AUTODESK UNIVERSITY

Generative Design Using Dynamo for Multi-Family Residential

Ramya Palani & Harish Palani


Perlman
ARCHITECTS

Ramya Palani

Job Captain - BIM Technician
Perlman Architects, Las Vegas.

Experience:	4 years
Ex. Employers:	Gensler, Las Vegas. W Design, Tulsa. R.dx, India. Autom, India.
2019 – Graduated	Master of Science in Architecture, University of Oklahoma.
2017 – Graduated	Bachelor of Architecture, Anna University.
Fun fact:	I lived in 6 cities in two different countries. Love travelling (not at all a foodie).

LinkedIn: Ramya Palani

Harish Palani

North Carolina State University - Class of 2020
Master of Architecture, College of Design.

Employers:	Third Space, India. PAN Architecture Studio, India
2019 – Graduated	Bachelor of Architecture, School of Architecture, Meenakshi College of Engineering.

Fun Fact: I am married to my wood workshop

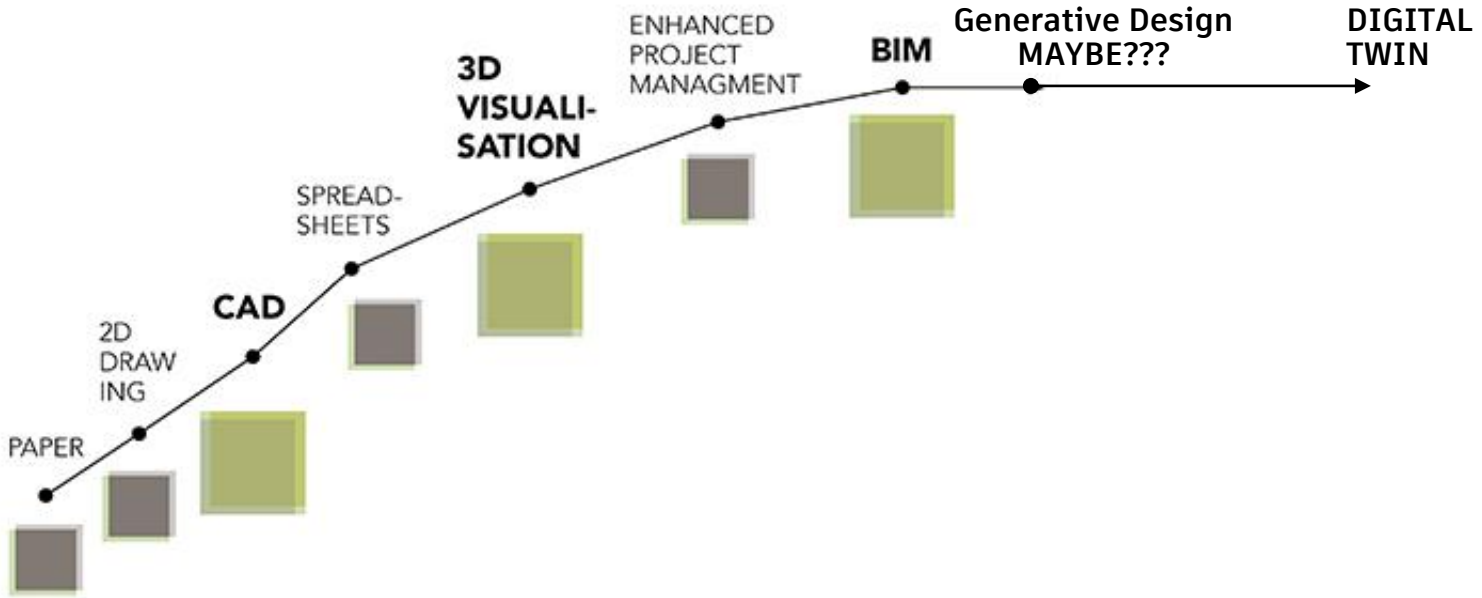
LinkedIn: @Harish Palani

AGENDA

1. EVOLUTION OF AEC INDUSTRY AND GENERATIVE DESIGN
2. LEARNING OBJECTIVE & GOALS
3. DESIGN SCOPE & GENERATIVE DESIGN BASICS
4. SITE SOLUTION – EXTRUDE & EVALUATE
5. BUILDING GENERATION
6. UNIT GENERATION
    1. RANDOM & EVALUATE METHOD
    2. REGULATIVE METHOD
7. INFERENCE & CONCLUSION

EVOLUTION OF TECHNOLOGY IN AEC INDUSTRY

FIGURE 1: EVOLUTION OF TECHNOLOGY WITHIN AEC INDUSTRY



Reference: https://www.indiacadworks.com/blog/successful-bim-adoption-for-architects/

LEARNING OBJECTIVE

1. Identify workflows in dynamo for producing “efficient” multi-family design options.
2. Implement similar automation processes to minimize downtime.
3. Discover innovative design solutions for custom site conditions.

GOALS

1. To explore design options for custom site, building, and units.
2. To understand how generative technology can in multi-family design.
3. To understand the pros and cons of using generative design.

