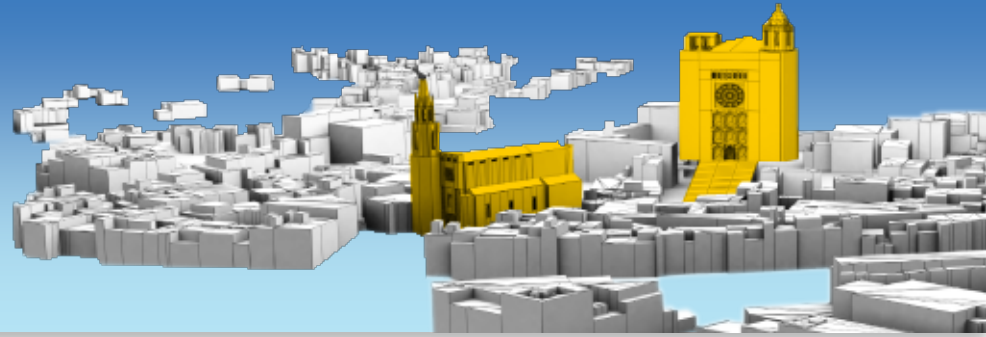




**Eurographics 2013**

May 6-10, Girona (Spain)



# Structure-Aware Shape Processing

Part III

## Example Applications

*Martin Bokeloh*

*Niloy Mitra*

*Michael Wand*

*Hao Zhang*

*Daniel Cohen-Or*

*Martin Bokeloh*

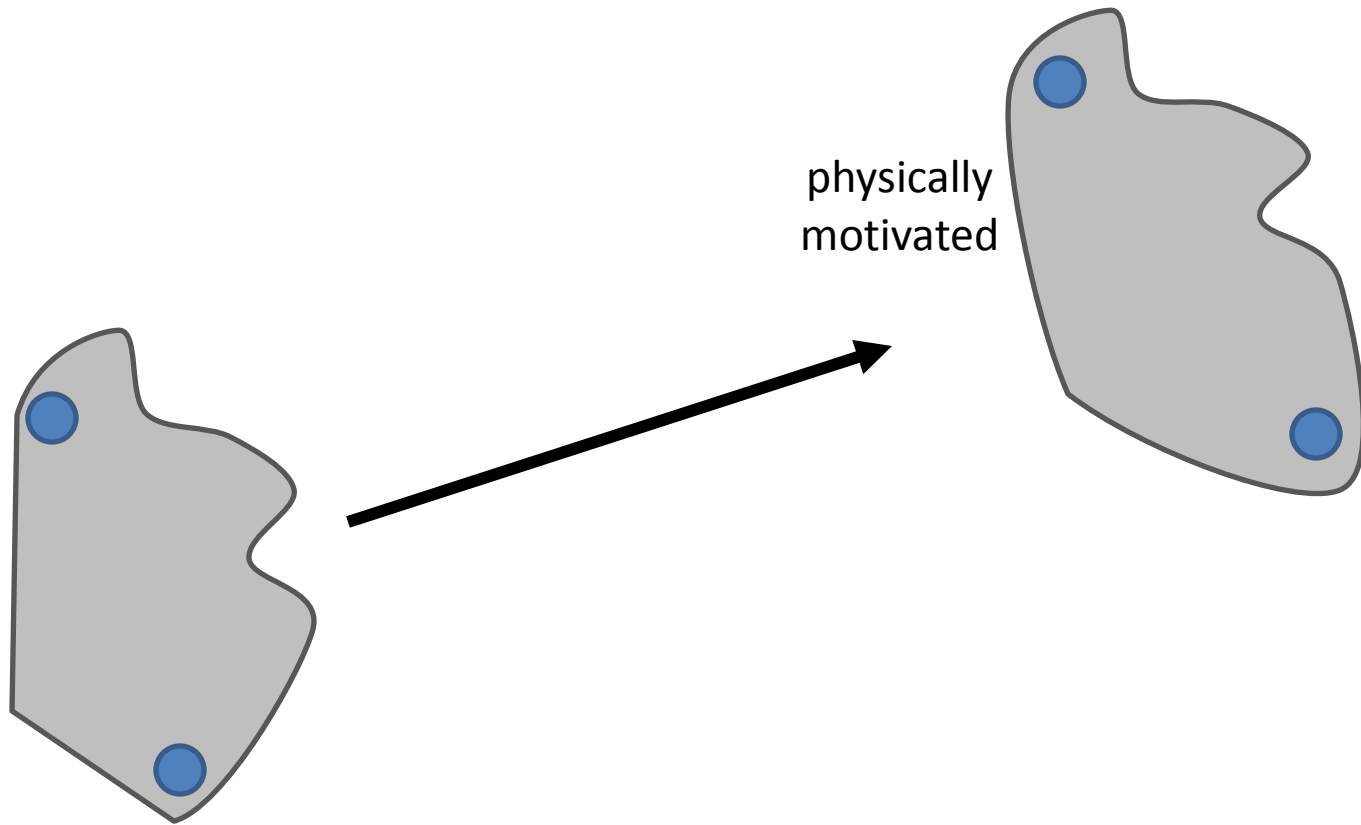


