

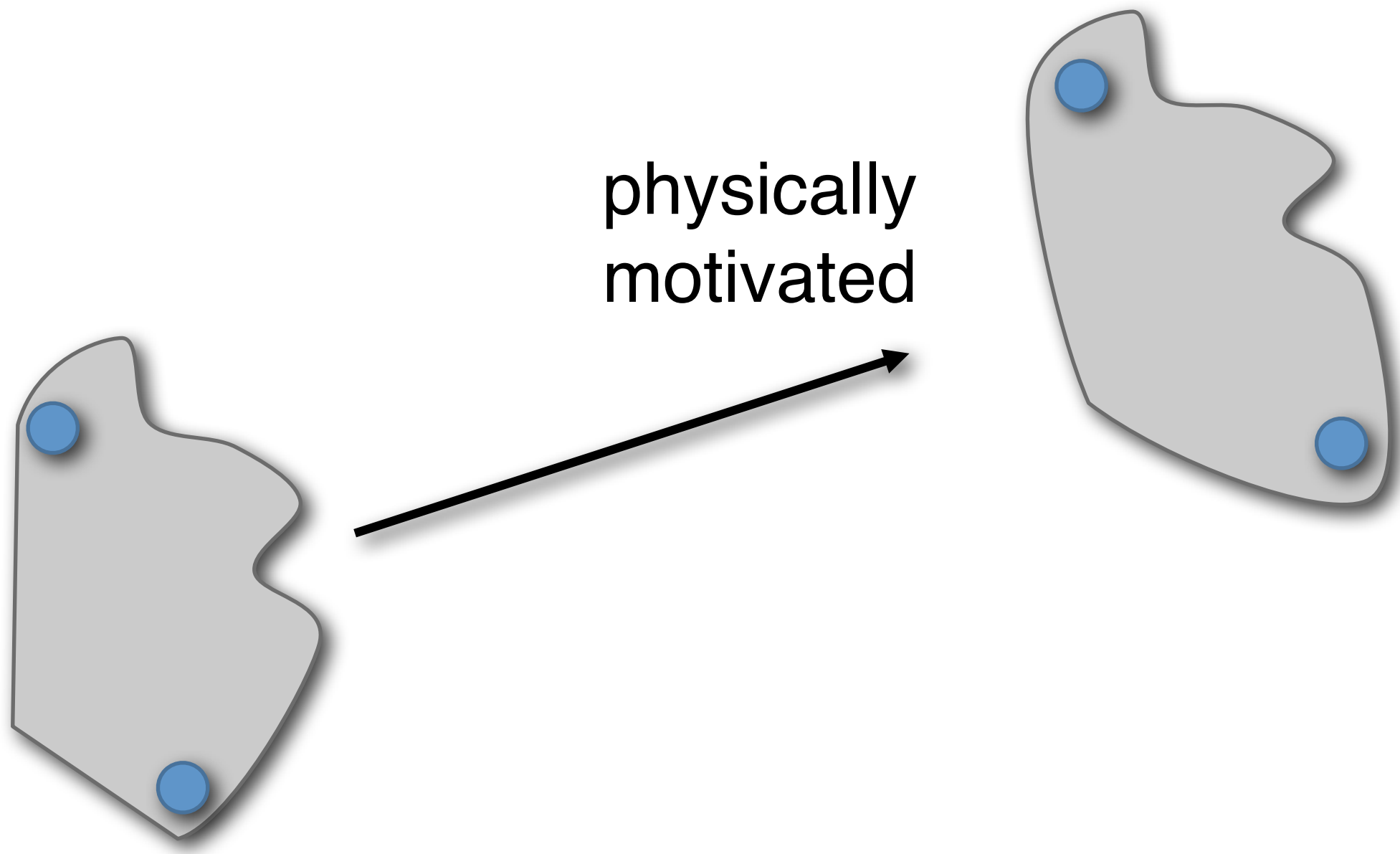
# Manipulating Structures

---

## Structure-guided Design

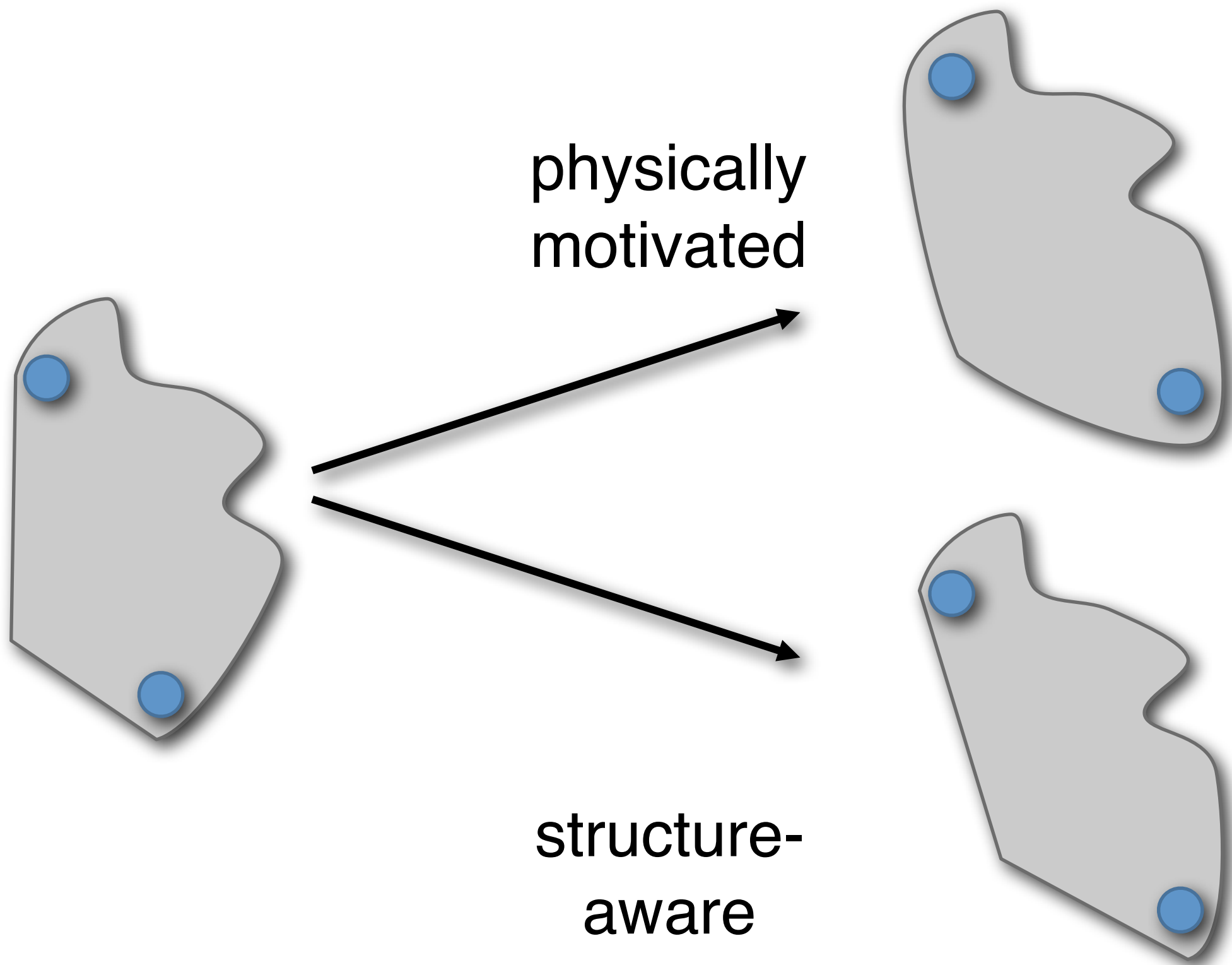
# Structure-Aware Deformation

---



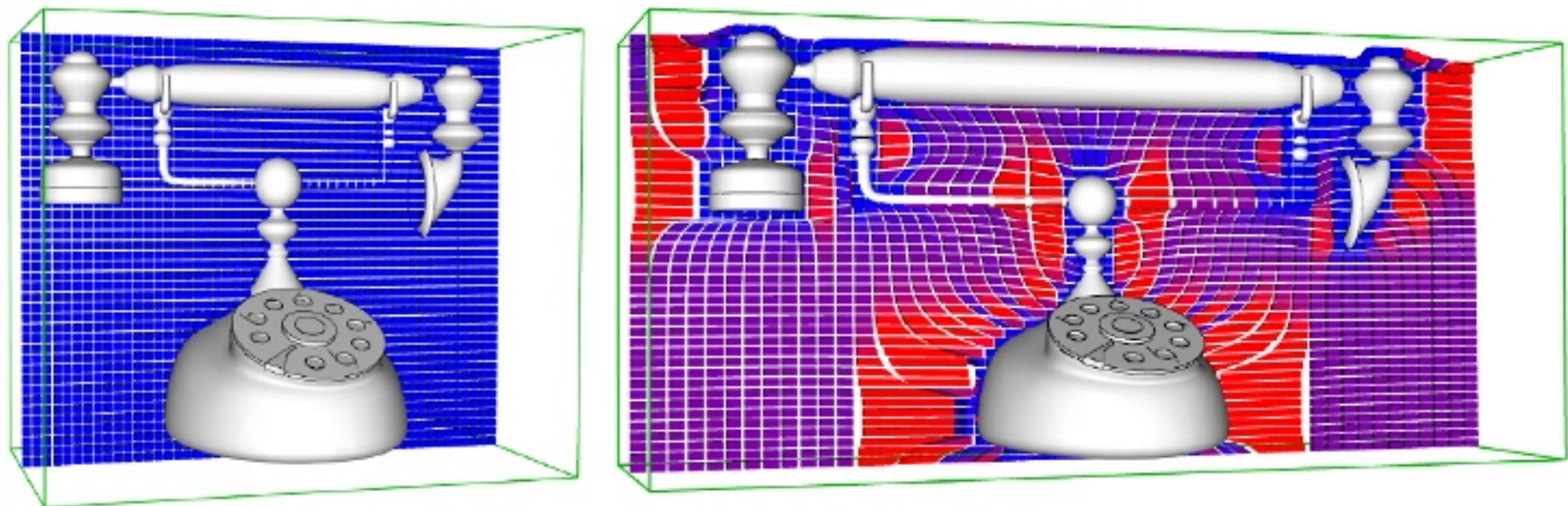


# Structure-Aware Deformation



# Local Adaptivity

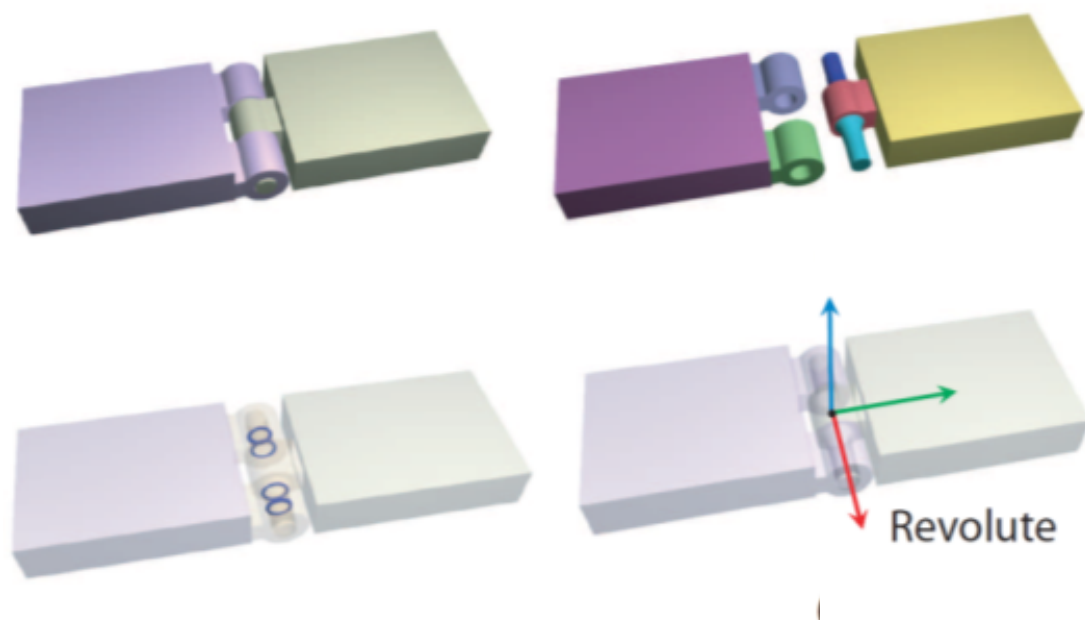
- Non-homogeneous resizing
  - Elastic deformation model
  - Introduce local ‘vulnerability’ term (parameters)
    - Prefer stretch in low curvature/high slippage regions



[Kraevoy et al. 2008]

# 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]

# Local Adaptivity

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

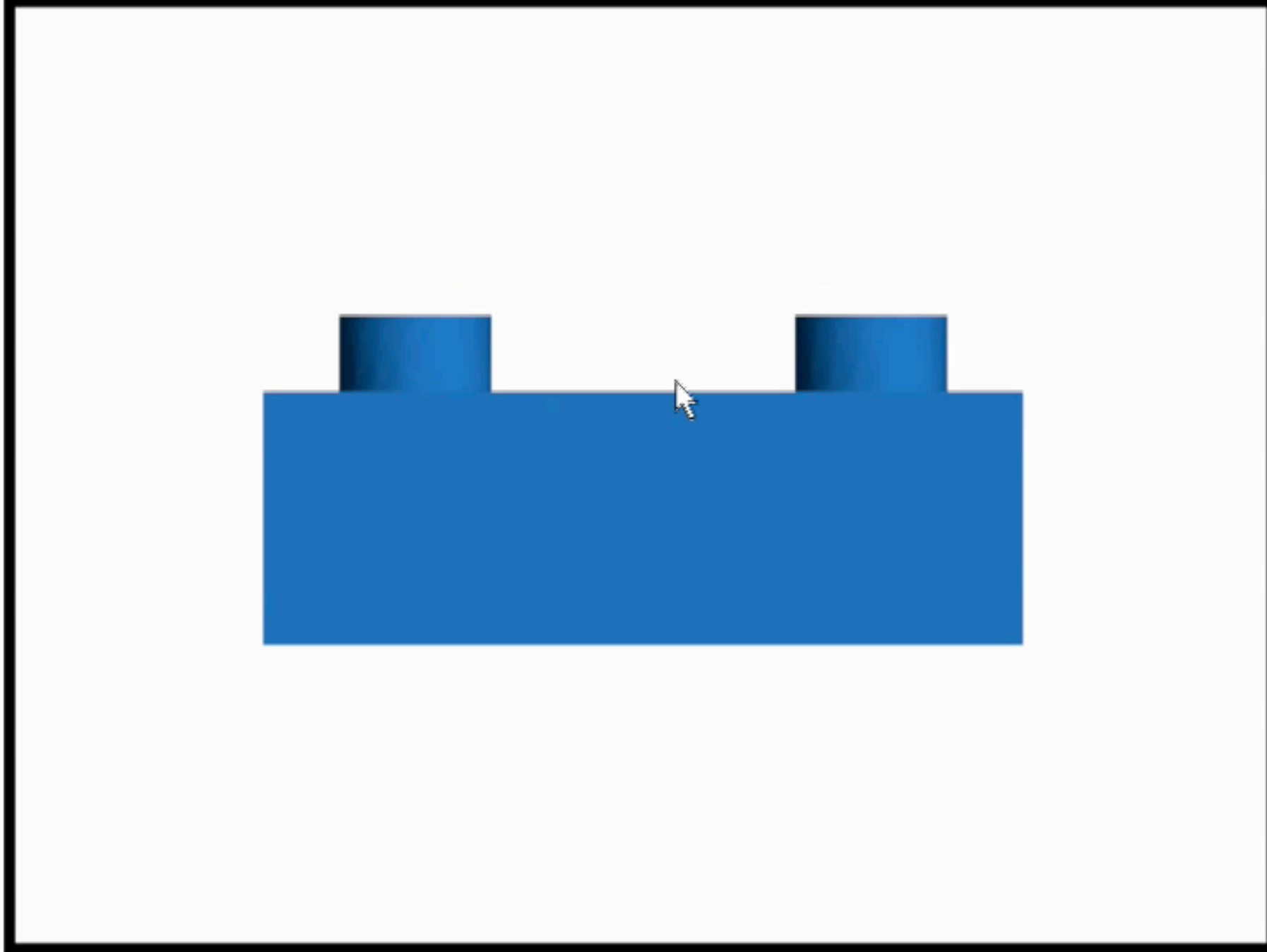


[Xu et al. 2009]

# Relations across Features

Detail-preserving deformation

Speed x2



[Gal et al., Siggraph 2009]

# Parts and their Relations

---



# Parts and their Relations

---

- ***Primitives:***



# Parts and their Relations

---

- ***Primitives:***
  - wires, i.e., sharp-edge curves



# Parts and their Relations

---

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  - wires, i.e., sharp-edge curves

# Parts and their Relations

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- ***Primitives:***
  - wires, i.e., sharp-edge curves
- ***Relations:***

# Parts and their Relations

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- ***Primitives:***
  - wires, i.e., sharp-edge curves
- ***Relations:***
  - *individual relations* (single wires)

# Parts and their Relations

---

- ***Primitives:***
  - wires, i.e., sharp-edge curves
- ***Relations:***
  - *individual relations* (single wires)
    - planarity, straight line, circle, etc.

# Parts and their Relations

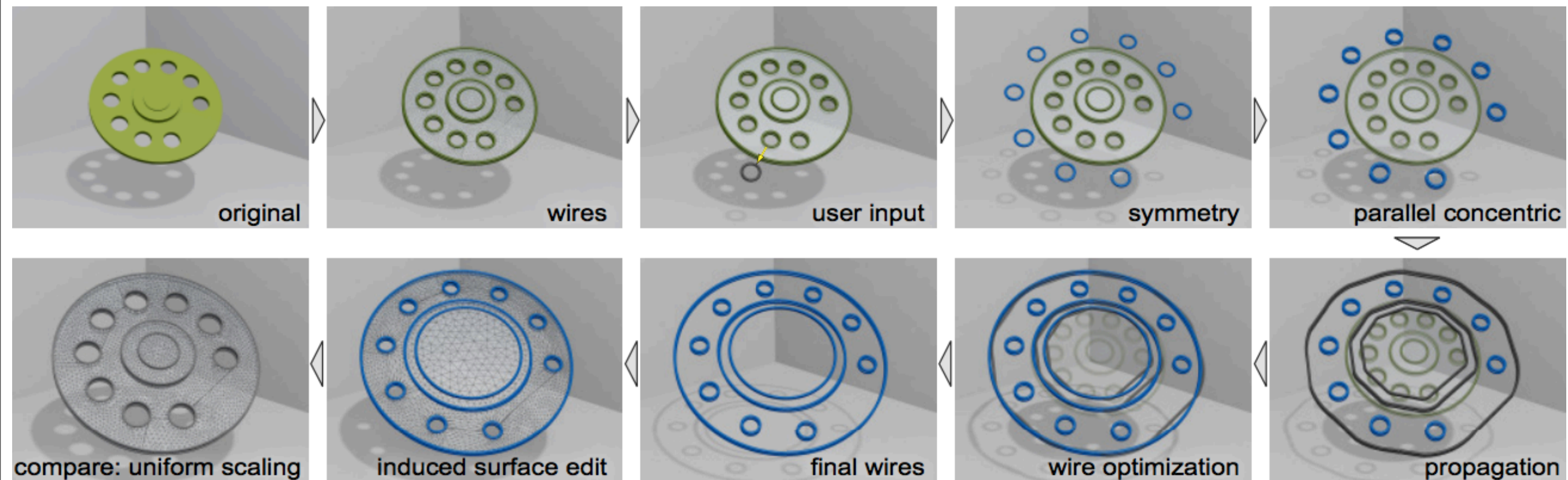
---

- ***Primitives:***
  - wires, i.e., sharp-edge curves
- ***Relations:***
  - *individual relations* (single wires)
    - planarity, straight line, circle, etc.