DESIGN SCOPE
+
GENERATIVE DESIGN BASICS

DESIGN SCOPE

1. SITE

Massing for custom site

WRAP LAYOUT

https://www.huduser.gov/portal/casestudies/study_02282013_1.html

2. BUILDING

Building envelop generation

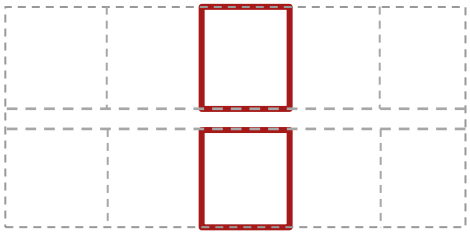
RECTANGULAR

https://homedecor7413.blogspot.com/2020/08/floor-plan-of-apartment-building.html

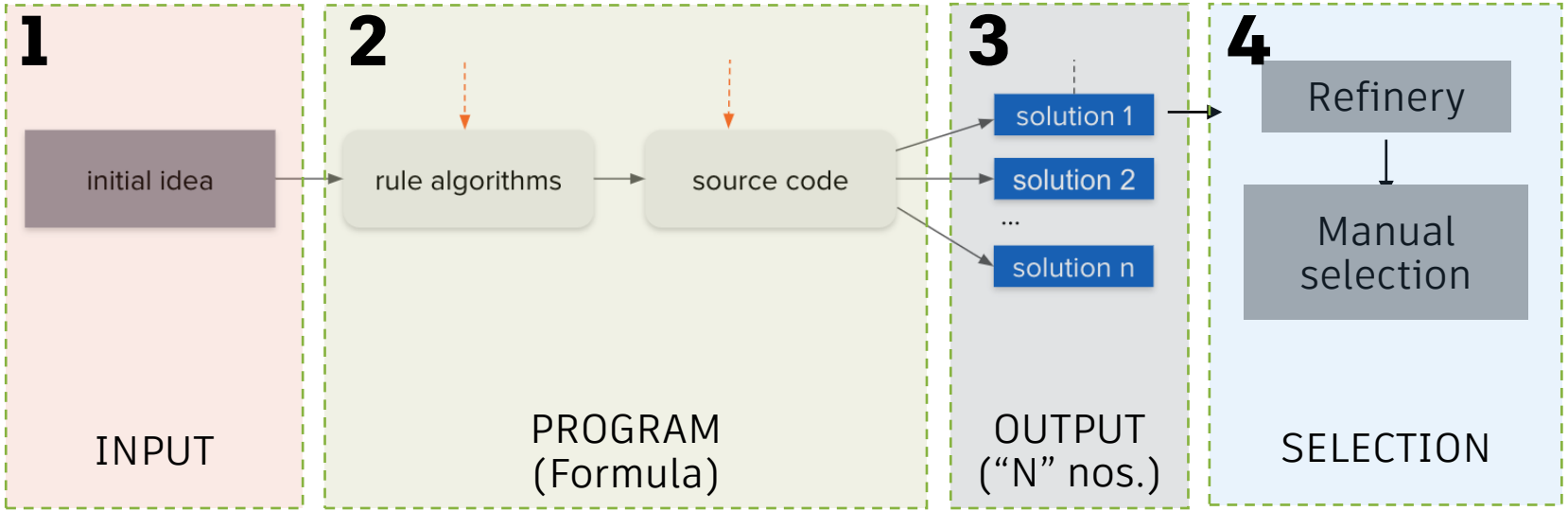
3. UNITS

1. Random & evaluate method
2. Regulative method

FLIP UNIT



BASICS OF GENERATIVE DESIGN



AUTODESK® REVIT®

Dynamo

Create Study | Explore Outcomes
Generative Design

https://formlabs.com/blog/generative-design/

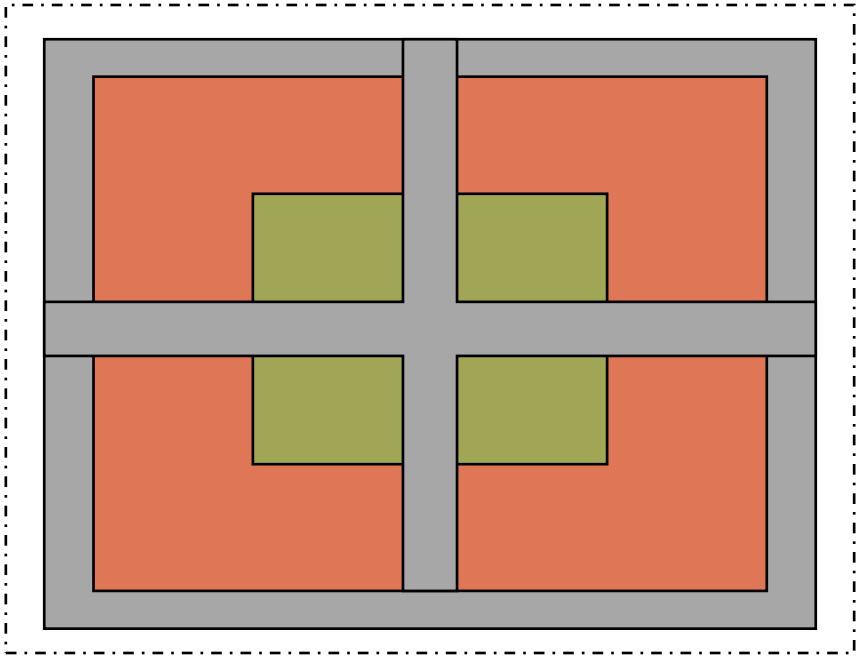
SITE SOLUTION - EXTRUDE & EVALUATE

SITE GENERATION

DESIGN SCOPE

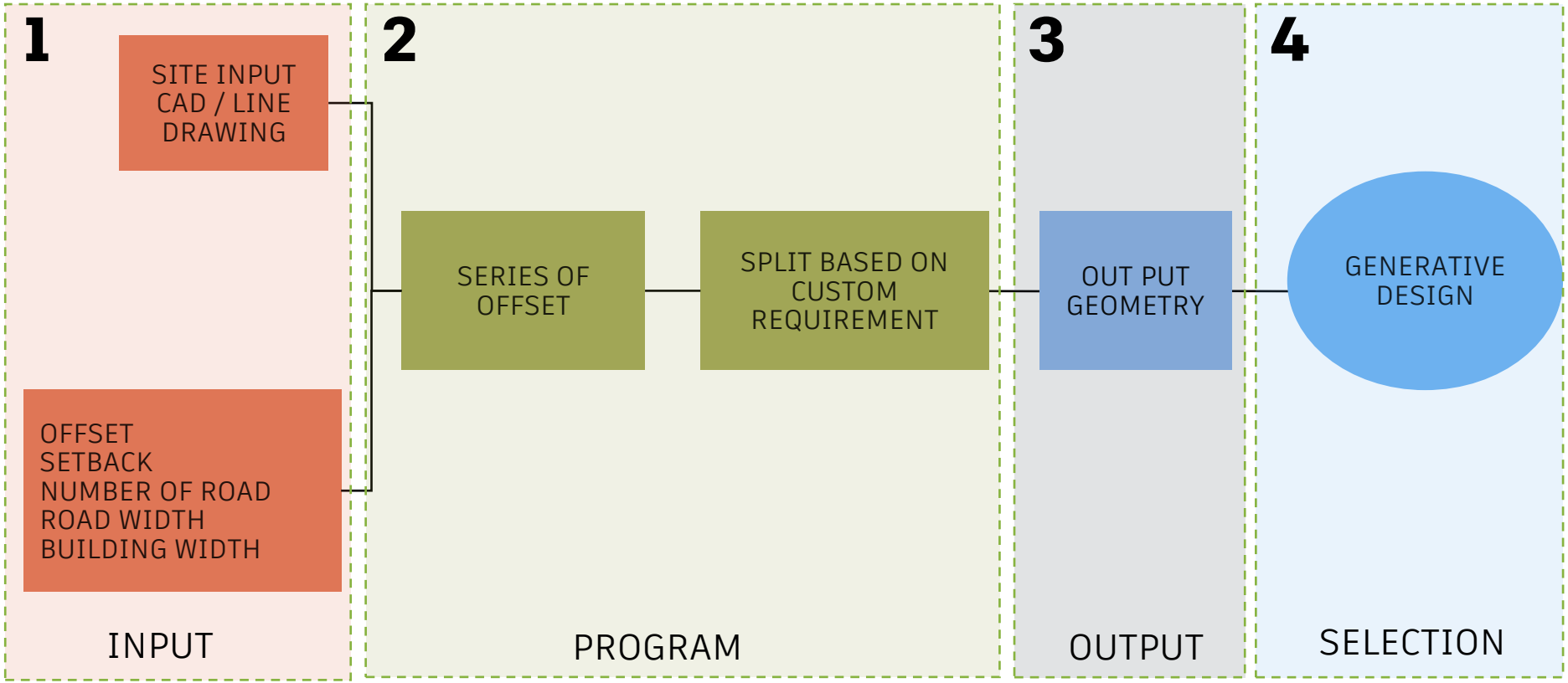
WRAP LAYOUT

https://www.huduser.gov/portal/casestudies/study_02282013_1.html



SITE GENERATION

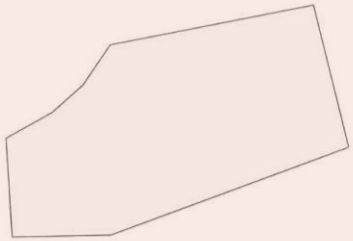
WORKFLOW



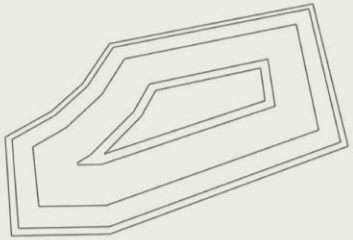
SITE GENERATION

VISUAL DYNAMO

1 SELECTION OF SITE BOUNDARY



2a SERIES OF OFFSET BASED ON INPUTS



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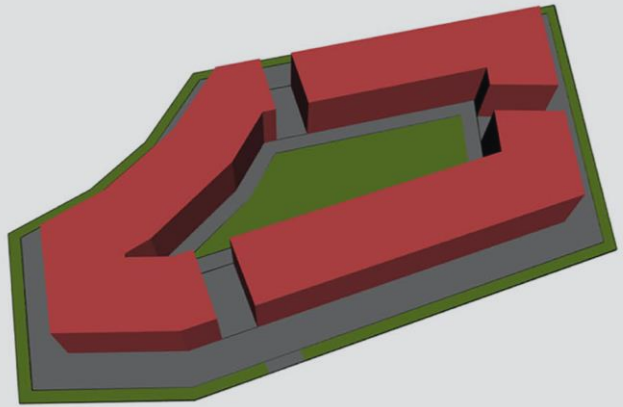
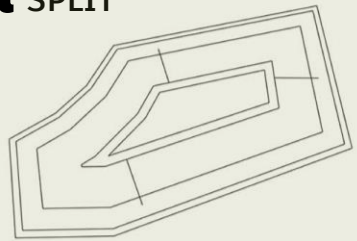
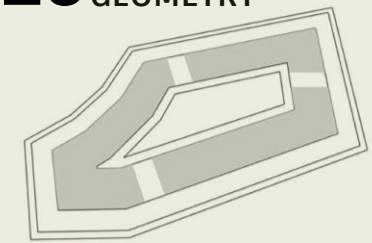


2a LOCATING MASSING SPLIT



2b BUILDING ENVLOPE

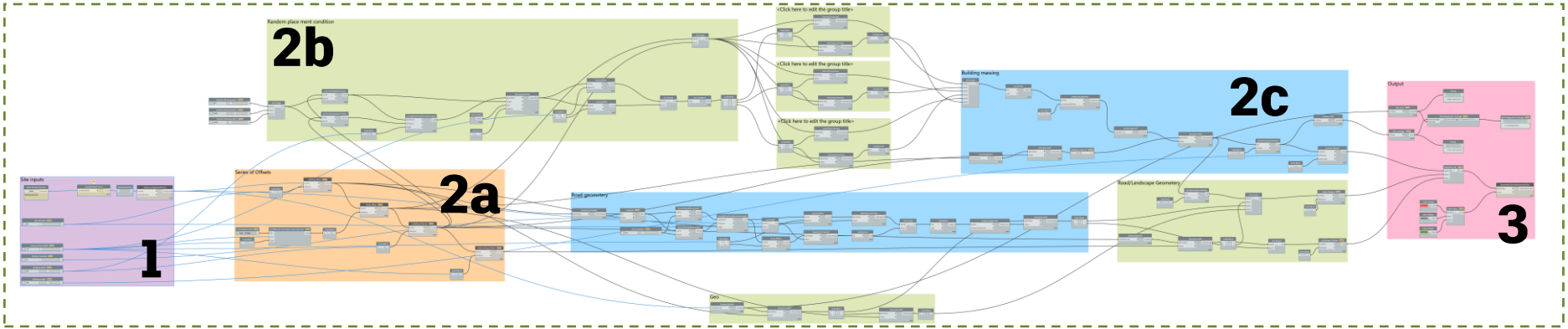
2c INTERSECTION GEOMETRY



3 THICKENING OF THE MASS

SITE GENERATION

DYNAMO SCRIPT

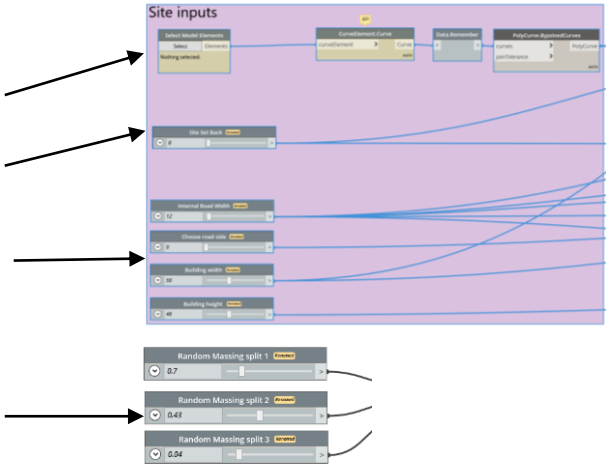


1 INPUT

SITE PROPERTY LINE

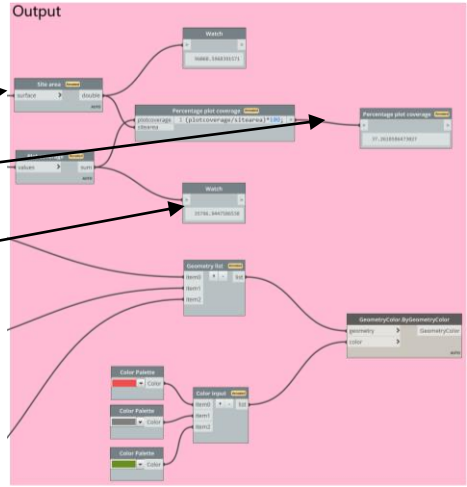
1. SETBACK
2. INTERNAL ROAD WIDTH
3. NUMBER OF ROADS
4. BUILDING WIDTH
5. BUILDING HEIGHT

CUSTOM SPLIT PARAMETER INPUT



3 OUTPUT

1. SITE AREA
2. PLOT COVERAGE PERCENTAGE
3. PLOT COVERAGE AREA



SITE GENERATION

GENERATIVE DESIGN

4

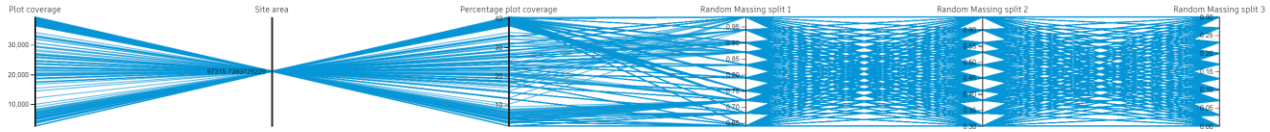
Site solution 1 _ 20210815 005

Charts Details

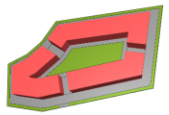
* = No Value

Plot coverage↑	Site area	Percentage plot coverage	Random Massing split 1	Random Massing split 2	Random Massing split 3
2510.942	97315.739	2.580	0.640	0.600	0.030
2510.942	97315.739	2.580	0.640	0.600	0.070
2510.942	97315.739	2.580	0.640	0.600	0.100
2510.942	97315.739	2.580	0.640	0.600	0.130
2510.942	97315.739	2.580	0.640	0.600	0.170
2510.942	97315.739	2.580	0.640	0.600	0.200
2510.942	97315.739	2.580	0.640	0.600	0.230
2510.942	97315.739	2.580	0.640	0.600	0.270
2510.942	97315.739	2.580	0.640	0.600	0.300
2510.942	97315.739	2.580	0.680	0.640	0.030
2510.942	97315.739	2.580	0.680	0.640	0.070
2510.942	97315.739	2.580	0.680	0.640	0.100
2510.942	97315.739	2.580	0.680	0.640	0.130
2510.942	97315.739	2.580	0.680	0.640	0.170
2510.942	97315.739	2.580	0.680	0.640	0.200
2510.942	97315.739	2.580	0.680	0.640	0.230
2510.942	97315.739	2.580	0.680	0.640	0.270
2510.942	97315.739	2.580	0.680	0.640	0.300

Enable filters Click and drag over axes to add filters



Details



Outputs

Plot coverage	38796.537
Site area	97315.739
Percentage plot coverage	39.867

Variables

Random Massing split 1	0.790
Random Massing split 2	0.410
Random Massing split 3	0.100

