AUTOMATA TOWER

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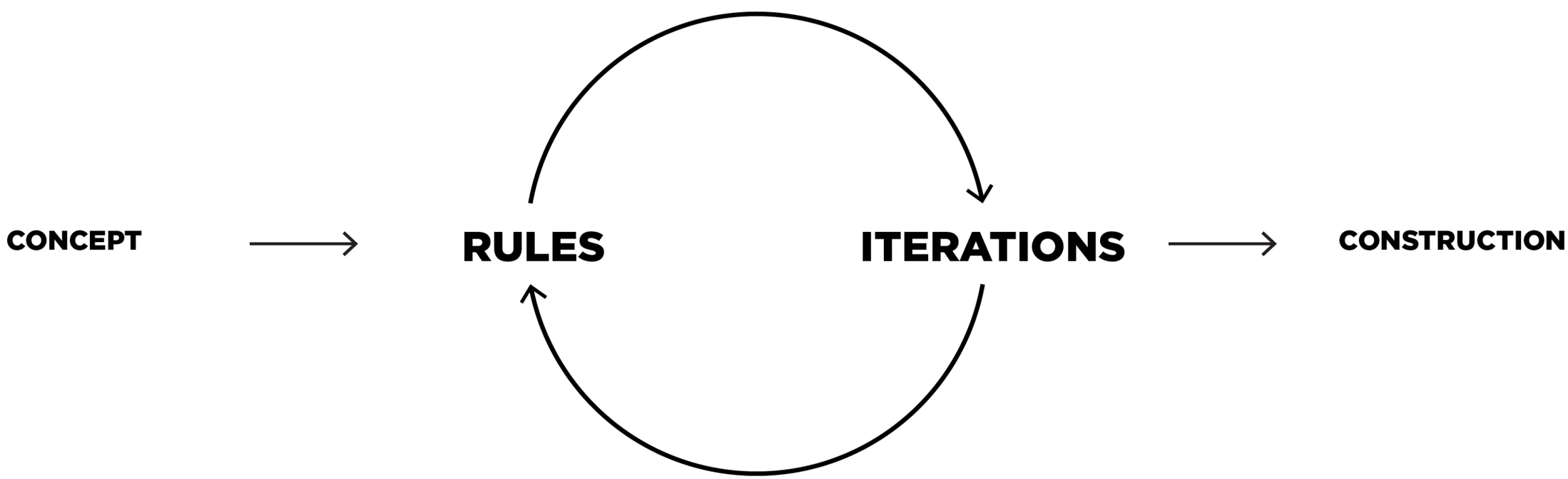
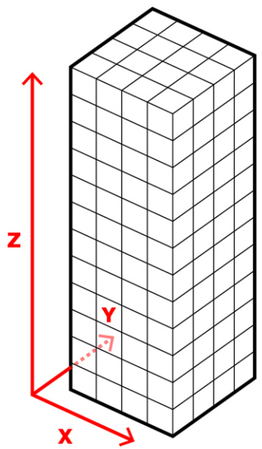
4.553 • PROGRAMMING SKETCHES | JUHONG PARK

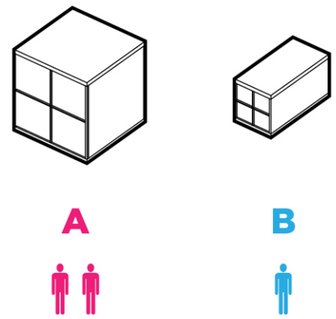
CONCEPTUAL DESIGN → **SCHEMATIC DESIGN** → **DESIGN DEVELOPMENT** → **CONSTRUCTION DOCUMENTS**