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  - wires, i.e., sharp-edge curves
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  - *individual relations* (single wires)
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  - *mutual relations* (pair of wires)

- ***Primitives:***
  - wires, i.e., sharp-edge curves
- ***Relations:***
  - *individual relations* (single wires)
    - planarity, straight line, circle, etc.
  - *mutual relations* (pair of wires)
    - parallel, orthogonal, concentric, etc.

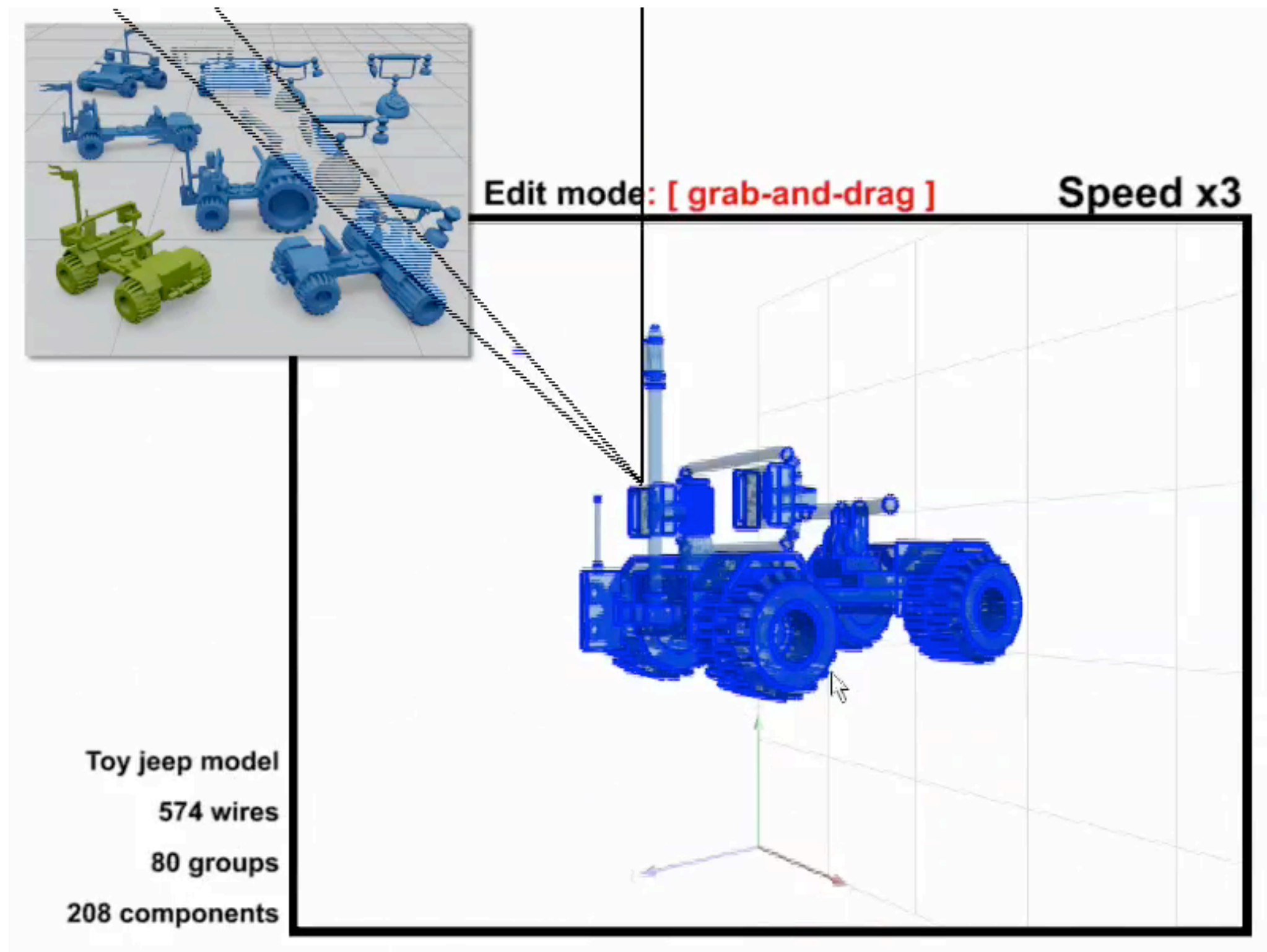
# Non-local Relations



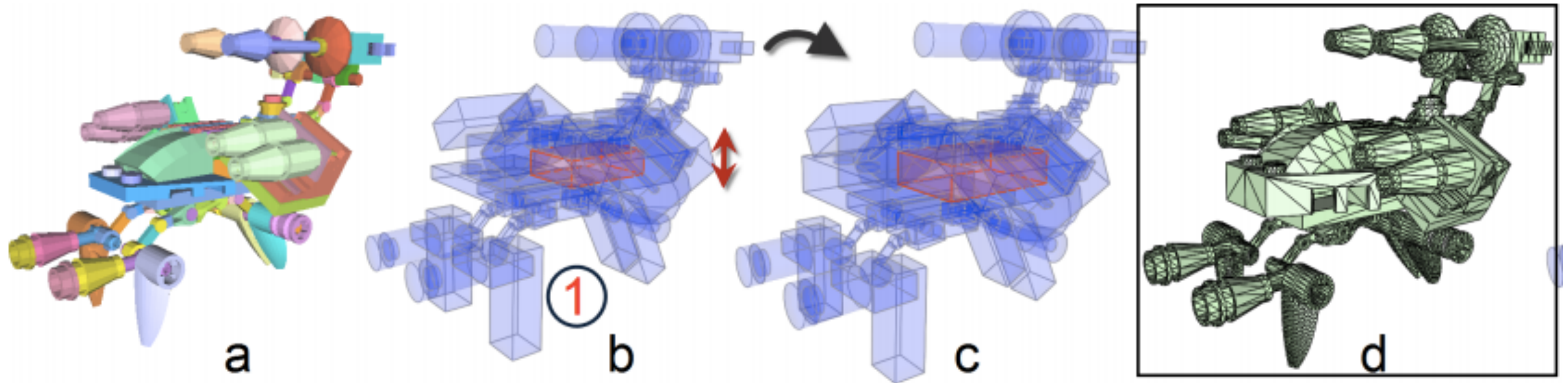


individual wire

# Sample Edit Session



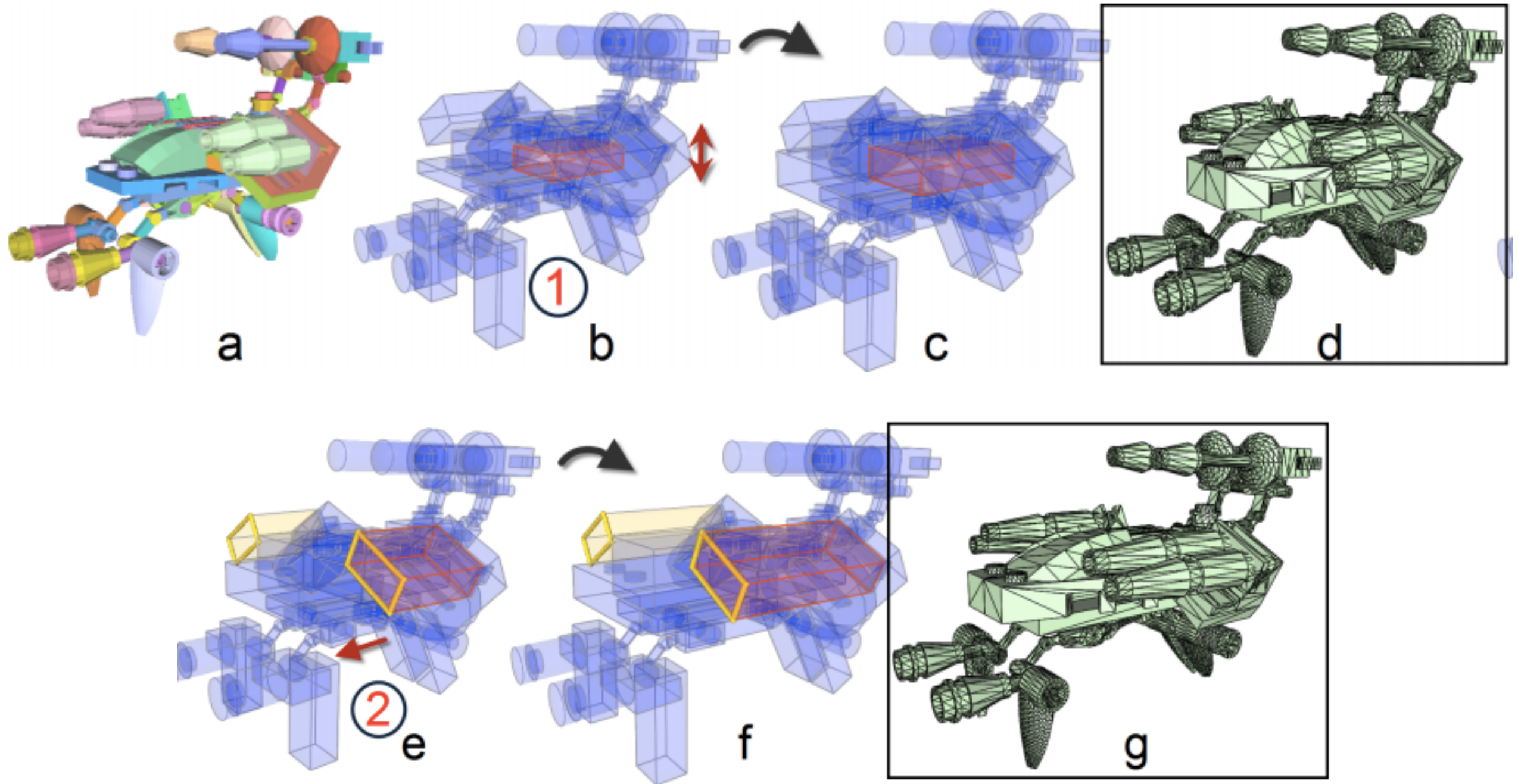
# Component-based Manipulation



[Zheng et al., Eurographics 2011]



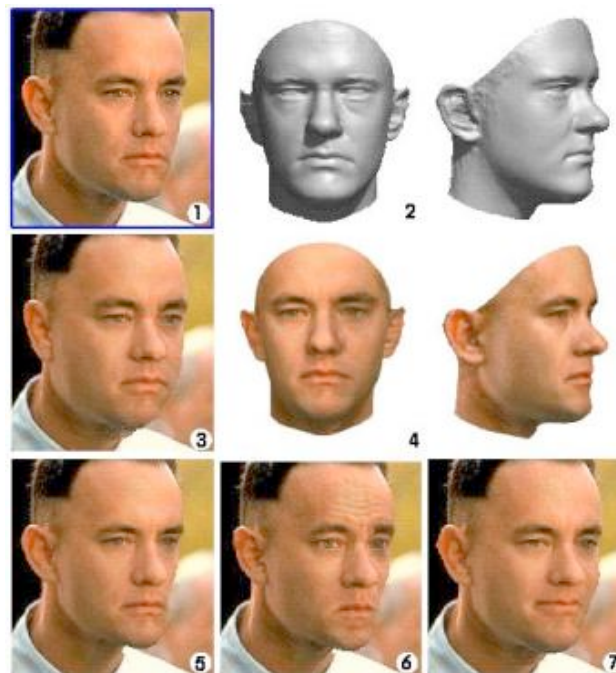
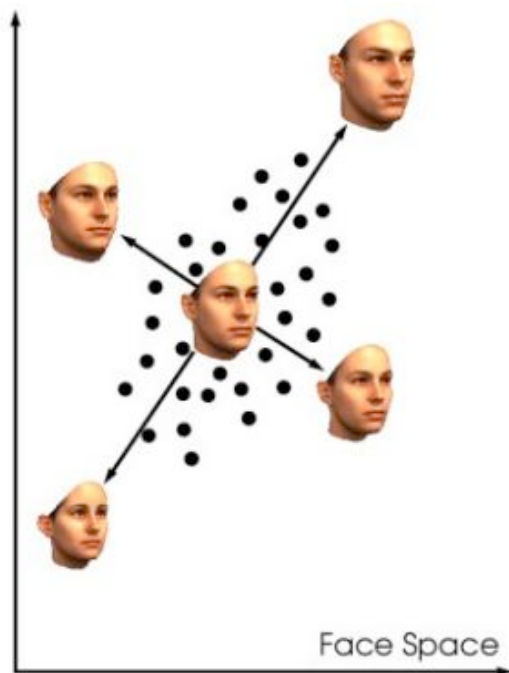
# Component-based Manipulation



[Zheng et al., Eurographics 2011]

# 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



[Blanz and Vetter 1999]

# Modeling by Example

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

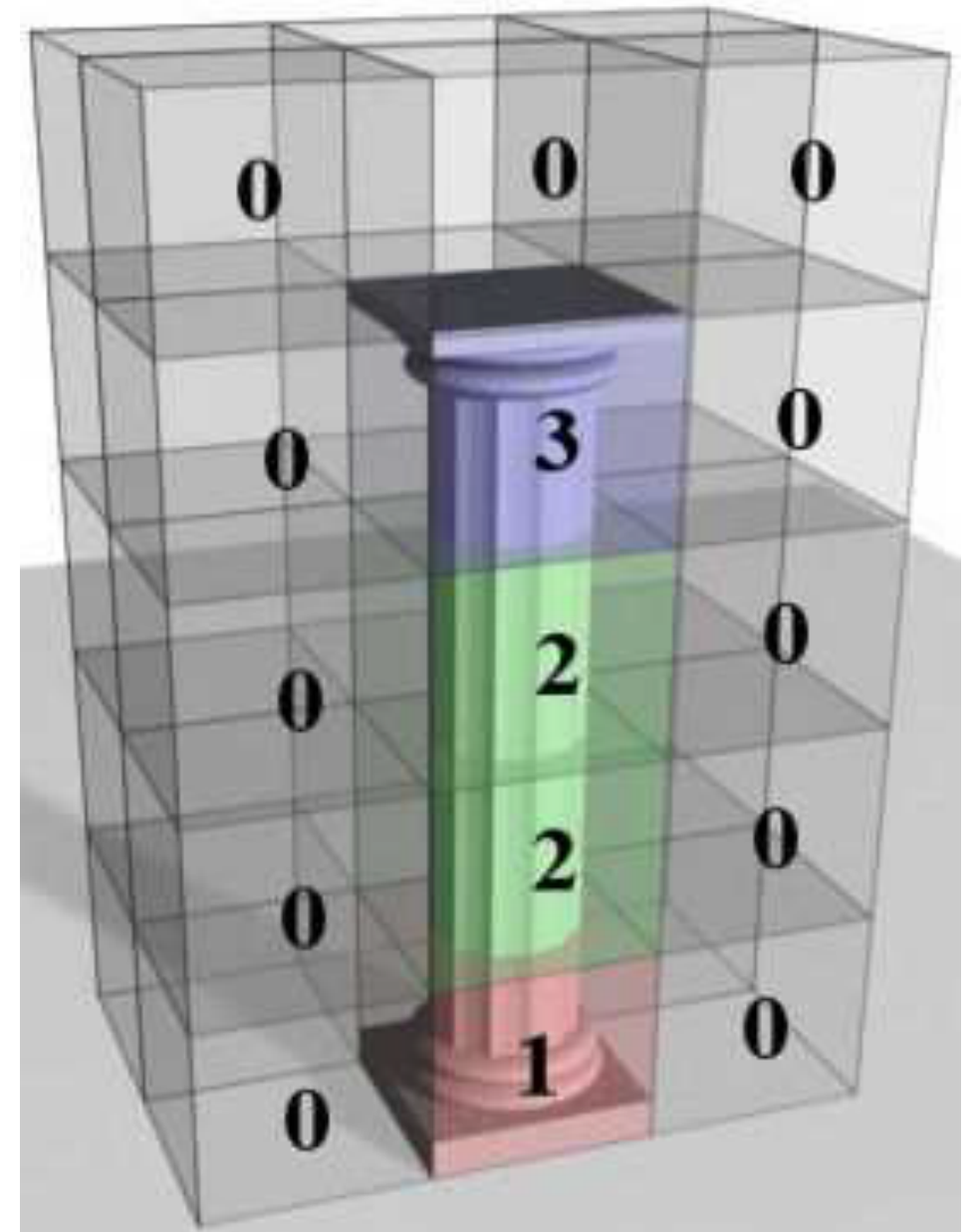


[Funkhouser et al. 2004]