# Part III - Overview

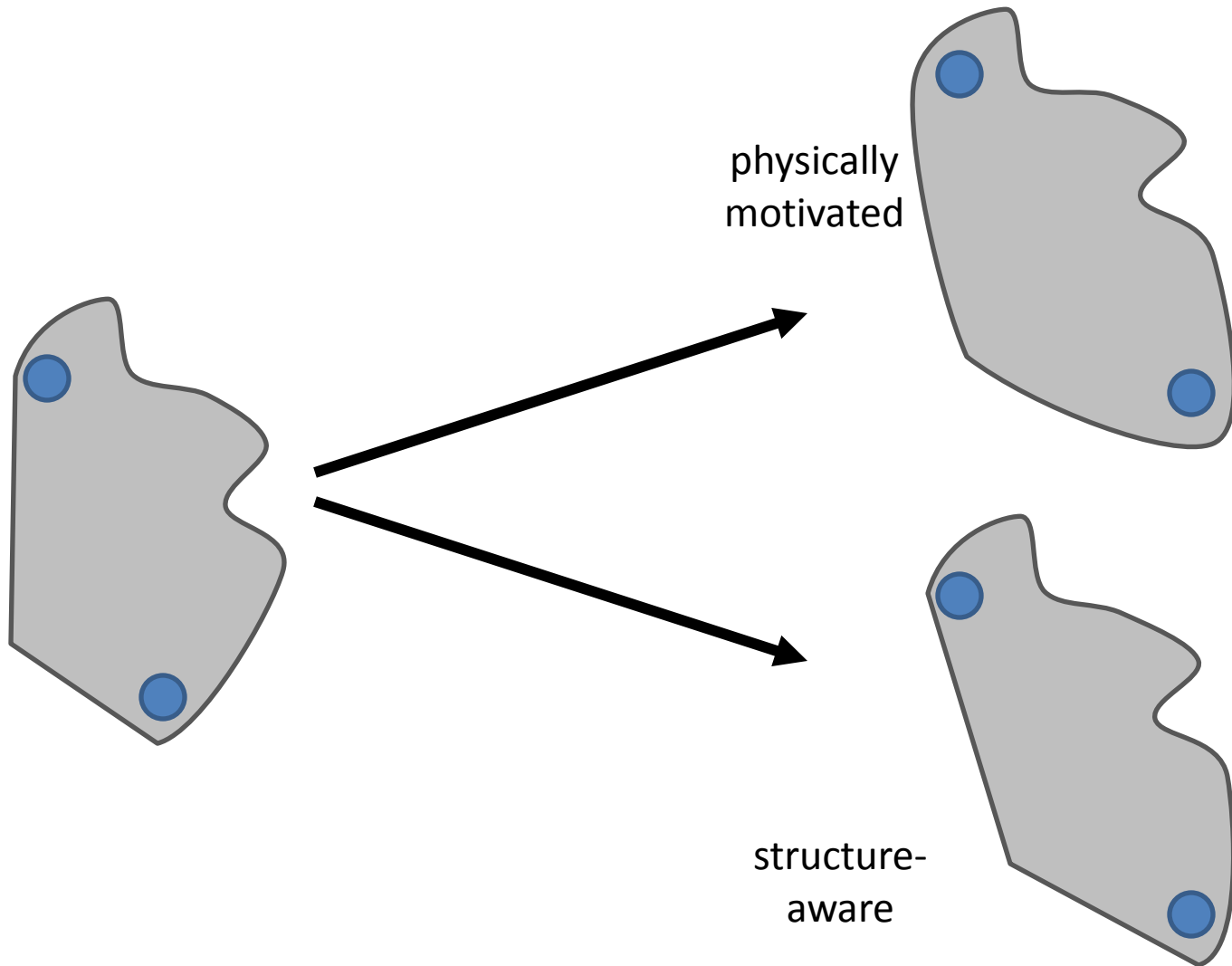
- Shape deformation
  - Local & global invariants
  - Learned deformations
- Shape synthesis by part recombination
  - Cutting & combination
  - Learned parts & relations
- Structure-aware reconstruction
- Structure-aware design exploration