CONCEPT
RULES
ITERATIONS
CONSTRUCTION

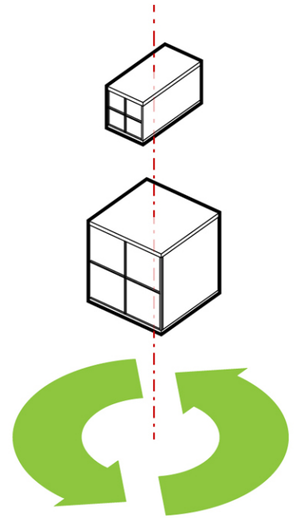


01 BOUNDARY

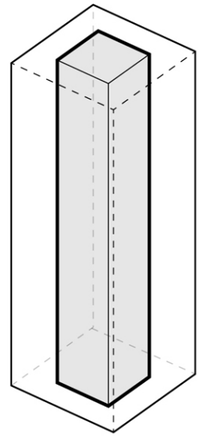
02 DISTRIBUTION RULE



03 CELL TYPES

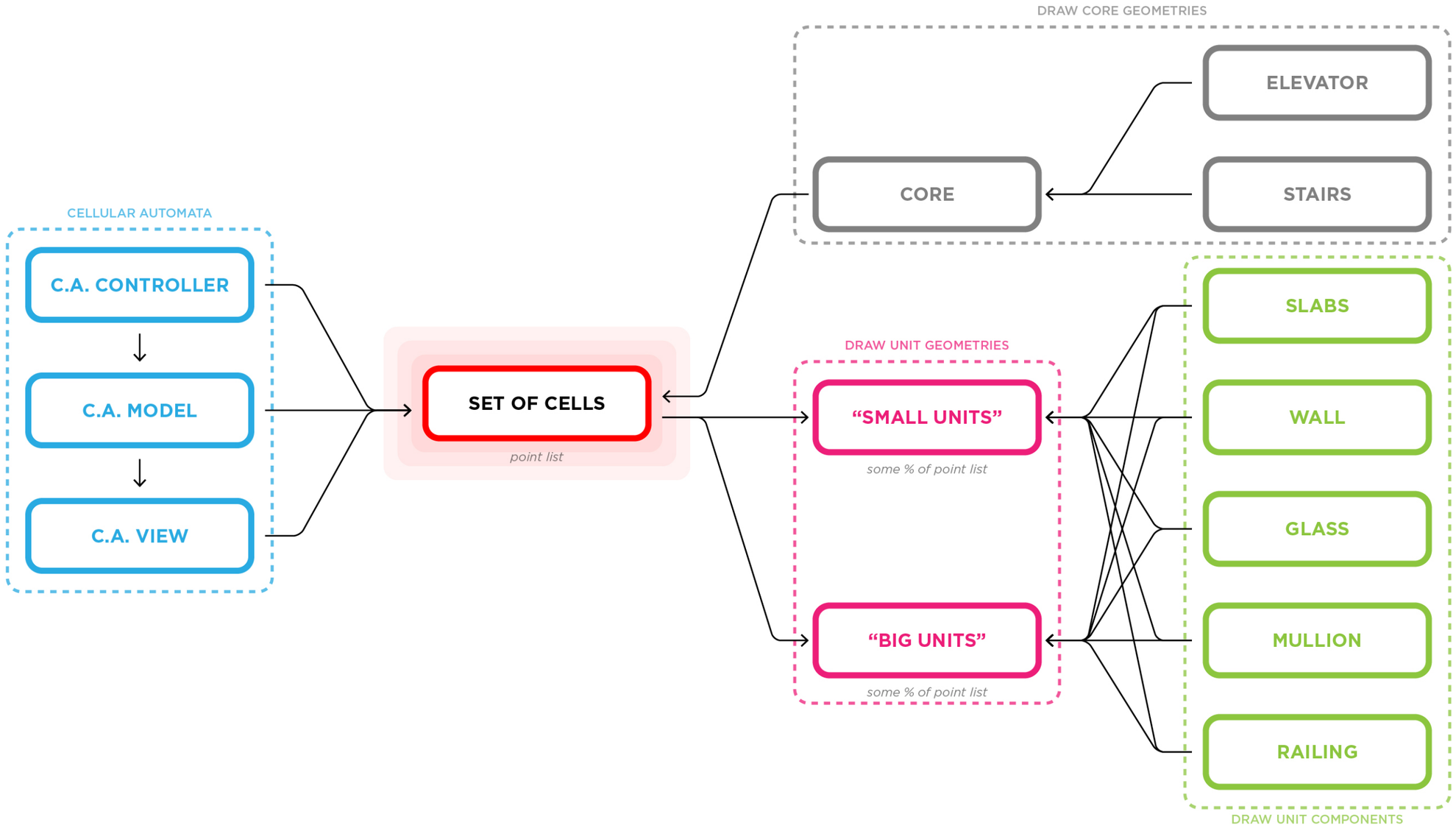


04 RANDOM ROTATE



05 CORE

t


DRAW CORE GEOMETRIES
ELEVATOR
CORE
STAIRS
CELLULAR AUTOMATA
C.A. CONTROLLER
C.A. MODEL
C.A. VIEW
SET OF CELLS
point list
DRAW UNIT GEOMETRIES
"SMALL UNITS"
some % of point list
"BIG UNITS"
some % of point list
SLABS
WALL
GLASS
MULLION
RAILING
DRAW UNIT COMPONENTS