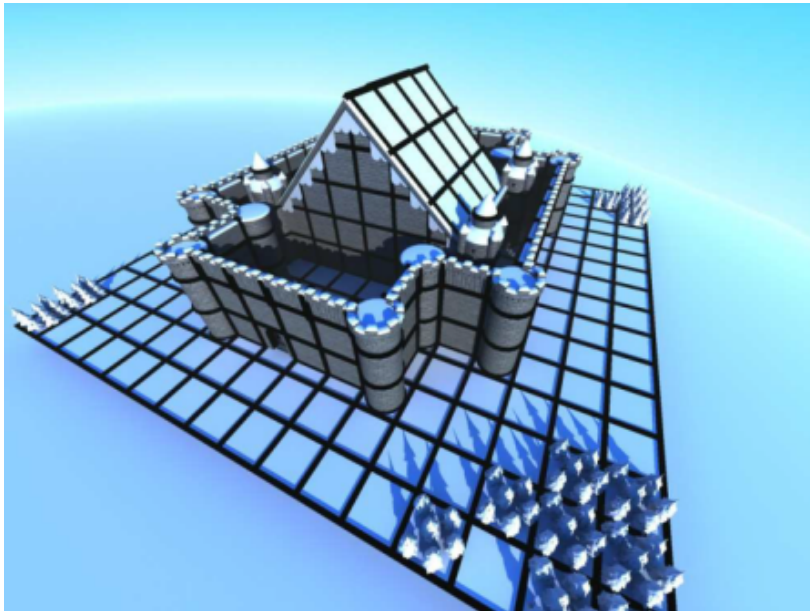
# Fixed-sized Tiles

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

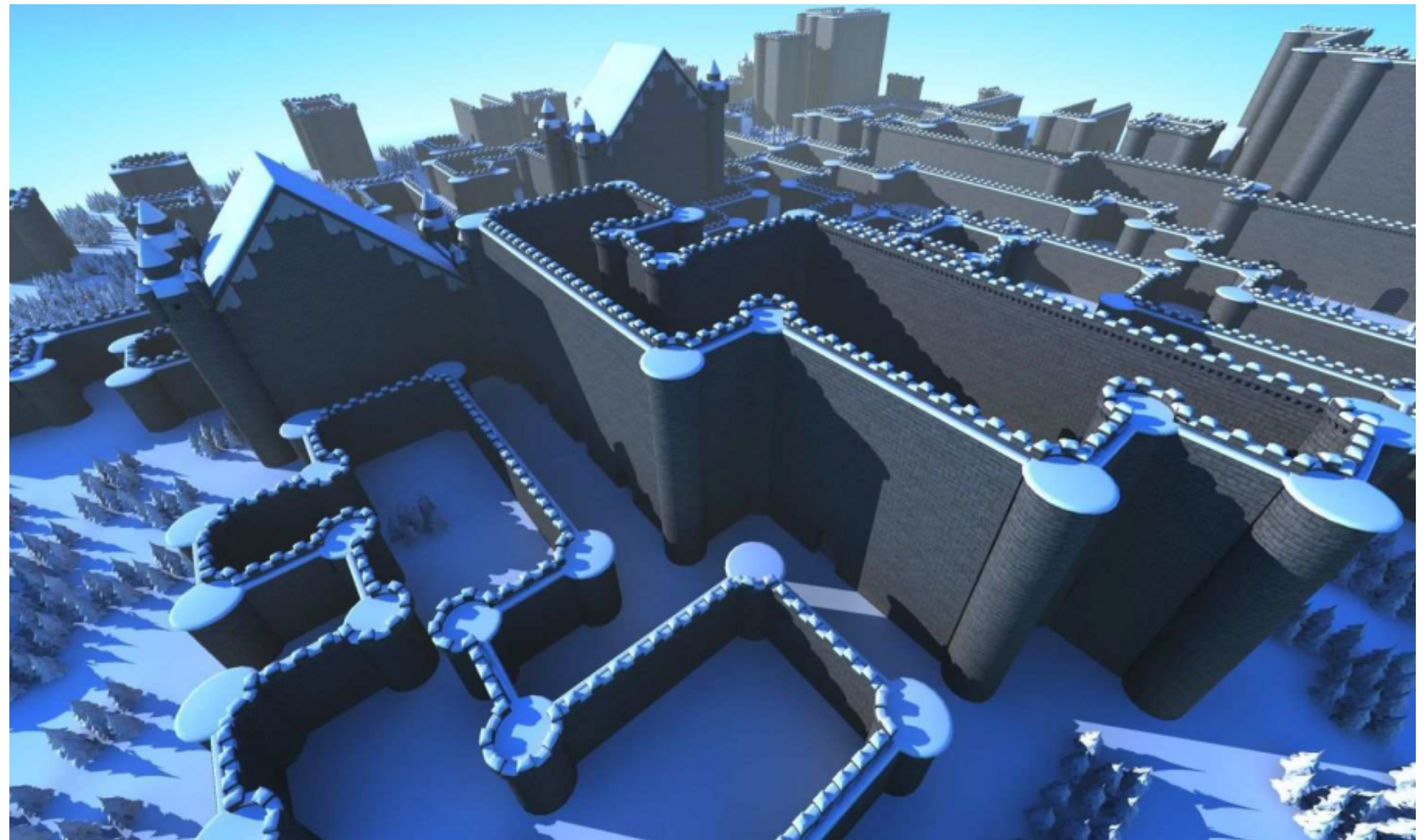


[Merrell 2007]

# Fixed-sized Tiles



input

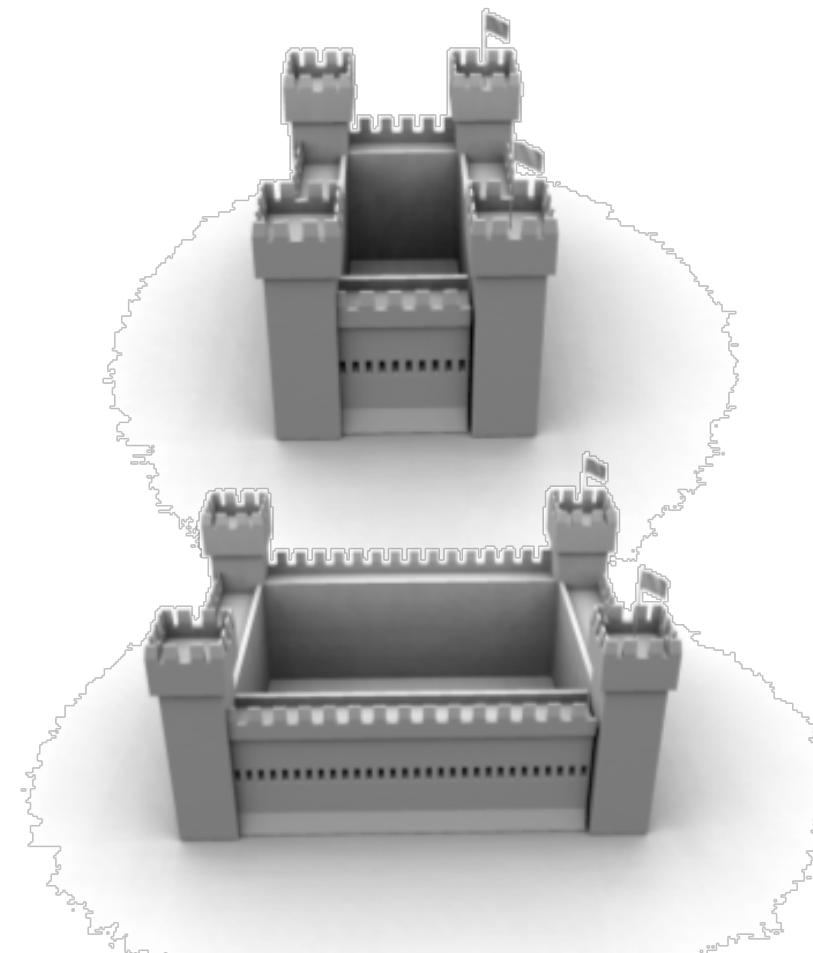
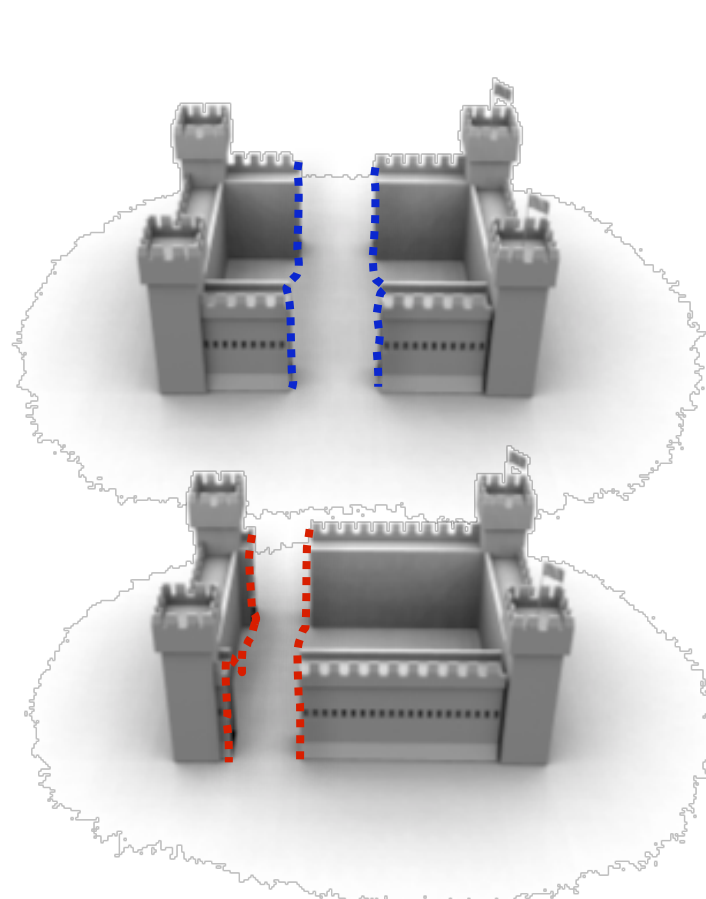
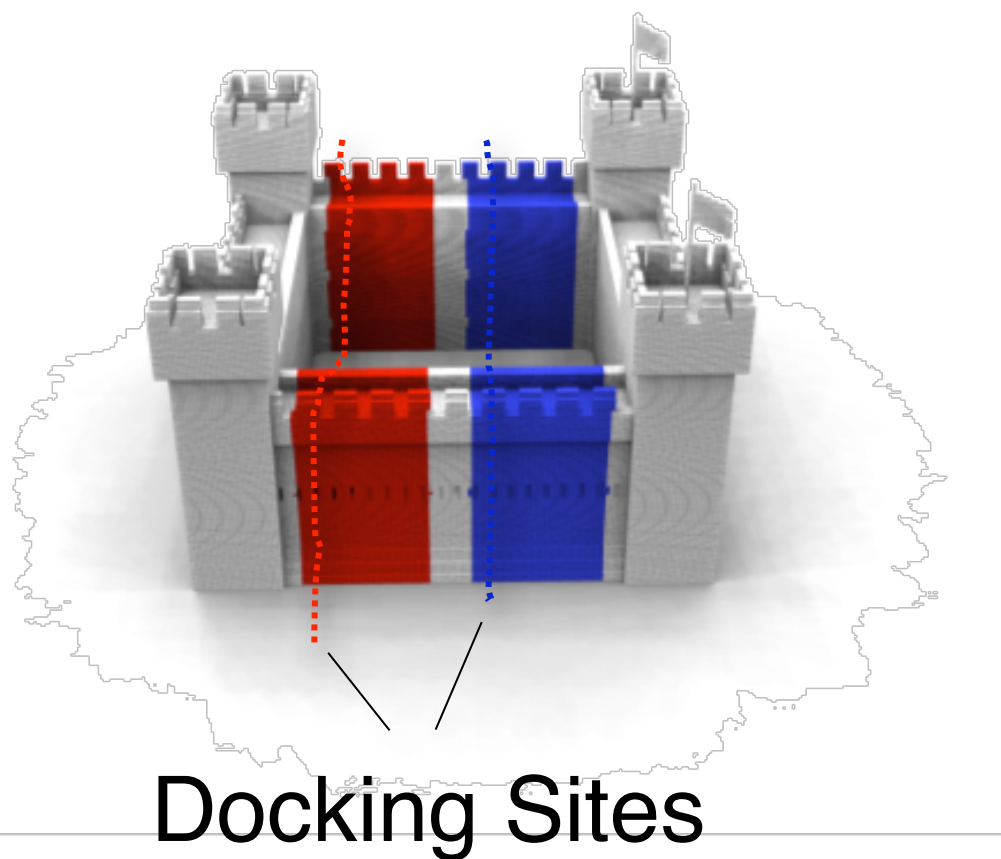


synthesized



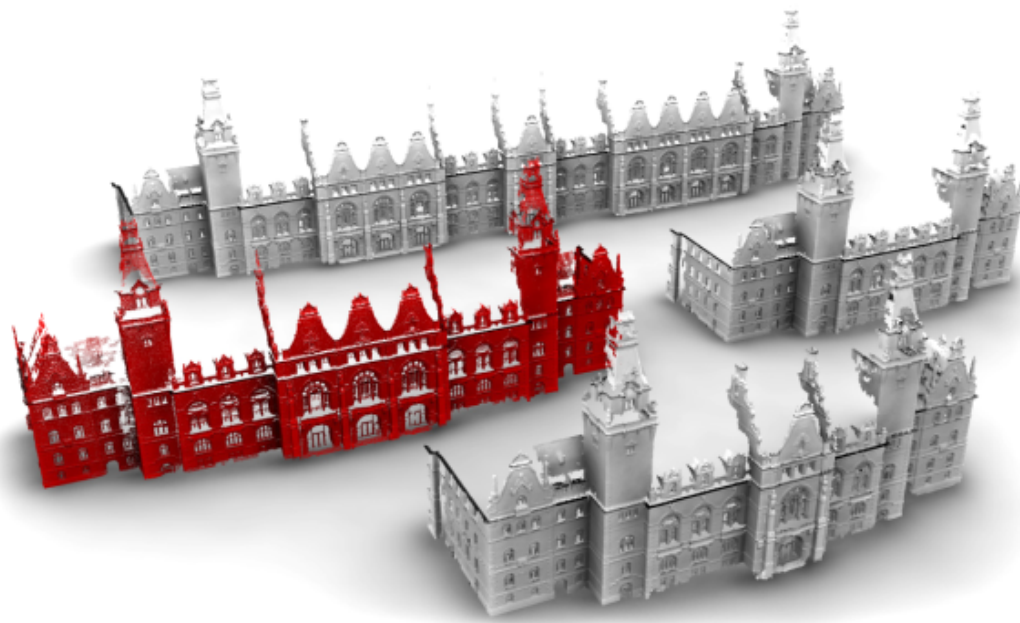
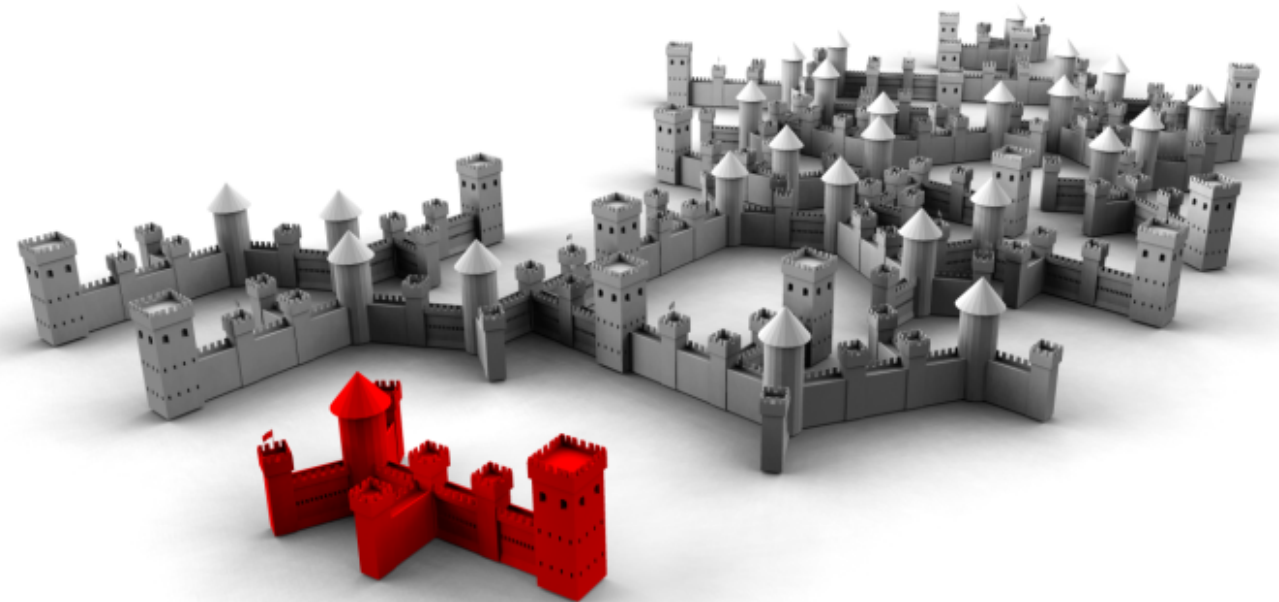
# Docking Sites

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



[Bokeloh et al., Siggraph 2010]