# **SHAPE DEFORMATION**

# Structure-Aware Deformation

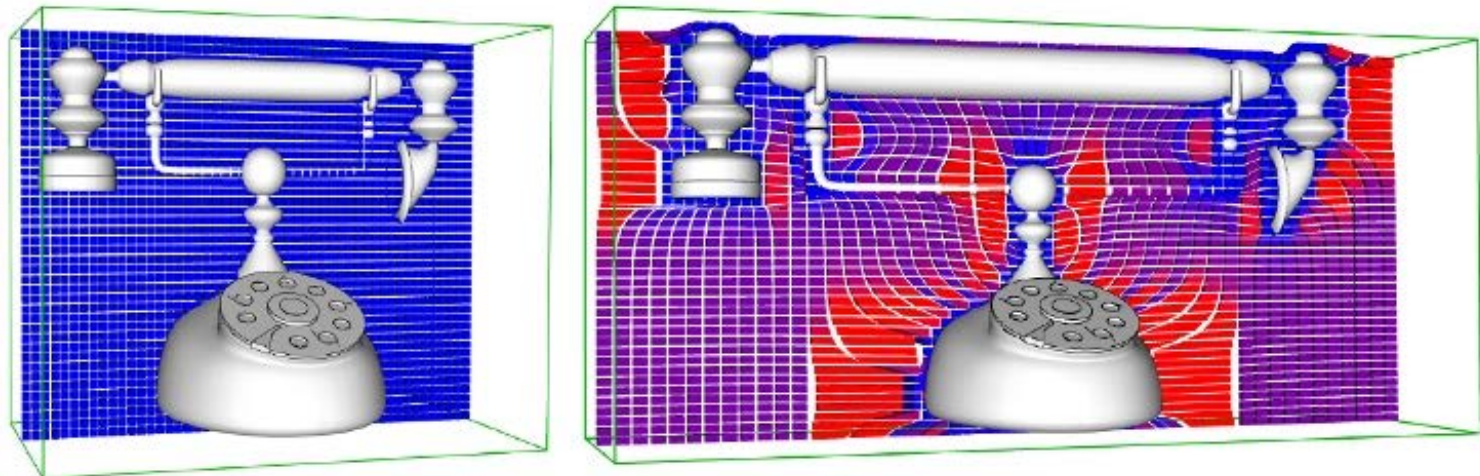


# Structure-Aware Deformation



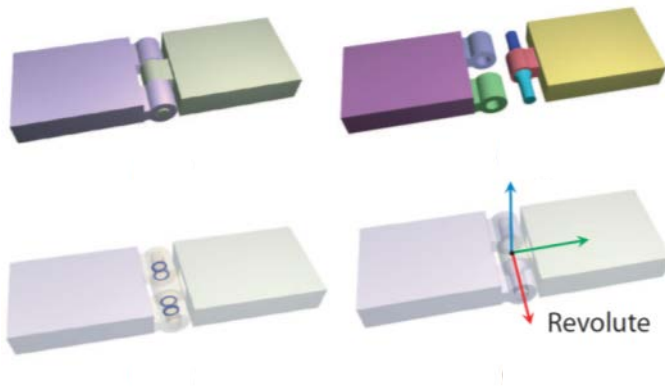
# Local Adaptivity

- Non-homogeneous resizing
  - Elastic deformation model
  - Introduce local ‘vulnerability’ term (parameters)
    - Prefer stretch in low curvature/high slippage regions



# Local Adaptivity

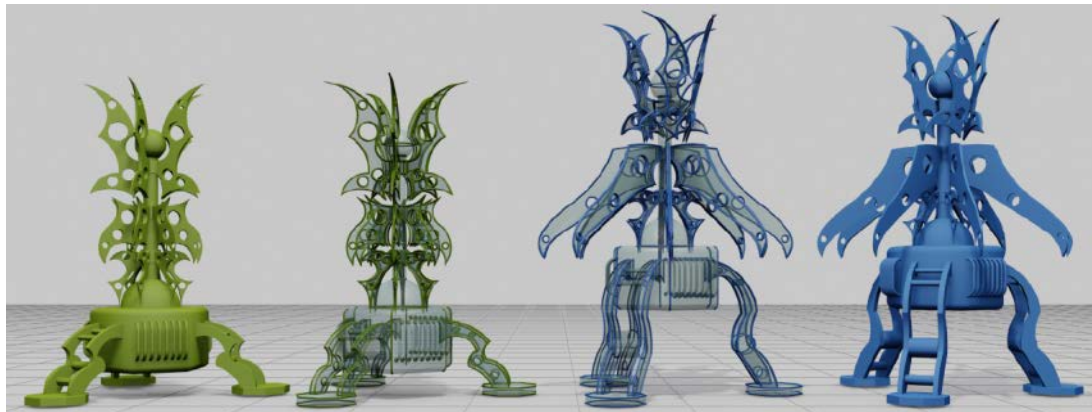
- Joint-aware deformation
  - Joint-analysis using slippage direction
  - Setup deformation cells (**parts**)
    - Prefer motions along joints in deformation (**parameters**)



[Xu et al. 2009]

# Non-local Relations

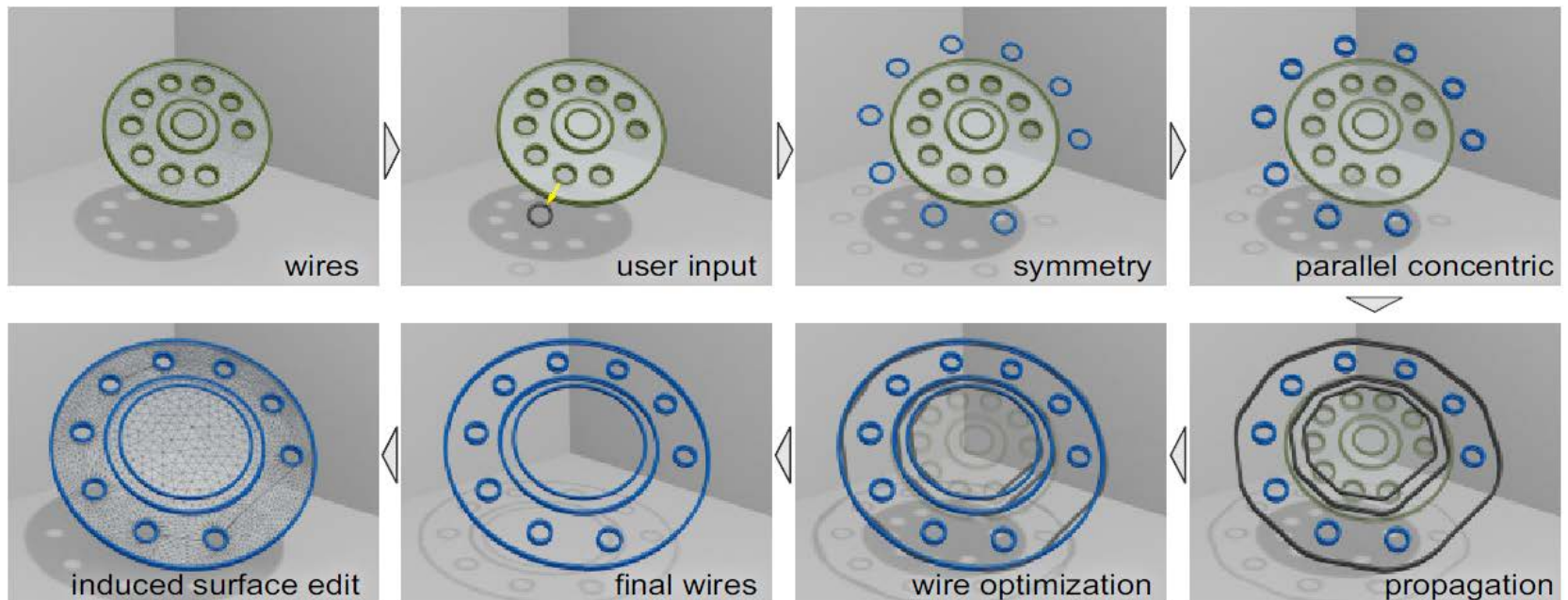
- iWires
  - Extract crease lines (parts)
  - Detect inter- and intra-wire properties (relations)
    - Parallelity, orthogonality, symmetry
  - Maintain relations under deformations



