
- Schedules/Quantities (all)
- Sheets (all)
- Families
- Groups
- Revit Links

{3D}



1" = 80'-0"

Mass : SiteA : SiteA

Dynamo

File | Edit | View | Packages | Settings | Help

BuildingMasser-2programsOTx.dyn*

Library

REFERENCE - Select Urban Context

Select a Revit mass representing the urban context.

Select Model Element

Change | Element

Element : 354632

REFERENCE - Select Site Volume

Select a Revit mass representing the volumetric constraints of a site (heights, setbacks, etc)

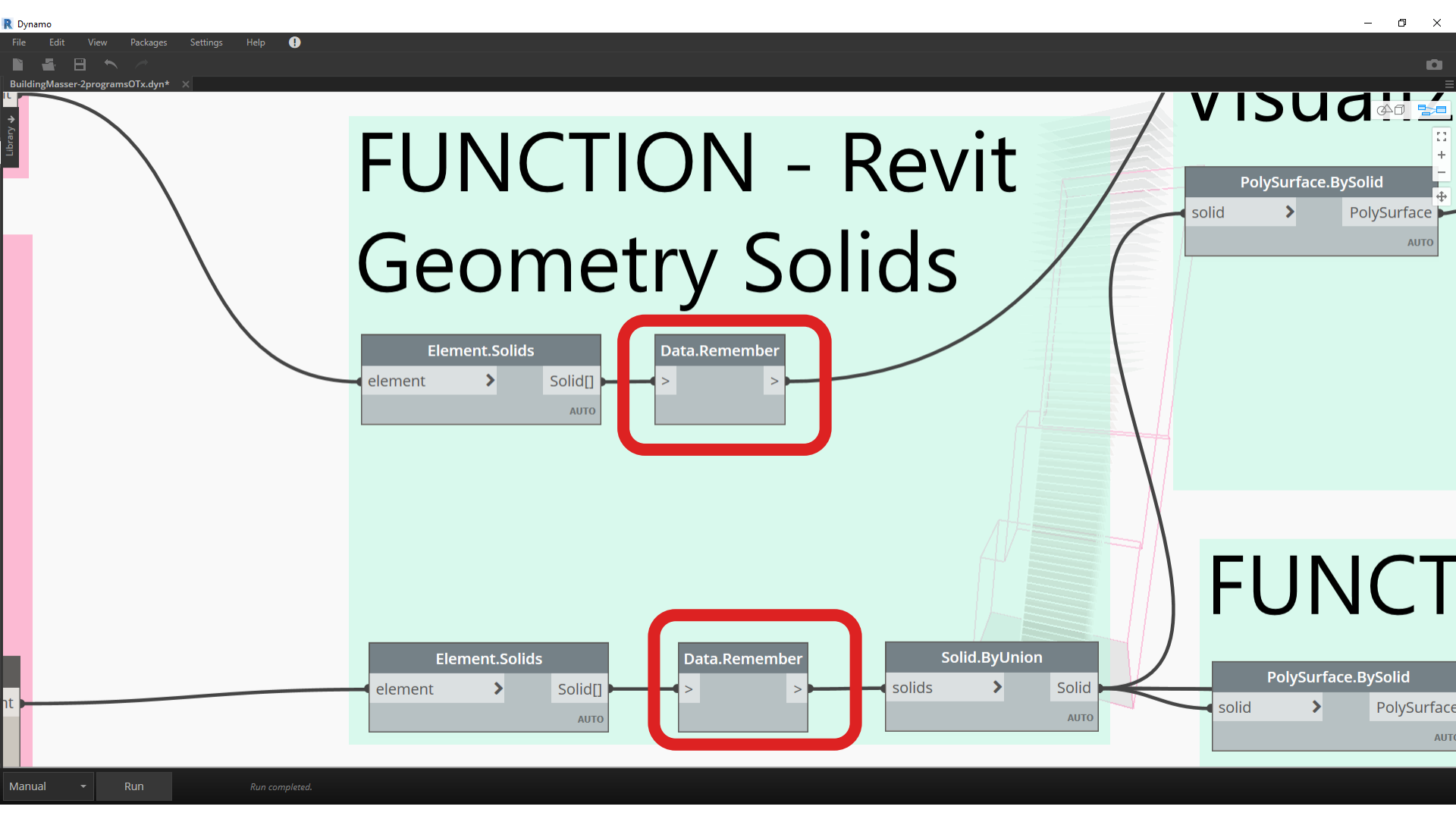
Select Model Element

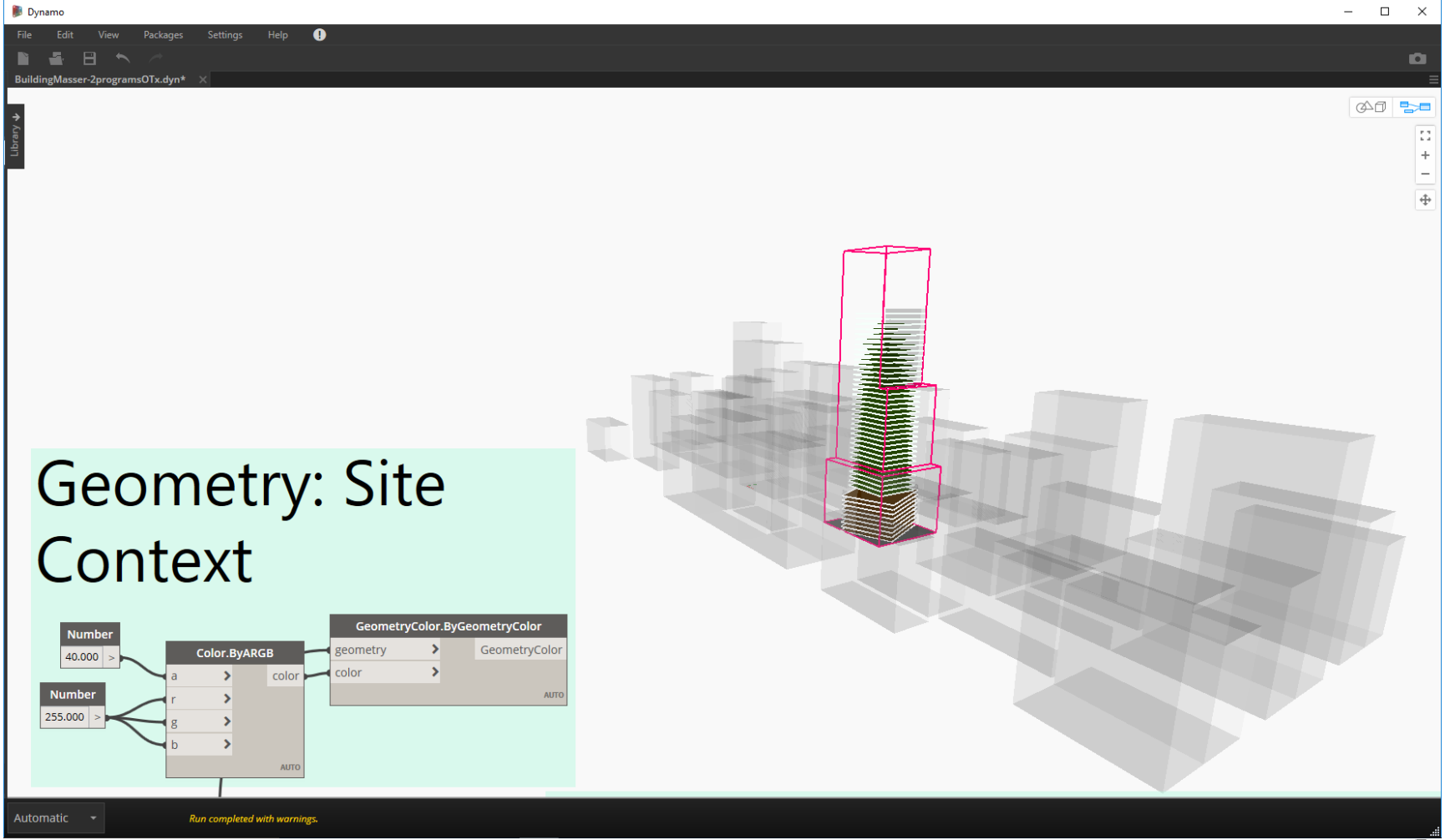
Change | Element

Element : 369858

Manual | Run | Run completed.

Main Model


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
FUNCTION - Revit
Geometry Solids
Element.Solids
element
Solid[]
AUTO
Data.Remember
>
>
PolySurface.BySolid
solid
PolySurface
AUTO
Element.Solids
element
Solid[]
AUTO
Data.Remember
>
>
Solid.ByUnion
solids
Solid
AUTO
PolySurface.BySolid
solid
Manual
Run
Run completed.


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
Geometry: Site Context
Number
40.000
Number
255.000
Color.ByARGB
a
r
g
b
color
AUTO
GeometryColor.ByGeometryColor
geometry
color
GeometryColor
AUTO
Automatic
Run completed with warnings.

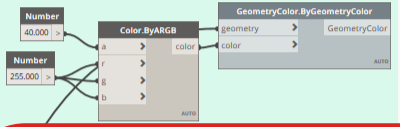
Dynamo

File Edit View Packages Settings Help

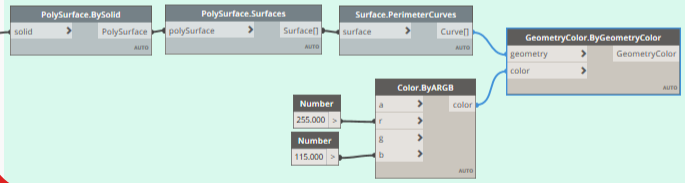
BuildingMasser-2programsOTx.dyn*

Library

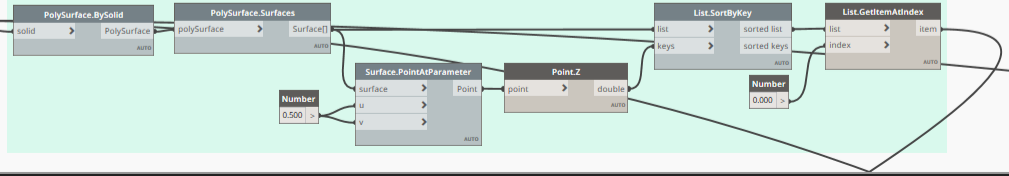
FUNCTION - Site Context Visualization

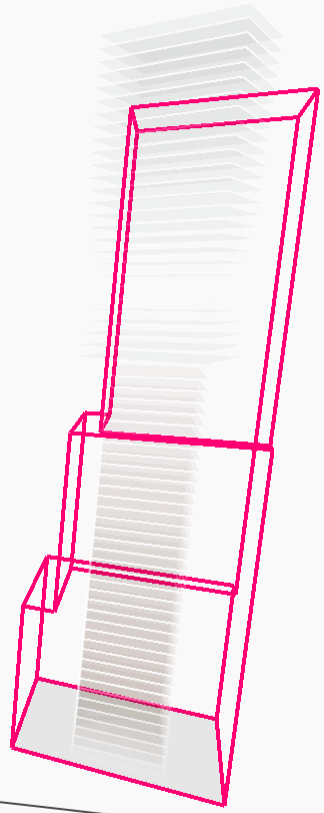


FUNCTION - Site Boundary Visualization



FUNCTION - Find Site Base Surface





Manual Run

Run completed.