# Docking Sites



# Pattern-aware Deformation

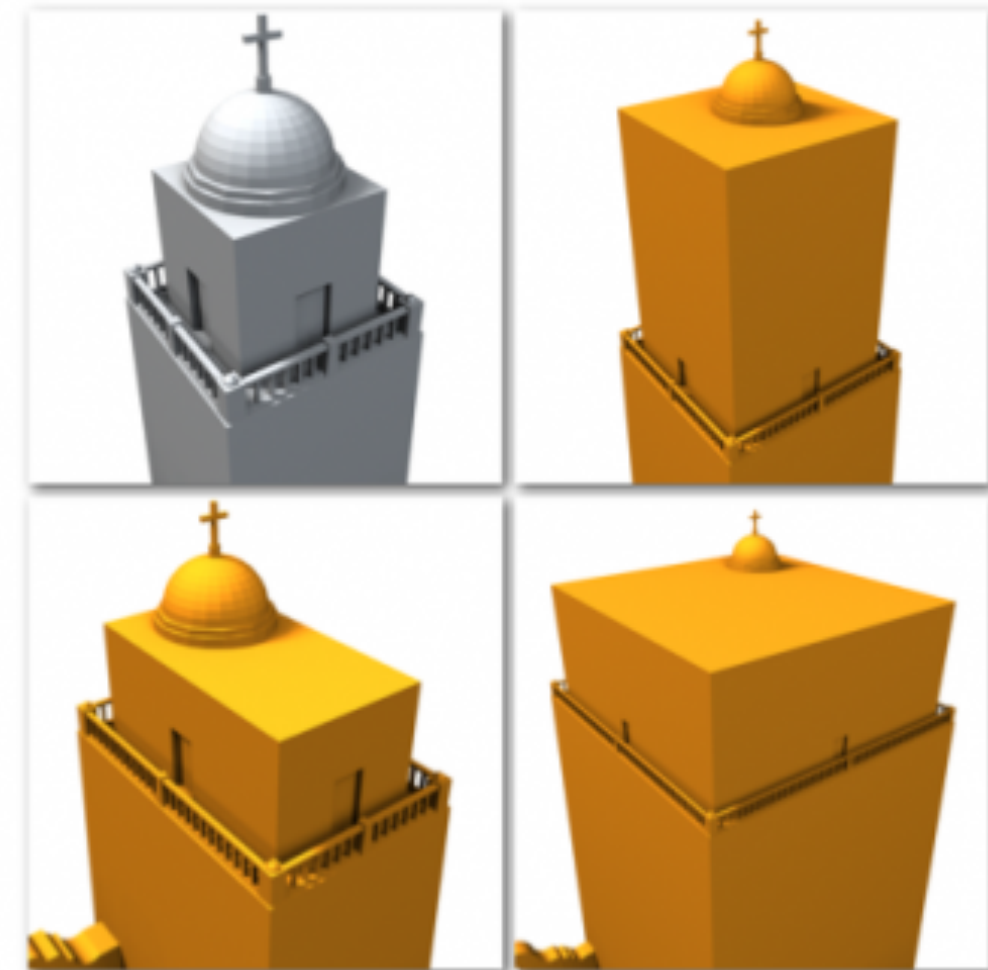
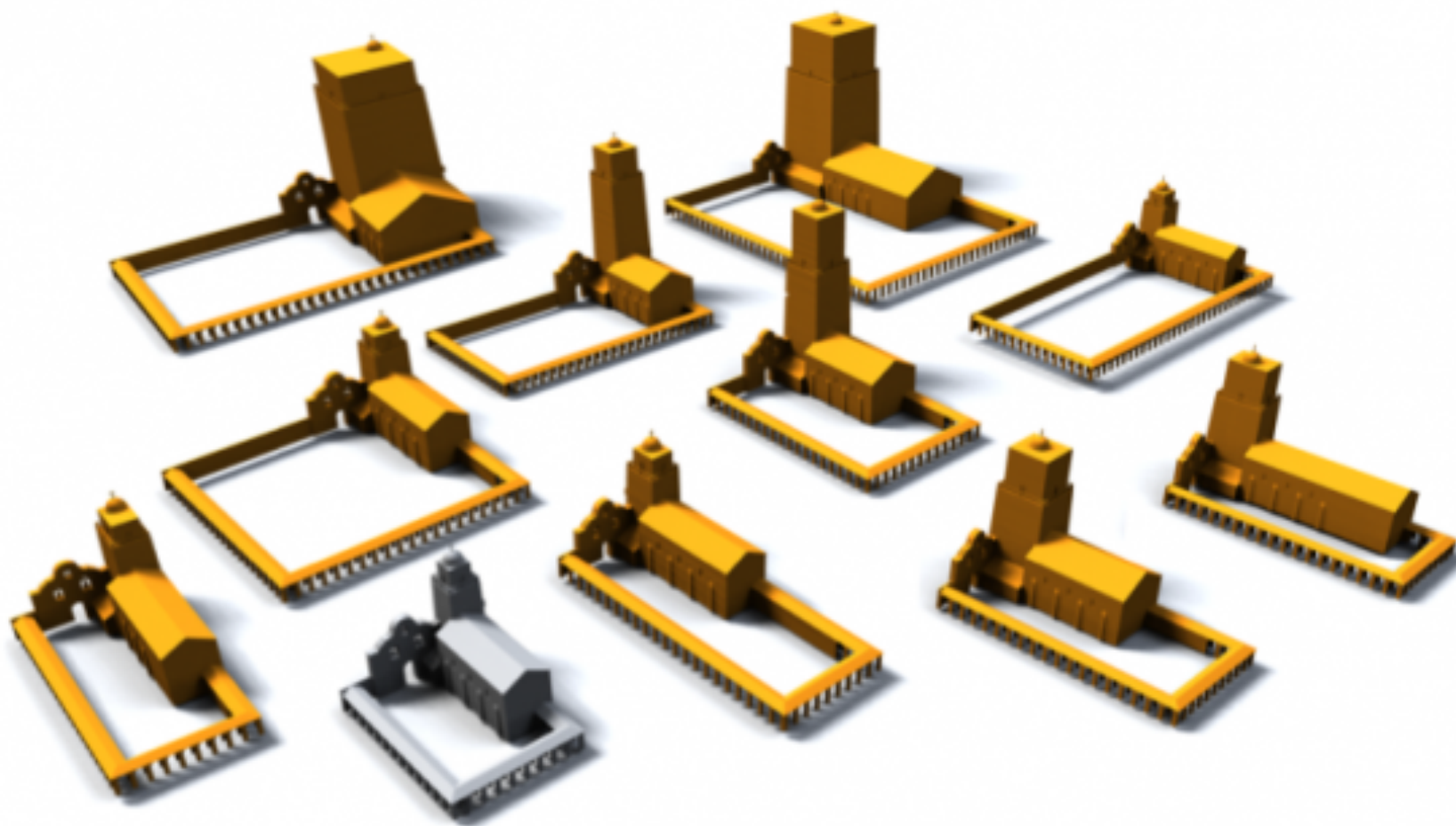
- Combine docking sites with structure-aware deformation
- Specific to *regular* patterns



[Bokeloh et al., Siggraph Asia 2011]



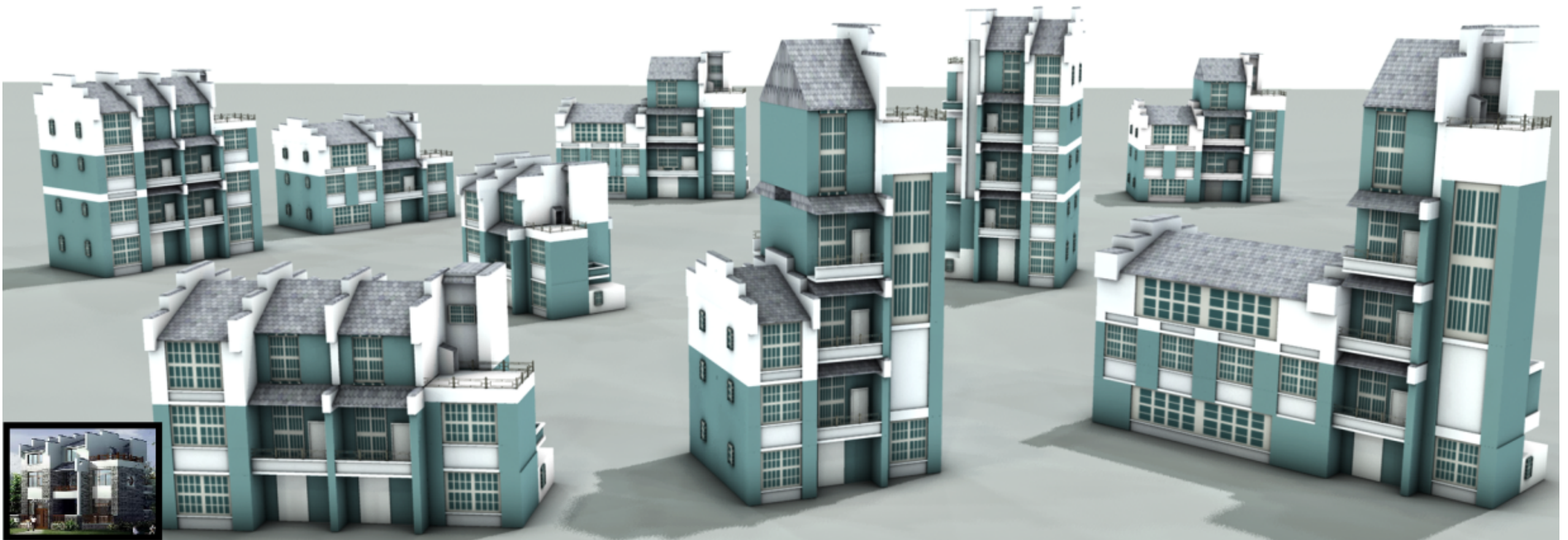
# Deformation Null Space



[Bokeloh et al., Siggraph 2012]

# Retargeting of Irregular Facades

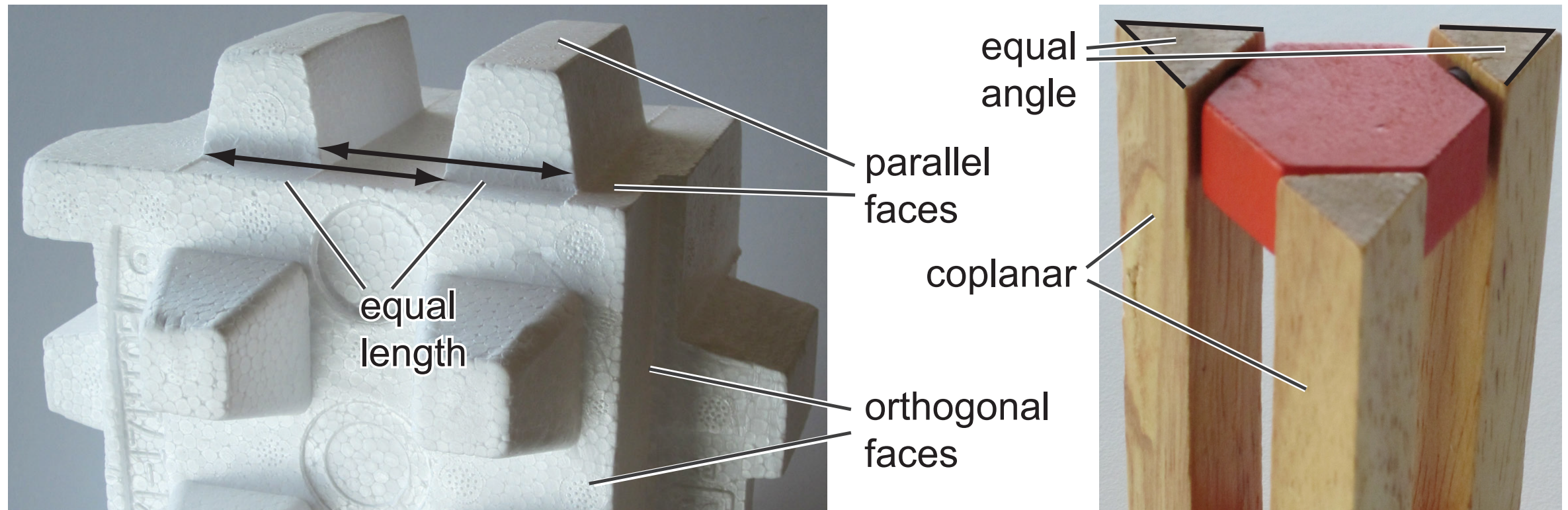
- User provides **rectangular parts**
  - Additionally specifies resizing parameters
- Formulate 2D-retargeting as **sequence** of 1D problems



[Lin et al. 2011]

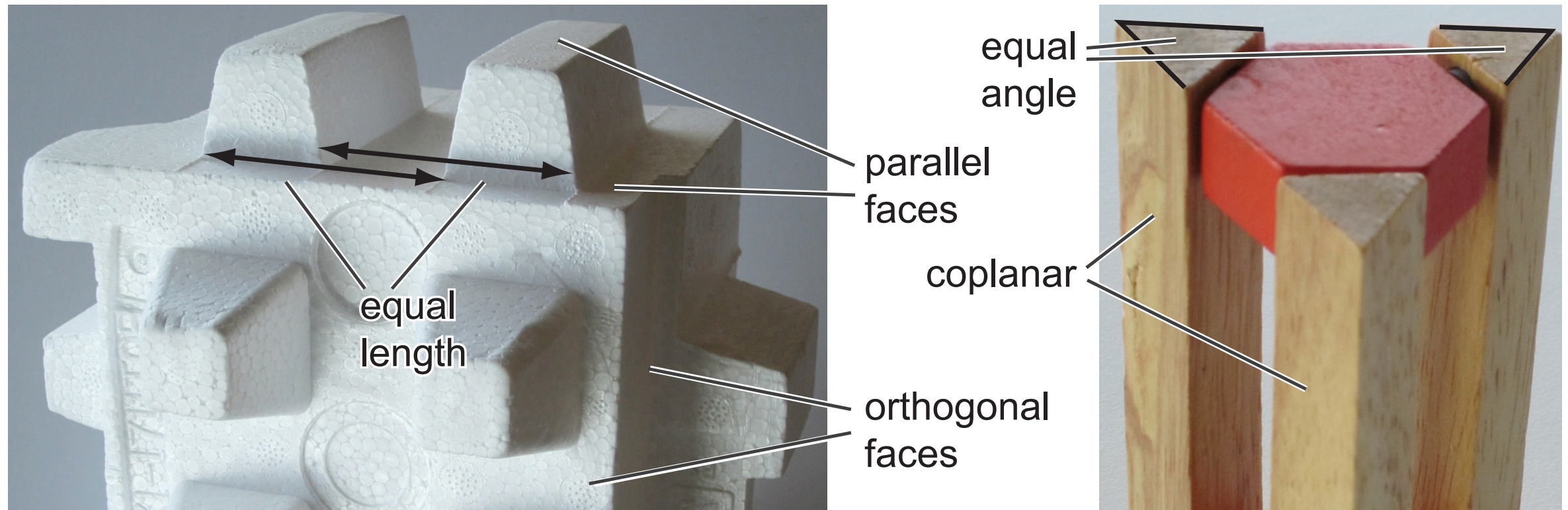


# Relations in Man-made Objects



[Li et al., Siggraph 2011]

# Relations in Man-made Objects

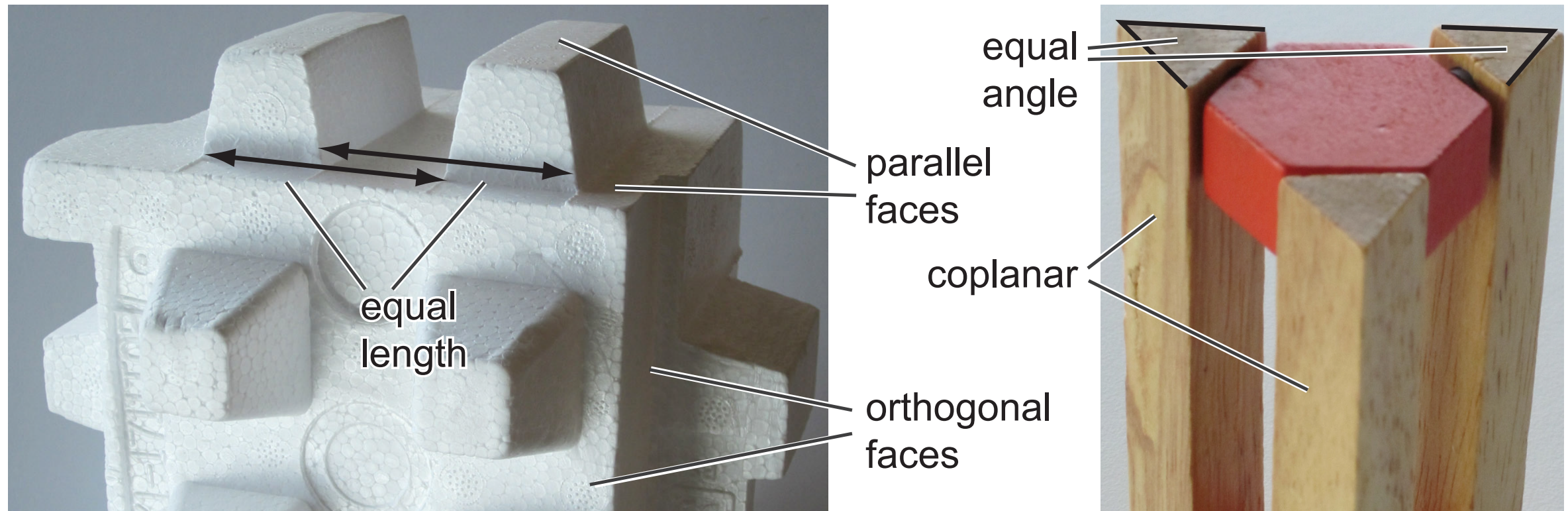


i) orthogonal/parallel relations, equal angle

[Li et al., Siggraph 2011]



# Relations in Man-made Objects

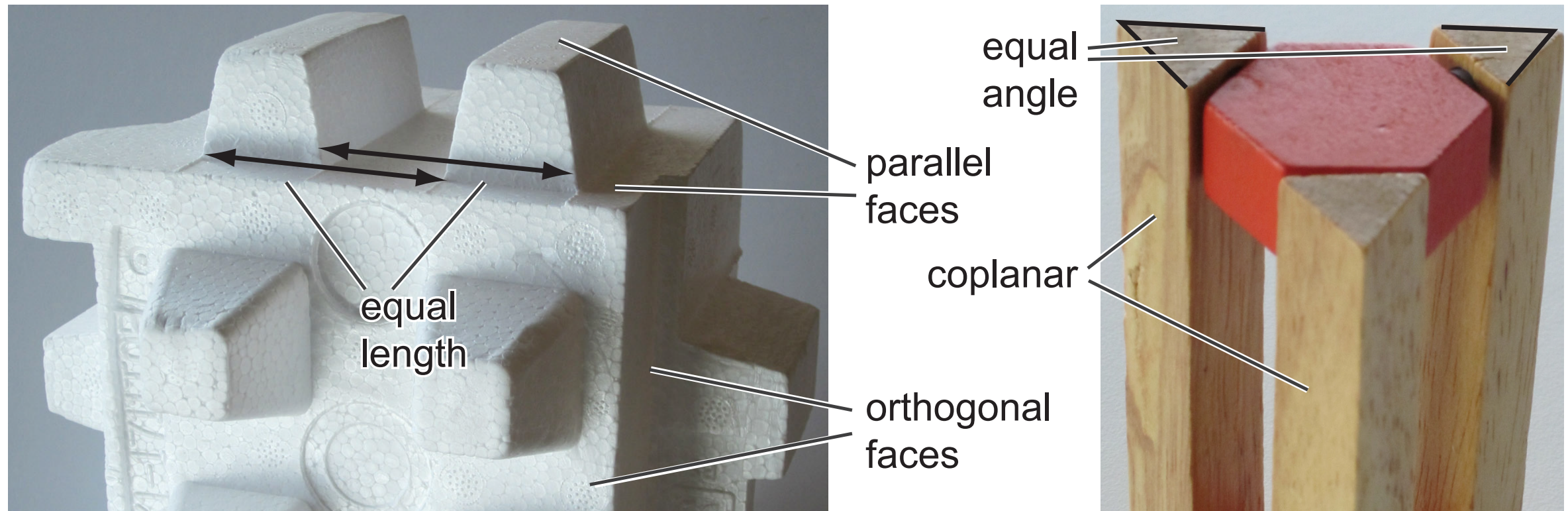


- i) orthogonal/parallel relations, equal angle
- ii) placement relation, e.g., coplanar, coaxial

[Li et al., Siggraph 2011]



# Relations in Man-made Objects



- i) orthogonal/parallel relations, equal angle
- ii) placement relation, e.g., coplanar, coaxial
- iii) equal length/radii relations

[Li et al., Siggraph 2011]

# Discover Global Relations

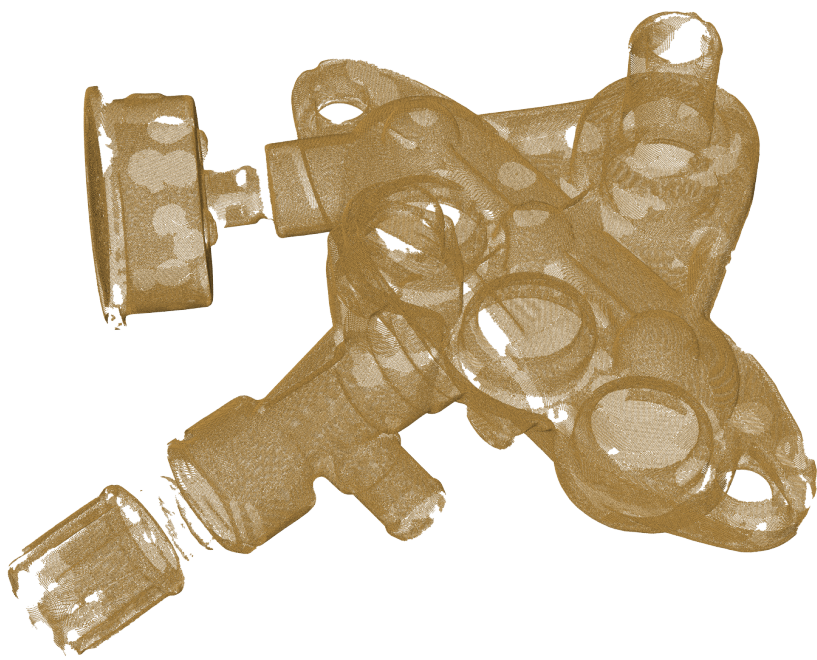
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# Discover Global Relations