[Gal et al. 2009]

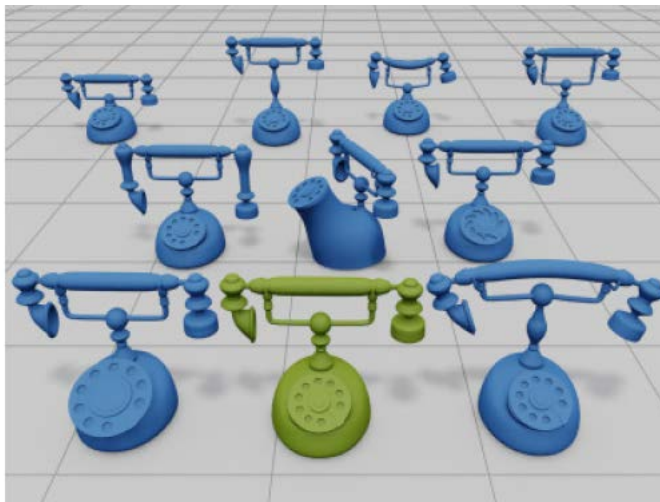
# Non-local Relations

- iWires



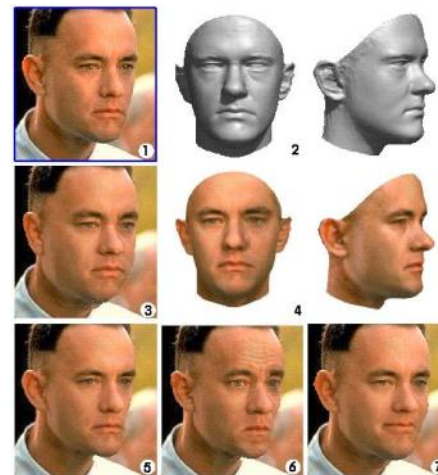
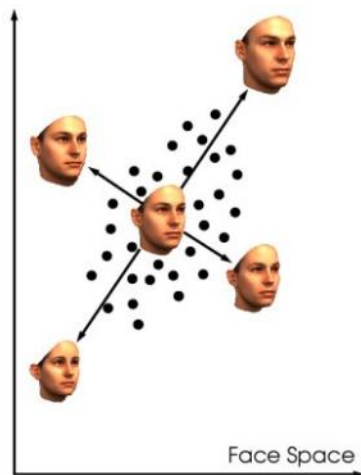
[Gal et al. 2009]

# Non-local Relations



# Learning Deformations

- PCA-based models
  - Establish *dense correspondences* between shapes from a database and a template shape
  - Fit linear generative model to data
    - Assume low-dimensional linear subspace



[Blaiz and Vetter 1999]

# **PART RECOMBINATION**

# Modeling by example

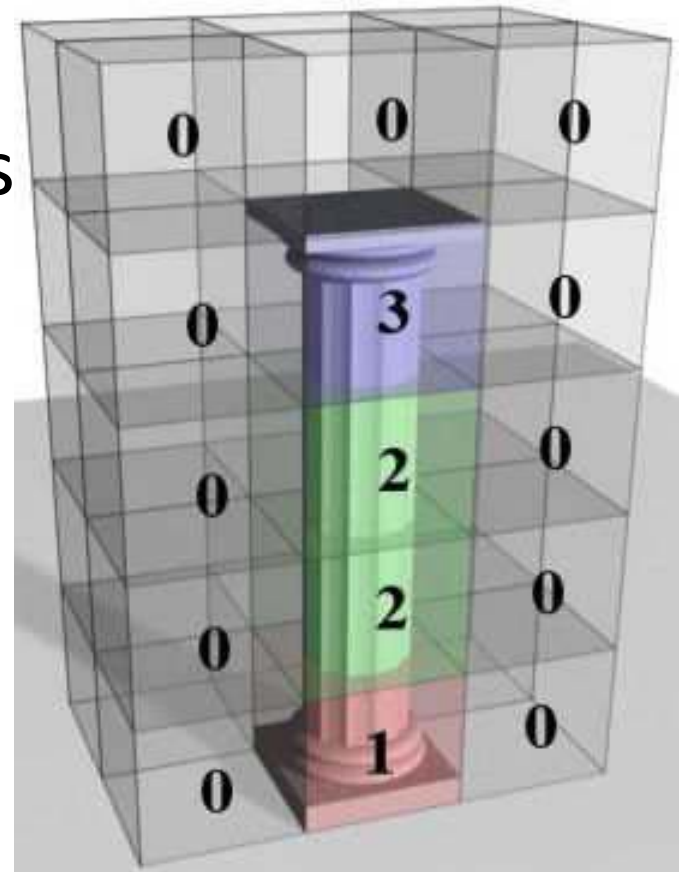
- User focused method
  - User defines parts and accepts suggestions from the database
- Method assists in composition



[Funkhouser et al. 2004]