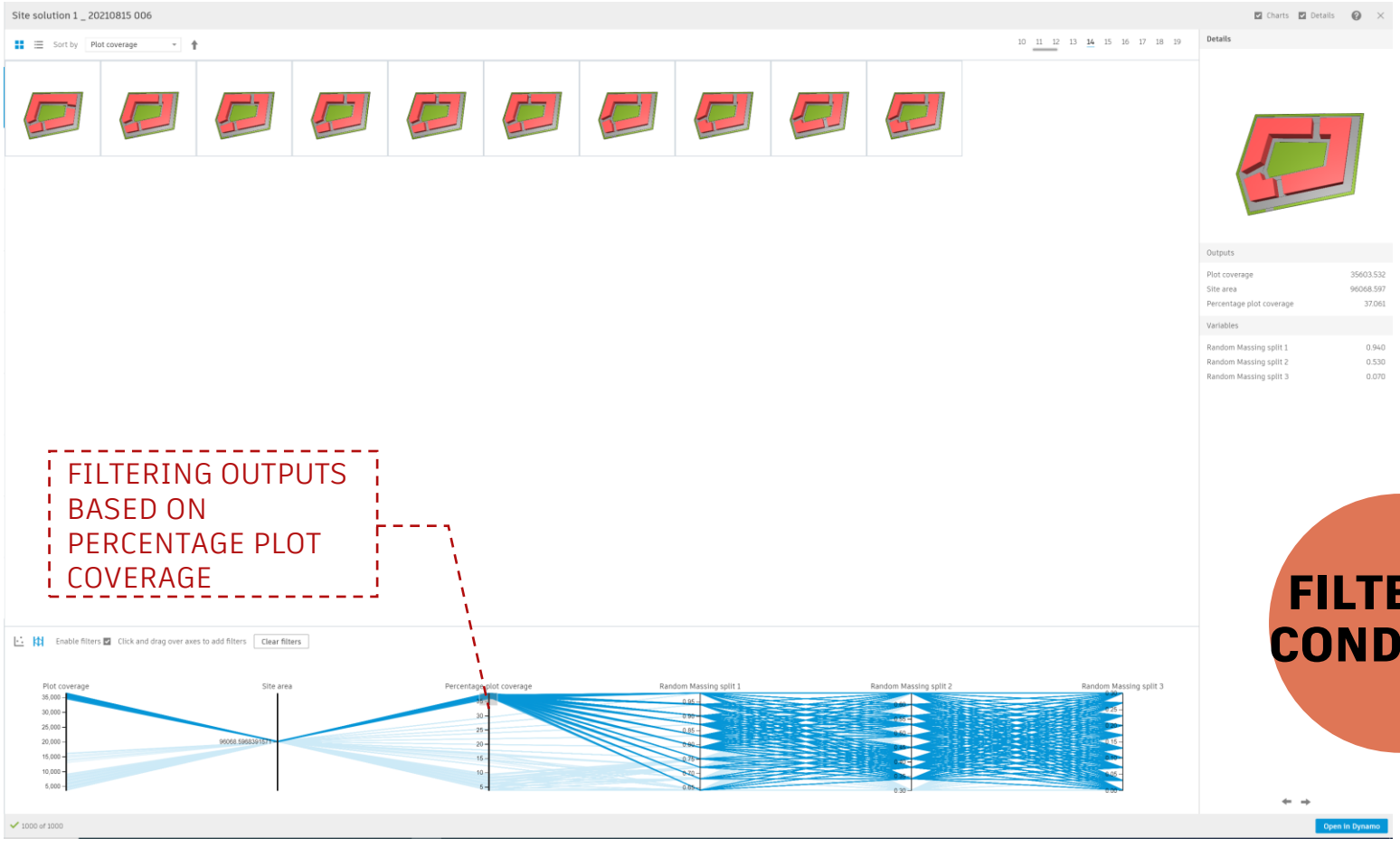
1. PLOT COVERAGE
2. SITE AREA
3. PERCENTAGE OF COVERAGE
4. CUSTOM VARIABLES

1000+ OPTIONS

SITE GENERATION

GENERATIVE DESIGN

4

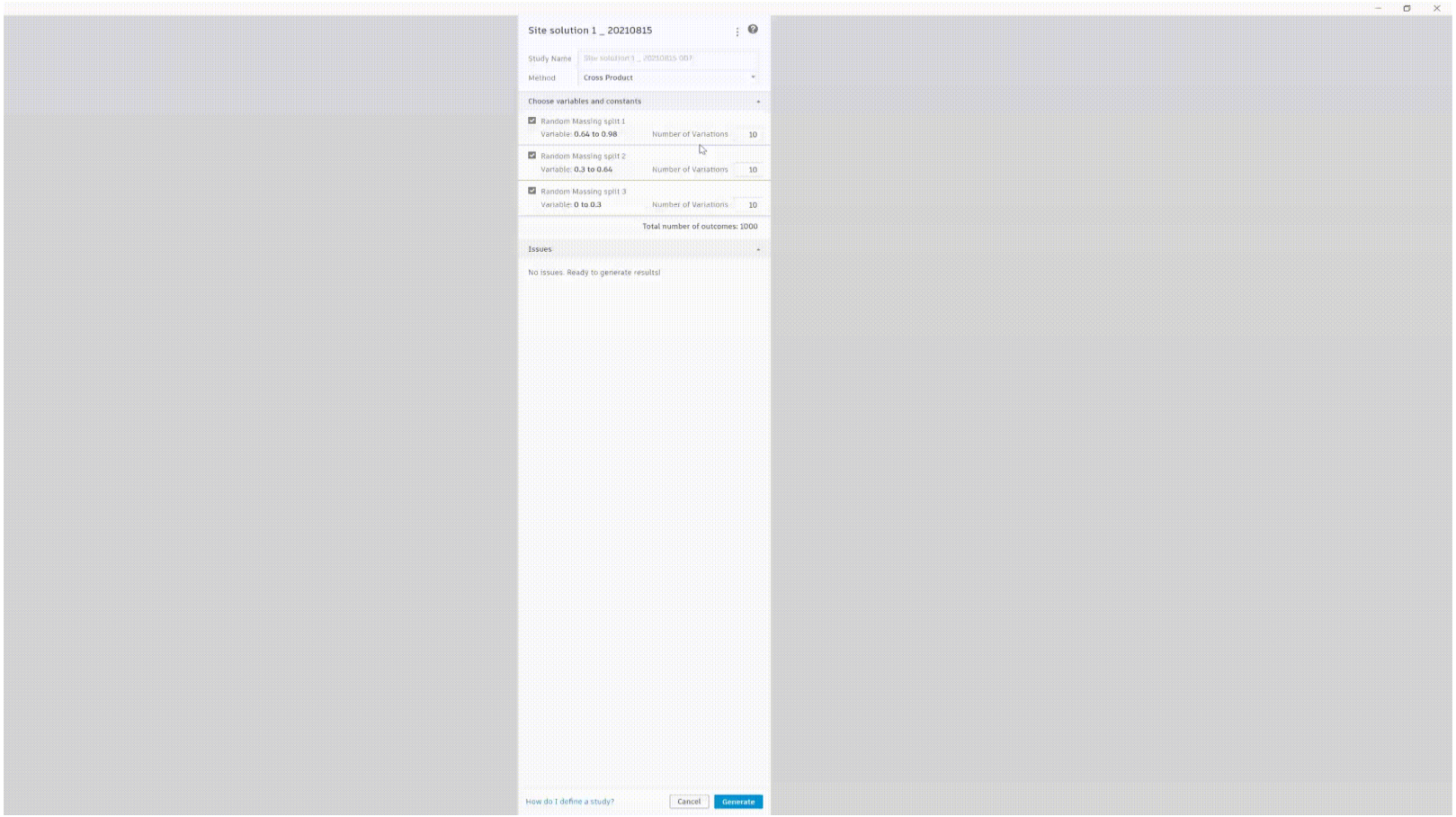


FILTER BY CONDITION

SITE GENERATION

GENERATIVE DESIGN

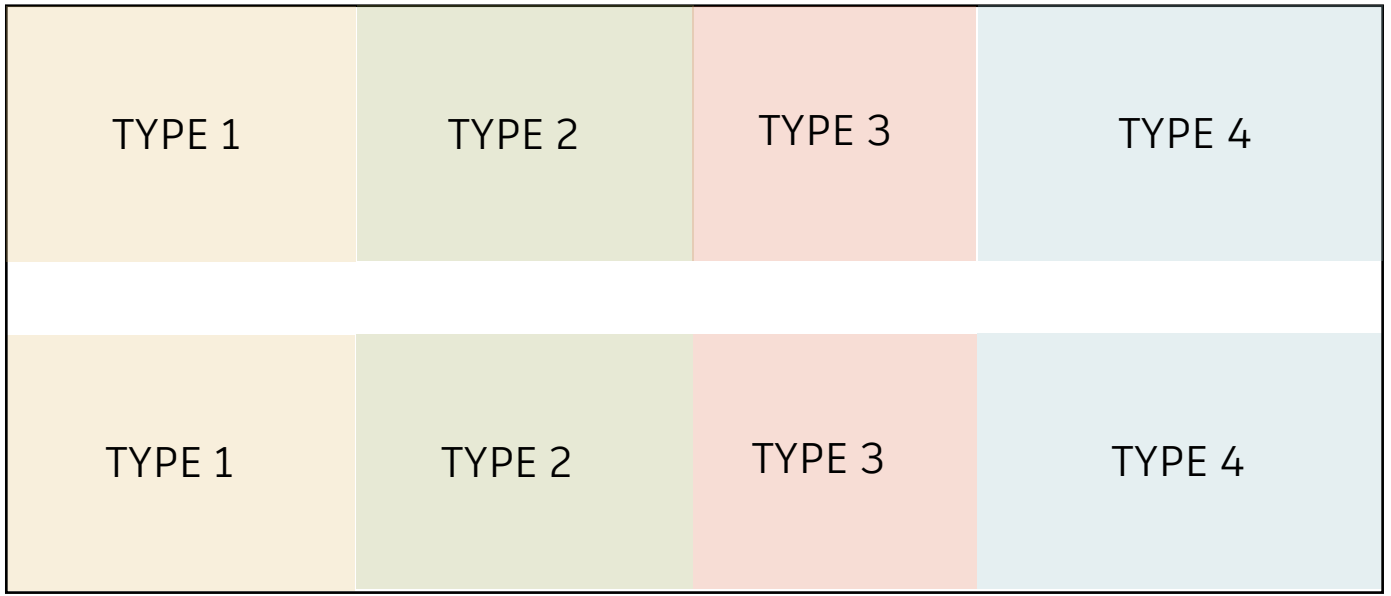
4



BUILDING GENERATION

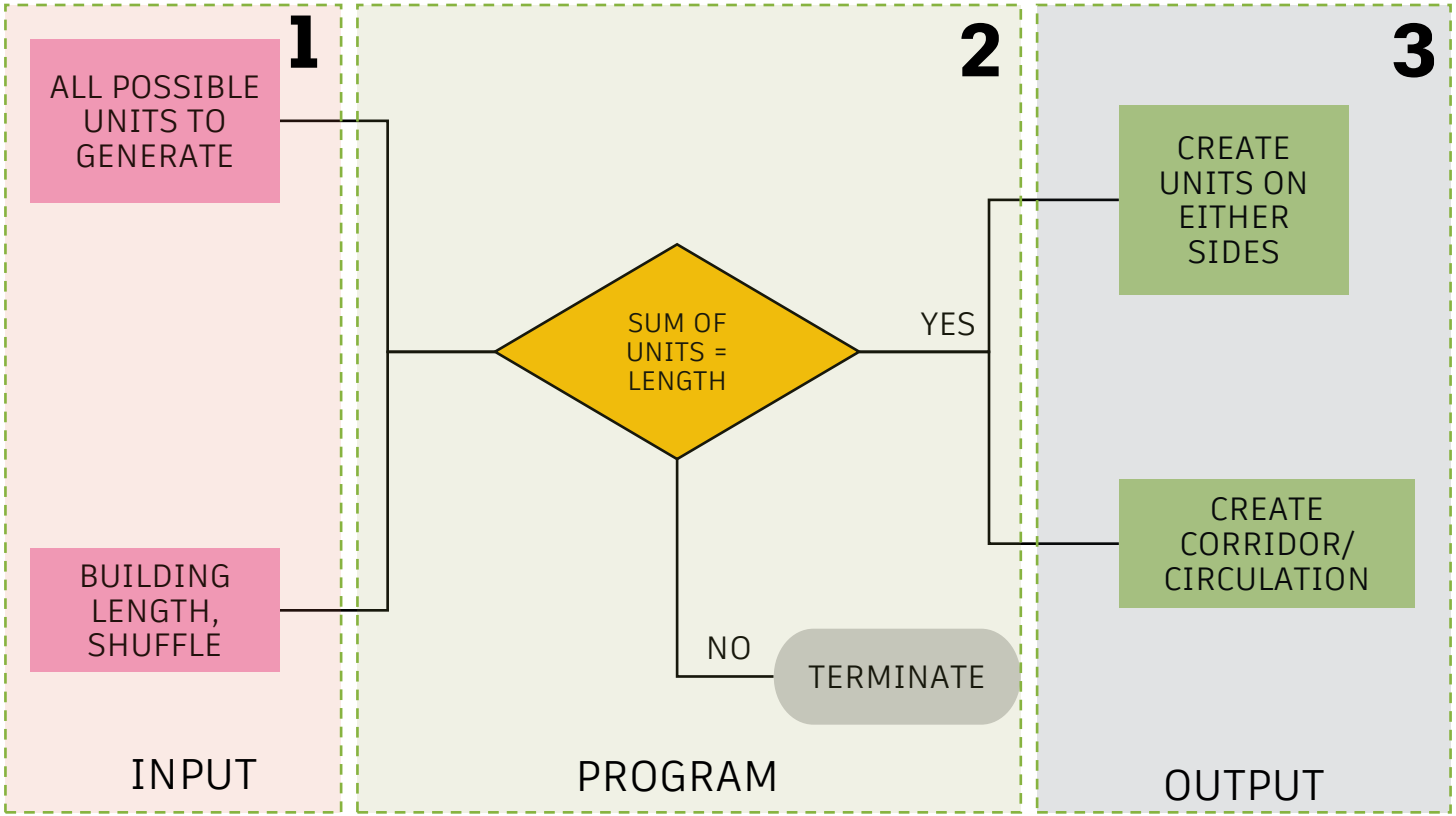
BUILDING GENERATION

DESIGN SCOPE



BUILDING GENERATION

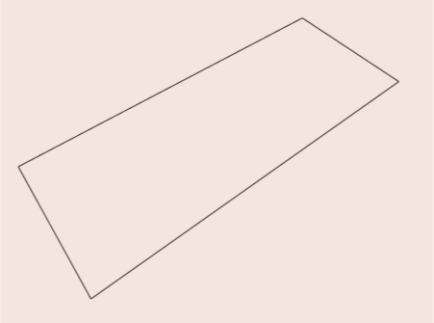
WORKFLOW



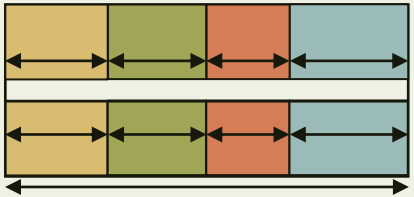
BUILDING GENERATION

VISUAL DYNAMO

1 SELECTION OF BUILDING SHAPE

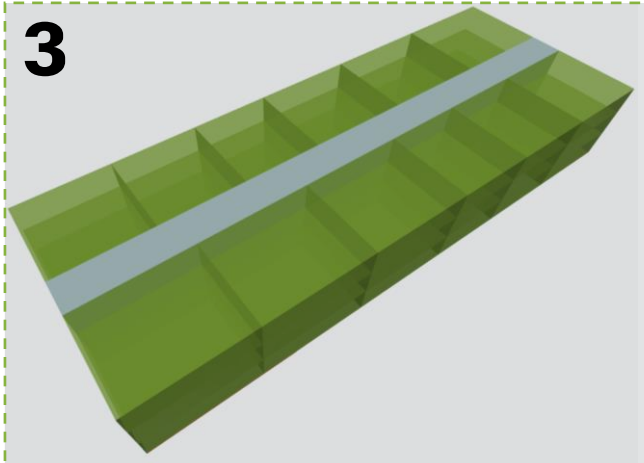


2a CONDITION

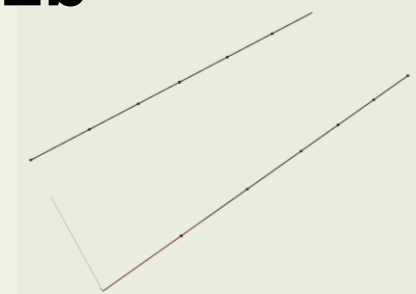


Sum of width of units = *Building Length*