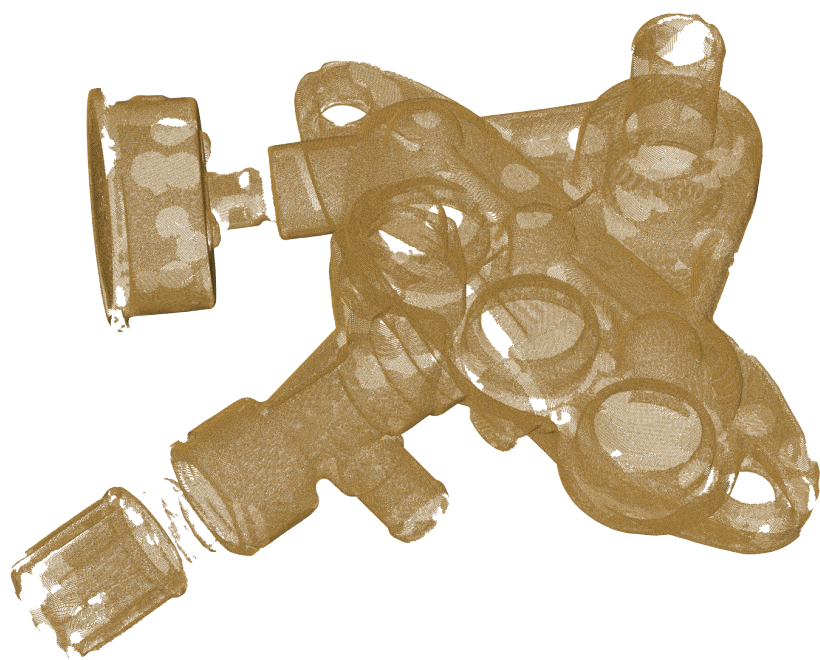
# Discover Global Relations



**point cloud**

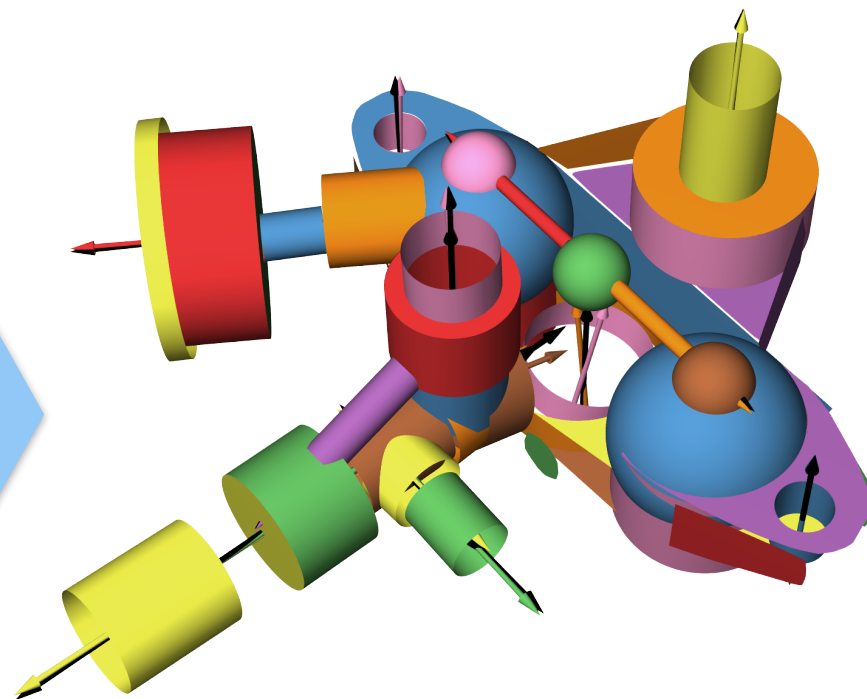


# Discover Global Relations



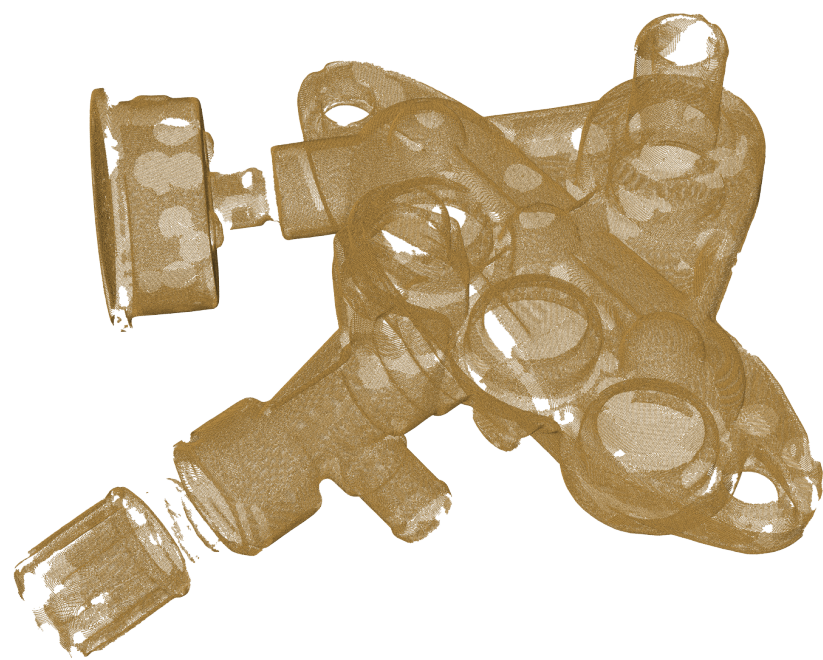
**point cloud**

RANSAC



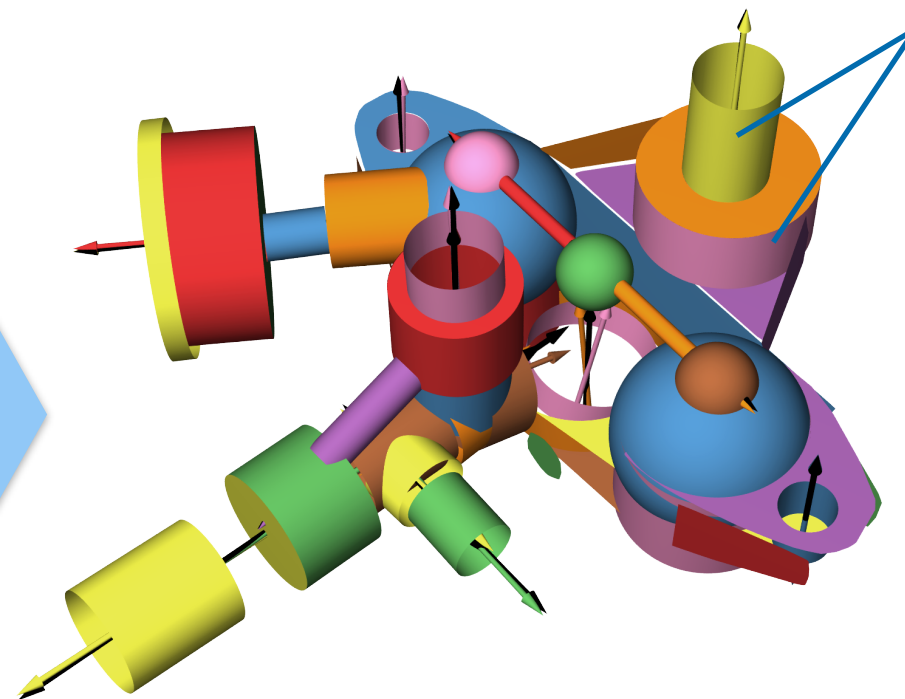
**primitives**

# Discover Global Relations



**point cloud**

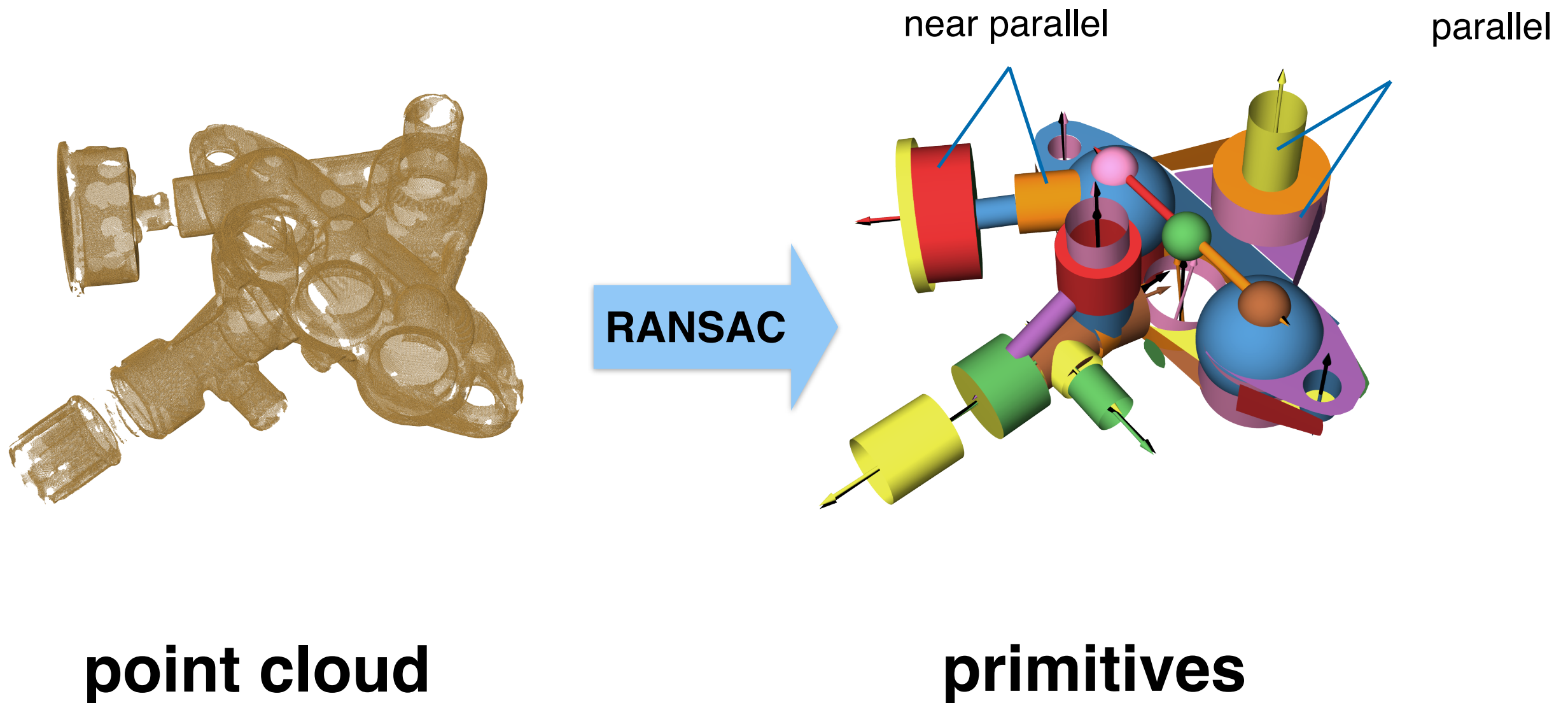
RANSAC



parallel

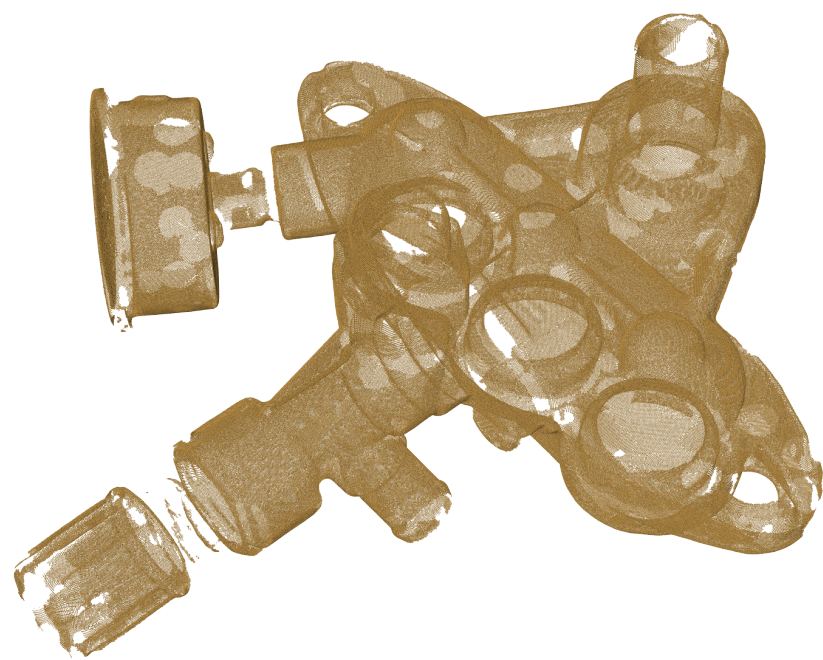
**primitives**

# Discover Global Relations



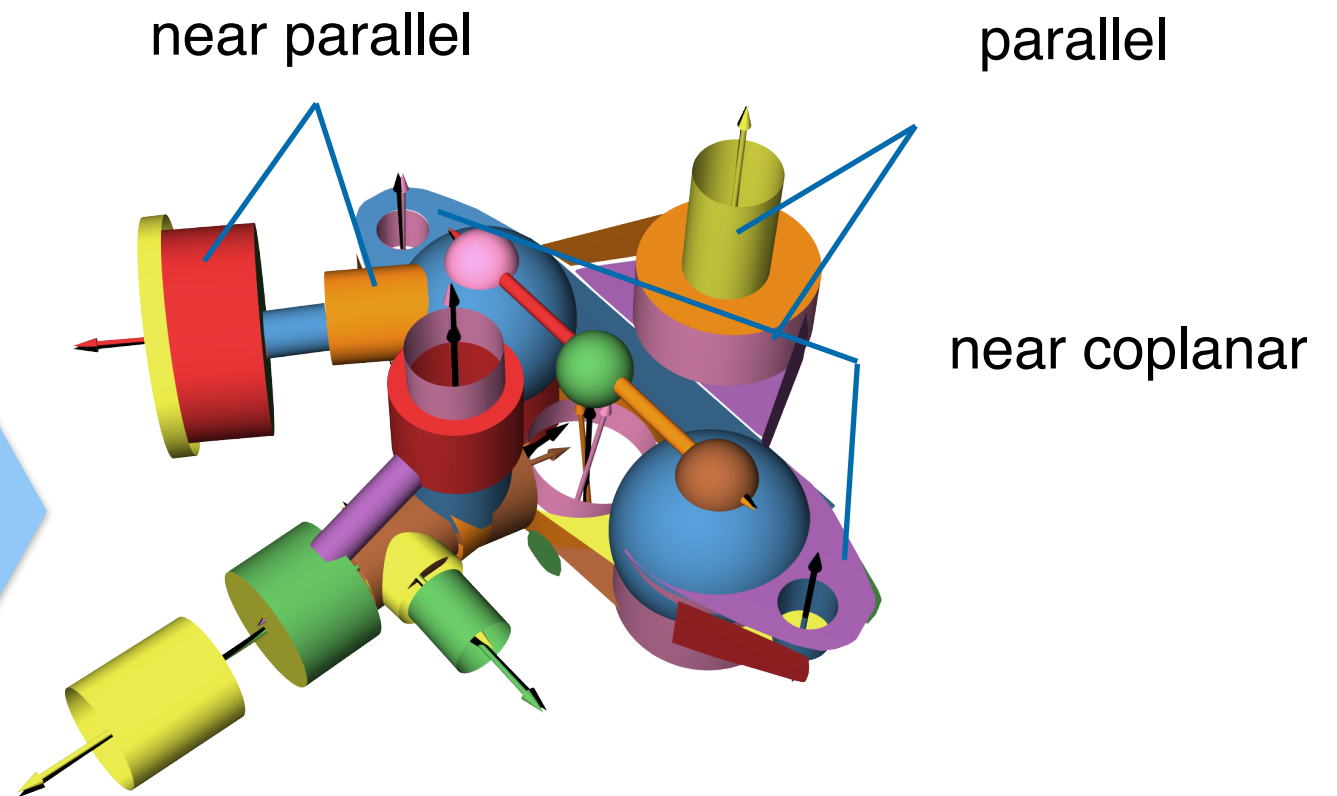