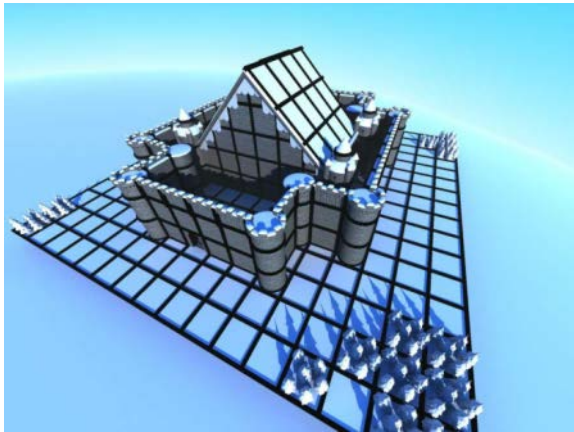
# Fixed-sized tiles

- Provide parts
- Find compatible boundaries
- MRF-based reassembling

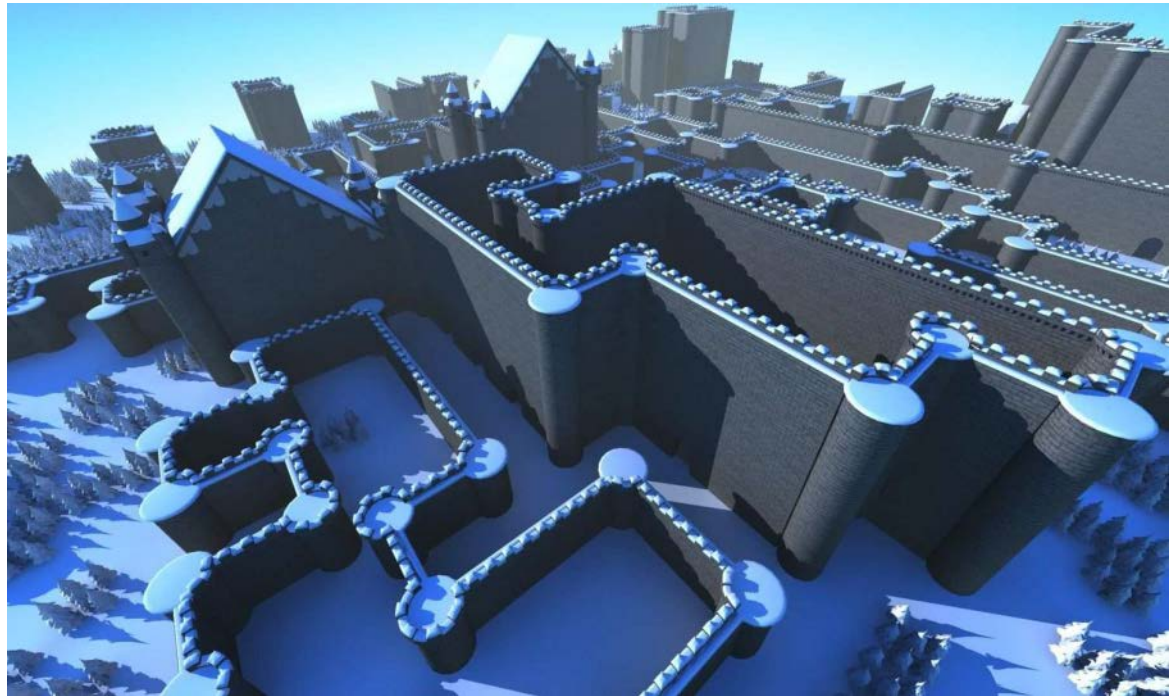


[Merrell 2007]

# Fixed-sized tiles



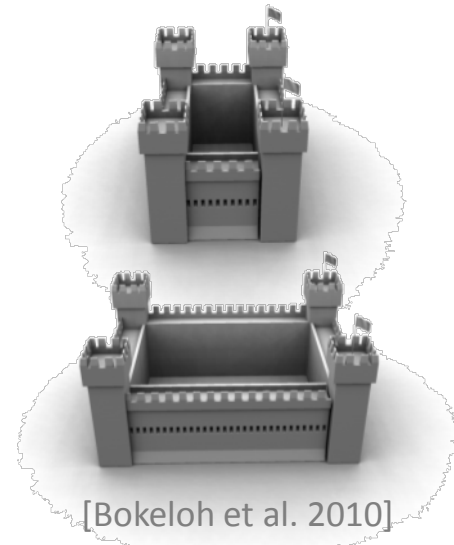
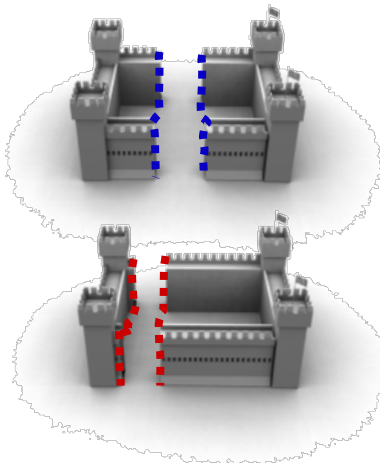
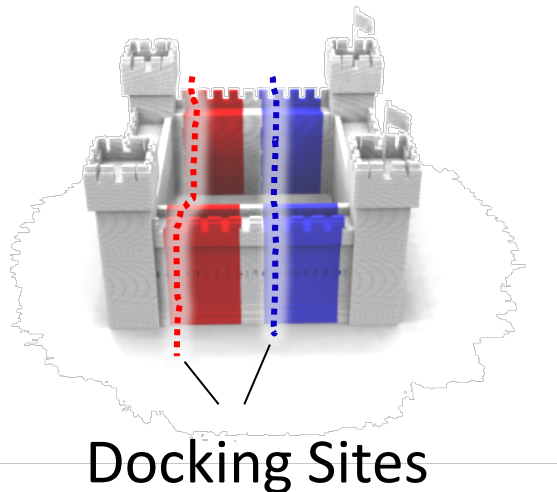
Input