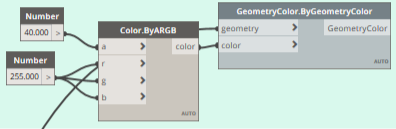
Dynamo

File Edit View Packages Settings Help

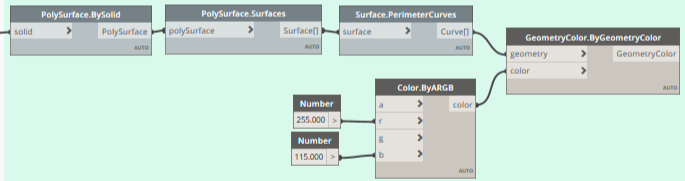
BuildingMasser-2programsOTx.dyn*

Library

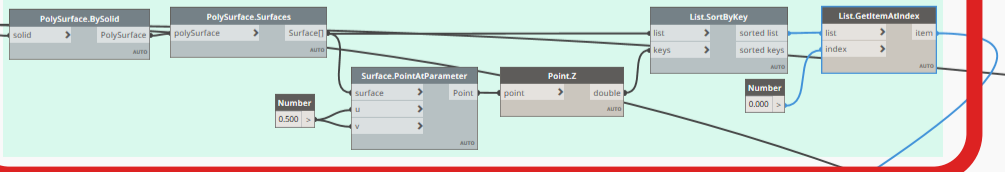
FUNCTION - Site Context Visualization

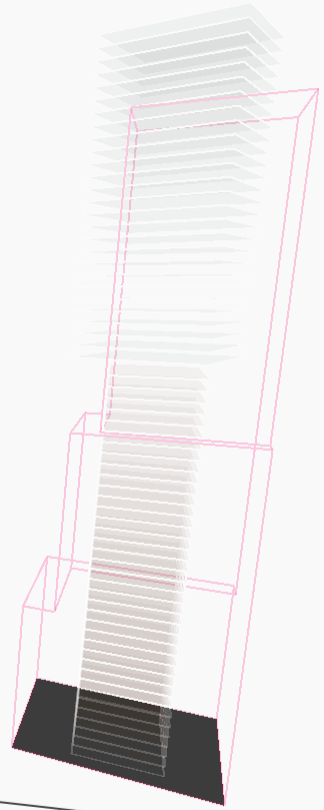


FUNCTION - Site Boundary Visualization



FUNCTION - Find Site Base Surface





Manual Run

Run completed.

Dynamo

File Edit View Packages Settings Help

BuildingMasser-2programsOTx.dyn*

Library

INPUT - Program Area Distributions

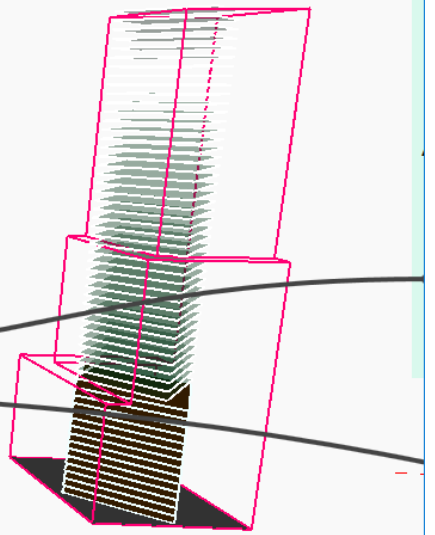
Users can set a gross square area and choose how to distribute the program among the 2 building masses

Gross Sq. Ft.
1200000.000 >

Retail%
0.3 >

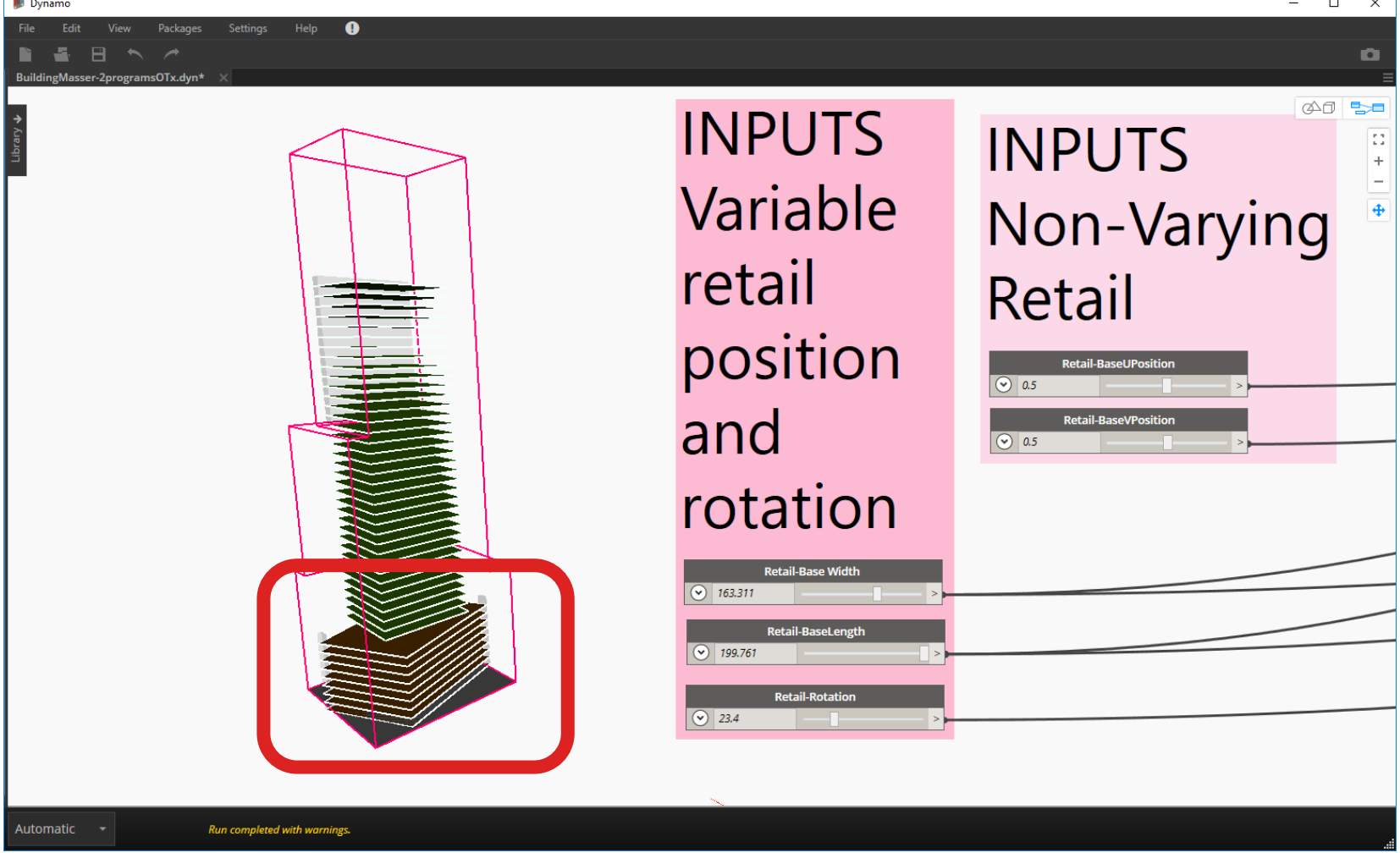
Code Block
area
percentage
retail = area*percentage; >
office = area - retail; >
sum = retail + office; >

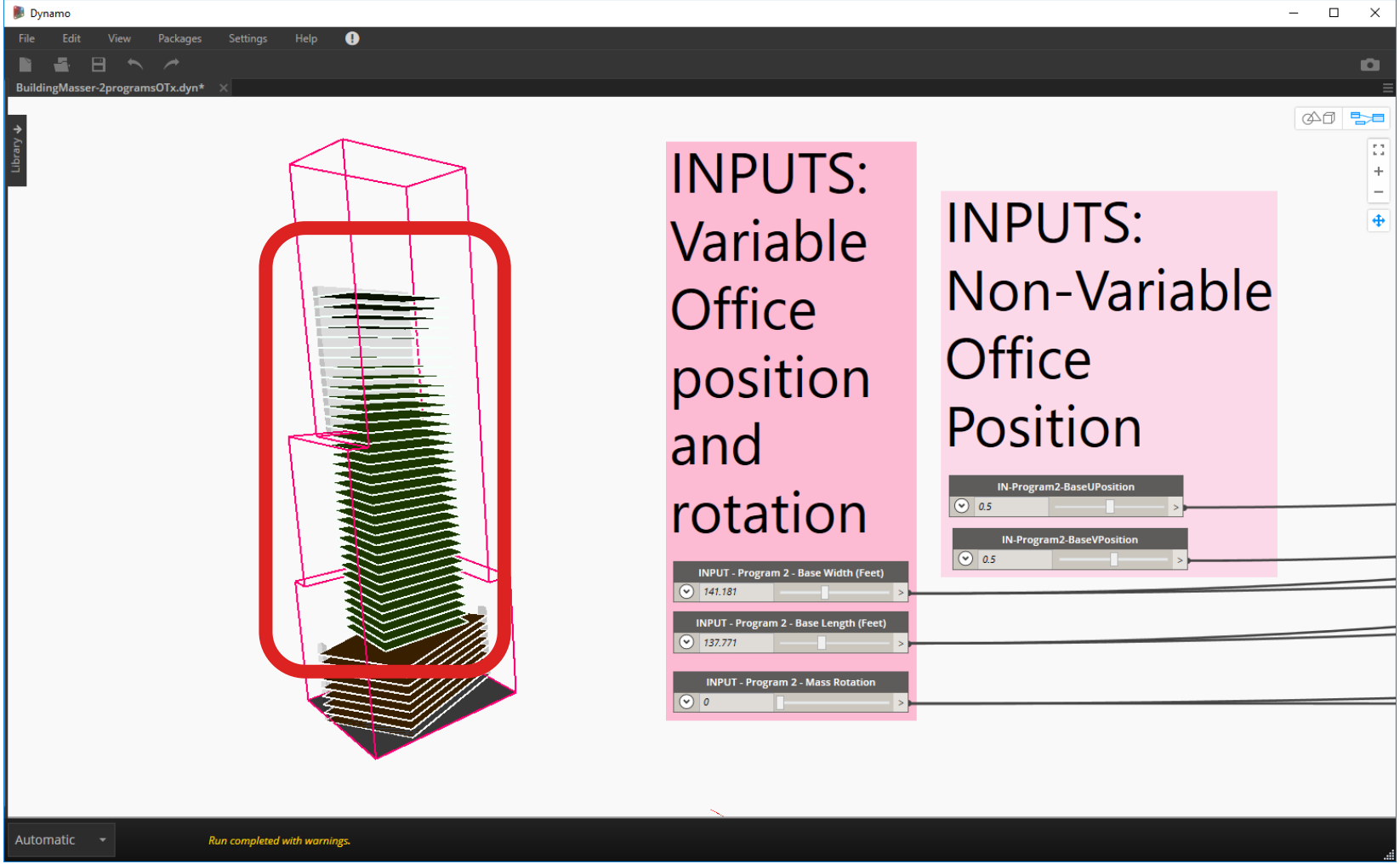
check the sum
> >
1200000



Automatic

Run completed with warnings.


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
INPUTS
Variable
retail
position
and
rotation
Retail-Base Width
163.311
Retail-BaseLength
199.761
Retail-Rotation
23.4
INPUTS
Non-Varying
Retail
Retail-BaseUPosition
0.5
Retail-BaseVPosition
0.5
Automatic
Run completed with warnings.