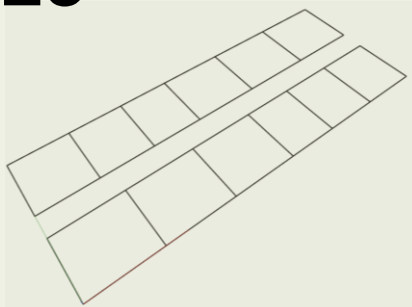
3



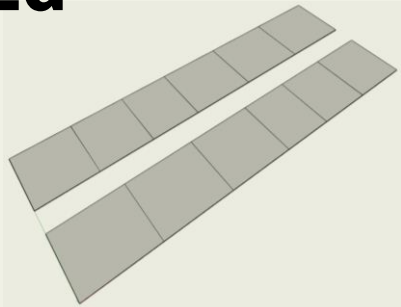
2b UNIT LOCATION



2c UNIT BOUNDARY

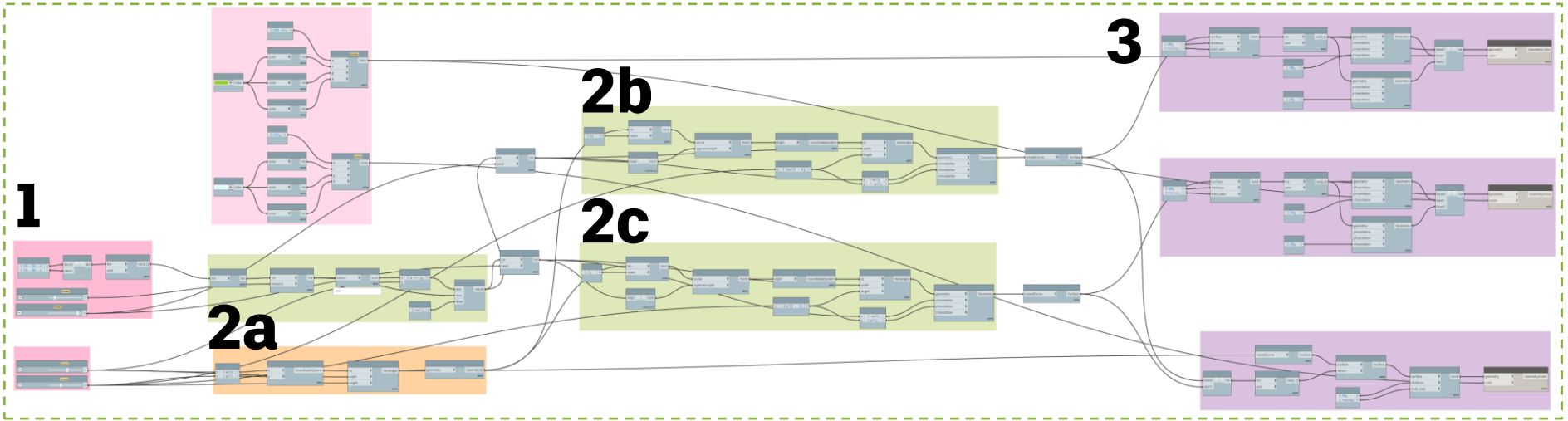


2d BUILDING FLOOR PLAN



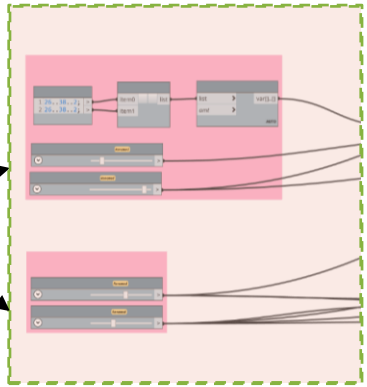
BUILDING GENERATION

DYNAMO SCRIPT



1 INPUTS

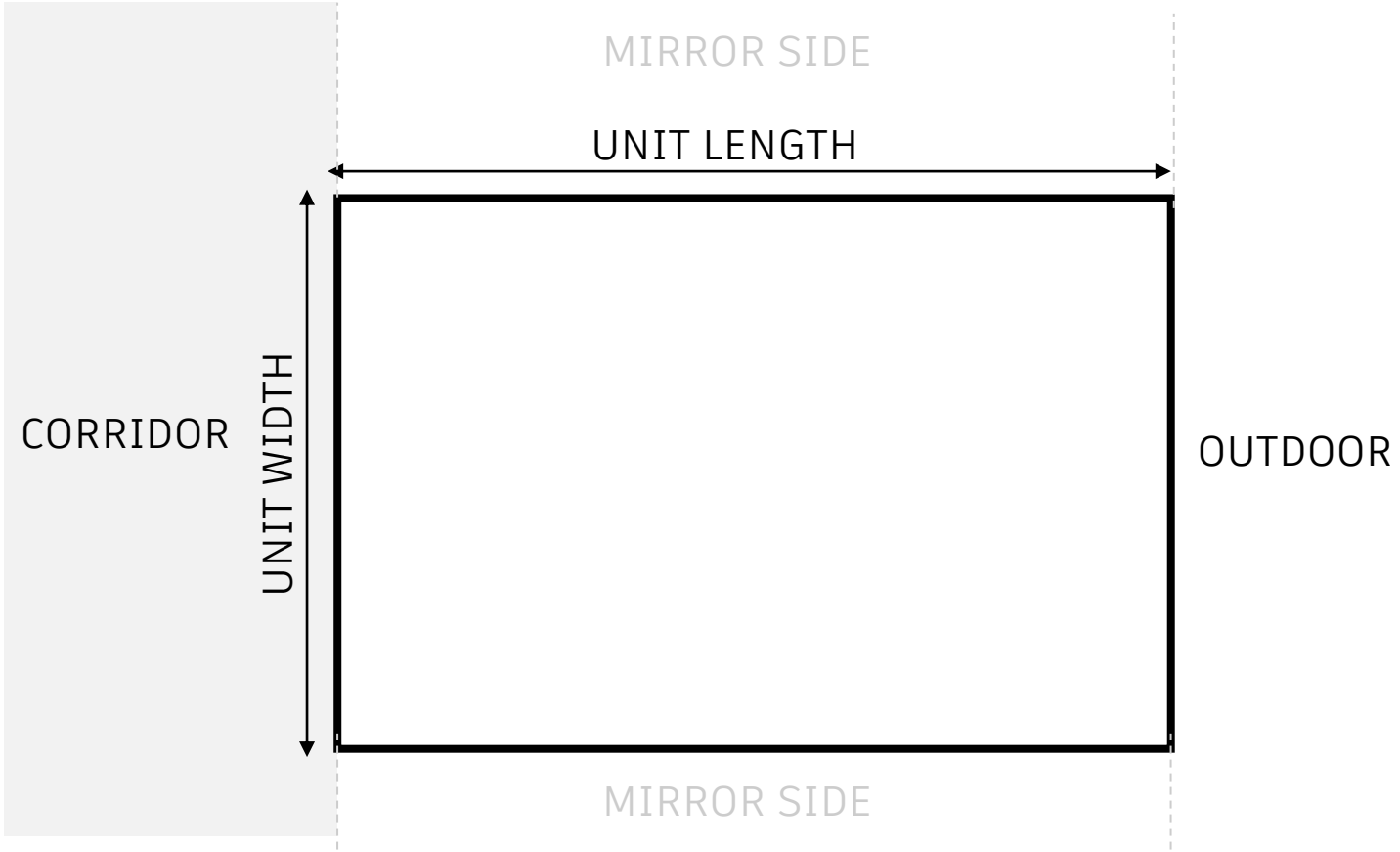
1. ALL UNIT SIZES
2. NUMBER OF UNITS
3. BUILDING LENGTH
4. BUILDING WIDTH



UNIT GENERATION - DESIGN SCOPE

UNIT GENERATION

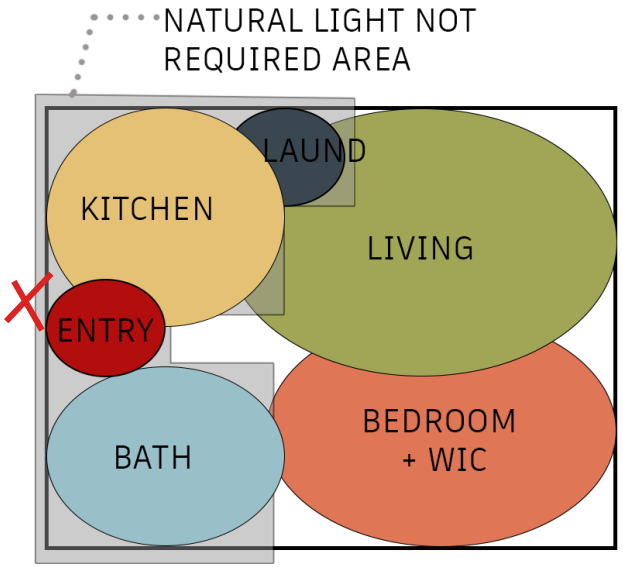
DESIGN SCOPE

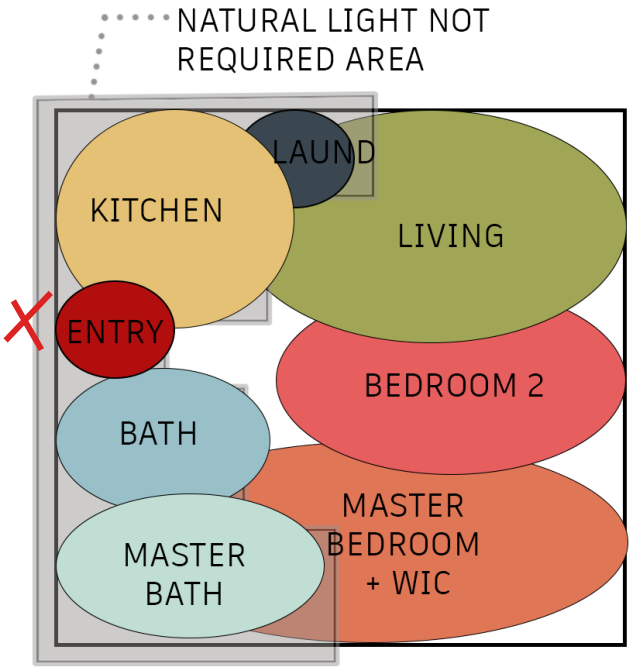


UNIT GENERATION

DESIGN SCOPE

UNIT LOGIC – GROUPING (NLR)

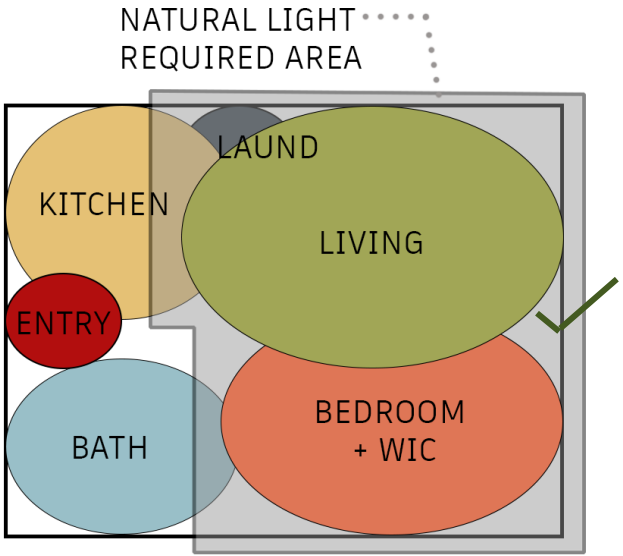


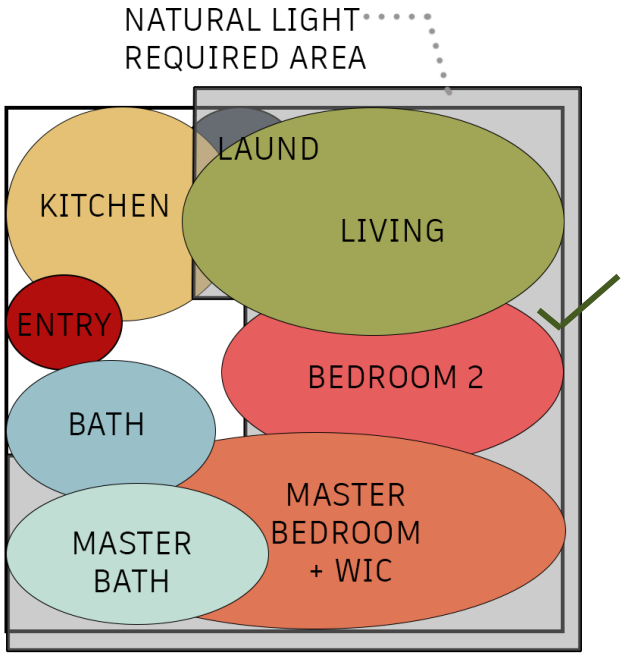


UNIT GENERATION

DESIGN SCOPE

UNIT LOGIC – GROUPING (LR)