GLOBAL VARIABLES

- Xnumber
- Ynumber
- Znumber
- smallunitpercentage
- iterations

CELLULAR AUTOMATA

- CELL
- SET OF CELLS
- AUTOMATA CONTROLLER
- AUTOMATA MODEL
- AUTOMATA VIEW

UNIT TYPES

- SMALL UNIT
- BIG UNIT

UNIT COMPONENTS

- SLABMAKER
- WALL
- GLASS
- MULLION
- RANDOMANGLE

CORE

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- BUILDSTAIRS

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```
class Cell():

def __init__(self, x, y, z):
    self.X = x
    self.Y = y
    self.Z = z
    self.Pos = [x,y,z]
    self.Visibility = False
    self.N = 0

def getVisibility(self):
    return self.Visibility

def setVisibility(self, v):
    self.Visibility = v

def getN(self):
    return self.N

def setN(self, n):
    self.N = n

def getX(self):
    return self.X

def getY(self):
    return self.Y

def getZ(self):
    return self.Z

def getPos(self):
    return self.Pos

def updateVisibility(self):
    if (self.Visibility == True):
        self.rule1_Visibility()
    else: #(self.Visibility == False)
        self.rule2_Population()
```

RULE FOR LIVE CELLS

```
def rule1_Visibility(self):
    if (self.N < 10):
        self.setVisibility(False)
    elif (self.N < 18):
        self.setVisibility(True)
    else:
        self.setVisibility(False)
```

RULE FOR DEAD CELLS

```
def rule2_Population(self):
    if (self.N == 0 or self.N == 5 or self.N == 10):
        self.setVisibility(True)
    elif (self.N < 10):
        self.setVisibility(False)
    elif (self.N < 18):
        self.setVisibility(True)
    else:
        pass
```

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```
class SetOfCells():

    def __init__(self):
        self.ListCells = []
        self.generateCells()
        self.setSeeds()

    def generateCells(self):
        xCellList = []
        for x in range(Xnumber):
            yCellList = []
            for y in range(Ynumber):
                zCellList = []
                for z in range(Znumber):
                    c = Cell(x,y,z)
                    zCellList.append(c)
                yCellList.append(zCellList)
            xCellList.append(yCellList)
        self.ListCells = xCellList  # returns the nested list into self.ListCells

    def setSeeds(self):
        for x in range(Xnumber):
            for y in range(Ynumber):
                for z in range(Znumber):
                    cell = self.ListCells[x][y][z]
                    if (x > 0 and x < Xnumber and y > 0 and y < Ynumber and z > 0 and z < Znumber):
                        cell.setVisibility(True)
                    else:
                        cell.setVisibility(False)

    def getCells(self):
        return self.ListCells
```

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BUILDSTAIRS

```
class AutomataController():

    def __init__(self):
        self.ListCells = []
        self.SC = SetOfCells()
        self.M = AutomataModel()

    def initiateModel(self):
        self.ListCells = self.SC.getCells()
        self.M.setListCells(self.ListCells)
        self.M.repeatProcesses()
```

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```
class AutomataModel():

    def __init__(self):
        self.ListCells = []
        self.V = AutomataView()

    def setListCells(self, lc):
        self.ListCells = lc

    def repeatProcesses(self):
        iterationNumber = iterations
        for i in range(iterationNumber):
            self.checkNeighboringCells()
            self.updateCellVisibility()
            self.V.setListCells(self.ListCells)
            points = self.V.getCoordinates()
            center = self.V.getCenter()
            self.V.makeUnits (points, center)
            self.V.moveGeometries()

    def checkNeighboringCells(self):
        for i in range(1,Xnumber-1):
            for j in range(1,Ynumber-1):
                for k in range(1,Znumber-1):
                    cell = self.ListCells[i][j][k]
                    x = cell.getX()
                    y = cell.getY()
                    z = cell.getZ()
                    n = self.calculateNumberOfNeighboringCells(x,y,z)
                    cell.setN(n)

    def calculateNumberOfNeighboringCells(self, x, y, z):
        cell0 = self.ListCells[x-1][y-1][z-1]
        cell1 = self.ListCells[x][y-1][z-1]
        cell2 = self.ListCells[x+1][y-1][z-1]
        cell3 = self.ListCells[x-1][y][z-1]
        cell4 = self.ListCells[x][y][z-1]
        cell5 = self.ListCells[x+1][y][z-1]
        cell6 = self.ListCells[x-1][y+1][z-1]
        cell7 = self.ListCells[x][y+1][z-1]
        cell8 = self.ListCells[x+1][y+1][z-1]