# Discover Global Relations



**point cloud**

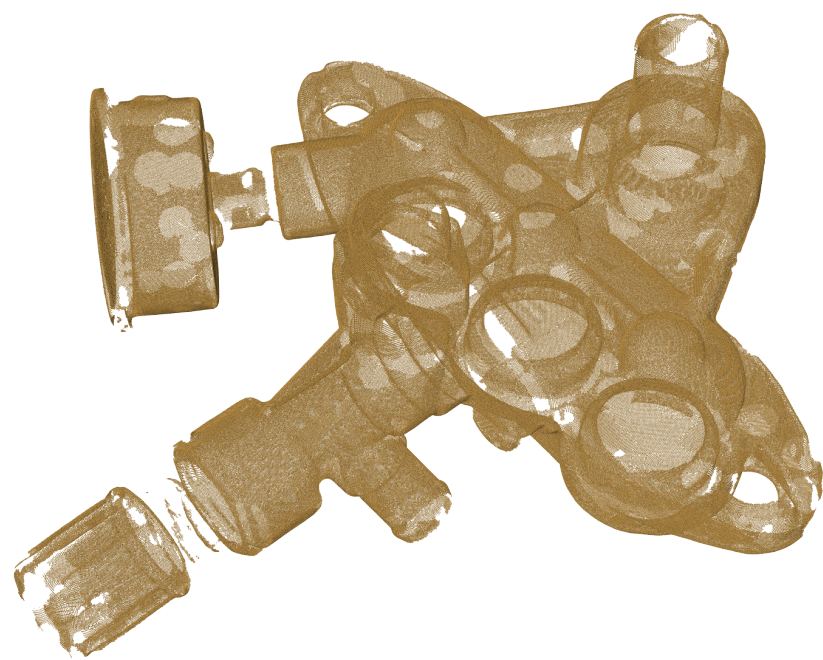
**RANSAC**



**primitives**

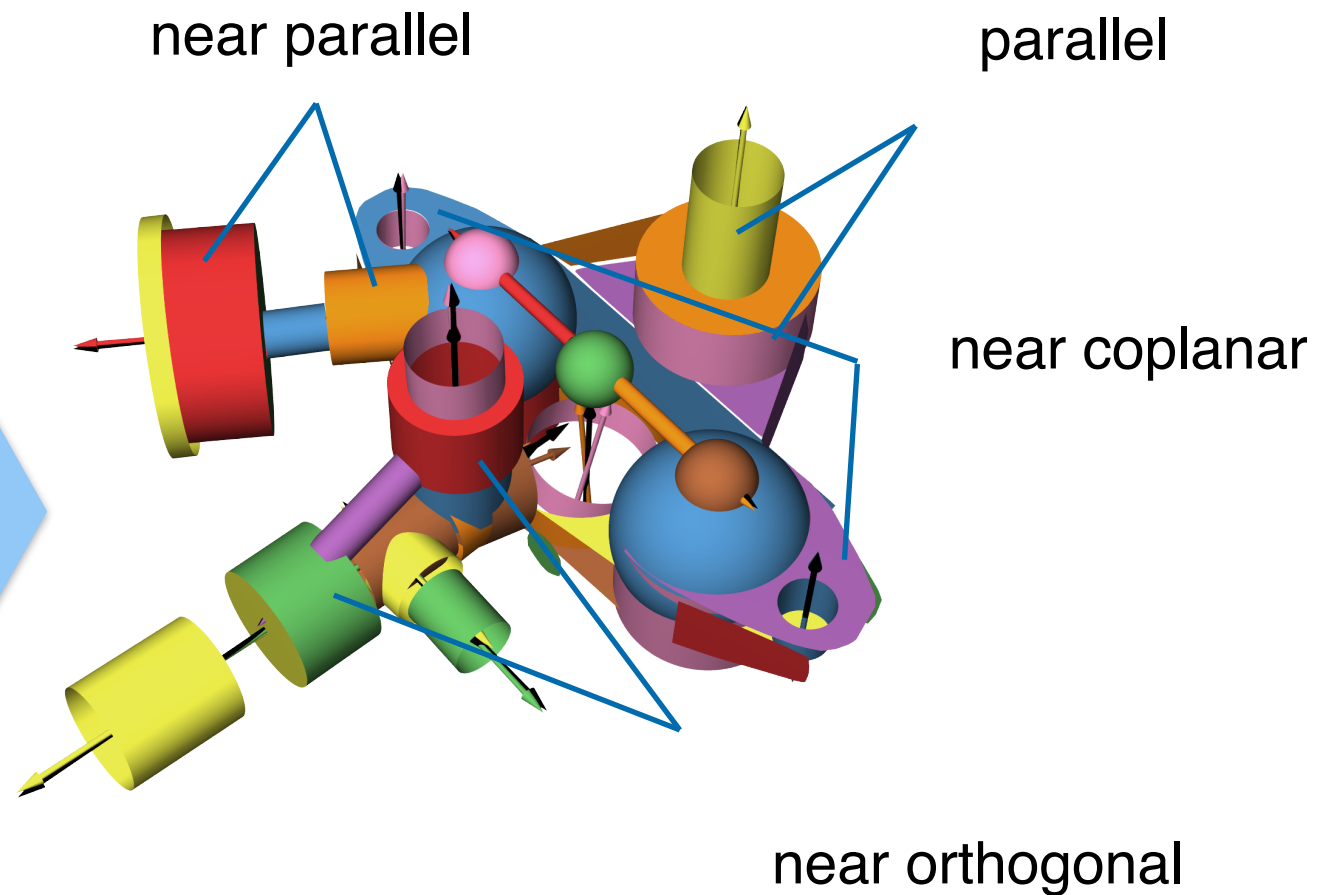


# Discover Global Relations



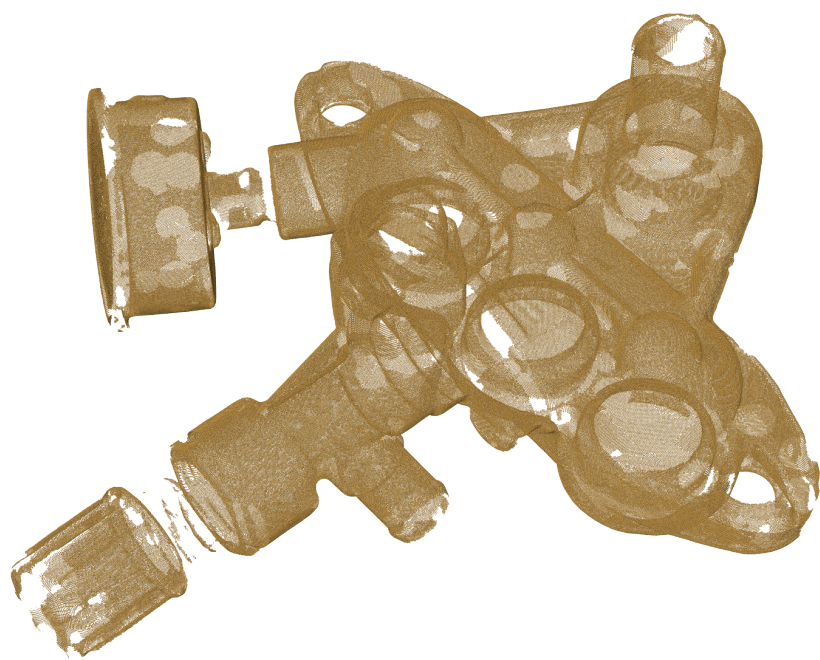
**point cloud**

**RANSAC**



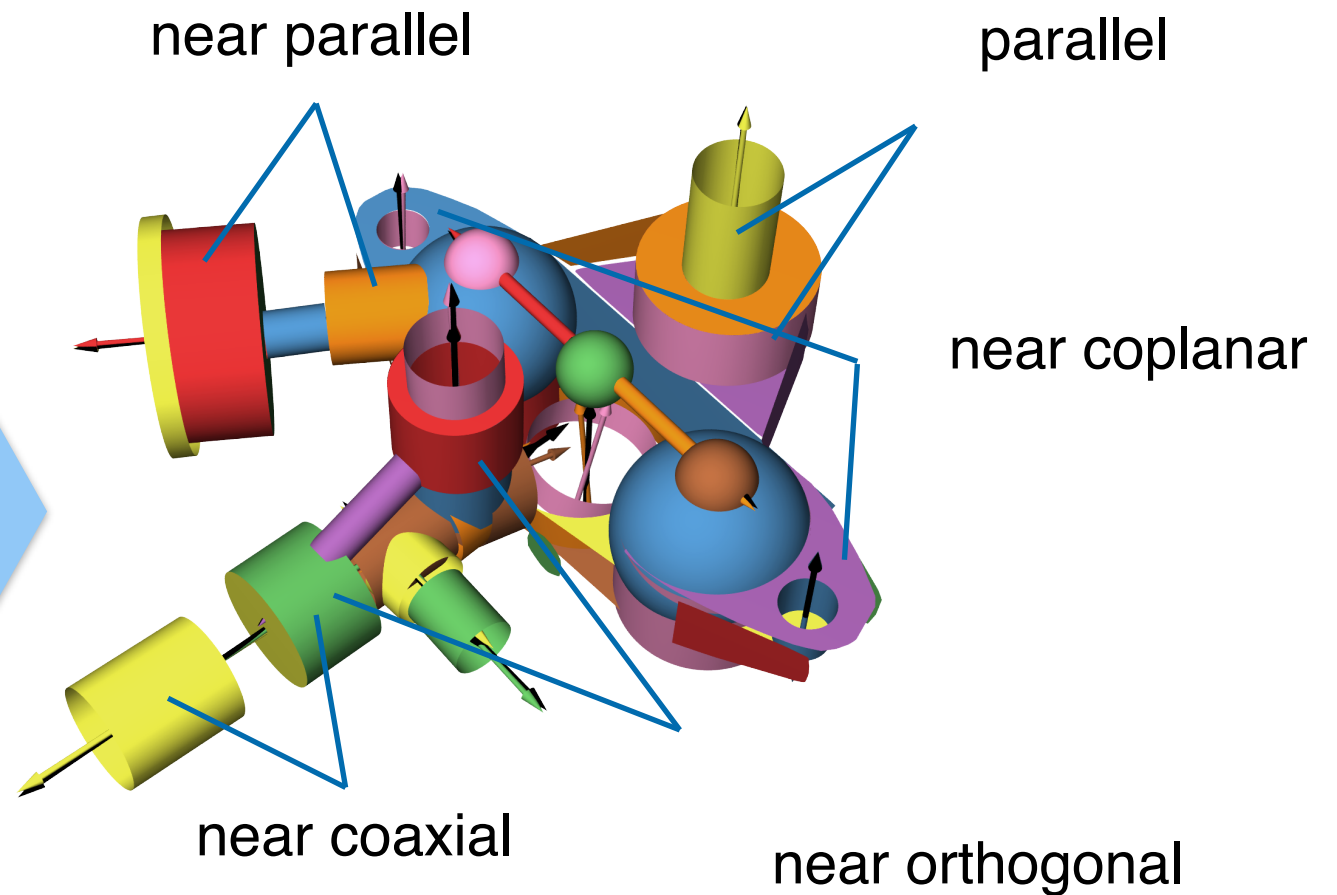
**primitives**

# Discover Global Relations



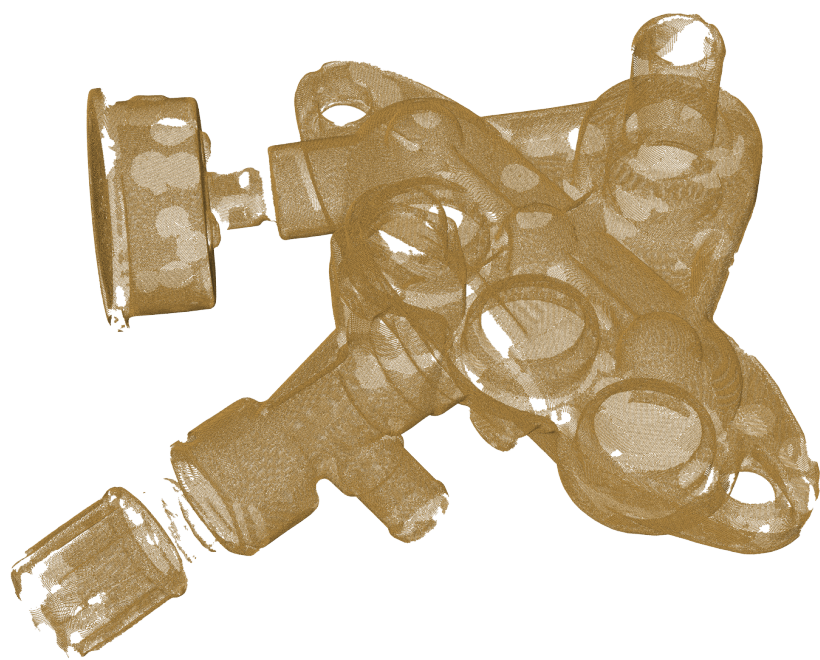
**point cloud**

**RANSAC**



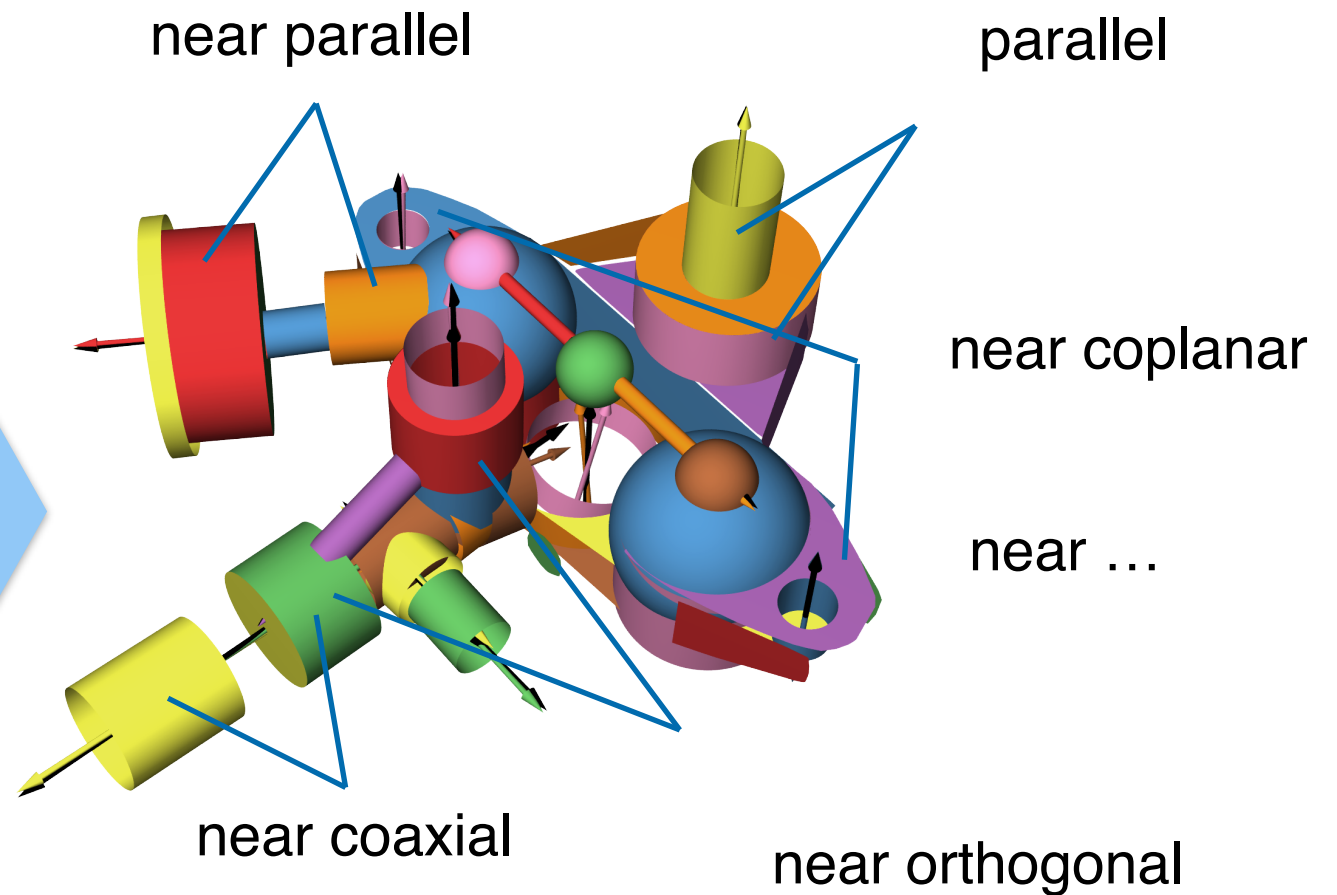
**primitives**

# Discover Global Relations



**point cloud**

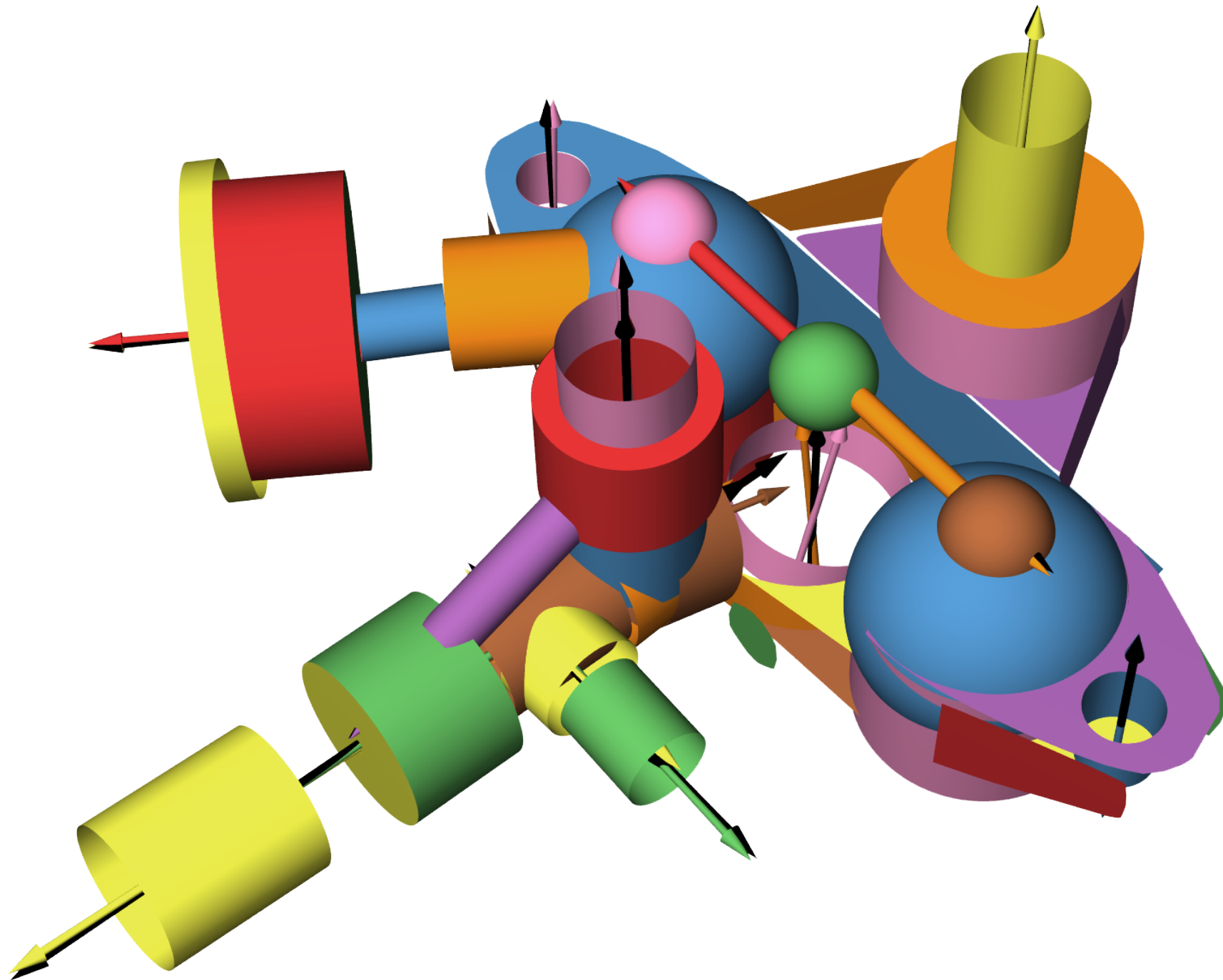