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
INPUTS: Variable Office position and rotation
INPUTS: Non-Variable Office Position
IN-Program2-BaseUPosition
0.5
IN-Program2-BaseVPosition
0.5
INPUT - Program 2 - Base Width (Feet)
141.181
INPUT - Program 2 - Base Length (Feet)
137.771
INPUT - Program 2 - Mass Rotation
0
Automatic
Run completed with warnings.

Dynamo

File Edit View Packages Settings Help

BuildingMasser-2programsOTx.dyn*

Library

Retail Metrics

Users can input cost and value factors for measuring and comparing options. Each program type may have its own cost and value return considerations.

Several factors may contribute to increased value of a floor pertaining to a program type. For example, offices that are higher, may be more valuable but retail that is higher (farther from the street) may be less valuable. Certain orientations towards certain views may be more valuable. These bonuses are calculated after some geometric analyis of the mass.

Retail Metrics

```
CostPerSF=180;
FloorToFloor=14;
RevenuePerSFPerYear=35;
ValueBonusElevation1=1;
 //0-50;
ValueBonusElevation2=0.25;
//51-150;
ValueBonusElevation3=0.1;
//151+;
```

Automatic

Run completed with warnings.

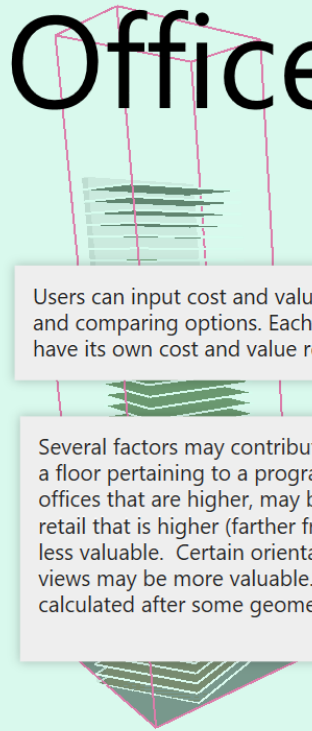
Dynamo

File Edit View Packages Settings Help

BuildingMasser-2programsOTx.dyn*

Library

Office Metrics



Users can input cost and value factors for measuring and comparing options. Each program type may have its own cost and value return considerations.

Several factors may contribute to increased value of a floor pertaining to a program type. For example, offices that are higher, may be more valuable but retail that is higher (farther from the street) may be less valuable. Certain orientations towards certain views may be more valuable. These bonuses are calculated after some geometric analysis of the mass.

Office Metrics

```
CostPerSF=300;
FloorToFloor=15;
RevenuePerSFPerYear=25;
ValueBonusElevation1=1;
 //0-50;
ValueBonusElevation2=1.2;
//51-150;
ValueBonusElevation3=1.5;
//151+;
ValueBonusOrientation1=1;
//0-20;
ValueBonusOrientation2=1.2;
//21-40;
ValueBonusOrientation3=1.5;
//41+;
```

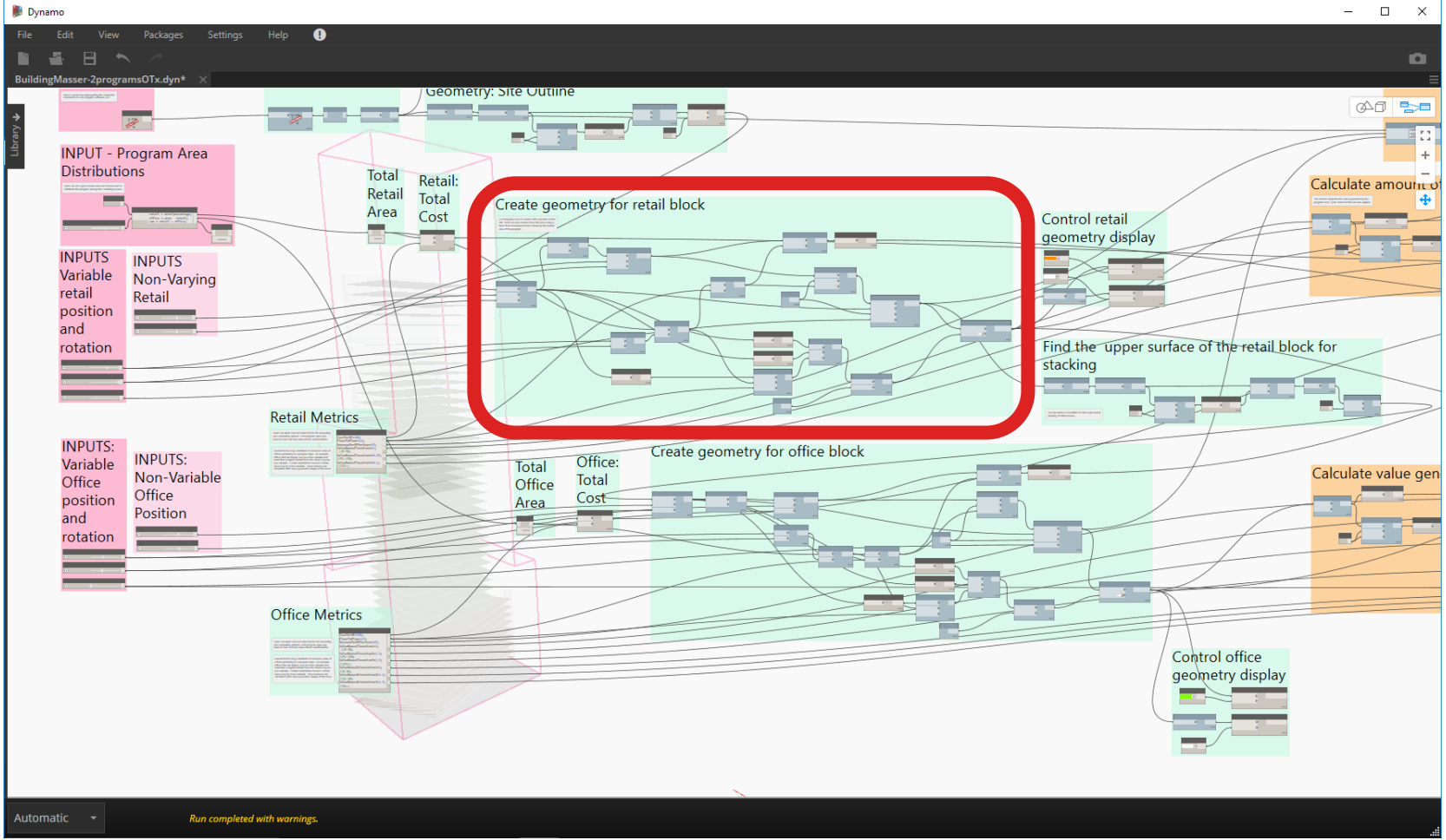
Automatic

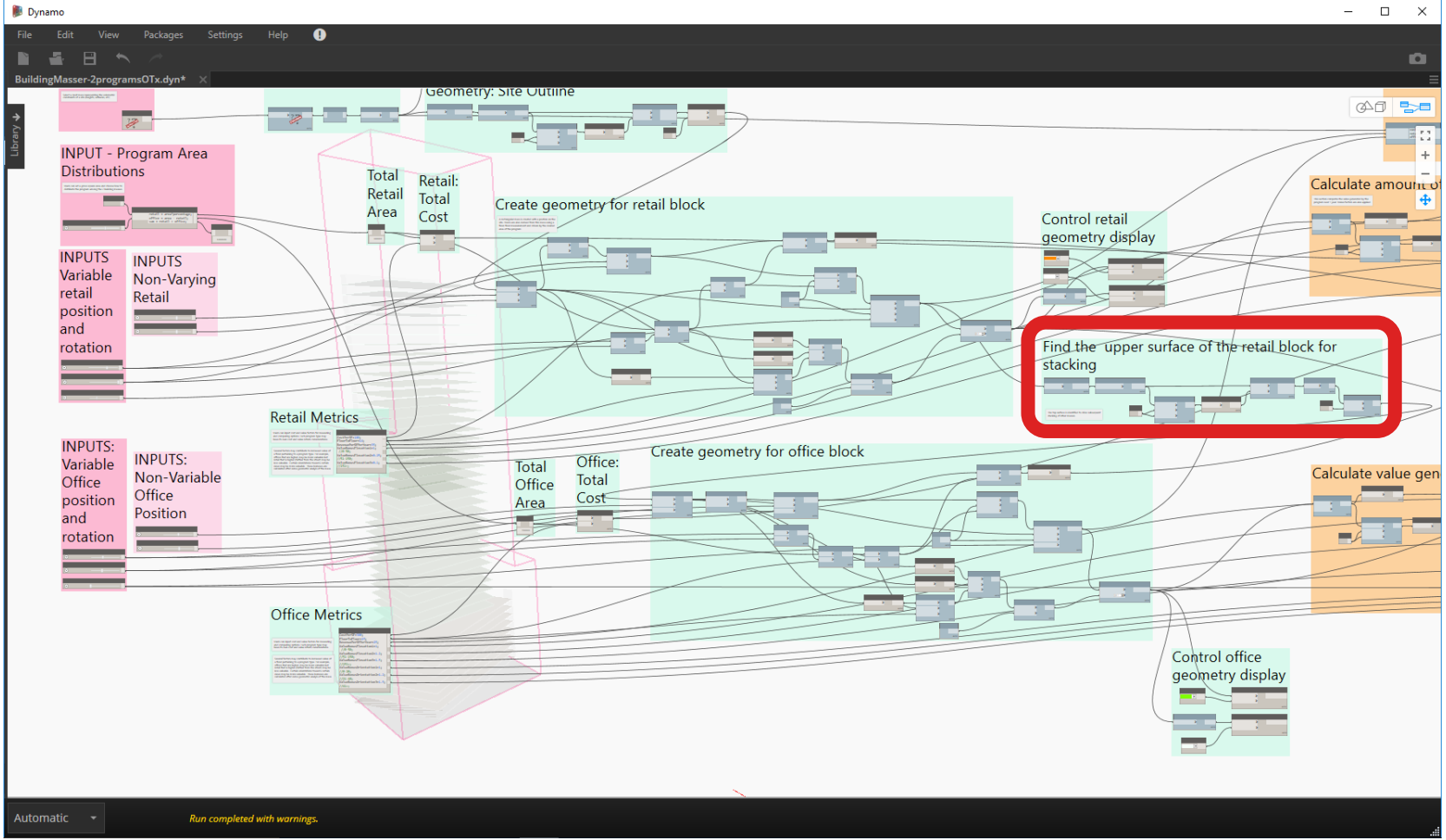
Run completed with warnings.