        cell9 = self.ListCells[x-1][y-1][z]
        cell10 = self.ListCells[x][y-1][z]
        cell11 = self.ListCells[x+1][y-1][z]
        cell12 = self.ListCells[x-1][y][z]
        cell13 = self.ListCells[x+1][y][z]
        cell14 = self.ListCells[x-1][y+1][z]
        cell15 = self.ListCells[x][y+1][z]
        cell16 = self.ListCells[x+1][y+1][z]

        cell17 = self.ListCells[x-1][y-1][z+1]
        cell18 = self.ListCells[x][y-1][z+1]
        cell19 = self.ListCells[x+1][y-1][z+1]
        cell20 = self.ListCells[x-1][y][z+1]
        cell21 = self.ListCells[x][y][z+1]
        cell22 = self.ListCells[x+1][y][z+1]
        cell23 = self.ListCells[x-1][y+1][z+1]
        cell24 = self.ListCells[x][y+1][z+1]
        cell25 = self.ListCells[x+1][y+1][z+1]

        v0 = cell0.getVisibility()
        v1 = cell1.getVisibility()
        v2 = cell2.getVisibility()
        v3 = cell3.getVisibility()
        v4 = cell4.getVisibility()
        v5 = cell5.getVisibility()
        v6 = cell6.getVisibility()
        v7 = cell7.getVisibility()
        v8 = cell8.getVisibility()
        v9 = cell9.getVisibility()
        v10 = cell10.getVisibility()
        v11 = cell11.getVisibility()
        v12 = cell12.getVisibility()
        v13 = cell13.getVisibility()
        v14 = cell14.getVisibility()
        v15 = cell15.getVisibility()
        v16 = cell16.getVisibility()
        v17 = cell17.getVisibility()
        v18 = cell18.getVisibility()
        v19 = cell19.getVisibility()
        v20 = cell20.getVisibility()
        v21 = cell21.getVisibility()
        v22 = cell22.getVisibility()
        v23 = cell23.getVisibility()
        v24 = cell24.getVisibility()
        v25 = cell25.getVisibility()

        sum =
v0+v1+v2+v3+v4+v5+v6+v7+v8+v9+v10+v11+v12+v13+v14+v15+v
16+v17+v18+v19+v20+v21+v22+v23+v24+v25

        return sum

    def updateCellVisibility(self):
        for x in range(1,Xnumber-1):
            for y in range(1,Ynumber-1):
                for z in range(1,Znumber-1):
                    cell = self.ListCells[x][y][z]
                    cell.updateVisibility()
```

MAKE GEOMETRIES
INHERITED FROM "VIEW"

CHECK NEIGHBORS

UPDATE VISIBILITY

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- iterations

CELLULAR AUTOMATA

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UNIT TYPES

- SMALL UNIT
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CORE

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smallunitpercetange = make smallunit
bigunitpercentage = makebigunit

```
class AutomataView():

def __init__(self):
    self.ListCells = []
    self.S = smallunit ()
    self.B = bigunit ()

def setListCells(self, lc):
    self.ListCells = lc

def getCoordinates(self):
    ptlist = []
    for x in range(Xnumber):
        for y in range(Ynumber):
            for z in range(Znumber):
                cell = self.ListCells[x][y][z]
                visibility = cell.getVisibility()
                if visibility == True:
                    pos = cell.getPos()
                    ptlist.append (pos)
    length = len (ptlist)
    return ptlist

def getCenter(self):
    ptlist = []
    for x in range(Xnumber):
        for y in range(Ynumber):
            for z in range(Znumber):
                cell = self.ListCells[x][y][z]
                visibility = cell.getVisibility()
                if visibility == True:
                    pos = cell.getPos()
                    shift = 0.5
                    center = [pos[0]+shift, pos[1]+shift, pos[2]]
                    ptlist.append (center)
    print ptlist
    return ptlist
```

GET COORDINATES FROM
CA OPERATION