**RANSAC**



**primitives**

# Consistent Primitive Fitting

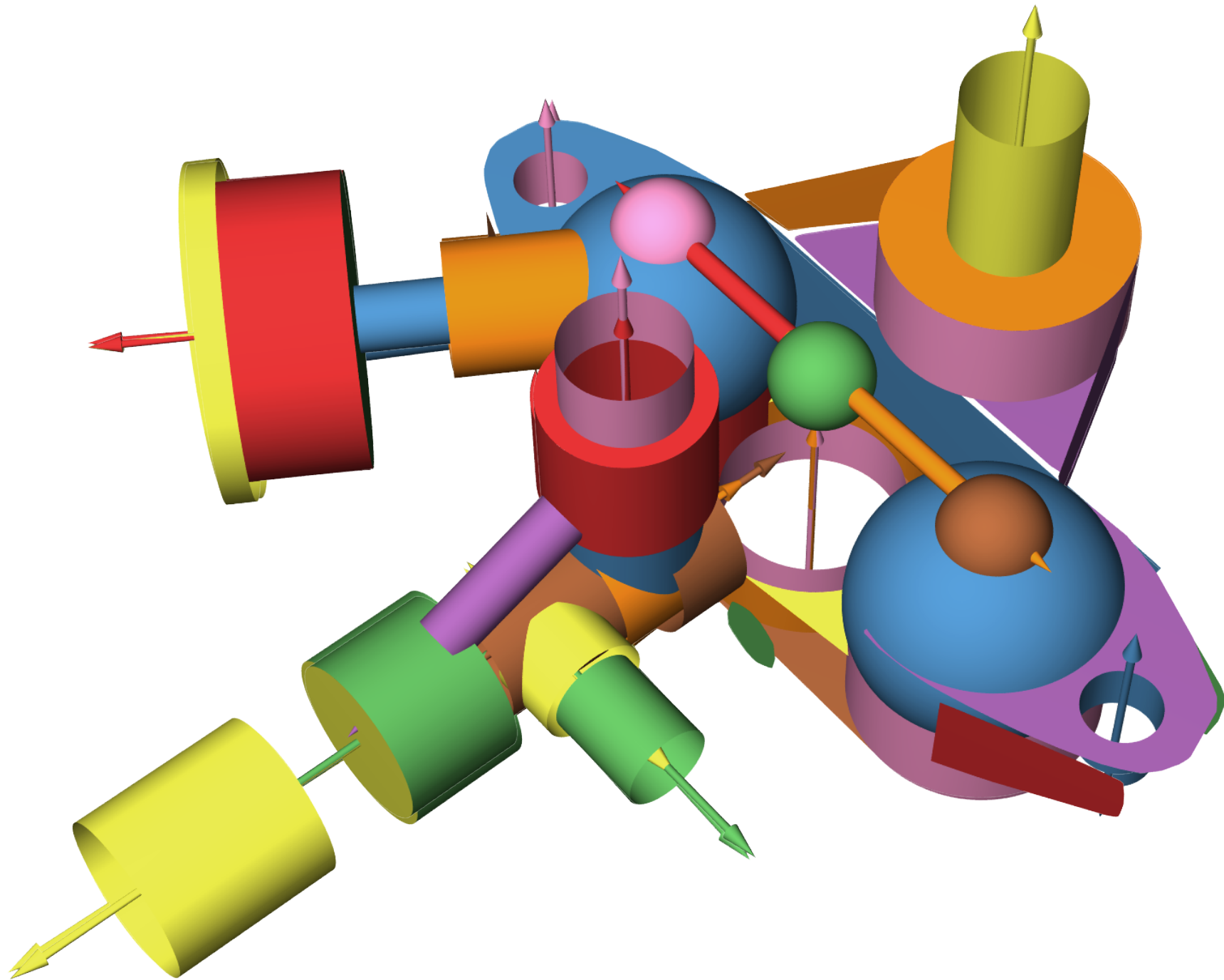
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# Consistent Primitive Fitting

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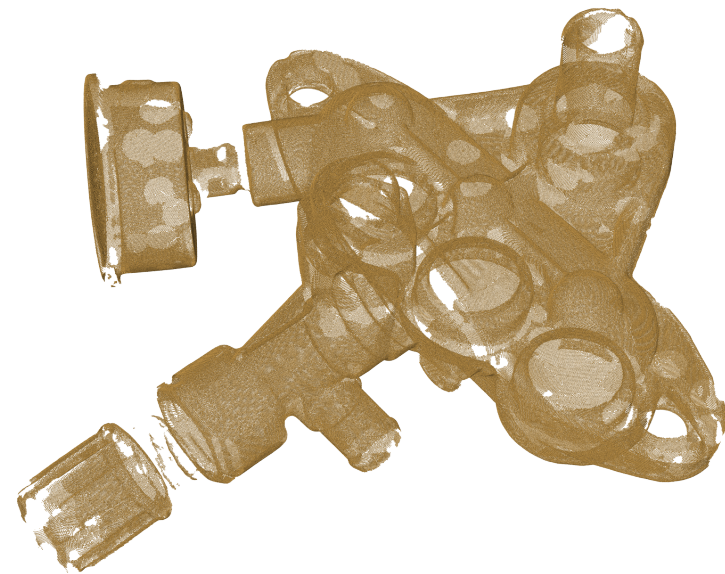


# Primitive Fitting with Global Relations

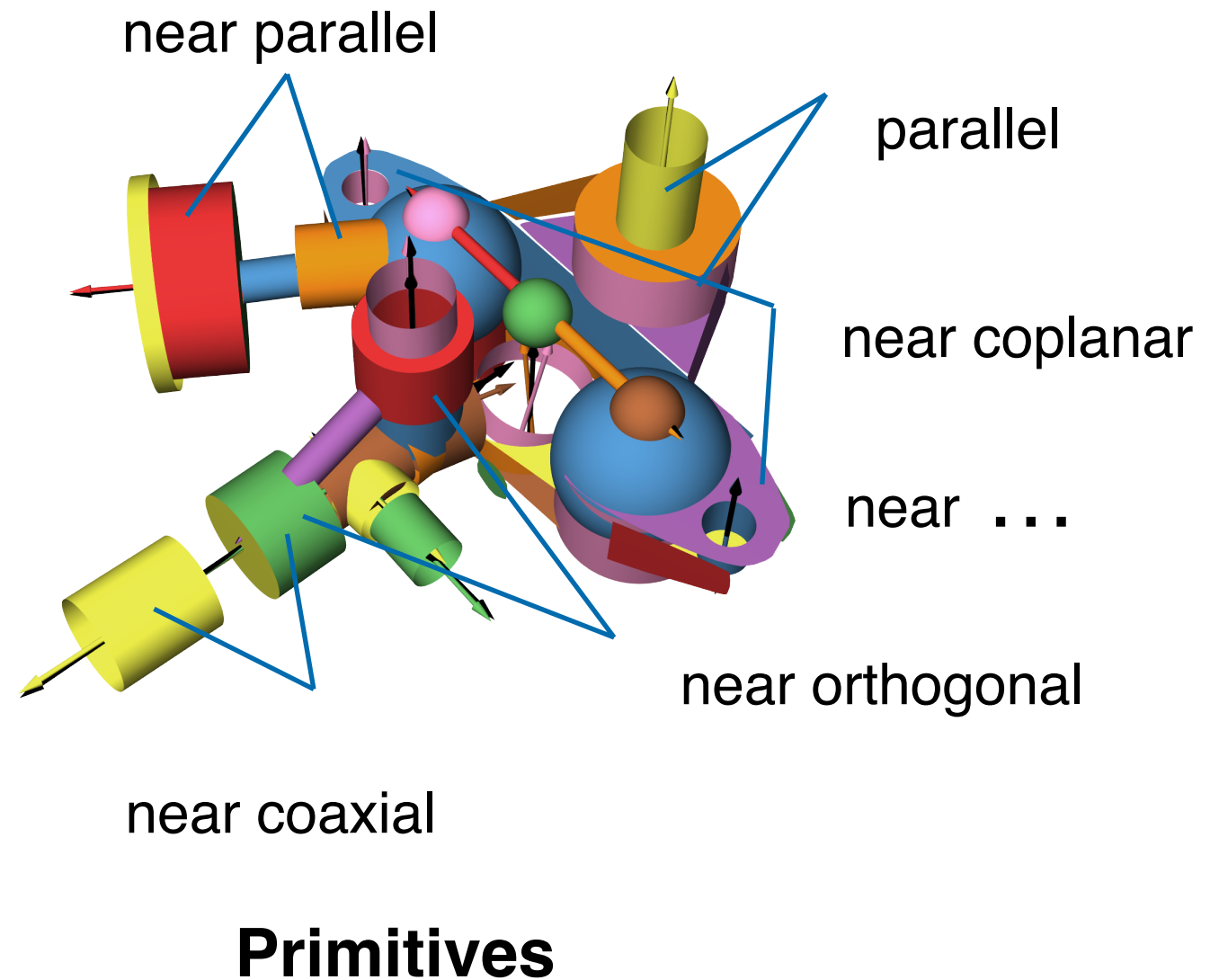
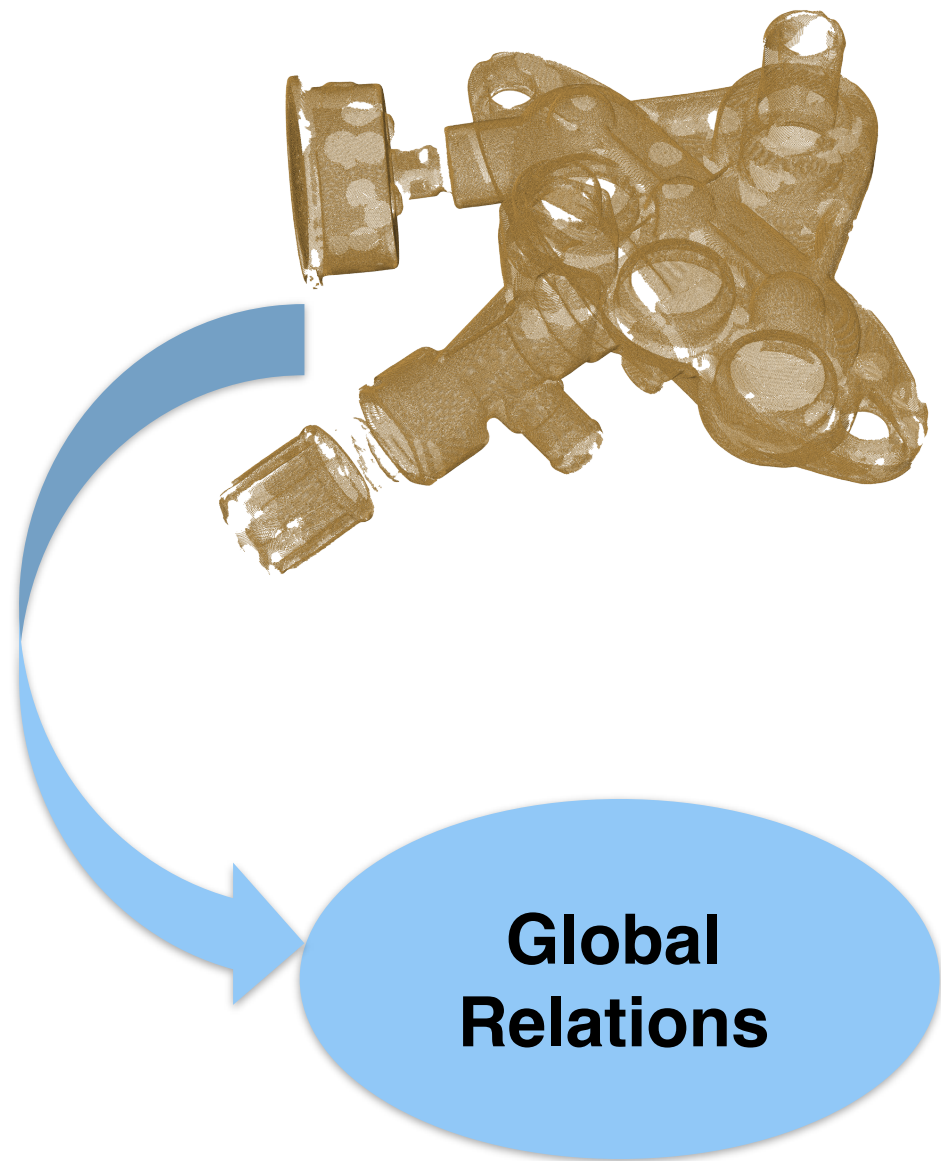
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# Primitive Fitting with Global Relations

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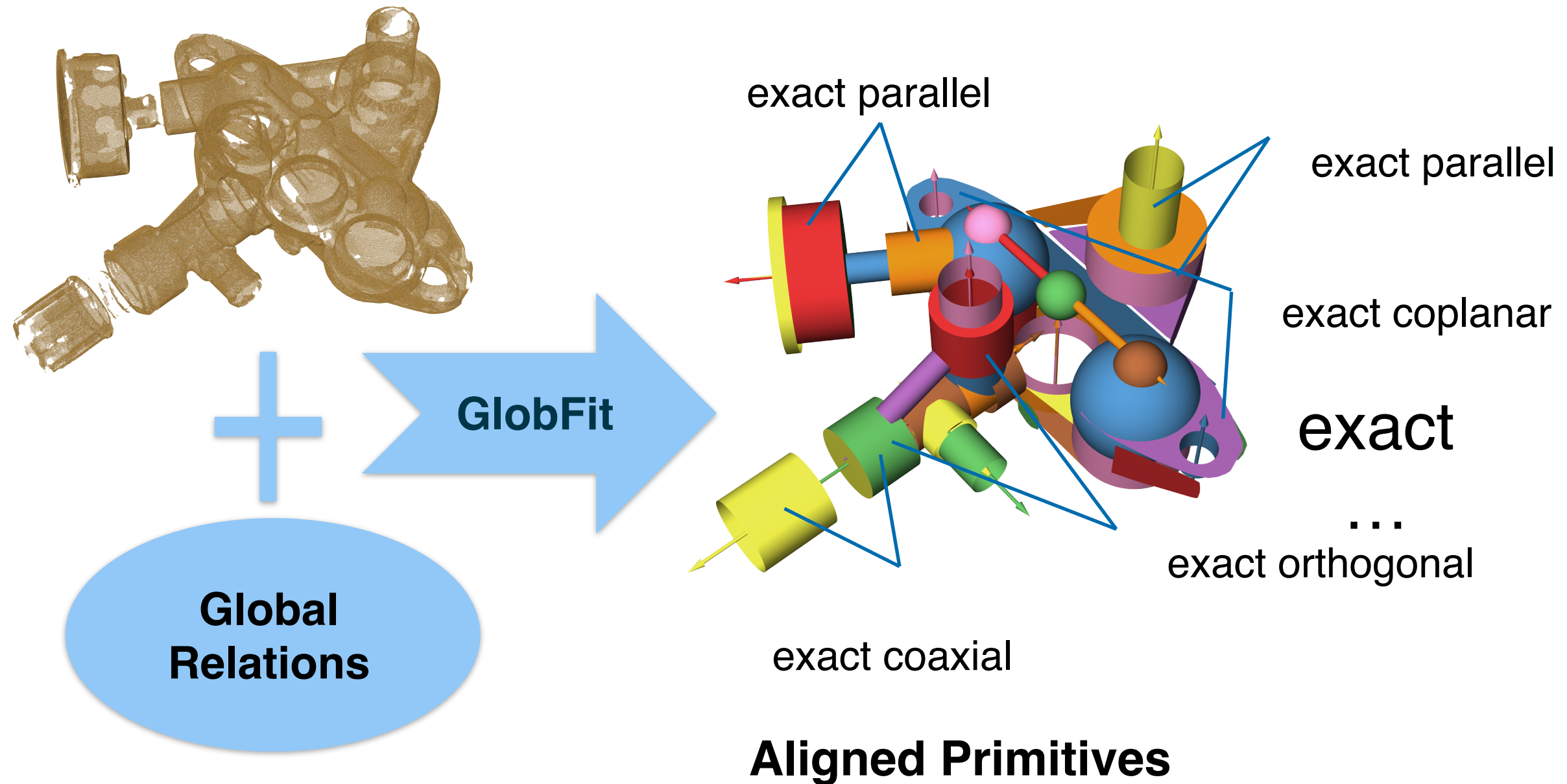