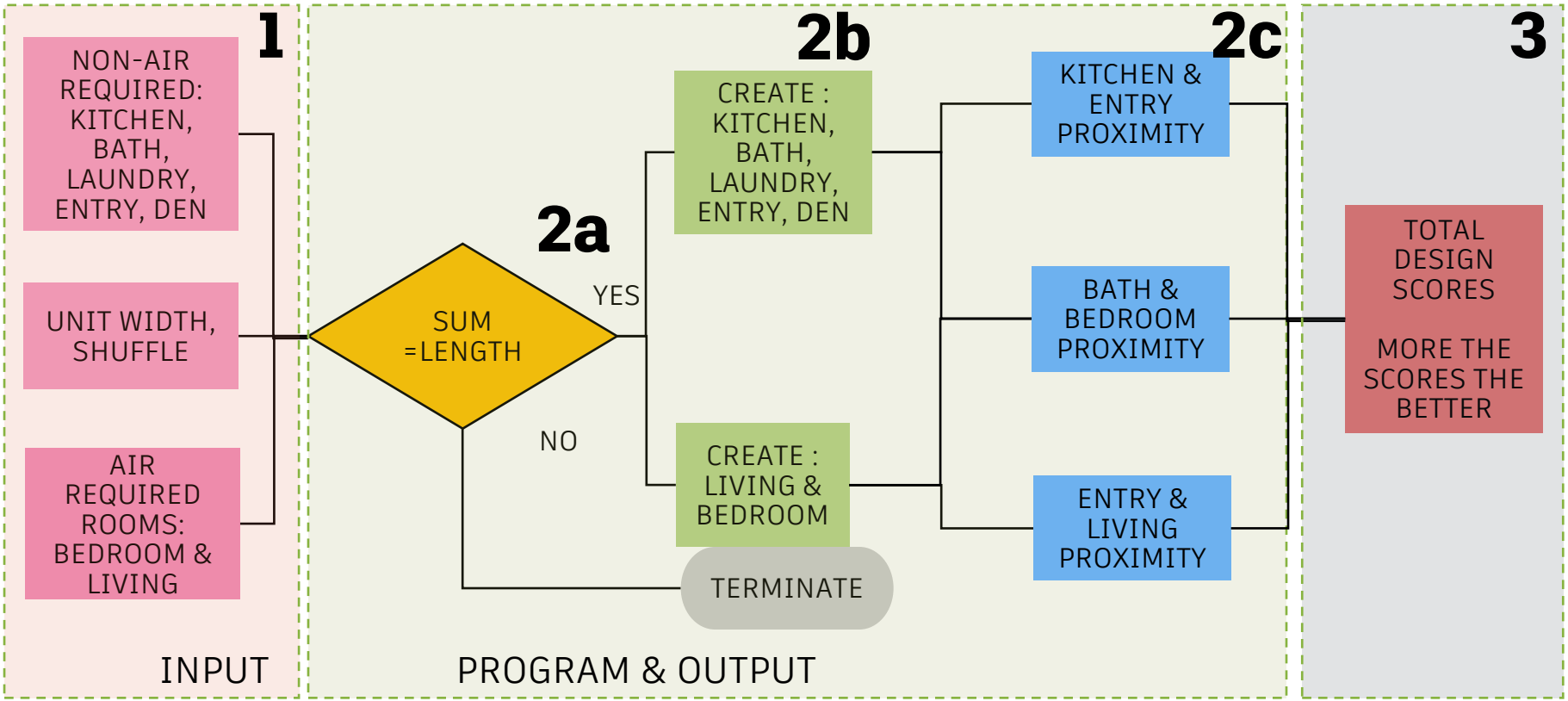




1. RANDOM & EVALUATE METHOD

UNIT GENERATION

WORKFLOW



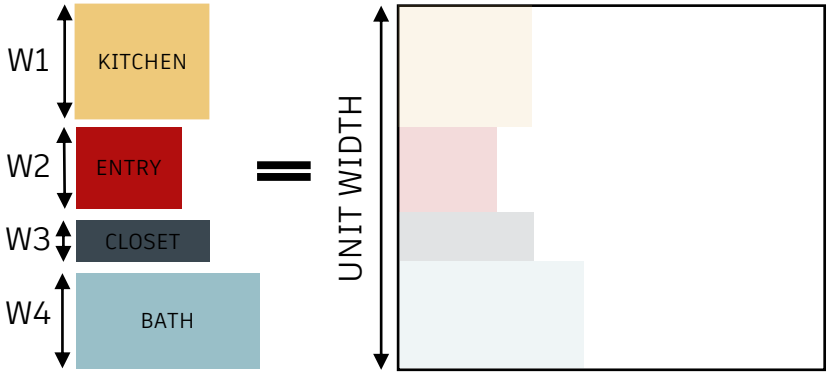
UNIT GENERATION

WORKFLOW

CONDITIONS

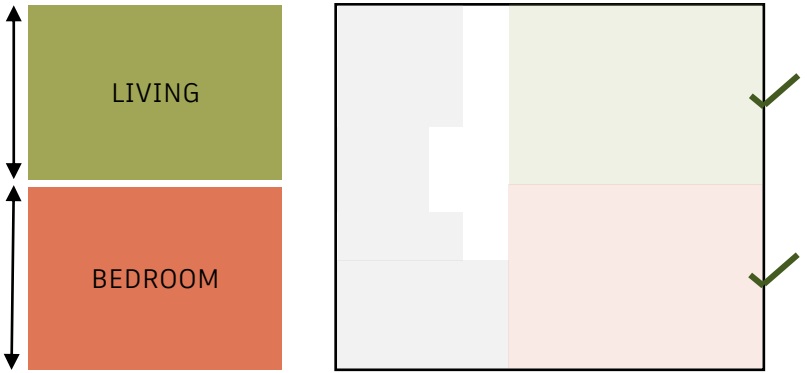
2a

CONDITION 1 – NLR ZONE



W1+W2+W3+W4 = UNIT WIDTH

CONDITION 2 – LR ZONE



W5+ W6 = UNIT WIDTH

If condition 1 **“and”** condition 2 is true, rooms are formed.