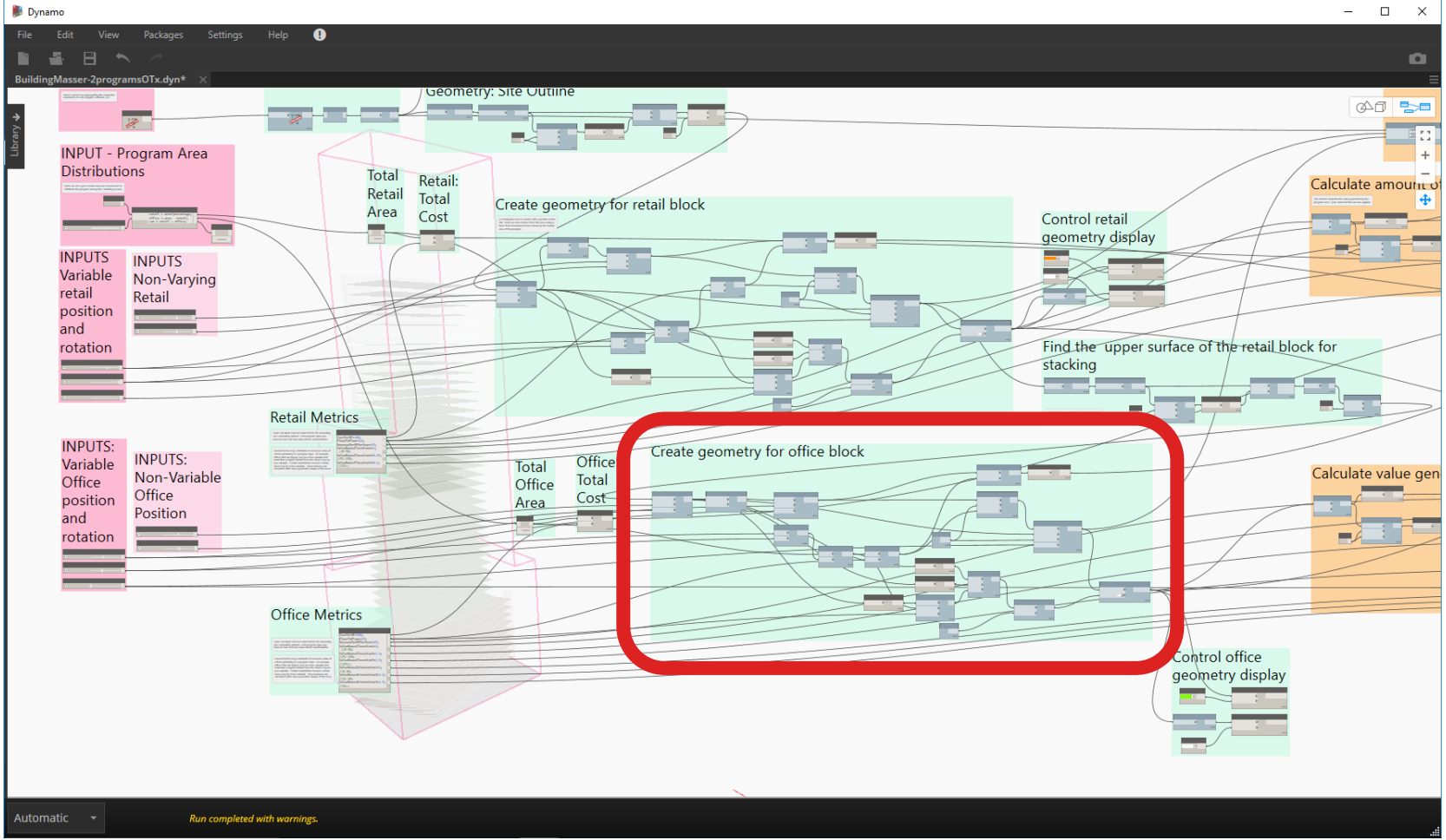
Metric Comparison

Building Massing Study

Metric	Retail	Office
Cost Per SF	$180	$300
Floor to Floor Height	14	15
Revenue/SF/YR	$35	$25
Elevation Bonus (0-50')	1	1
Elevation Bonus 51-150'	0.25	1.2
Elevation Bonus 151'+	0.1	1.5
Orientation Bonus 0-20	n/a	1
Orientation Bonus 21-40	n/a	1.2
Orientation Bonus 41+	n/a	1.5


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
Geometry: Site Outline
INPUT - Program Area Distributions
Total Retail Area
Retail: Total Cost
Create geometry for retail block
Control retail geometry display
Calculate amount
INPUTS Variable retail position and rotation
INPUTS Non-Varying Retail
Find the upper surface of the retail block for stacking
Retail Metrics
INPUTS: Variable Office position and rotation
INPUTS: Non-Variable Office Position
Total Office Area
Office: Total Cost
Create geometry for office block
Calculate value gen
Office Metrics
Control office geometry display
Automatic
Run completed with warnings.


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
Geometry: Site Outline
INPUT - Program Area Distributions
Total Retail Area
Retail: Total Cost
Create geometry for retail block
Control retail geometry display
Calculate amount
INPUTS Variable retail position and rotation
INPUTS Non-Varying Retail
Find the upper surface of the retail block for stacking
Retail Metrics
INPUTS: Variable Office position and rotation
INPUTS: Non-Variable Office Position
Total Office Area
Office: Total Cost
Create geometry for office block
Calculate value gen
Office Metrics
Control office geometry display
Automatic
Run completed with warnings.


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
Geometry: Site Outline
INPUT - Program Area Distributions
Total Retail Area
Retail: Total Cost
Create geometry for retail block
Control retail geometry display
Calculate amount
INPUTS Variable retail position and rotation
INPUTS Non-Varying Retail
Find the upper surface of the retail block for stacking
Retail Metrics
INPUTS: Variable Office position and rotation
INPUTS: Non-Variable Office Position
Total Office Area
Office Total Cost
Create geometry for office block
Calculate value gen
Office Metrics
Control office geometry display
Automatic
Run completed with warnings.

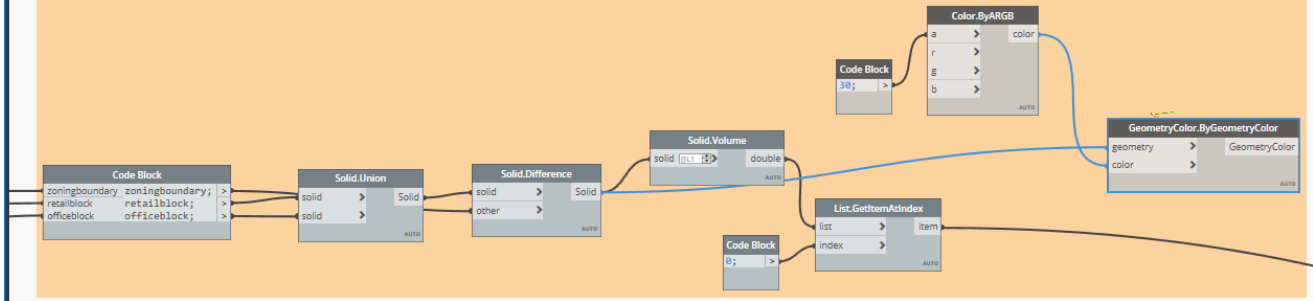
Dynamo

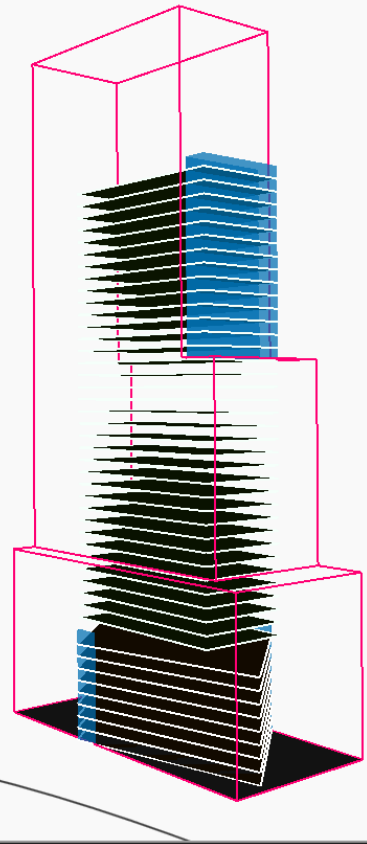
File Edit View Packages Settings Help

BuildingMasser-2programsOTx.dyn*

Library

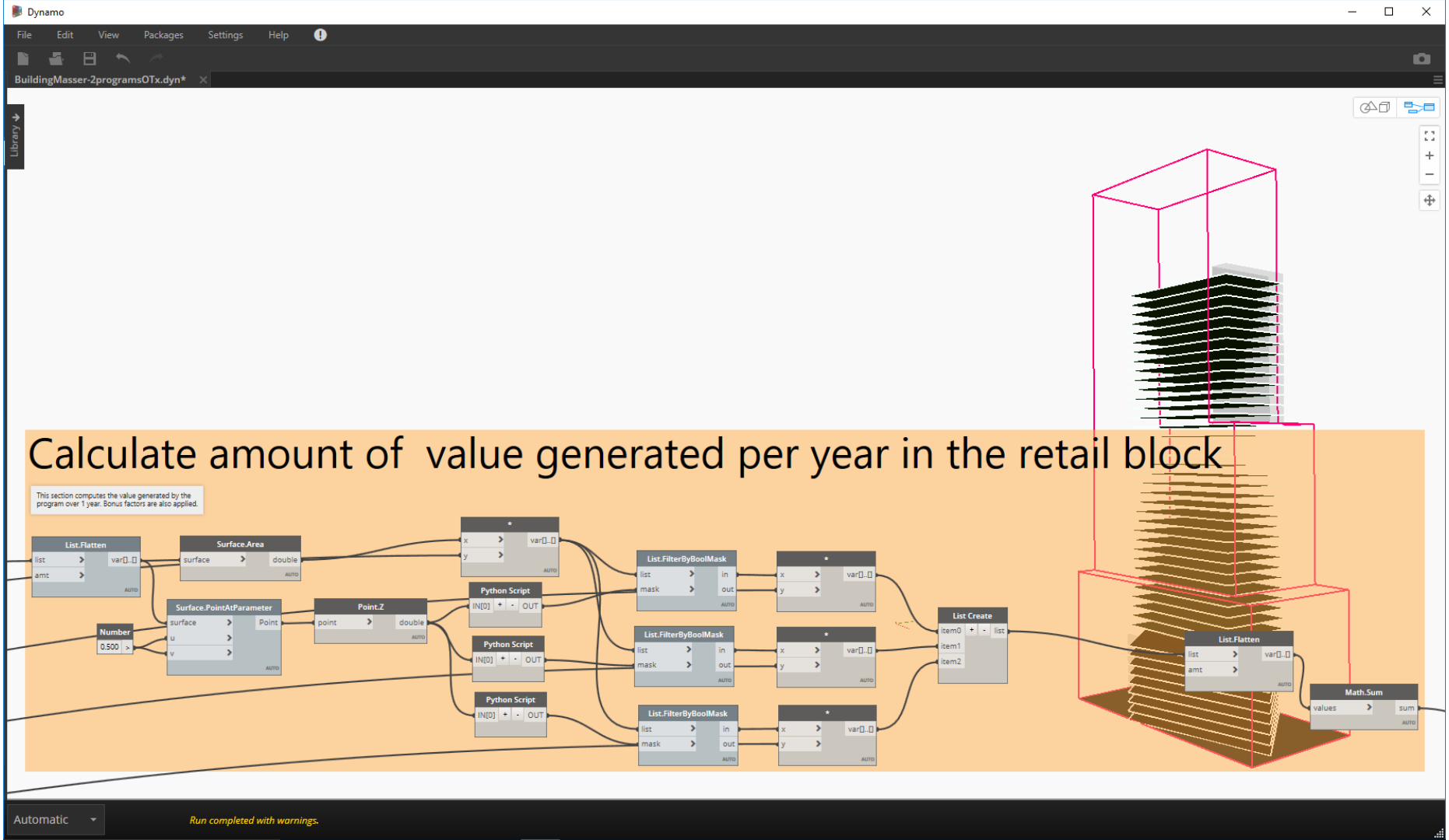
Calculate volume outside zoning boundary