```
def makeUnits (self, points, center):
    length = len (points)
    print "point list =", points
    print "point list length =", length
    percent = smallunitpercentage * length
    minority = int(percent)
    print "minority # =", minority
    majority = length - minority

    minorityrandomlist = []
    for i in range(minority):
        randomvalues = random.randint (0, length-1)
        minorityrandomlist.append (randomvalues)

    minorityrandomlist = list (set(minorityrandomlist))
    minorityrandomlist.sort()
    print "minority random list =", minorityrandomlist

    majorityrandomlist = []
    for i in range (length):
        majorityrandomlist.append (i)
    print majorityrandomlist =", majorityrandomlist

    for x in minorityrandomlist:
        majorityrandomlist.remove (x)

    self.S.makeunit (minorityrandomlist, points, center)
    self.B.makeunit (majorityrandomlist, points, center)

def moveGeometries(self):
    #rs.Sleep(1000)
    allObjIDs = rs.AllObjects()
    trans = [0,0,Znumber-1]
    rs.MoveObjects(allObjIDs, trans)
```

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```
class smallunit():

    def __init__(self):
        self.slab = slabmaker()
        self.wall = wall()
        self.glass = glass()
        self.mullion = mullion_s()
        self.railing = railing()
        self.randomangle = randomangle()

        self.slabthickness = 0.05
        self.wallthickness = 0.02
        self.glassoffset = 0.02

        self.railingheight = 0.1
        self.floorheight = 0.5
        self.xdimension = 0.5
        self.ydimension = 1

    def makeunit (self, unitnumber, points, center):

        for r in unitnumber :
            rs.AddLayer("Small Unit", Color.Red)
            rs.CurrentLayer("Small Unit")

            x = points [r][0]
            y = points [r][1]
            z = points [r][2]

            pt0 = [x, y, z]
            pt1 = [x, y + self.ydimension , z]
            pt2 = [x + self.xdimension, y + self.ydimension, z]
            pt3 = [x + self.xdimension, y, z]

            rectangle = rs.AddRectangle(points[r], self.xdimension,
self.ydimension)

            slabs = self.slab.slabmaker (rectangle, self.slabthickness,
self.floorheight)
            wall1 = self.wall.wall(pt0, self.wallthickness,
self.ydimension, self.floorheight, self.slabthickness)
            wall2 = self.wall.wall(pt2, -self.wallthickness,
-self.ydimension, self.floorheight, self.slabthickness)

            glass1 = self.glass.glass(pt2, pt1, pt0, self.glassoffset,
self.floorheight, self.slabthickness)
            glass2 = self.glass.glass(pt0, pt3, pt1, self.glassoffset,
self.floorheight, self.slabthickness)

            mullion1 = self.mullion.mullion(pt2, pt1, pt0,
-self.glassoffset, self.floorheight, self.slabthickness)
            mullion2 = self.mullion.mullion(pt0, pt3, pt1,
self.glassoffset, self.floorheight, self.slabthickness)

            railing = self.railing.railingmaker(rectangle,
self.railingheight, self.floorheight)

            angle = self.randomangle.generator()

            verticalshift = [0, 0.5]
            shift = choice(verticalshift)
            path = [0, 0, shift]

            rs.RotateObjects(slabs, center[r], angle)
            rs.RotateObjects(wall1, center[r], angle)
            rs.RotateObjects(wall2, center[r], angle)
            rs.RotateObjects(glass1, center[r], angle)
            rs.RotateObjects(glass2, center[r], angle)
            rs.RotateObjects(mullion1, center[r], angle)
            rs.RotateObjects(mullion2, center[r], angle)
            rs.RotateObjects(railing, center[r], angle)

            rs.MoveObjects(slabs, path)
            rs.MoveObjects(wall1, path)
            rs.MoveObjects(wall2, path)
            rs.MoveObjects(glass1, path)
            rs.MoveObjects(glass2, path)
            rs.MoveObjects(mullion1, path)
            rs.MoveObjects(mullion2, path)
            rs.MoveObjects(railing, path)

            #rs.DeleteObject(path)

            rs.DeleteObject(rectangle)
```

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```
class bigunit():

    def __init__(self):
        self.slab = slabmaker()
        self.wall = wall()
        self.glass = glass()
        self.mullion = mullion_b()
        self.railing = railing()
        self.randomangle = randomangle()

        self.slabthickness = 0.05
        self.wallthickness = 0.02
        self.glassoffset = 0.02

        self.railingheight = 0.1
        self.floorheight = 1
        self.xdimension = 1
        self.ydimension = 1

    def makeunit (self, unitnumber, points, center):
        for r in unitnumber :
            rs.AddLayer("Large Unit", Color.Blue)
            rs.CurrentLayer("Large Unit")

            x = points [r][0]
            y = points [r][1]
            z = points [r][2]

            pt0 = [x, y, z]
            pt1 = [x, y + self.ydimension , z]
            pt2 = [x + self.xdimension, y + self.ydimension, z]
            pt3 = [x + self.xdimension, y, z]

            rectangle = rs.AddRectangle(points[r], self.xdimension,
self.ydimension)
            slab = self.slab.slabmaker (rectangle, self.slabthickness,
self.floorheight)