UNIT GENERATION

VISUAL DYNAMO

1 ROOMS WIDTH & LENGTH

Kitchen width
Bath width
Laundry width
Closet width
WIC width,

Living width
Bedroom width

Unit width

2a CONDITIONS

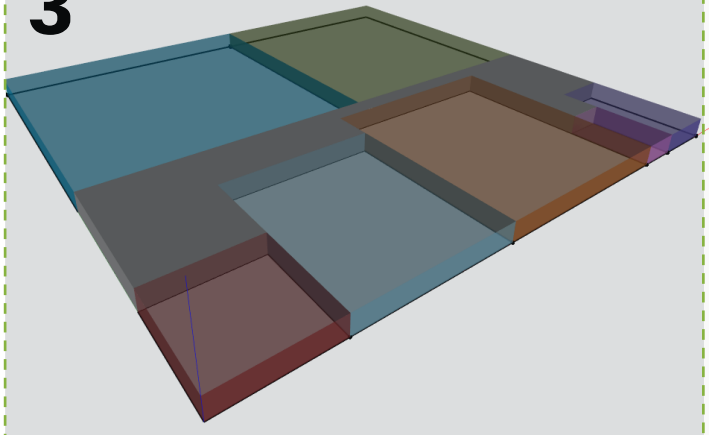
Condition 1

Sum of width of (NLR) = *Unit Width*

Condition 2

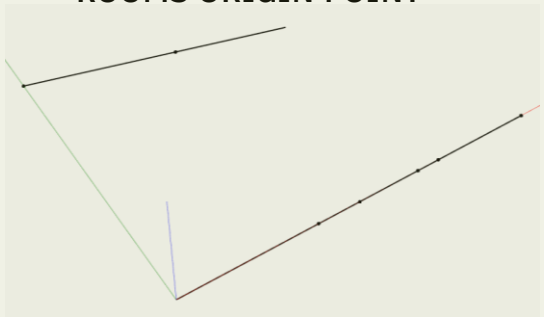
Sum of width of (LR) = *Unit Width*

3

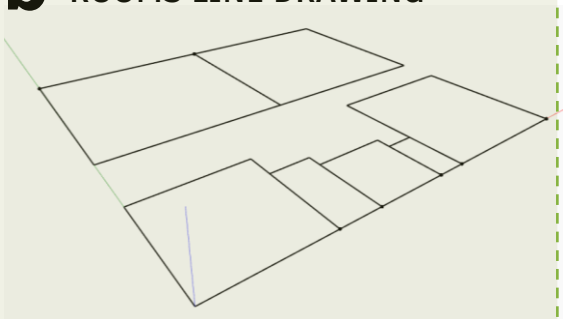


UNIT BOUNDARY

ROOMS ORIGIN POINT

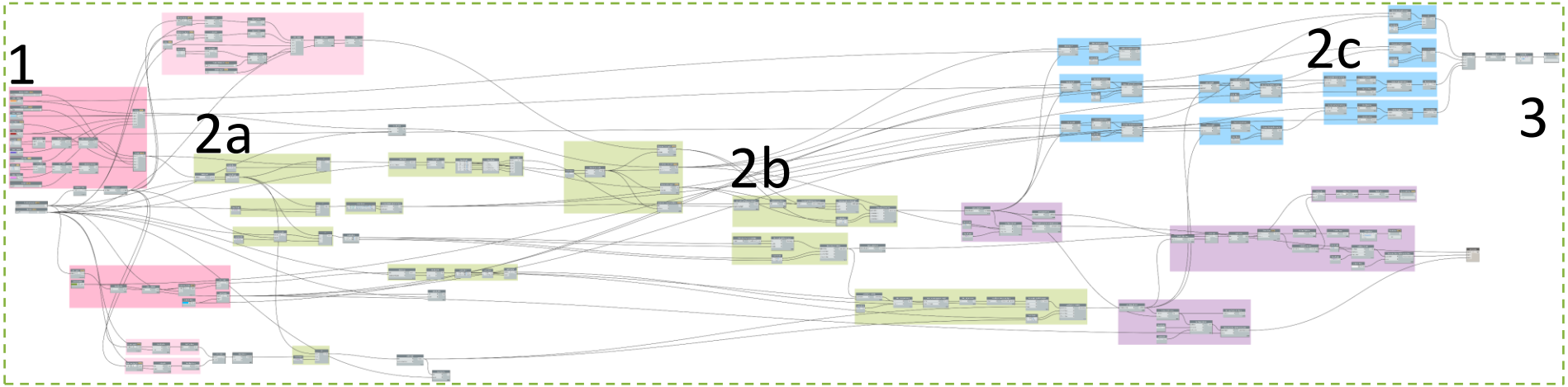


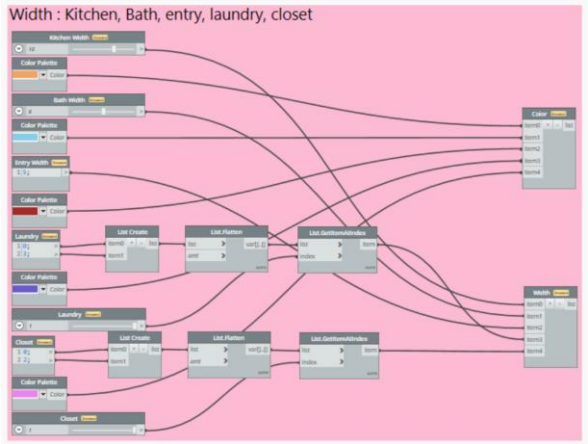
2b ROOMS LINE DRAWING

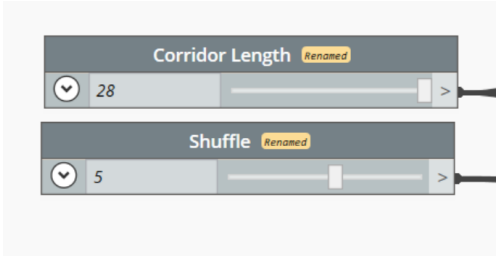


UNIT GENERATION

DYNAMO SCRIPT







AREA & UNIT LENGTH DETERMINATION

IF UNIT WIDTH = 24
AREA = 500 SF
LENGTH = 500/WIDTH
OR
ELSE IF UNIT WIDTH = 25- 26
AREA = 650 SF
LENGTH = 650/WIDTH

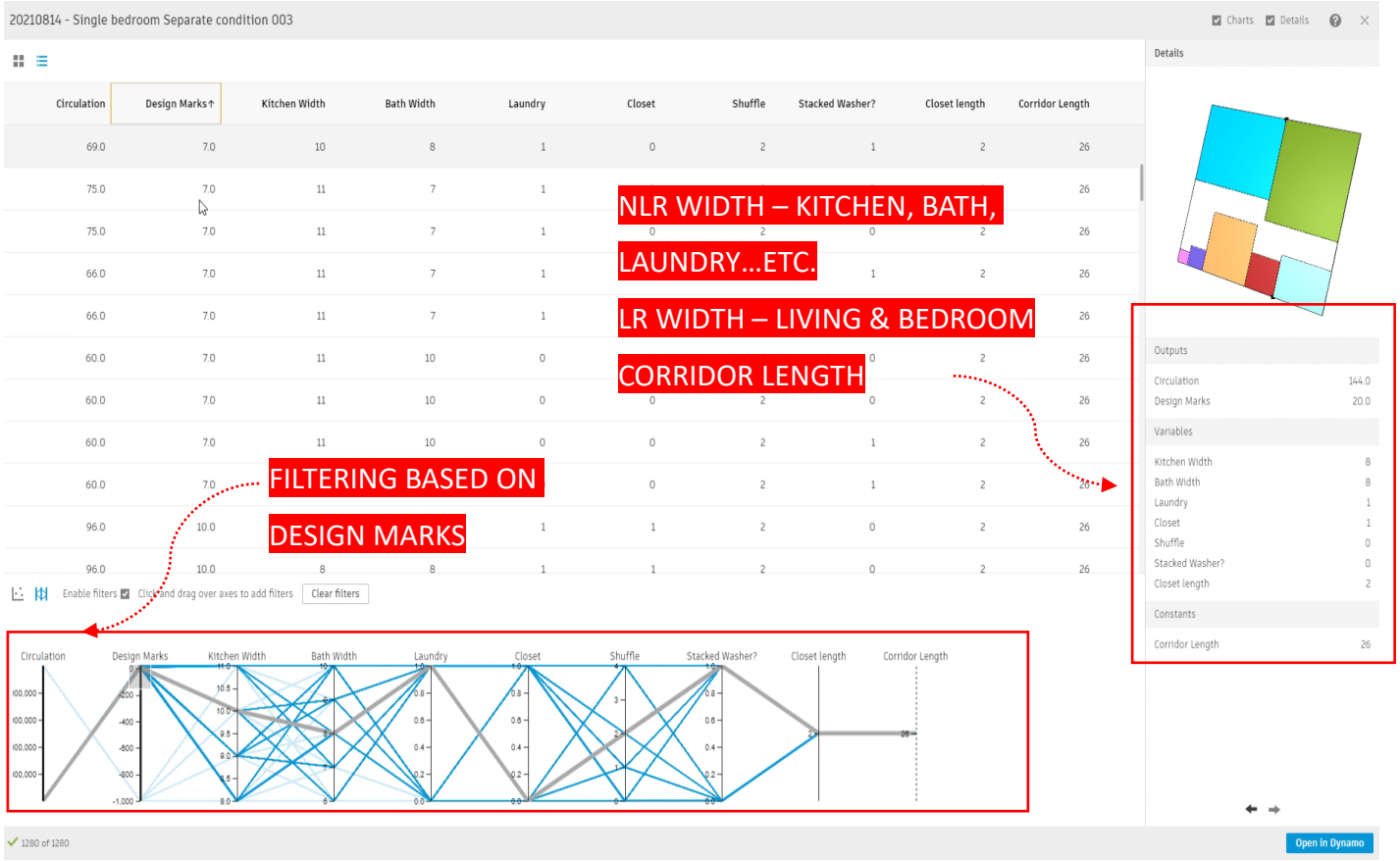
ELSE IF UNIT WIDTH = 27 – 28
AREA = 750 SF
LENGTH = 750/WIDTH

UNIT GENERATION

GENERATIVE DESIGN

26’ - SINGLE BEDROOM – **CROSS PRODUCT**

4

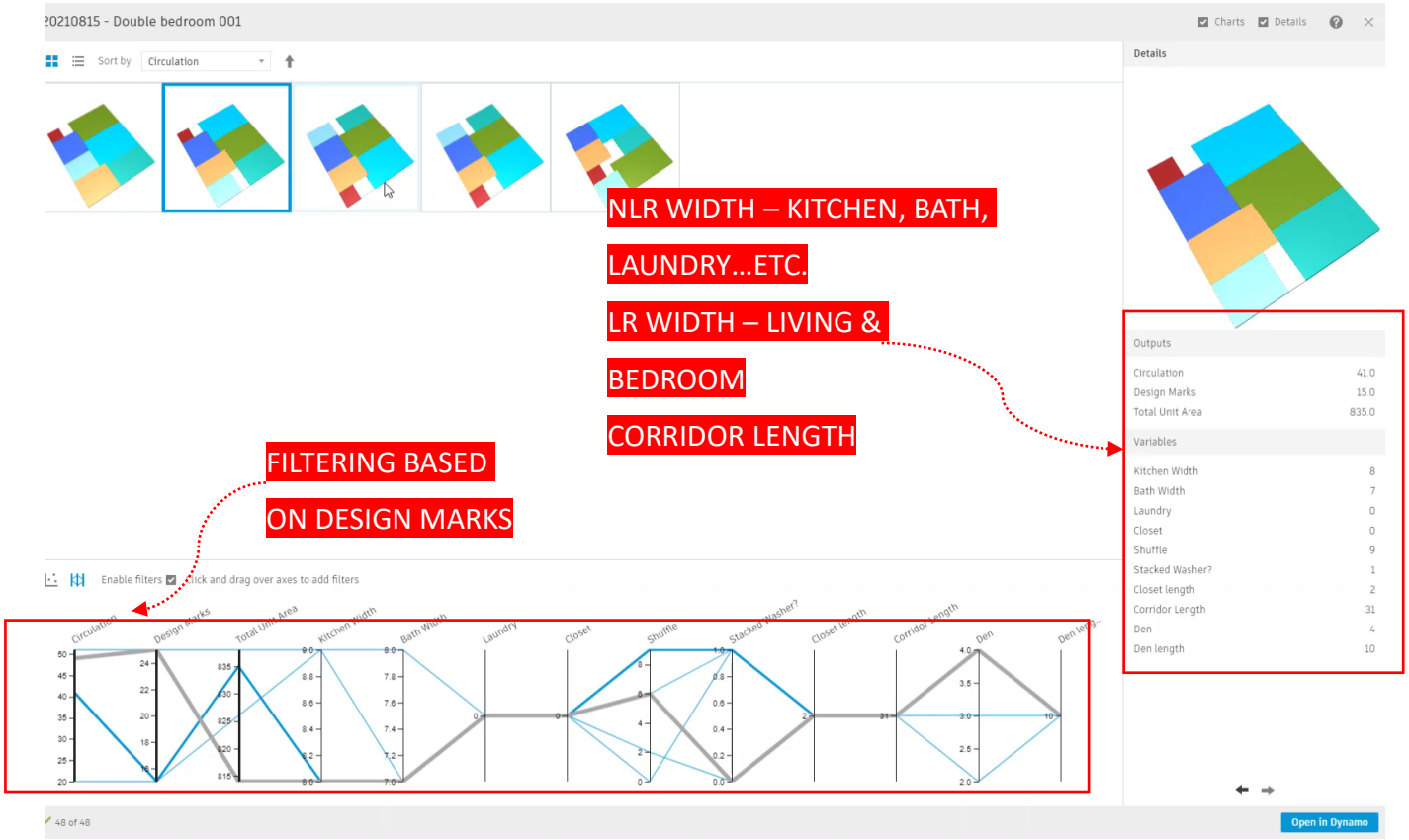


UNIT GENERATION

GENERATIVE DESIGN

28’ - SINGLE BEDROOM - OPTIMISED

4

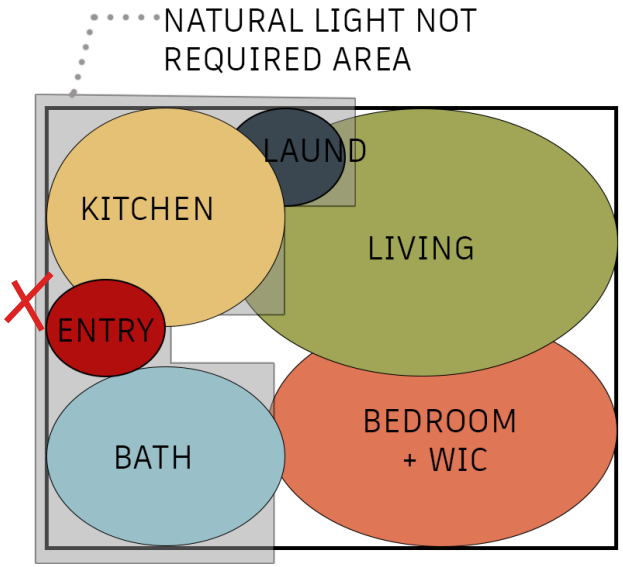


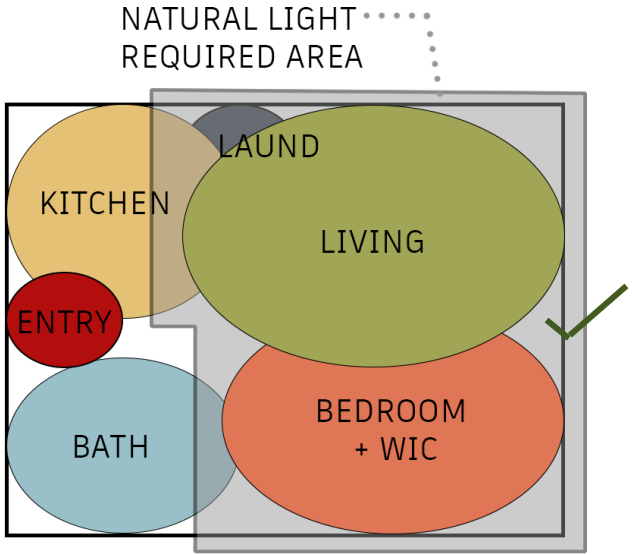
2. REGULATIVE METHOD

UNIT GENERATION

DESIGN SCOPE

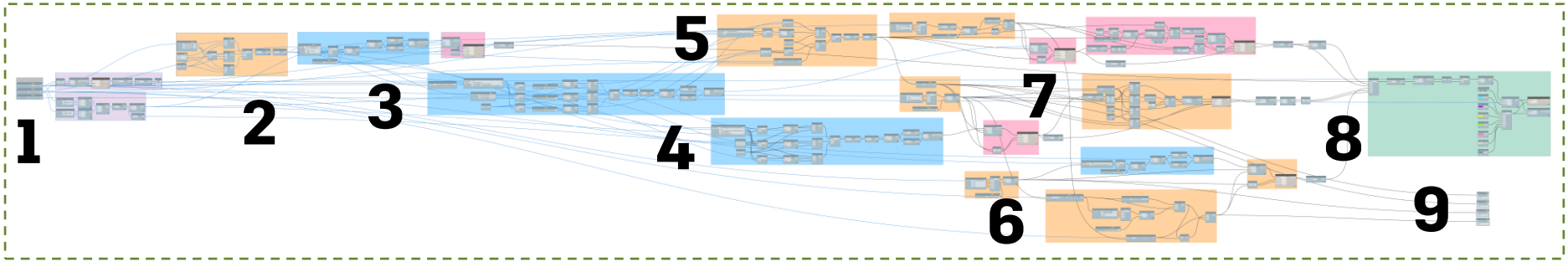
UNIT LOGIC – GROUPING (LR & NLR)