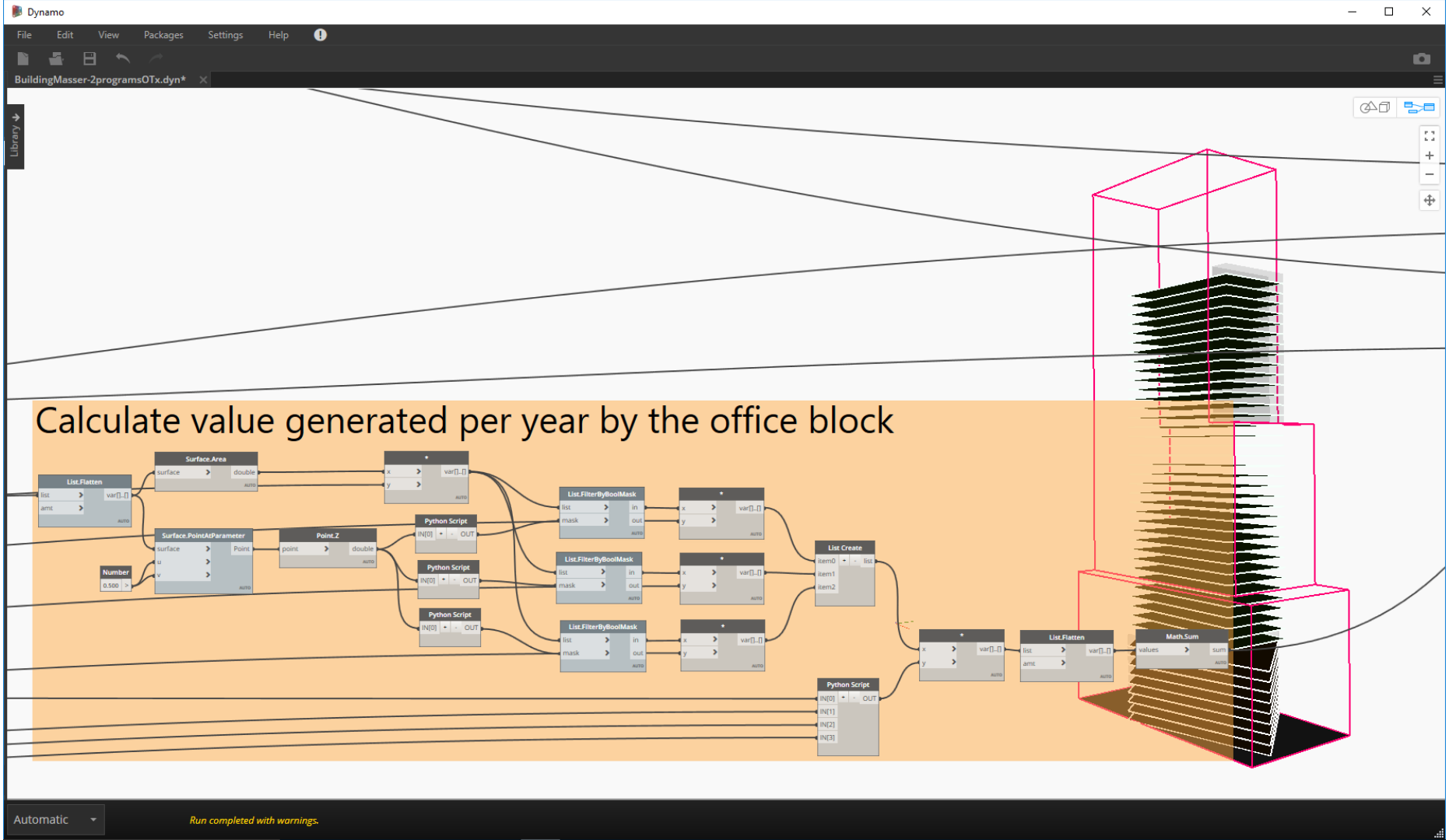




Automatic

Run completed with warnings.


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
Calculate amount of value generated per year in the retail block
This section computes the value generated by the program over 1 year. Bonus factors are also applied.
List.Flatten
Surface.Area
Surface.PointAtParameter
Point.Z
Number
Python Script
Python Script
Python Script
List.FilterByBoolMask
List.FilterByBoolMask
List.FilterByBoolMask
List Create
List.Flatten
Math.Sum
Automatic
Run completed with warnings.


Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
Calculate value generated per year by the office block
List.Flatten
Surface.Area
Surface.PointAtParameter
Point.Z
Number
Python Script
List.FilterByBoolMask
List Create
Math.Sum
Automatic
Run completed with warnings.

Dynamo

File Edit View Packages Settings Help

BuildingMasser-2programsOTx.dyn*

Library

OUTPUT - Overall Metrics

The overall metrics show aggregate clashes, cost, and value generated. These metrics can be used as fitness functions for Refinery to evaluate.

OUTPUT - Program 1 - Value Generated
5994507.24329625

OUTPUT - Program 2 - Value Generated
25966614.480585

List Create
item0 + - list
item1

Math.Sum
values sum
AUTO

TotValue/Yr
31961121.7238813

VolumeOutsideZoning
567803.869391852

/
x
y
var[]..[]
AUTO

YrsToPayback
8.26003549815149

OUTPUT - Program 1 - Building Cost
54000000

OUTPUT - Program 2 - Building Cost
210000000

List Create
item0 + - list
item1

Math.Sum
values sum
AUTO

TotCost
264000000

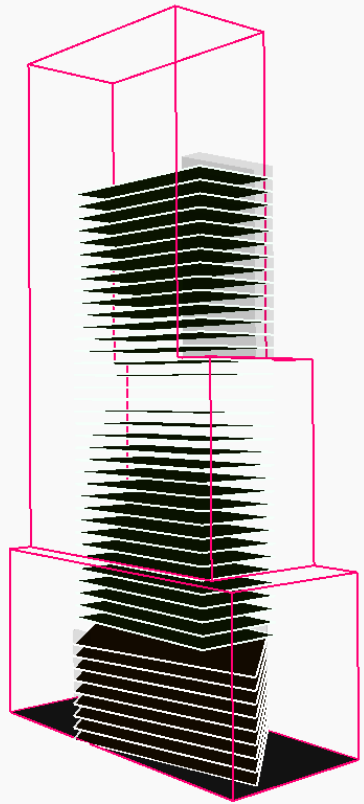
OUTPUT - Program 1 - Ext. Surface Area
93485.85450901

OUTPUT - Program 2 - Ext. Surface Area
301172.081013767

List Create
item0 + - list
item1

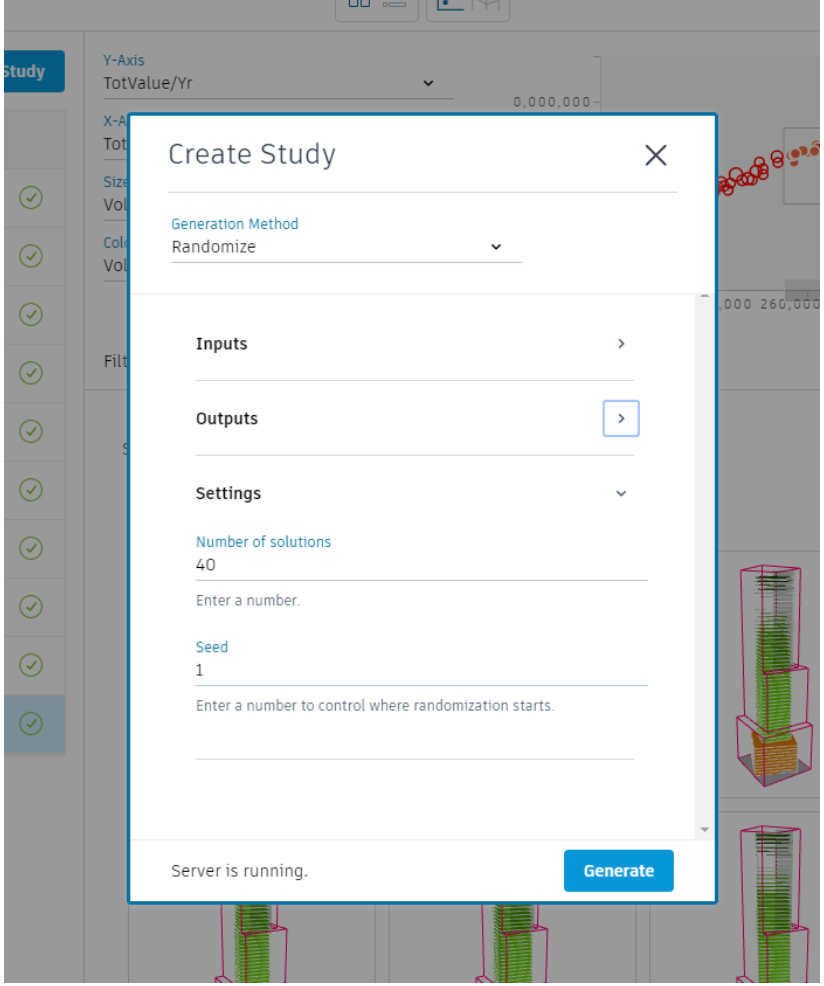
Math.Sum
values sum
AUTO

TotExtSurfArea
394657.935522777



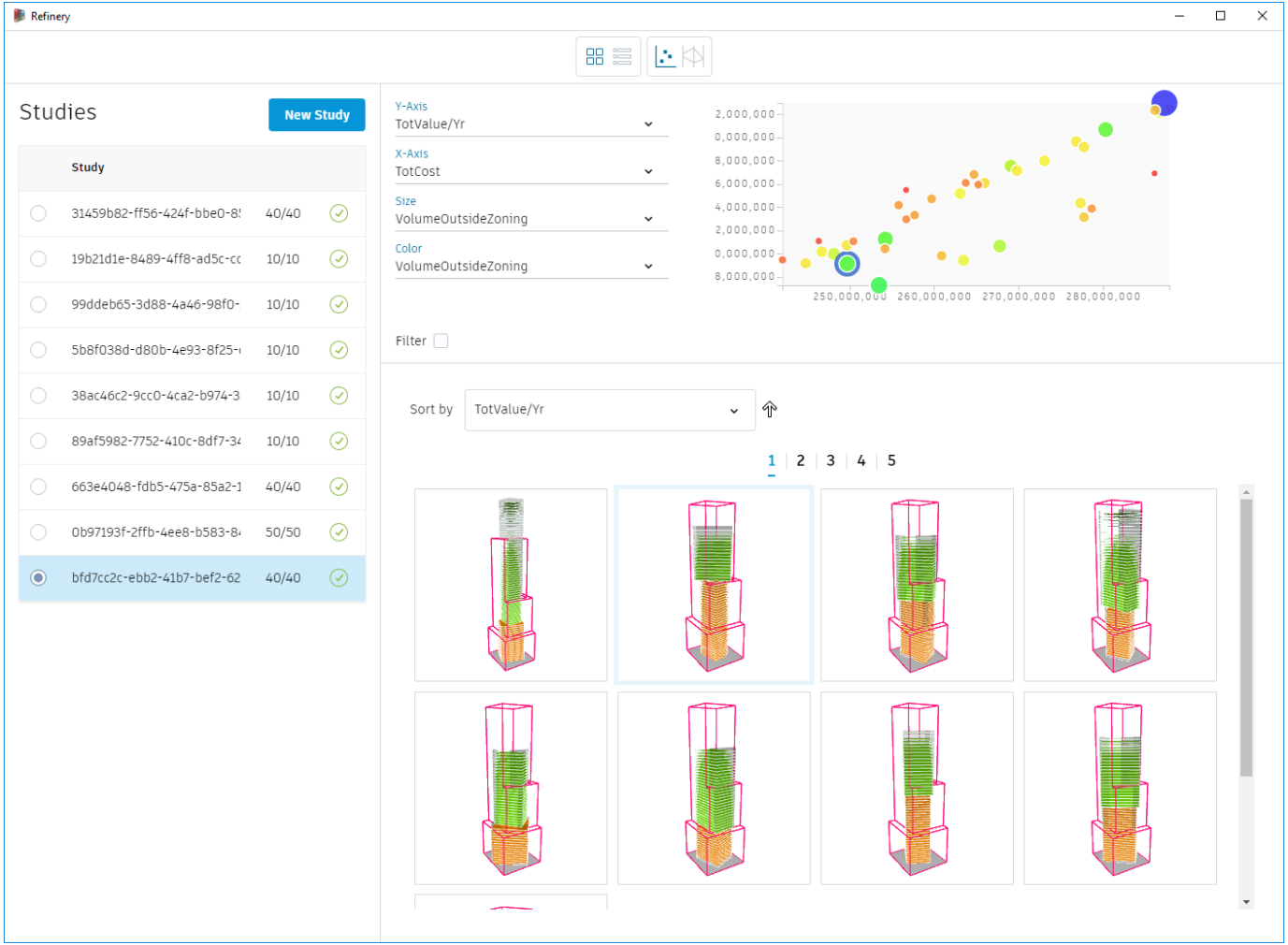
Automatic

Run completed with warnings.