            wall1 = self.wall.wall(pt0, self.wallthickness,
self.ydimension, self.floorheight, self.slabthickness)
            wall2 = self.wall.wall(pt2, -self.wallthickness,
-self.ydimension, self.floorheight, self.slabthickness)

            glass1 = self.glass.glass(pt2, pt1, pt0, self.glassoffset,
self.floorheight, self.slabthickness)
            glass2 = self.glass.glass(pt0, pt3, pt1, self.glassoffset,
self.floorheight, self.slabthickness)

            mullion1 = self.mullion.mullion(pt2, pt1, pt0,
-self.glassoffset, self.floorheight, self.slabthickness)
            mullion2 = self.mullion.mullion(pt0, pt3, pt1,
self.glassoffset, self.floorheight, self.slabthickness)

            railing = self.railing.railingmaker(rectangle,
self.railingheight, self.floorheight)

            angle = self.randomangle.generator()

            slab = rs.RotateObjects(slab, center[r], angle)

            wall1 = rs.RotateObjects(wall1, center[r], angle)
            wall2 = rs.RotateObjects(wall2, center[r], angle)
            glass1 = rs.RotateObjects(glass1, center[r], angle)
            glass2 = rs.RotateObjects(glass2, center[r], angle)
            mullion1 = rs.RotateObjects(mullion1, center[r], angle)
            mullion2 = rs.RotateObjects(mullion2, center[r], angle)
            railing = rs.RotateObjects(railing, center[r], angle)

            rs.DeleteObject(rectangle)
```

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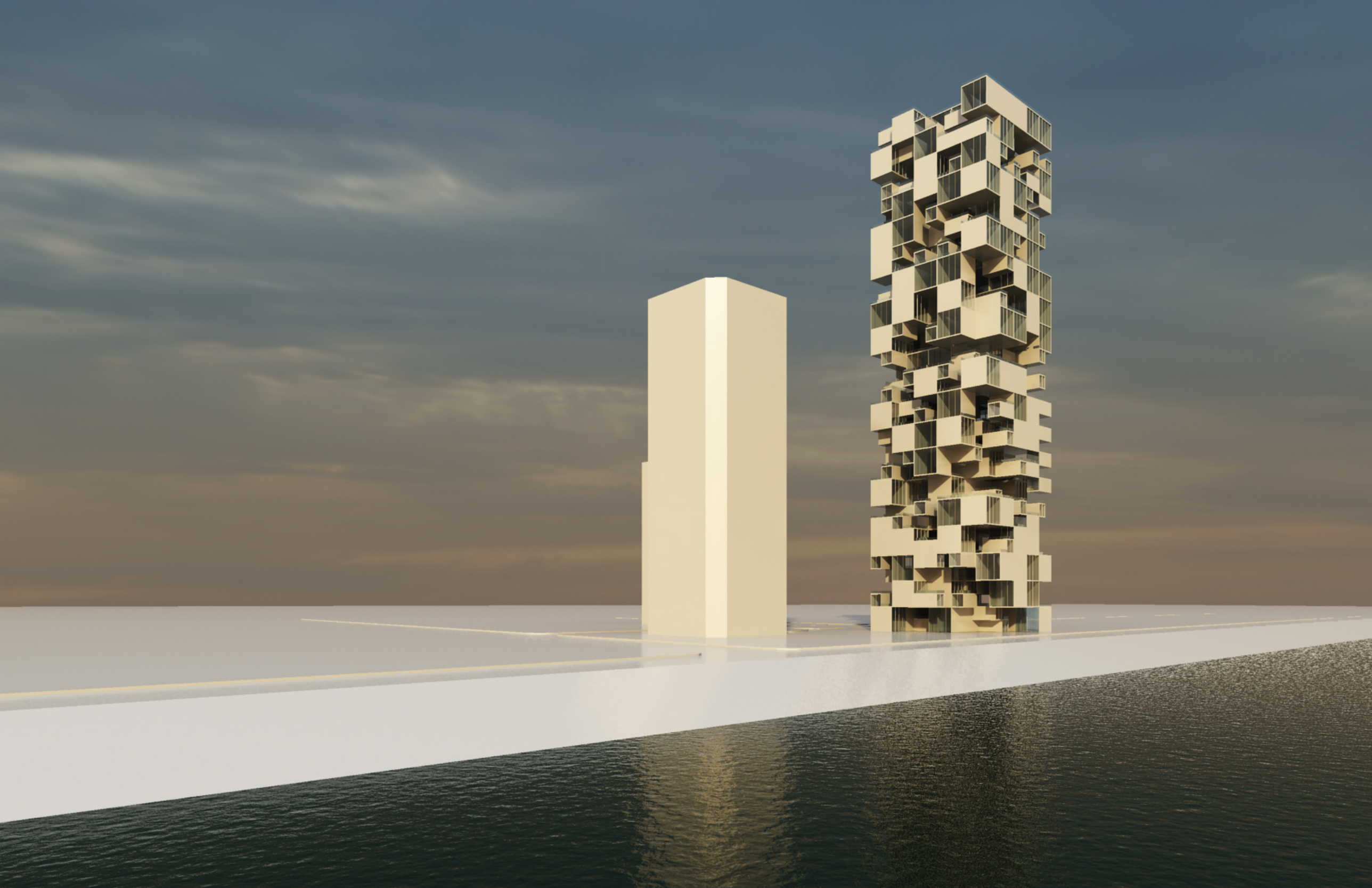
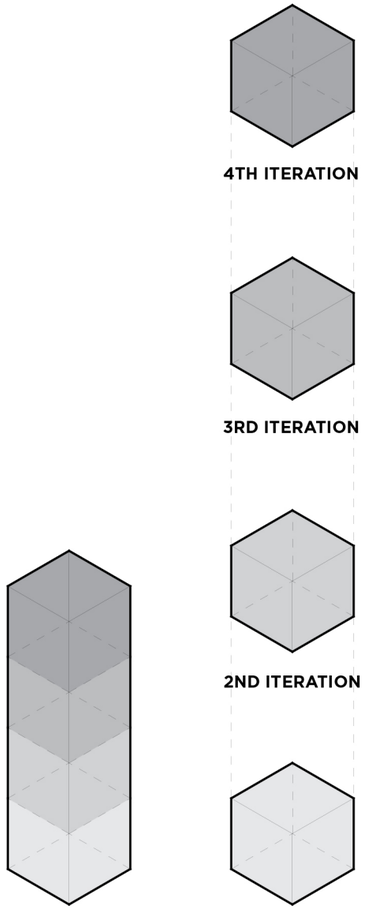
```
class Site():