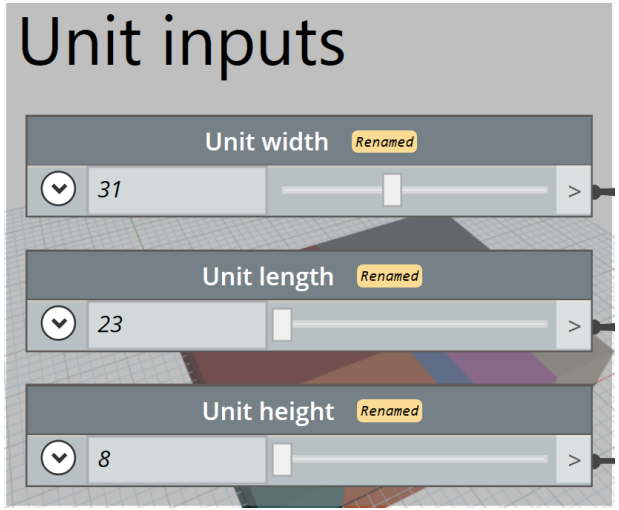


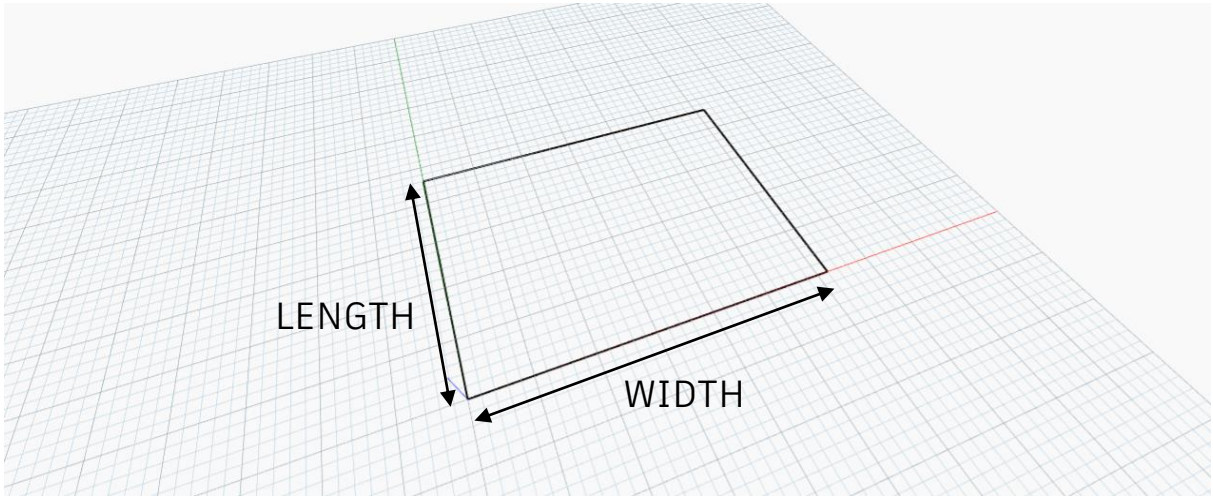
UNIT GENERATION

DYNAMO SCRIPTING

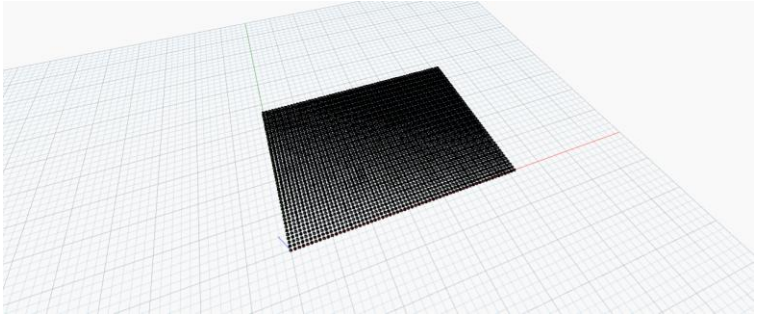


STEP 1 – UNIT BOUNDARY CREATION

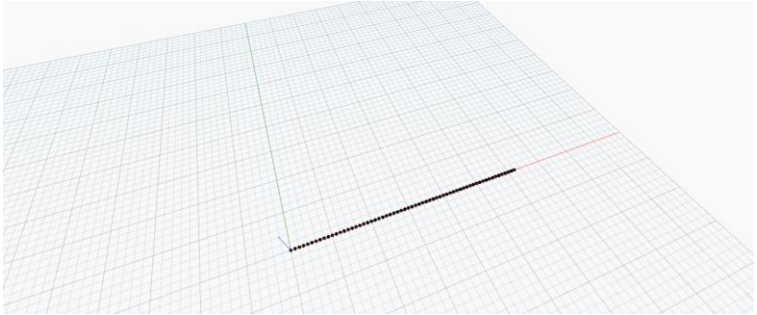




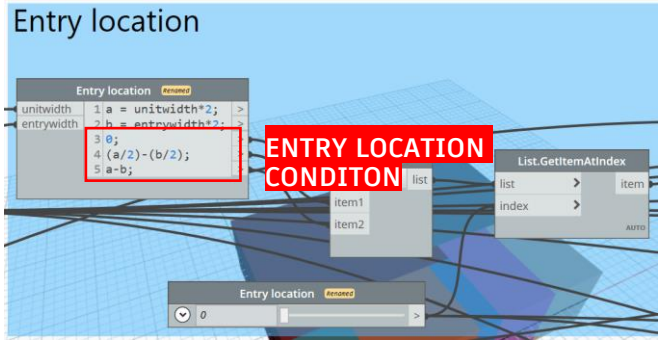
STEP 2 – GENERATING POINTS BASED ON GEOMETRY

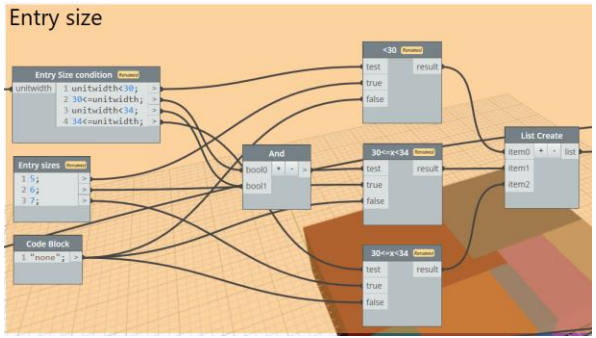


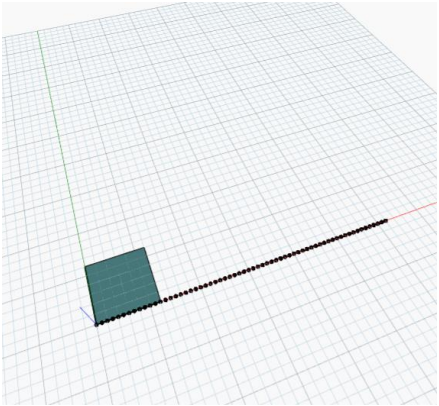
STEP 3 – ISOLATING POINTS ON CORRIDOR SIDE



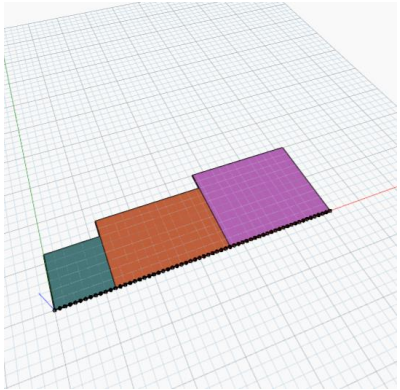
STEP 4 – LOCATING ENTRY BASED ON CONDITIONS