Y-Axis
TotValue/Yr
Create Study
Generation Method
Randomize
Inputs
Outputs
Settings
Number of solutions
40
Enter a number.
Seed
1
Enter a number to control where randomization starts.
Server is running.
Generate

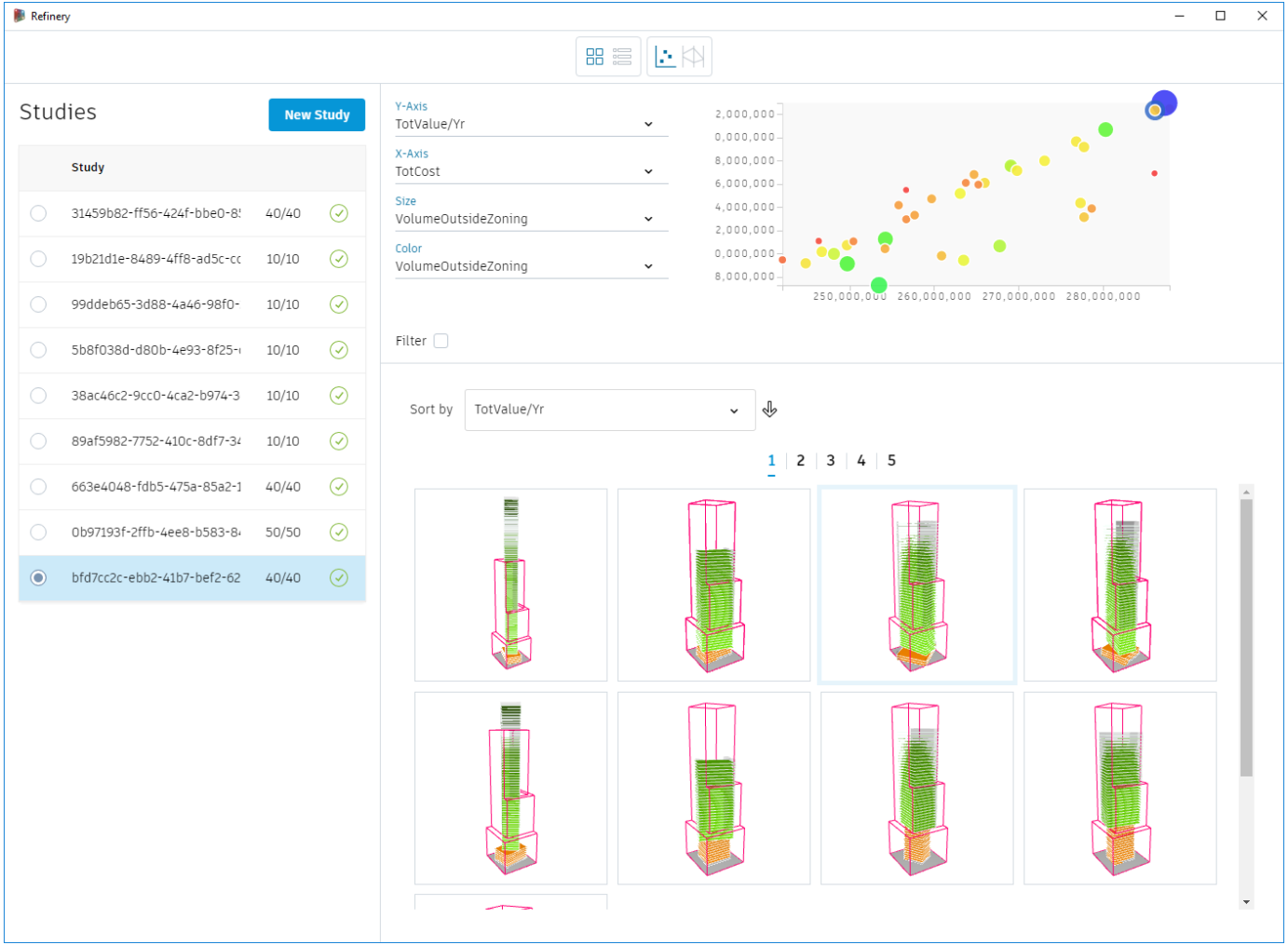
Refinery

40 Random Runs
Least Value/Yr



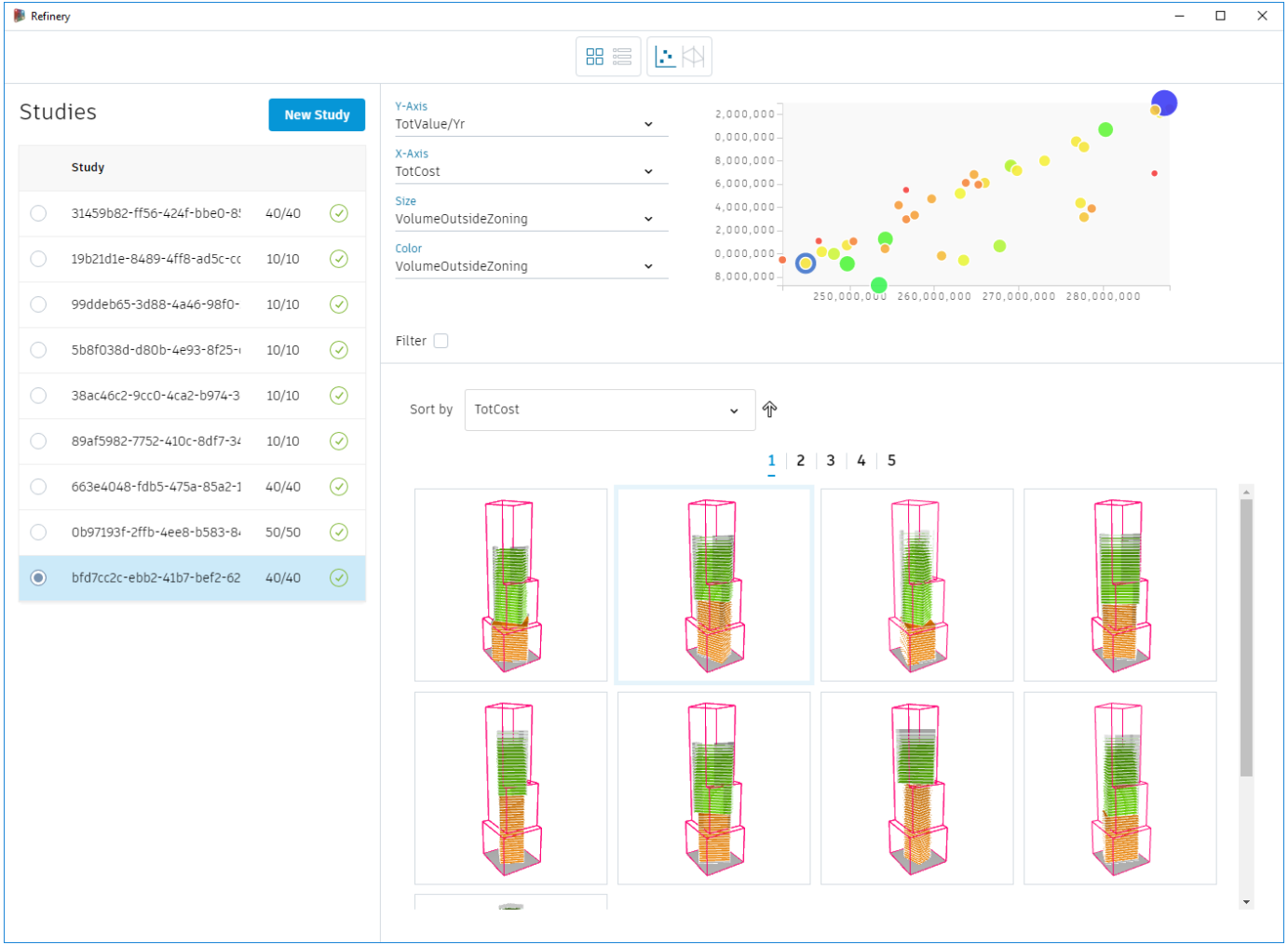
Refinery

40 Random Runs
Most Value/Yr



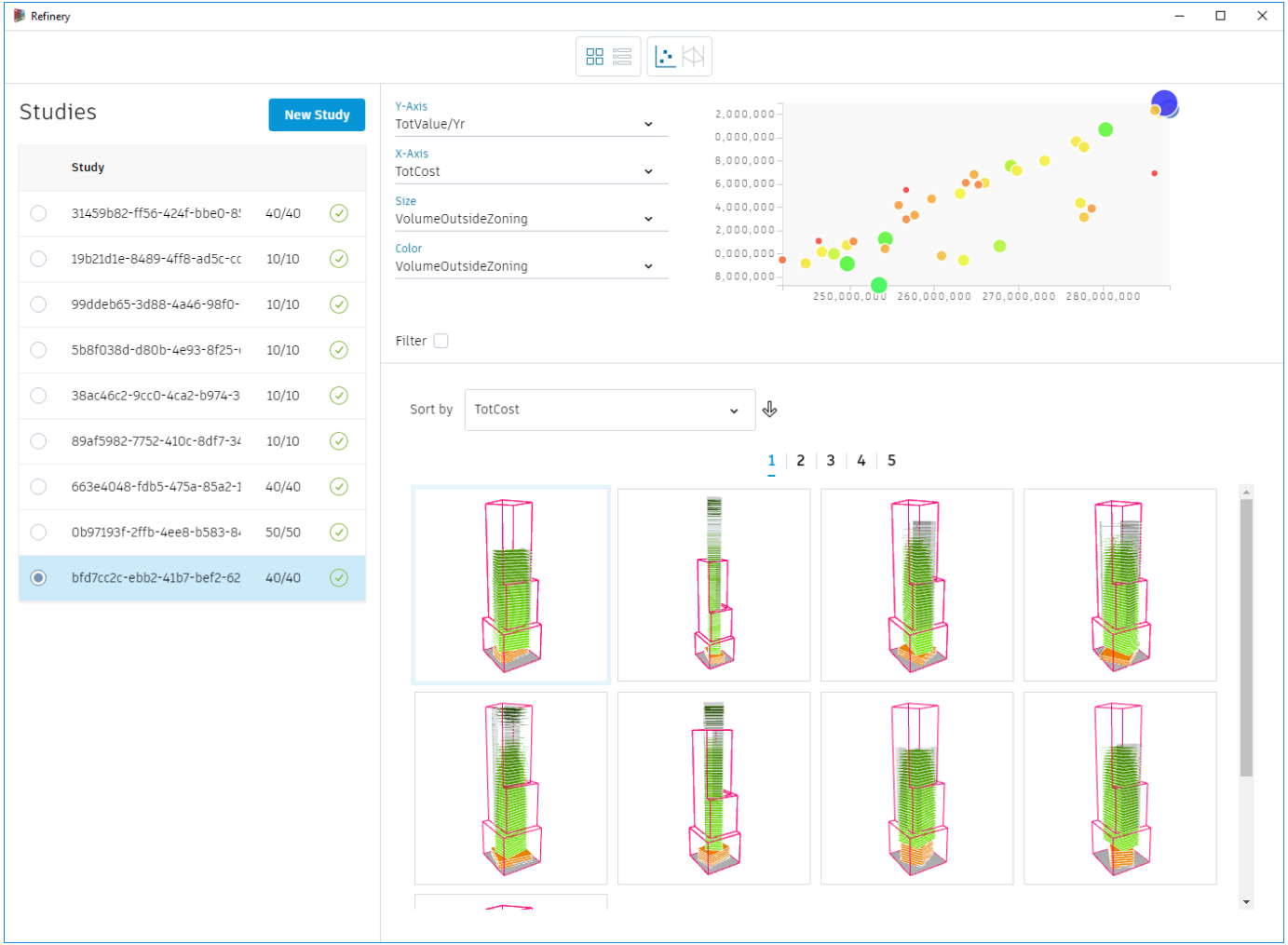
Refinery

40 Random Runs
Lowest Cost



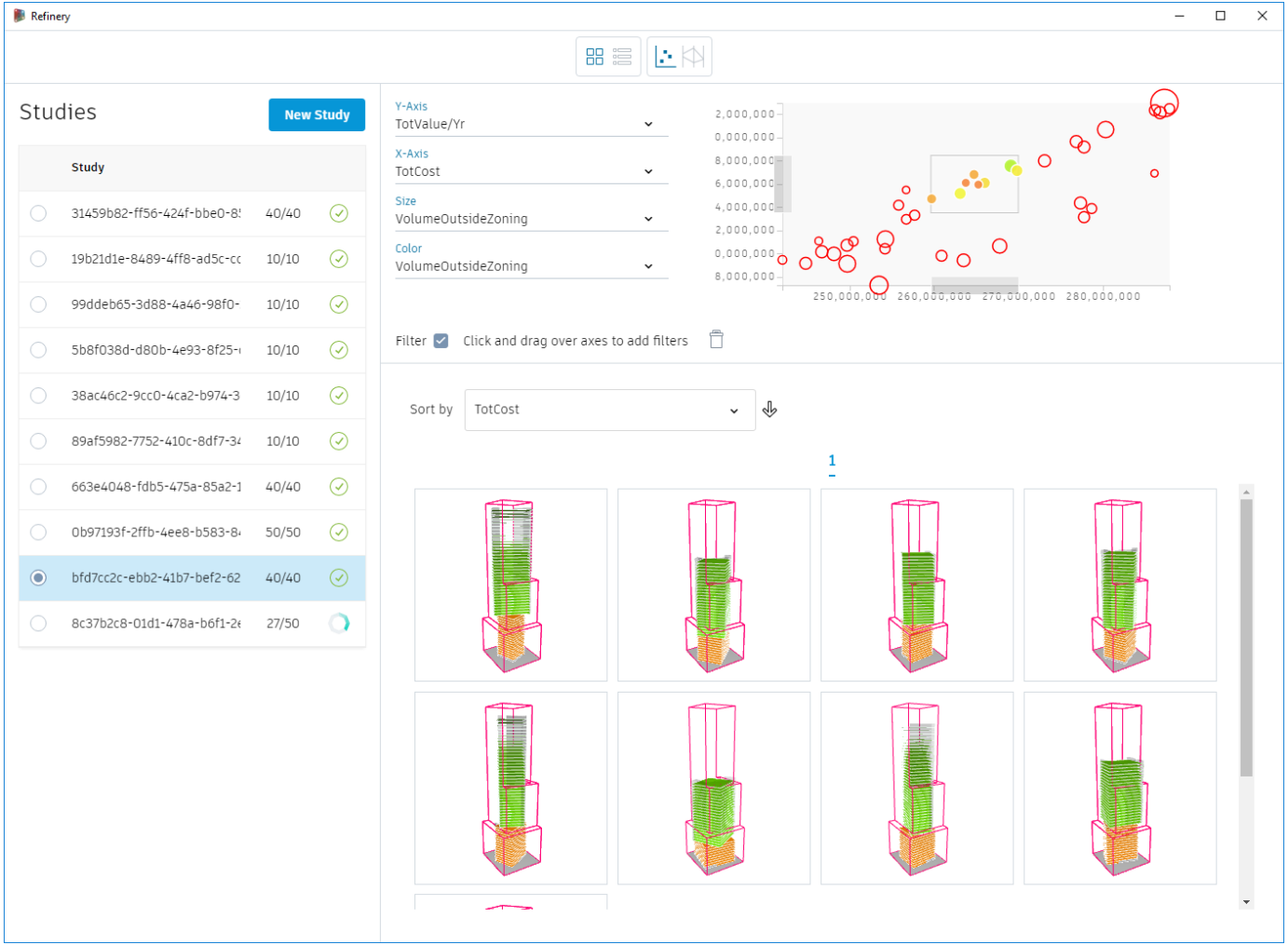
Refinery

40 Random Runs
Highest Cost



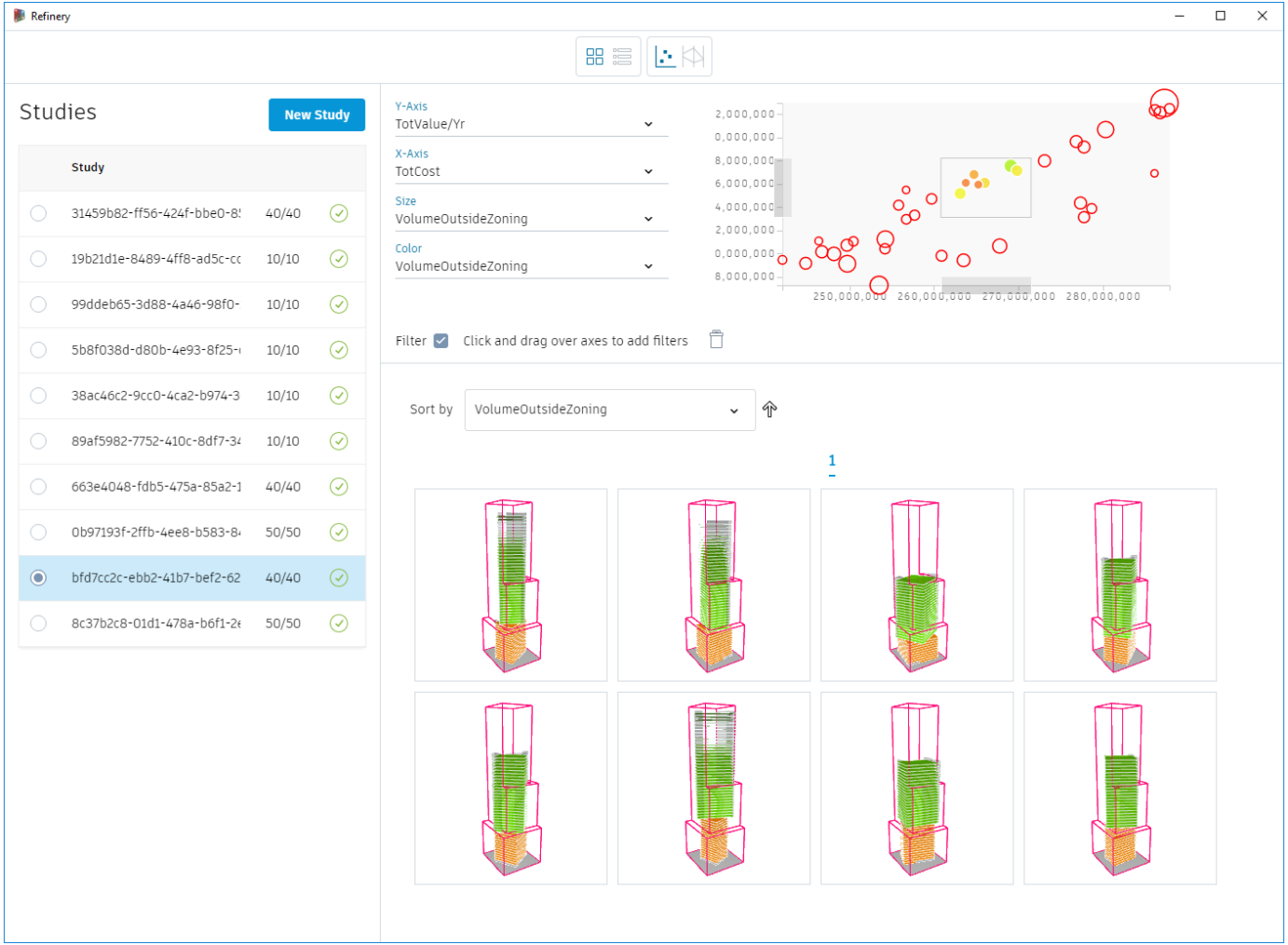
Refinery

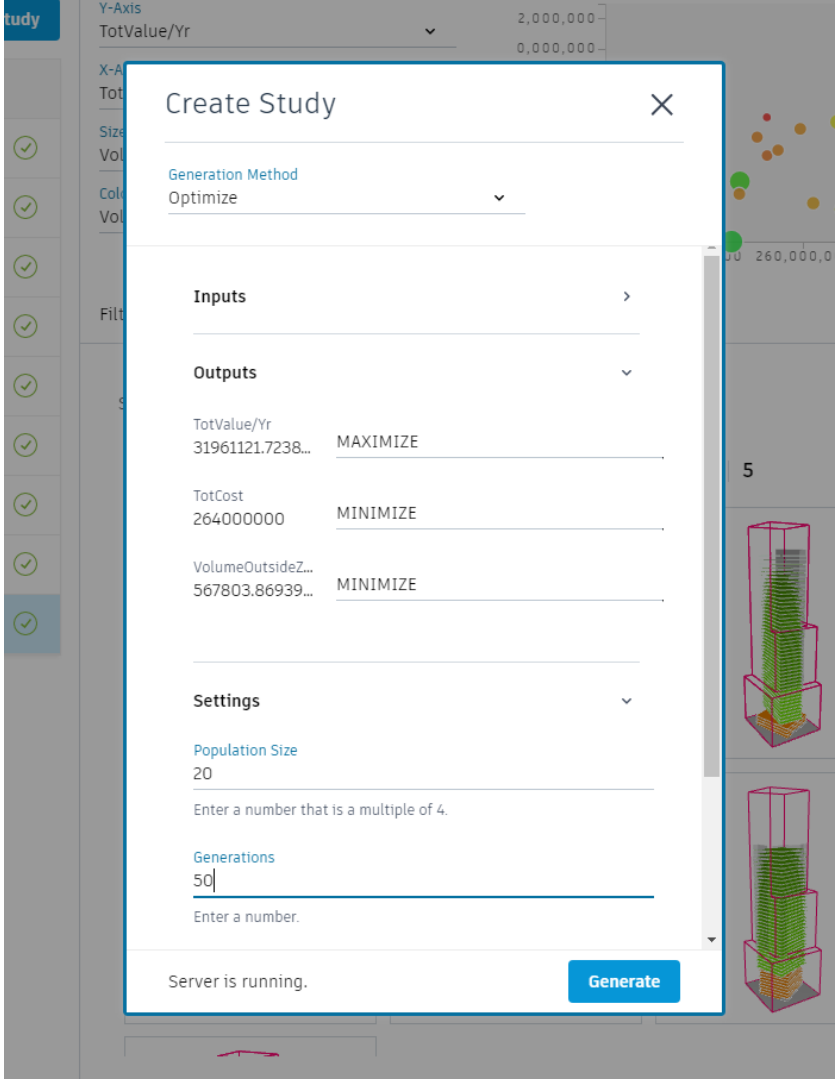
40 Random Runs
Medium Cost
Medium Value



Refinery

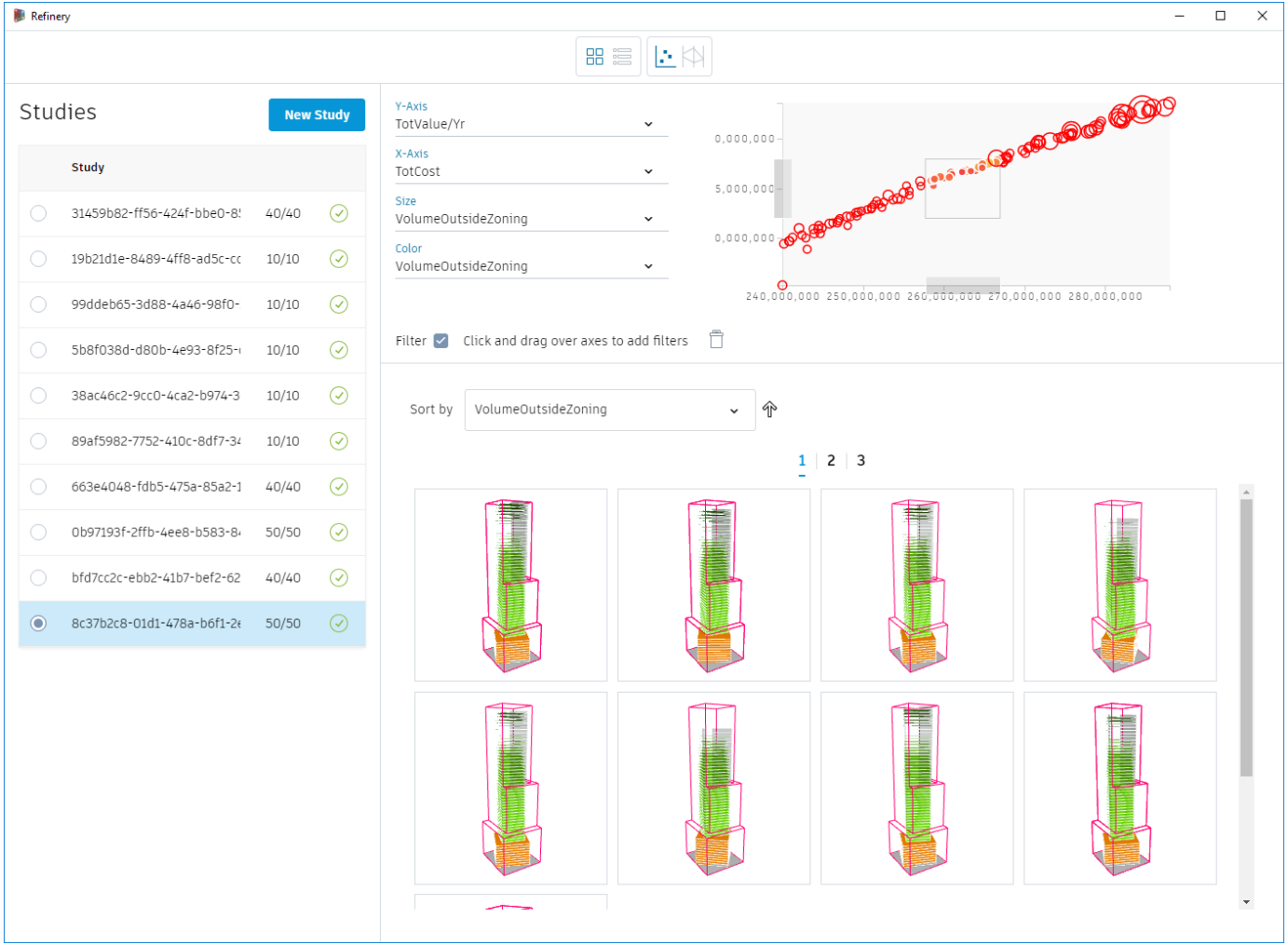
40 Random Runs
Medium Cost
Medium Value
Lowest volume
Outside zoning

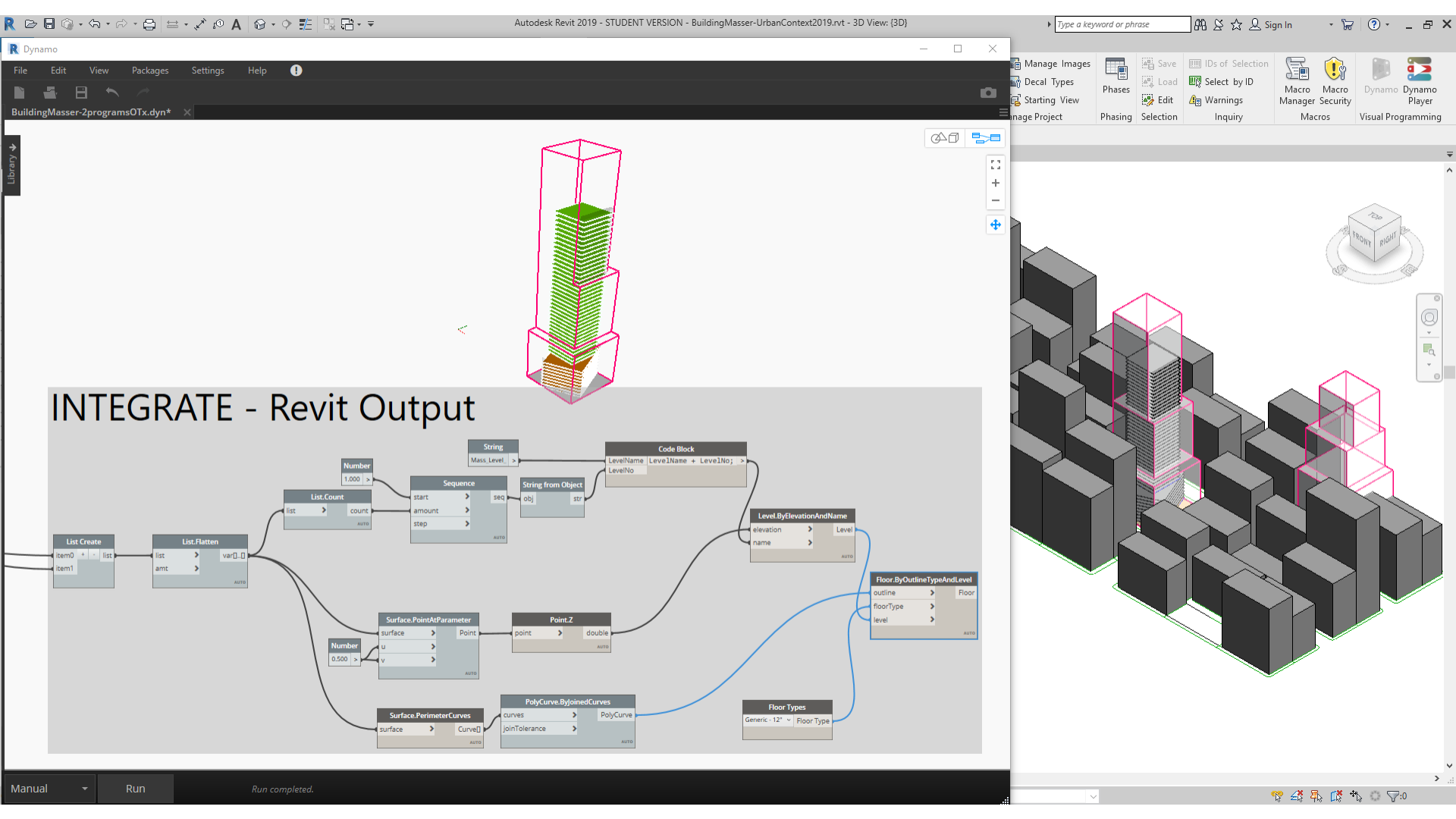



Y-Axis
TotValue/Yr
2,000,000
0,000,000
Create Study
Generation Method
Optimize
Inputs
Outputs
TotValue/Yr
31961121.7238...
MAXIMIZE
TotCost