    def __init__ (self):
        self.p = rs.WorldXYPlane()
        self.w = 100
        self.h = 100

    def makeSite(self):
        site_boundary = rs.AddRectangle(self.p, self.w, self.h)
        site = rs.AddPlanarSrf(site_boundary)

s = Site()
site = s.makeSite()
```

```
class Core():

    def __init__ (self):
        self.center = [40,40,0]
        self.p = rs.WorldXYPlane()
        self.w = 20
        self.h = 20
        self.core_h = 400

    def makeCore(self):
        core_boundary = rs.AddRectangle(self.p, self.w, self.h)
        core_boundary = rs.MoveObject(core_boundary,
self.center)
        path = rs.AddLine([0,0,0], [0,0,self.core_h])
        core = rs.ExtrudeCurve(core_boundary, path)
        rs.DeleteObject(path)
        core = rs.CapPlanarHoles(core)
        return core

c = Core()
core = c.makeCore()
```

```
class Elevator():

    def __init__ (self):
        self.core_h = 400
        self.ptS = [50,0,0]
        self.ptE = [50,100,0]
        self.p = rs.WorldZXPlane()
        self.h = 6
        self.w = 7
        self.trans = [42,60,0]
        self.trans2 = [52,60,0]
        self.n_floors = 40
        self.f_h = 10

    def makeECoreWall(self):
        pt1 = [41,51,0]
        pt2 = [49,51,0]
        pt3 = [49,59,0]
        pt4 = [41,59,0]
        pts = [pt1,pt2,pt3,pt4,pt1]
        ecorefloor_l = rs.AddPolyline(pts)
        path = rs.AddLine([0,0,0], [0,0,self.core_h])
        ecorefloor = rs.ExtrudeCurve(ecorefloor_l, path)
        rs.DeleteObject(path)
        ecorefloor2 = rs.MirrorObject(ecorefloor, self.ptS, self.ptE,
True)
        return ecorefloor
        return ecorefloor2

    def makeEdoor(self):
        Edoor_l = rs.AddRectangle(self.p, self.w, self.h)
        Edoor_l = rs.MoveObject(Edoor_l, self.trans)
        path = rs.AddLine([0,0,0],[0,-1,0])
        Edoor = rs.ExtrudeCurve(Edoor_l, path)
        rs.DeleteObject(path)
        rs.DeleteObject(Edoor_l)
        return Edoor

