Building Construction Sets by Tiling Grammar Simplification
Construction set fabrication from model

Creating “bricks”

Reassembly into varied geometry
Intro

Varied geometry

Minimize required art

Simple building blocks

Tradeoff against expressiveness
Inverse procedural modeling

Decomposition into blocks

Assembly rules

Avoid complex shapes

Avoid complex assembly rules
Simplifying tiling grammars

Start with complex tiling grammar

Minimize objective function

Complexity vs. expressiveness

Approximate shape matching to minimize building blocks

Monte Carlo search
Grammar generation

Identify partial symmetries

r-symmetry - Identical spherical neighborhoods

r-similarity - Every point r-symmetric to point in another shape

Microtiles - Connected points sharing symmetry transformations
Tiling graphs

Show adjacency

Implicit grammar encoding

Object valid if all connections exist in graph
Grammar simplification

Cost function - Suitability for 3D manufacturing

Reduce # of pieces

Simplify tiling graph; grammar implicitly updated

Redundancy - Minimize # of times a piece of geometry is repeated
Grammar simplification

Simplicity - Minimize the # of different piece types

Assemblability - Minimize bounding box overlap

Shape variability - Minimum number of global symmetric cuts
Grammar simplification

Edge collapses - Merging two tiles

Tile replacement - Making two similar tiles equivalent

Counters artist errors

Monte Carlo search of transformation series
Evaluation

Order of magnitude improvement to cost function

Improvement on manual decomposition

3D-printable

Variable complexity

Reasonably fast
Limitations

Assumes planar cuts are ideal

Structural strength

Requires symmetry
Further work

Structural strength

Human reception

Arbitrarily shaped cuts
Applications

Construction game

Procedural generation

Modeling tool