264000000
MINIMIZE
VolumeOutsideZ...
567803.86939...
MINIMIZE
Settings
Population Size
20
Enter a number that is a multiple of 4.
Generations
50
Enter a number.
Server is running.
Generate

Refinery

20x50 Optimization
Medium Cost
Medium Value
Lowest volume
Outside zoning




Autodesk Revit 2019 - STUDENT VERSION - BuildingMasser-UrbanContext2019.rvt - 3D View: {3D}
Dynamo
File
Edit
View
Packages
Settings
Help
BuildingMasser-2programsOTx.dyn*
Library
INTEGRATE - Revit Output
String
Mass_Level
Code Block
LevelName Level1Name + Level1No;
LevelNo
Number
1.000
Sequence
start
amount
step
seq
List.Count
list
count
String from Object
obj
str
List Create
item0
item1
List.Flatten
list
amt
var[]..[]
Level.ByElevationAndName
elevation
name
Level
Floor.ByOutlineTypeAndLevel
outline
floorType
level
Floor
Surface.PointAtParameter
surface
u
v
Point
Point.Z
point
double
Number
0.500
Surface.PerimeterCurves
surface
Curve[]
PolyCurve.ByJoinedCurves
curves
joinTolerance
PolyCurve
Floor Types
Generic - 12"
Floor Type
Manual
Run
Run completed.
Manage Images
Decal Types
Starting View
Phases
Save
Load
Edit
IDs of Selection
Select by ID
Warnings
Macro Manager
Macro Security
Dynamo
Dynamo Player
Phasing
Selection
Inquiry
Macros
Visual Programming
Type a keyword or phrase
Sign In
TOP
FRONT
RIGHT

Additional Learning Resources

- Getting Started with Dynamo:
  - https://primer.dynamobim.org/
- Dynamo Questions, inspiration:
  - https://forum.dynamobim.com/
- Design Script:
  - https://dynamobim.org/wp-content/uploads/forum-assets/colin-mccroneautodesk-com/07/10/Dynamo_language_guide_version_1.pdf
  - http://designscript.io/DesignScript_user_manual_0.1.pdf
  - https://dynamobim.org/wp-content/links/DesignScriptDocumentation.pdf
  - https://github.com/Amoursol/dynamoDesignScript
- Refinery:
  - https://www.autodesk.com/solutions/refinery-beta
- Generative Design education:
  - https://medium.com/generative-design

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