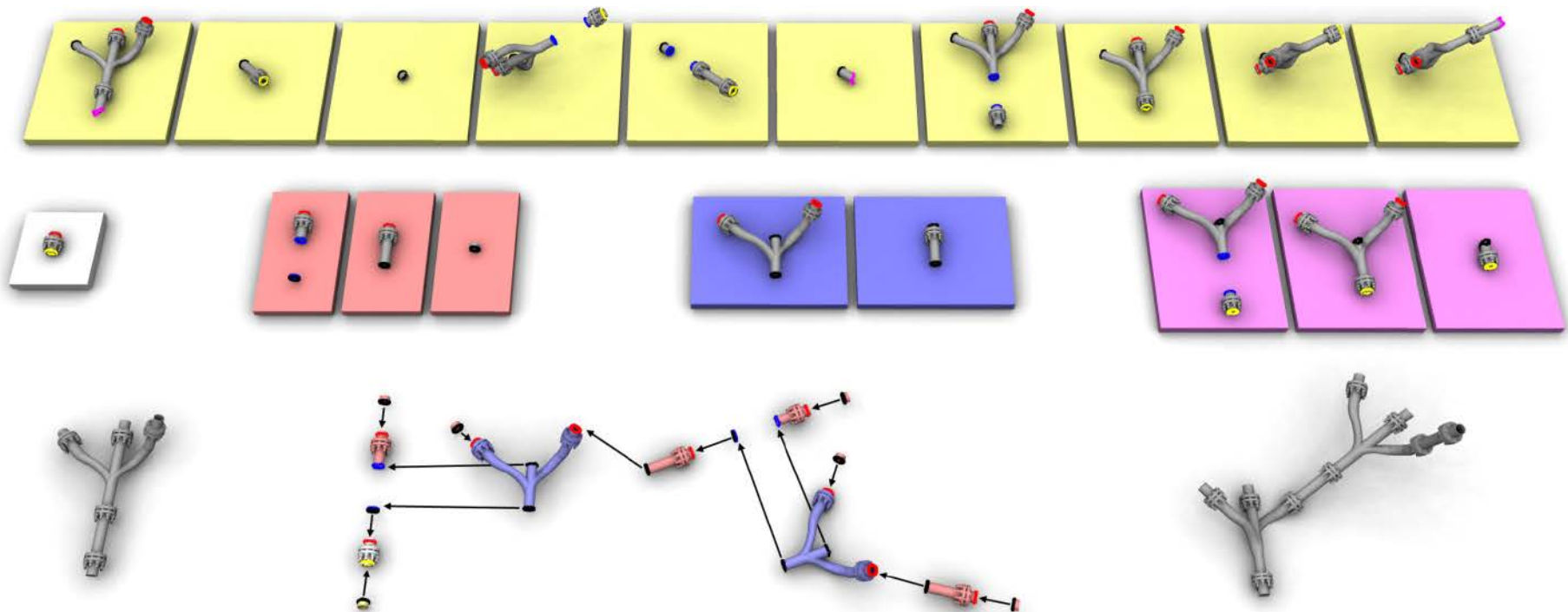
[Merrell 2007]

# Docking Sites

- Cut model at symmetry boundaries
- Symmetric boundaries yield replacement rules
- Precompute shape grammar