    def makeEdoor2(self):
        Edoor_l = rs.AddRectangle(self.p, self.w, self.h)
        Edoor_l = rs.MoveObject(Edoor_l, self.trans2)
        path = rs.AddLine([0,0,0],[0,-1,0])
        Edoor2 = rs.ExtrudeCurve(Edoor_l, path)
        rs.DeleteObject(path)
        rs.DeleteObject(Edoor_l)
        return Edoor2

    def copyEdoor(self, Edoor):
        index = range(1, self.n_floors)
        for i in index:
            trans2 = [0, 0, self.f_h * i]
            objID2 = rs.CopyObject(Edoor, trans2)

    def copyEdoor2(self, Edoor2):
        index = range(1, self.n_floors)
        for i in index:
            trans2 = [0, 0, self.f_h * i]
            objID2 = rs.CopyObject(Edoor2, trans2)

    def makeECore(self):
        ecore_wall = self.makeECoreWall()
        edoor = self.makeEdoor()
        edoors = self.copyEdoor(edoor)
        edoor2 = self.makeEdoor2()
        edoors2 = self.copyEdoor2(edoor2)

e = Elevator()
e.makeECore()
```



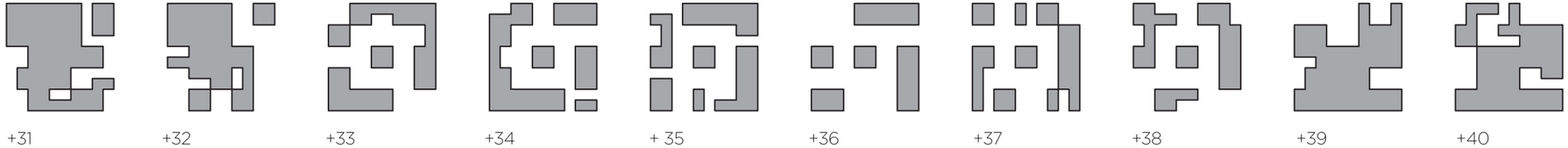


4TH ITERATION

3RD ITERATION

2ND ITERATION

1ST ITERATION



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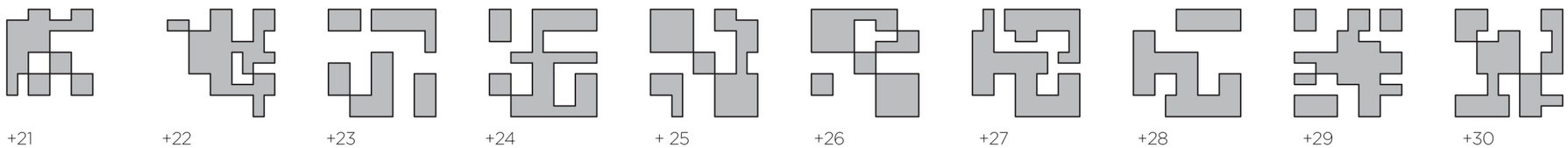

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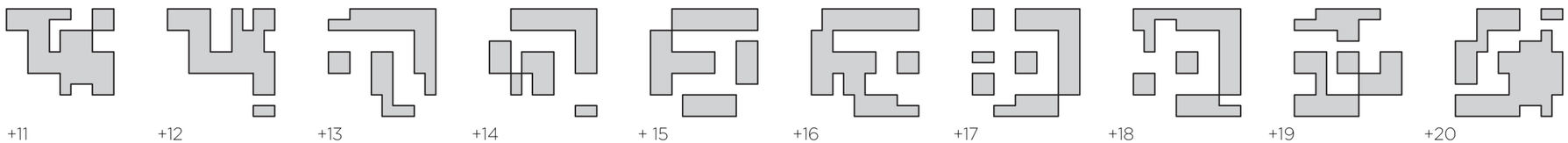

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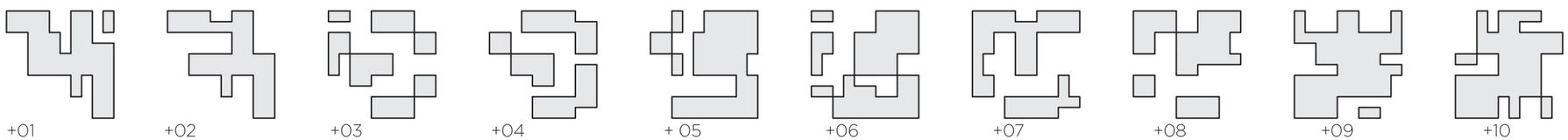

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