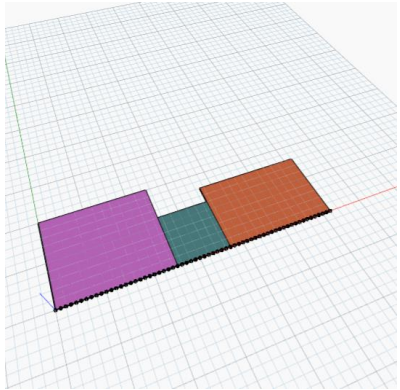


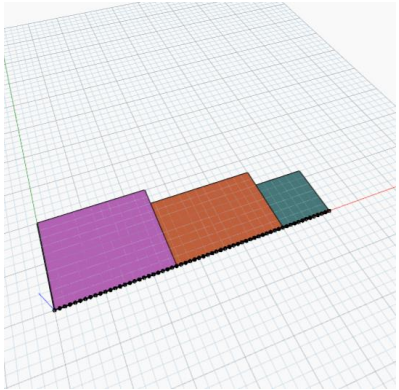


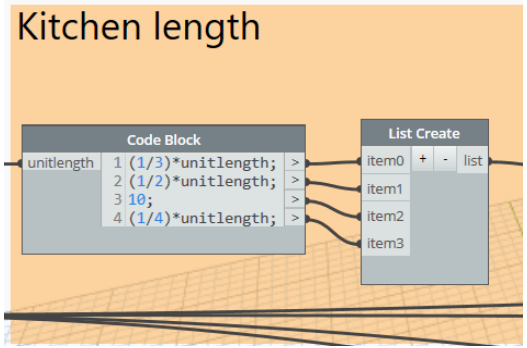


STEP 5 – CREATION OF KITCHEN AND UTILITARIAN SPACES

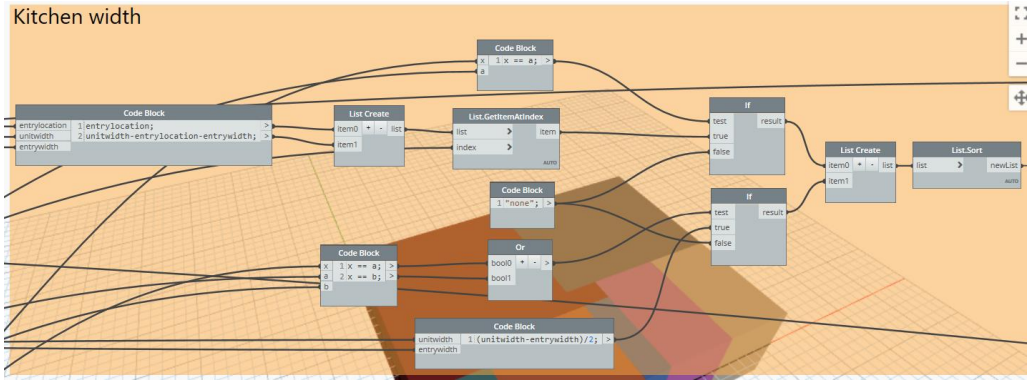


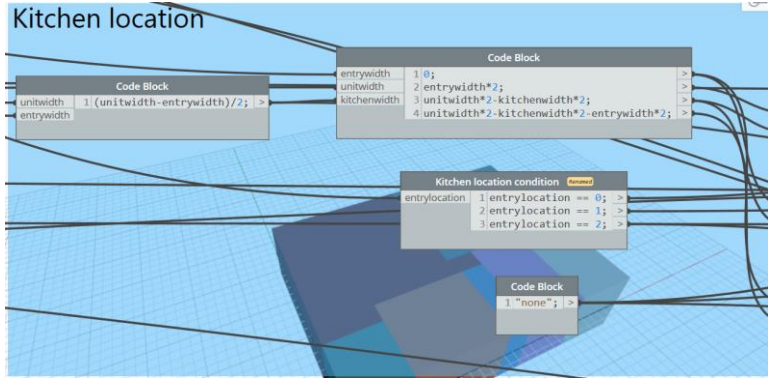


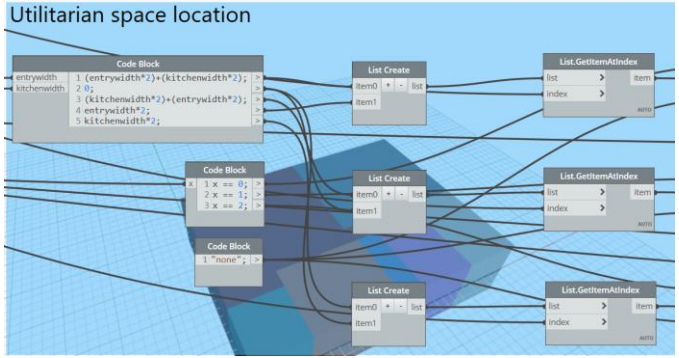


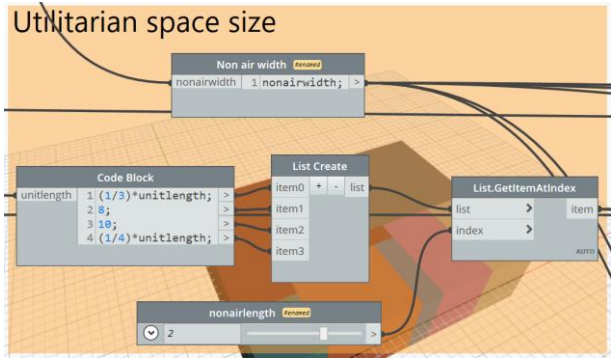


ENTRY KITCHEN UTILITARIAN

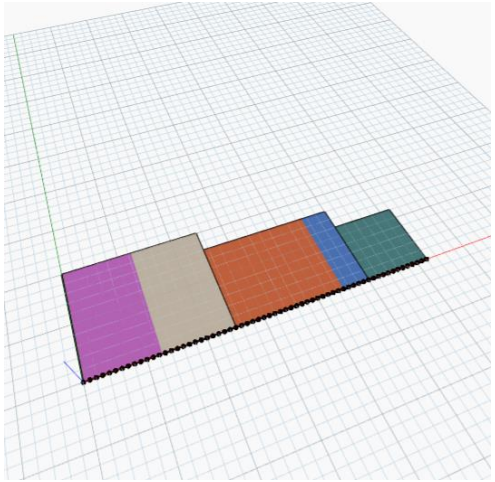




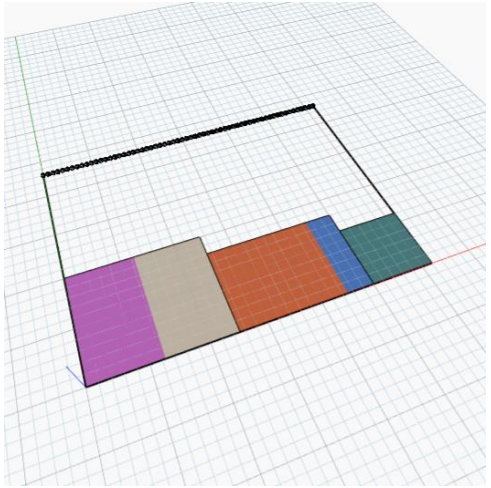




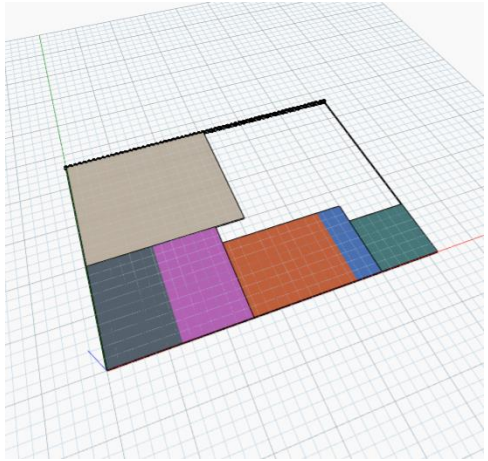
STEP 6 – SUBDIVIDING KITCHEN AND UTILITARIAN SPACES

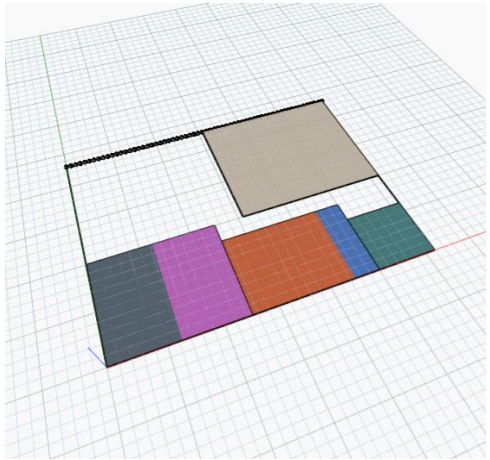


STEP 7 – ISOLATING POINTS ON OUTDOOR SIDE



STEP 8 – LOCATING BEDROOM



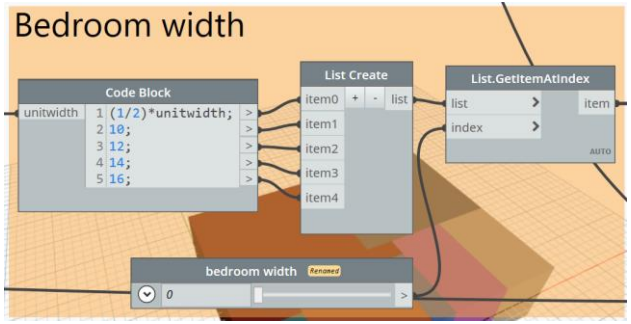


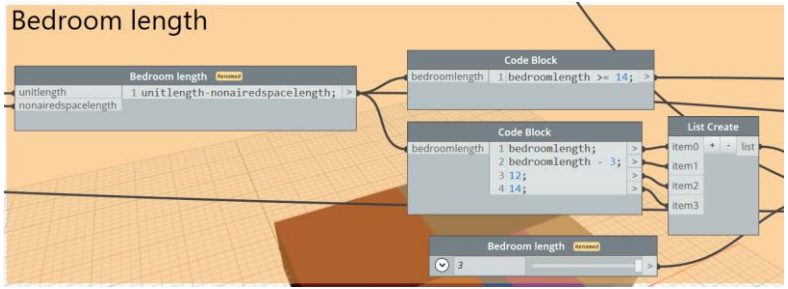
ENTRY

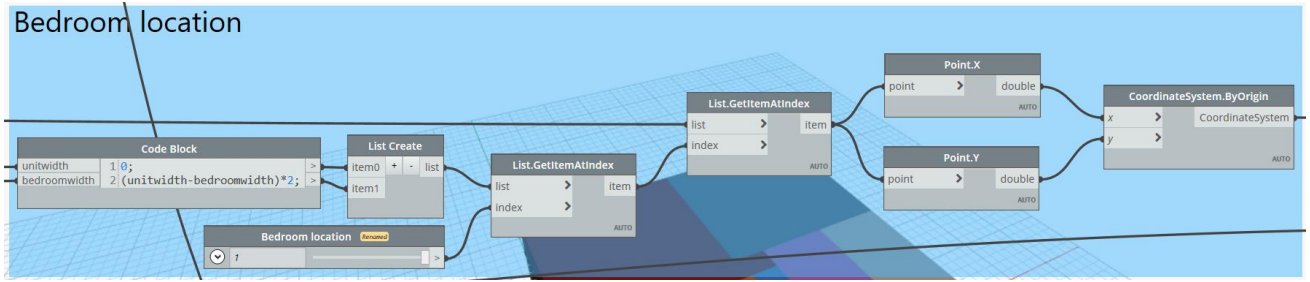
KITCHEN

UTILITARIAN

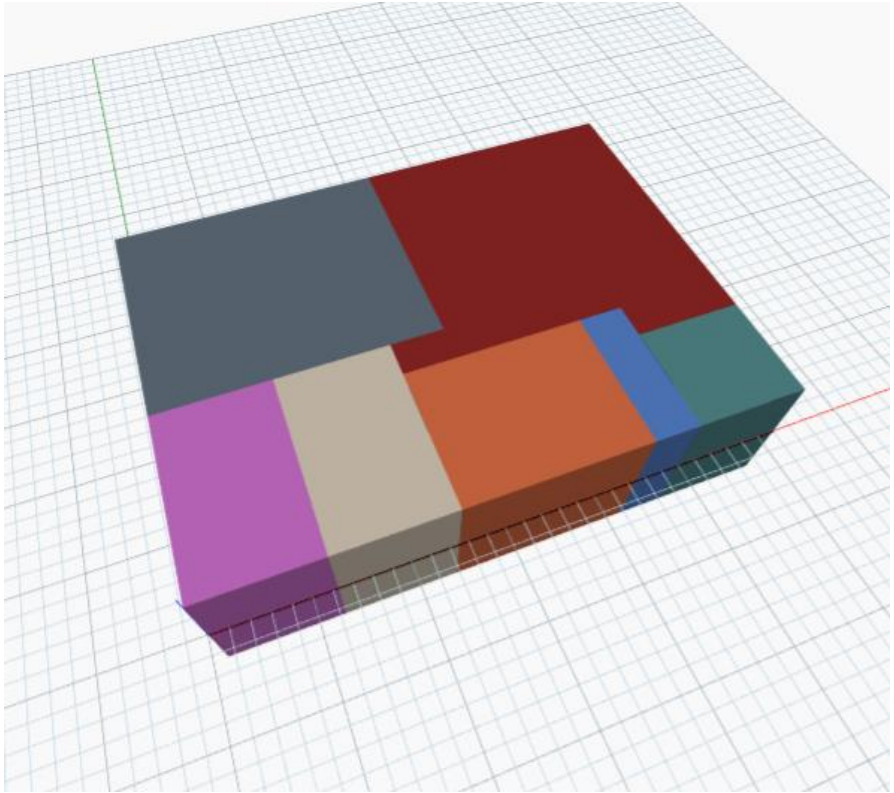
BEDROOM

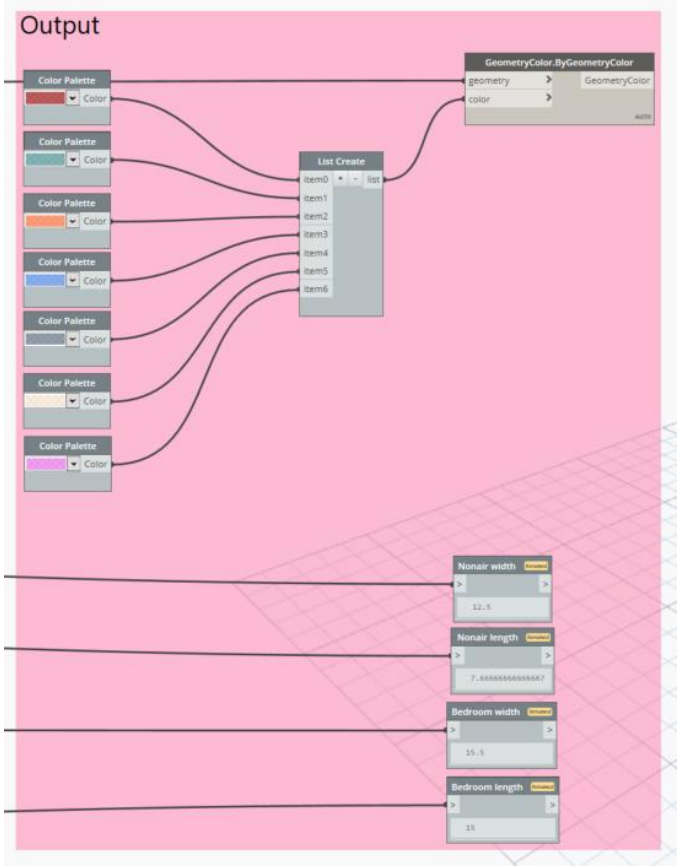






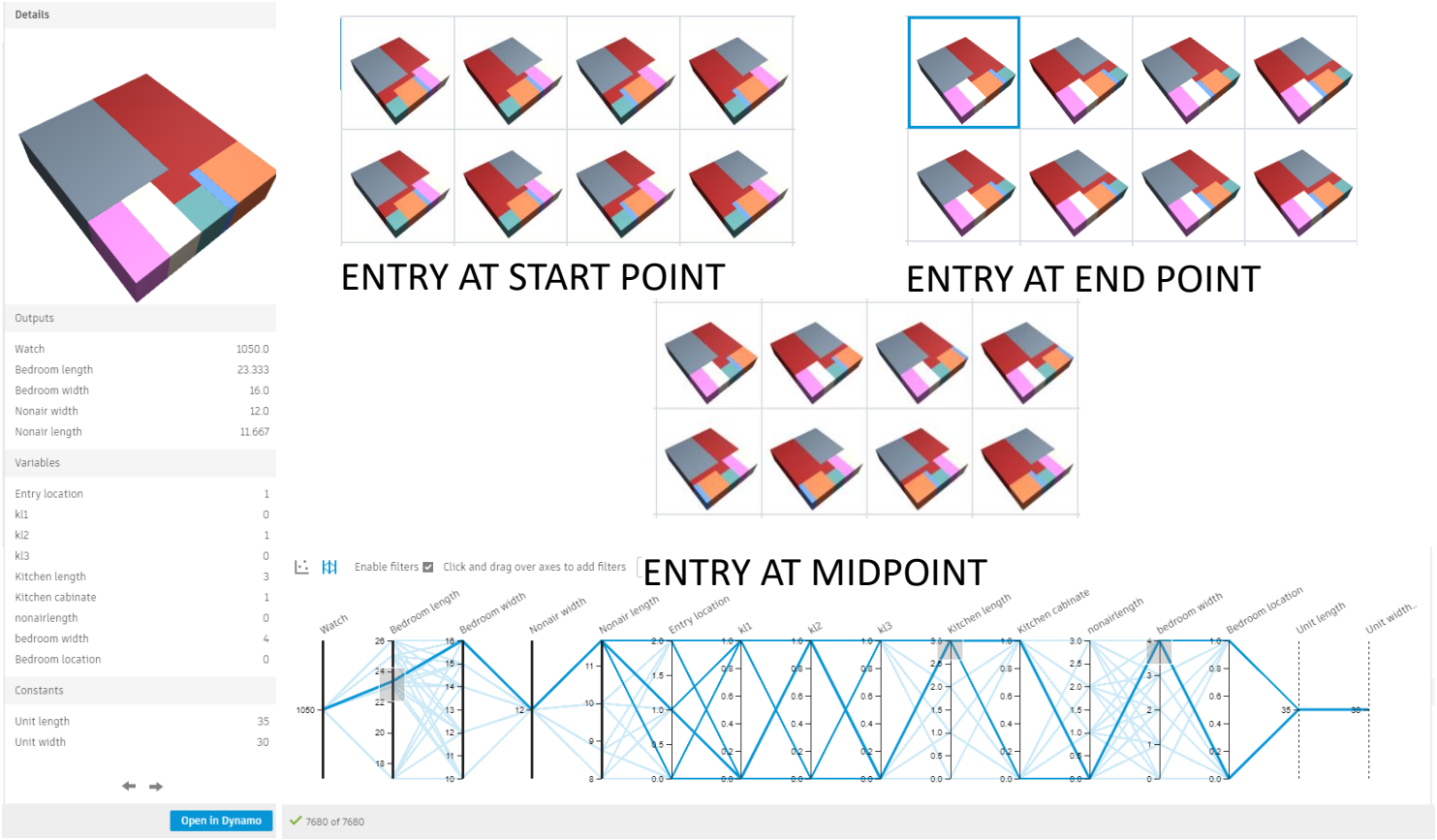
STEP 9 –DIFFERENCE TO FORM LIVING SPACE.





UNIT GENERATION

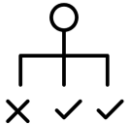
GENERATIVE DESIGN



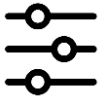
CONCLUSION

INFERENCE

Understanding of design scope and goals



“n” number of options generated

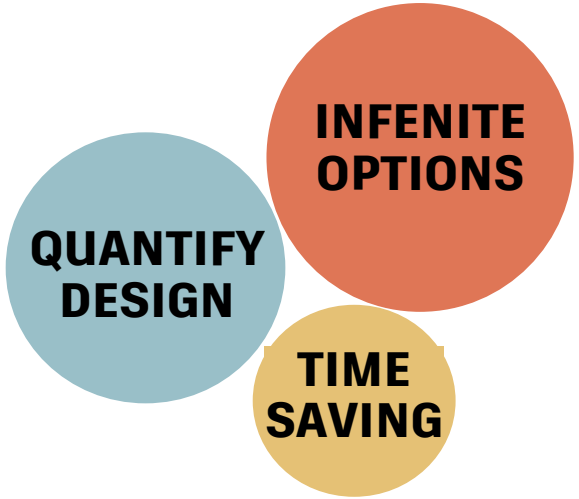


Customize “ideal situation”

Optimized for specific conditions or multiple conditions

Quantified design options

Time saving



CONCLUSION

*“Generative design can be used in multifamily to produce efficient **design options** with further detailing of the graph. and to produce innovative and quantified designs ”*

THANK YOU!!!

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