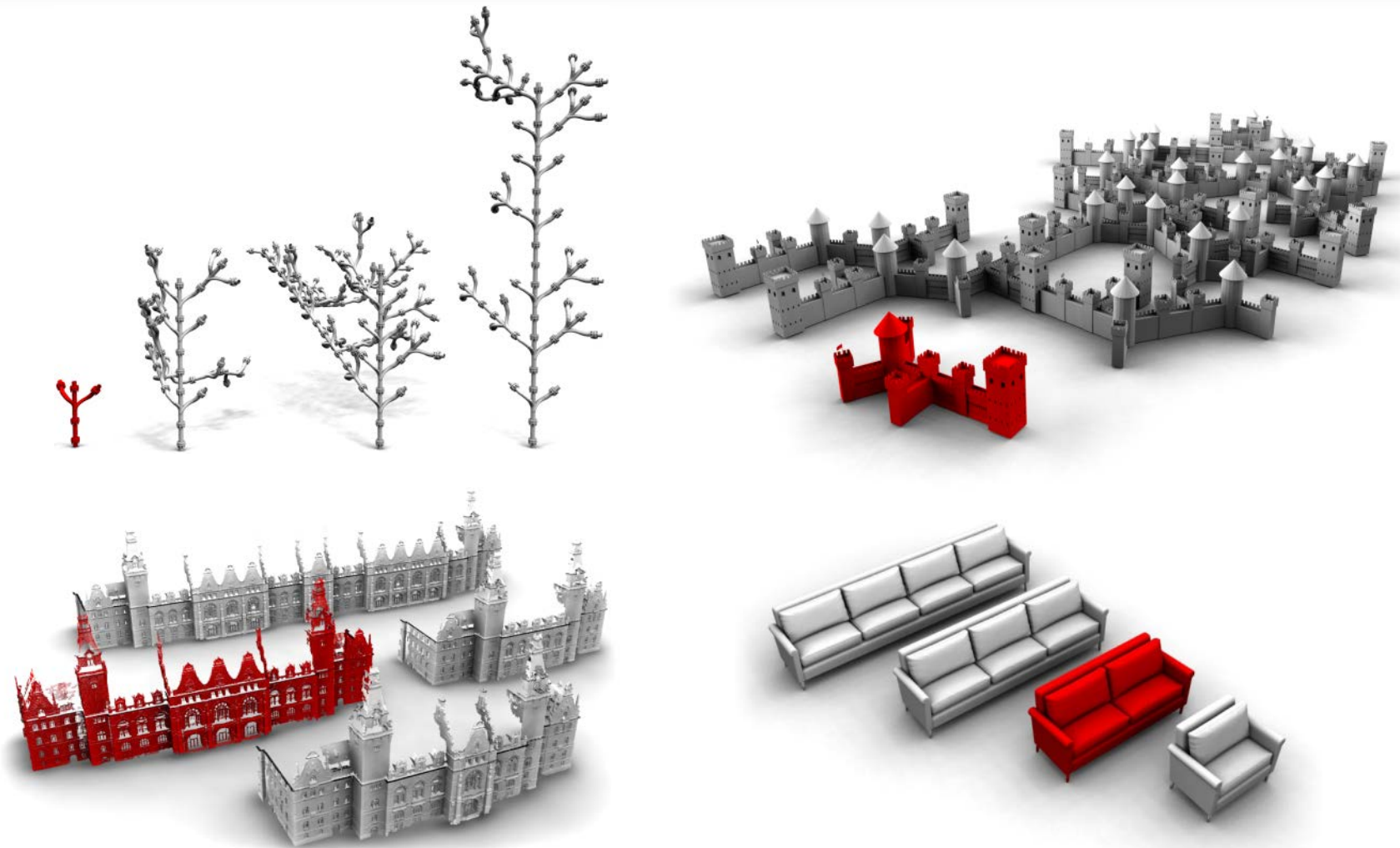


# Docking Sites



[Bokeloh et al. 2010]

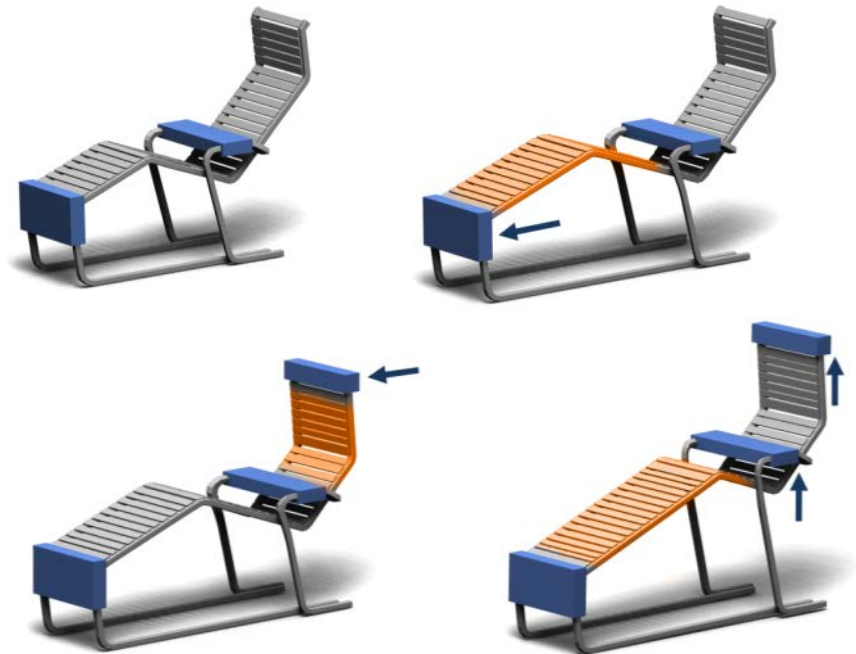
# Docking Sites



[Bokeloh et al. 2010]

# Pattern-aware Deformation

- Combine docking sites with structure-aware deformation
- Specific to *regular* patterns



[Bokeloh et al. 2011]

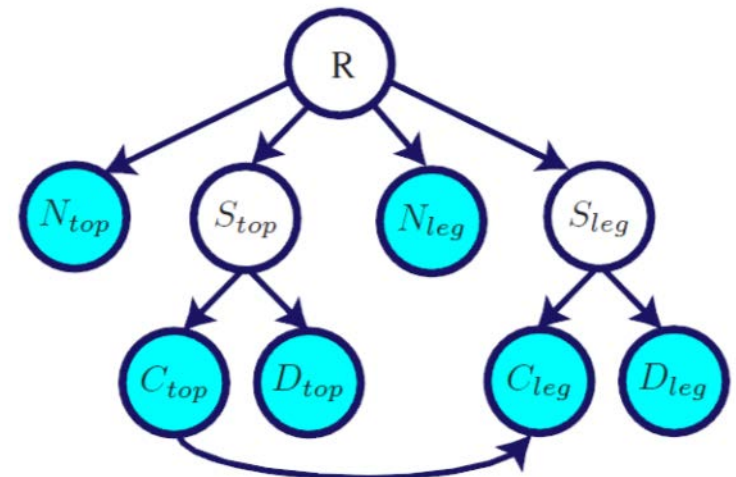
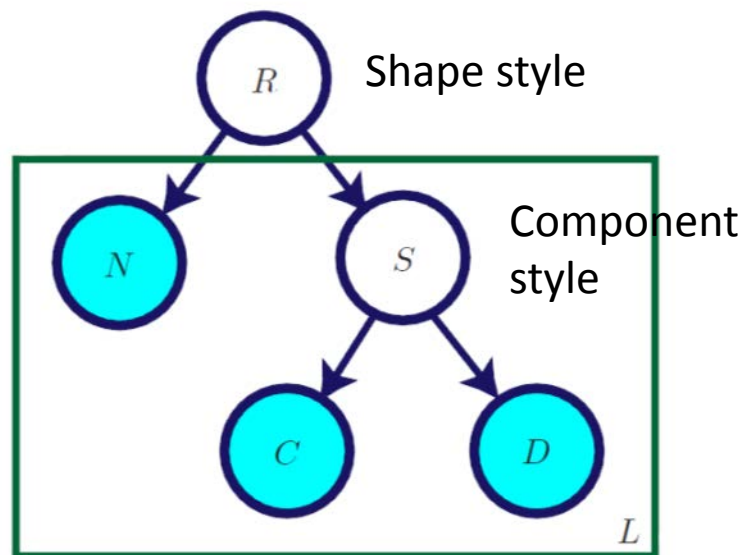
# Retargeting of Irregular Facades

- User provides rectangular parts
  - Additionally specifies resizing parameters
- Formulate 2D-retargeting as sequence of 1D problems

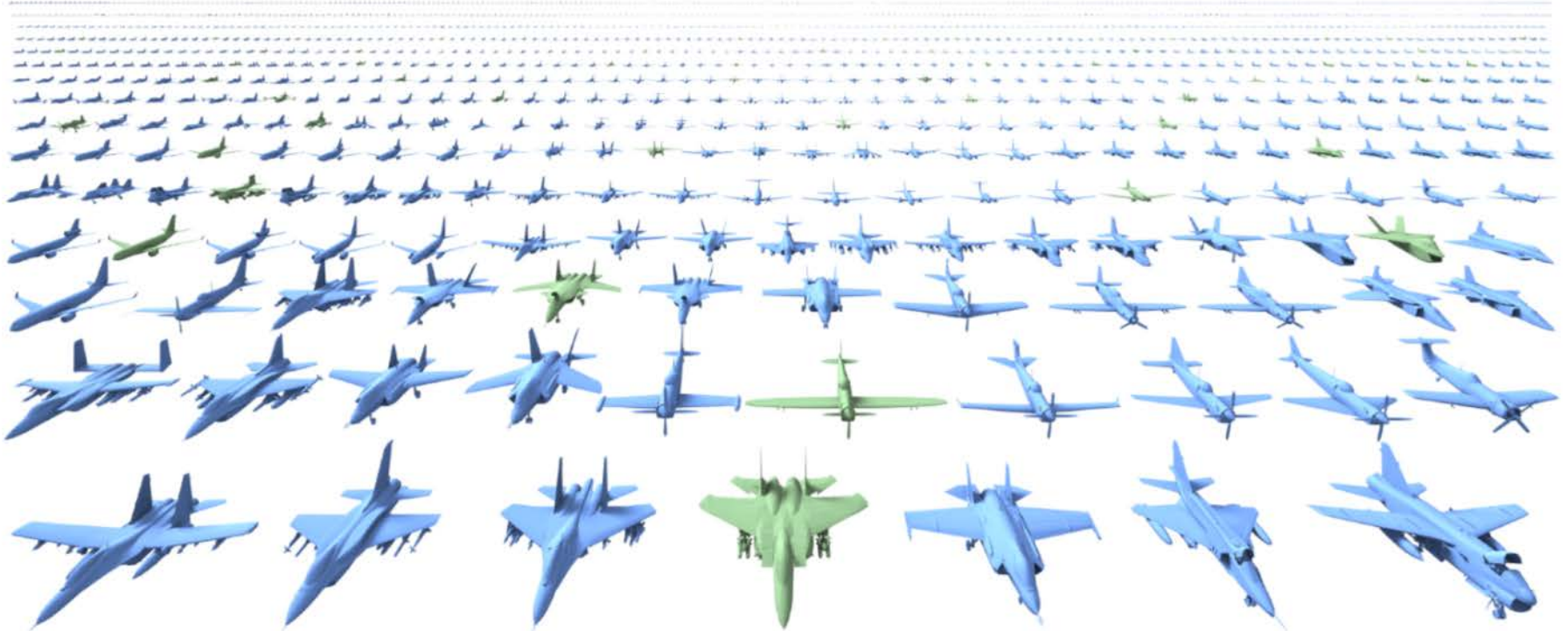


# Probabilistic Shape Model

- Learning parameters & relations
  - Input: Segmented shape database
  - Learn probabilistic model



# Probabilistic Shape Model



# Set Evolution

- Define mutation operator
  - Cross-shape
- Evolve a set of shapes
  - User defines fitness
  - Additionally: Diversity



# Set Evolution



Input



Generation 5



Generation 10

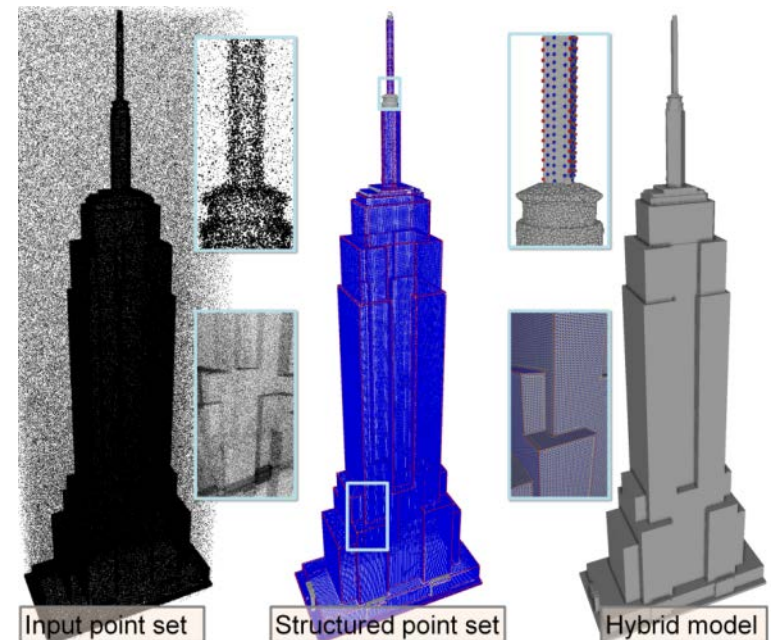


Generation 15

# **STRUCTURE-AWARE RECONSTRUCTION**

# Point Set Structuring

- Detect planes
- Build primitive graph
- Construct a *structured point set*
- Reconstruct using graph cut optimization



# Structure recovery through part assembly

- Reconstruct kinect data with high quality 3d database (labeled)



[Shen et al. 2012]

# **STRUCTURE-AWARE DESIGN EXPLORATION**

# Constrained meshes

- Explore shape space w.r.t. specific constraints (implicit non-linear constraints)



[Yang et al. 2011]

# Structural optimization

- Improve structural stability of 3d masonry buildings
  - Apply local changes to stabilize