# Primitive Fitting with Global Relations



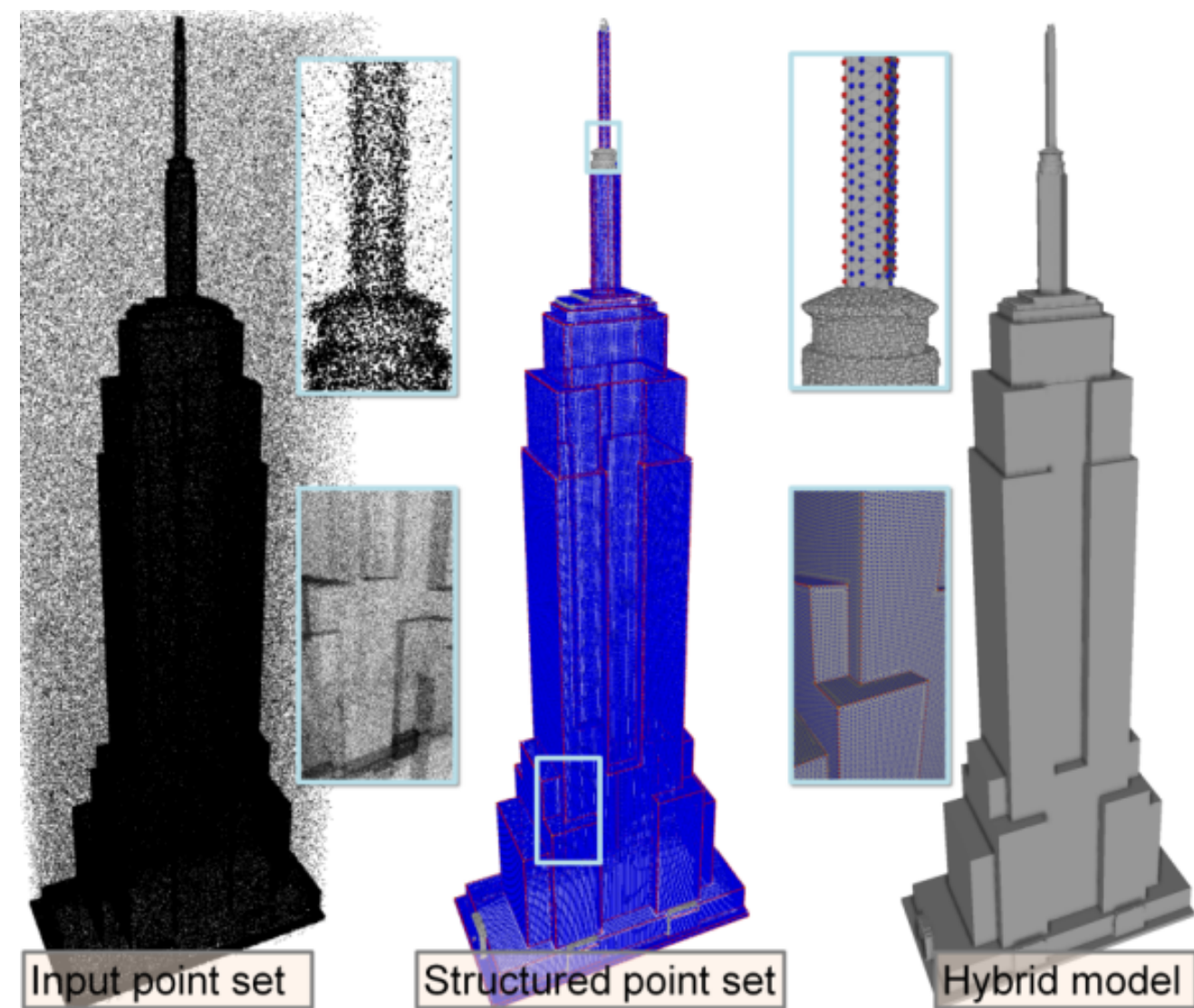


# Primitive Fitting with Global Relations



# Point Set Structuring

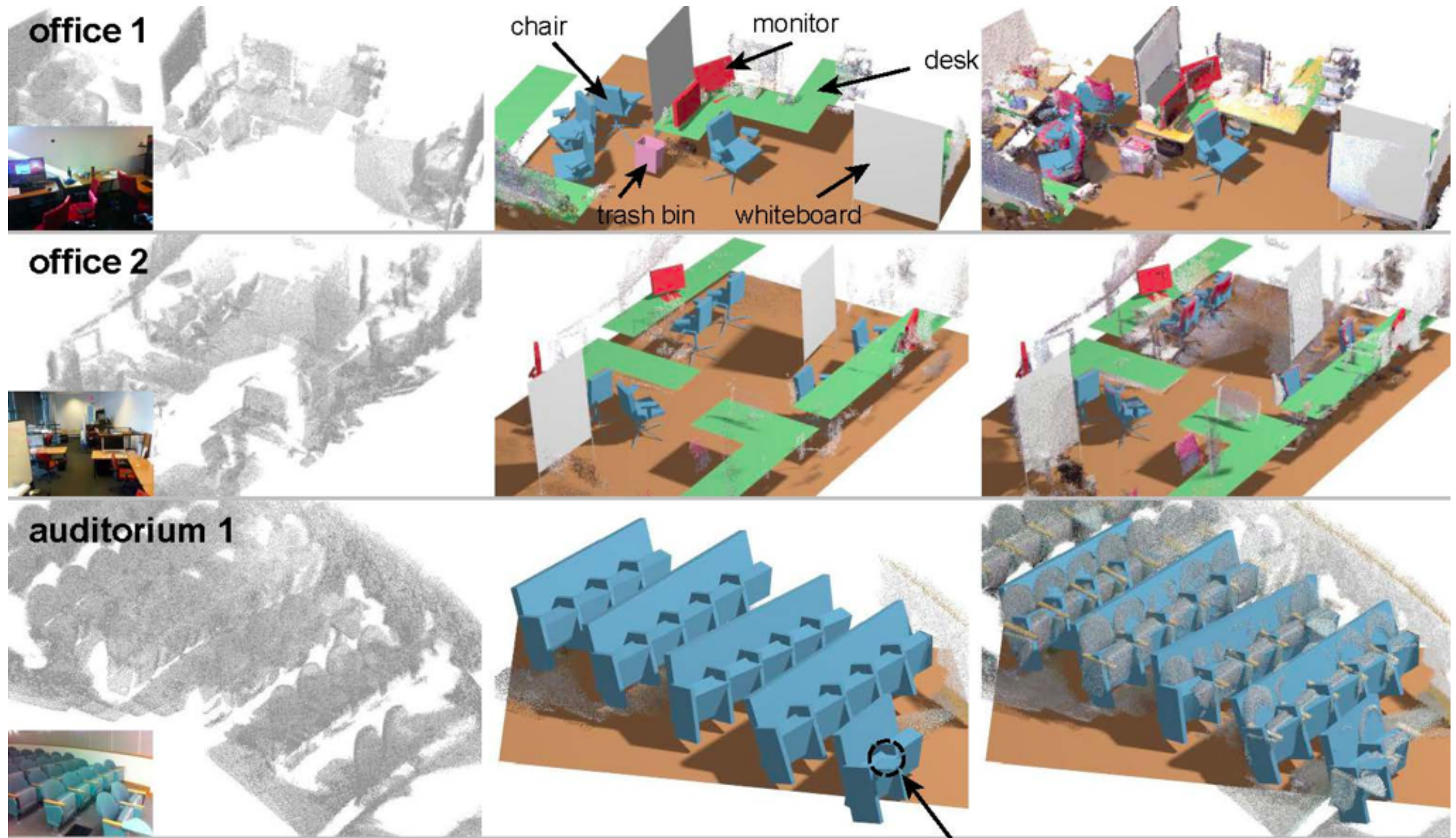
- Detect planes
- Build primitive graph
- Construct a *structured point set*
- Reconstruct using graph cut optimization



[Lafarge and Alliez, Eurographics 2013]



# Structures as Features

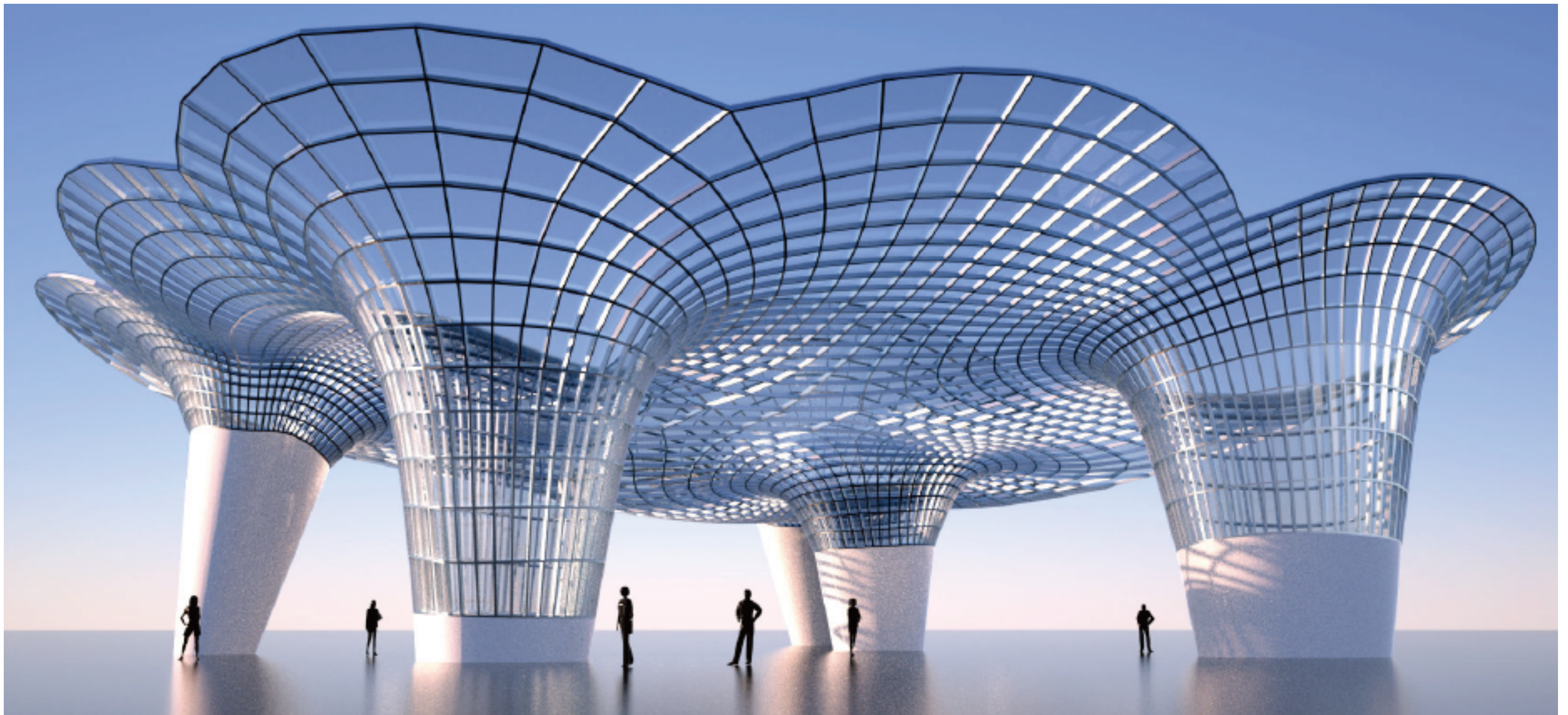


[Kim et al., Siggraph Asia 2012]



# Constrained Meshes

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



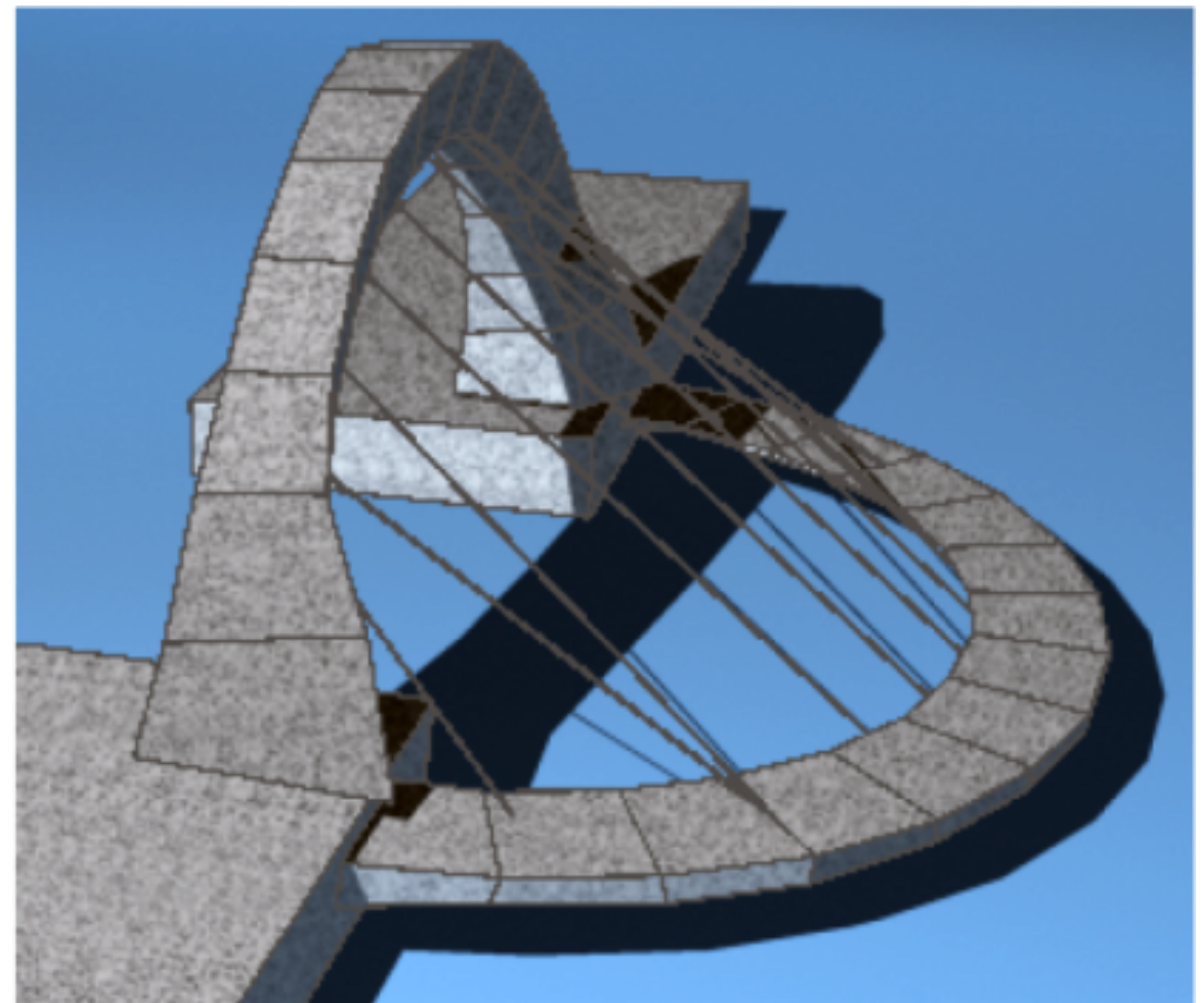
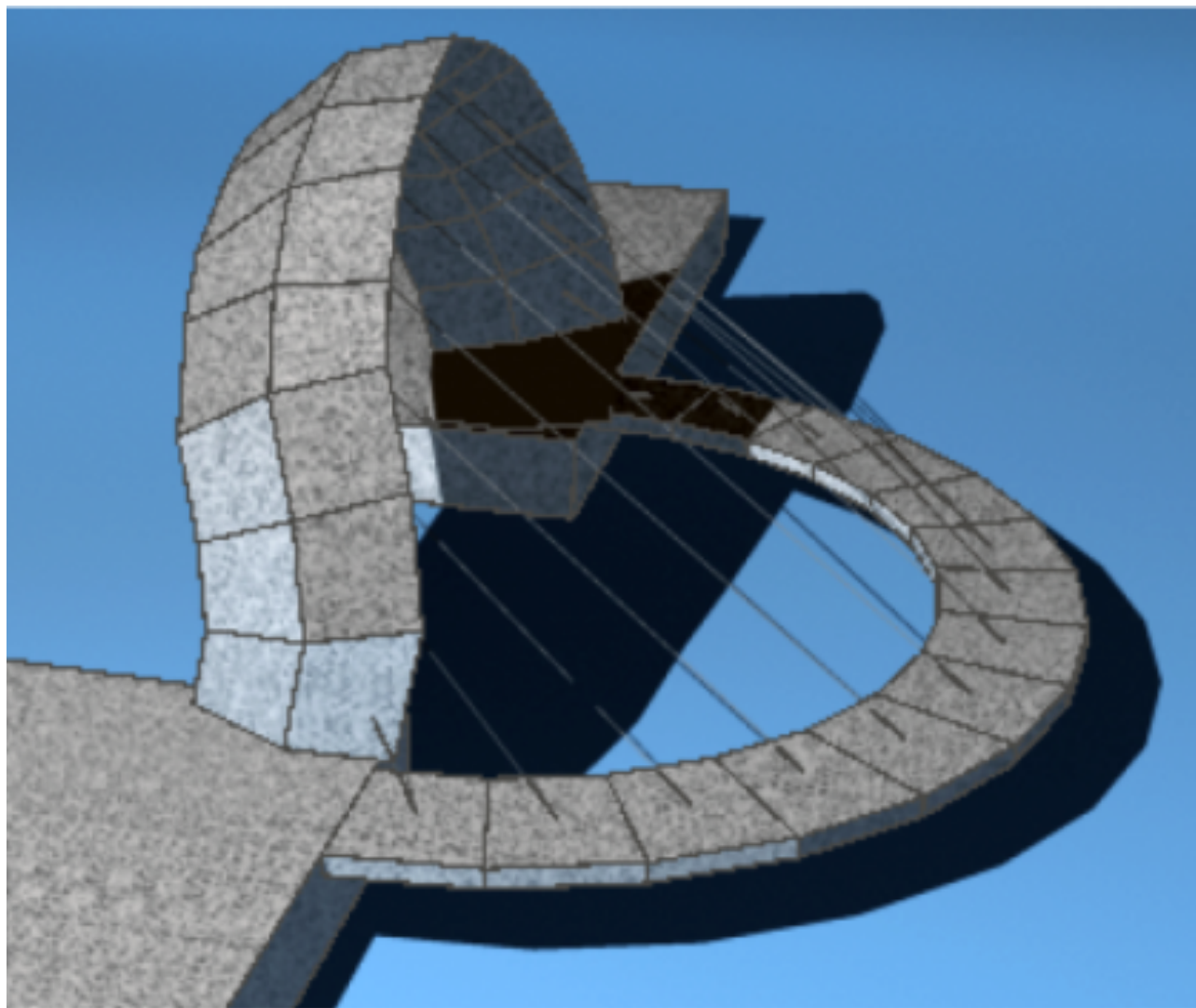
[Yang et al., Siggraph Asia 2011]



## Flat Circular Mesh Exploration

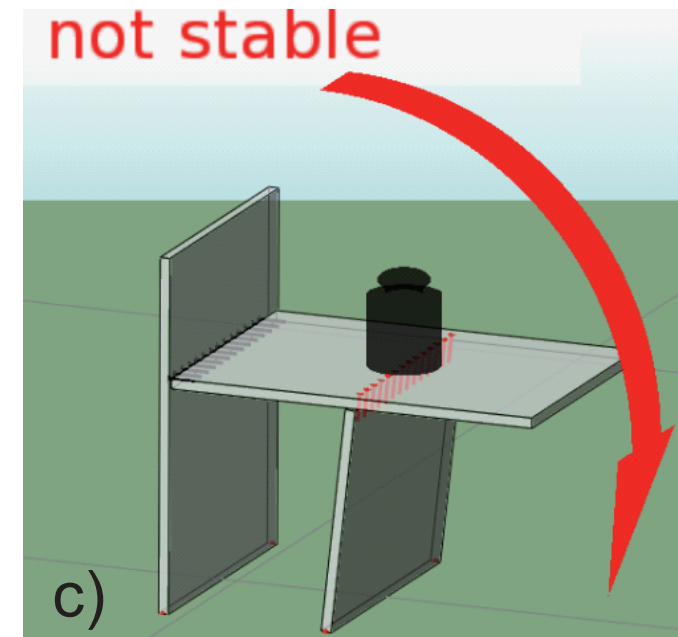
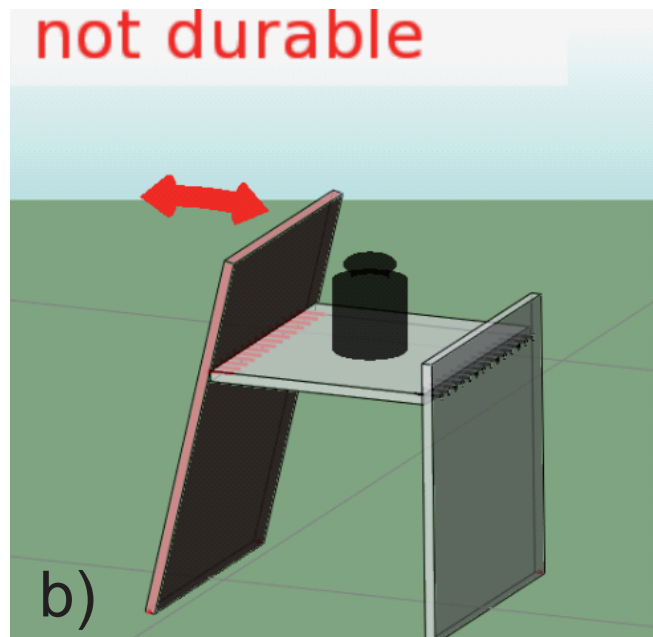
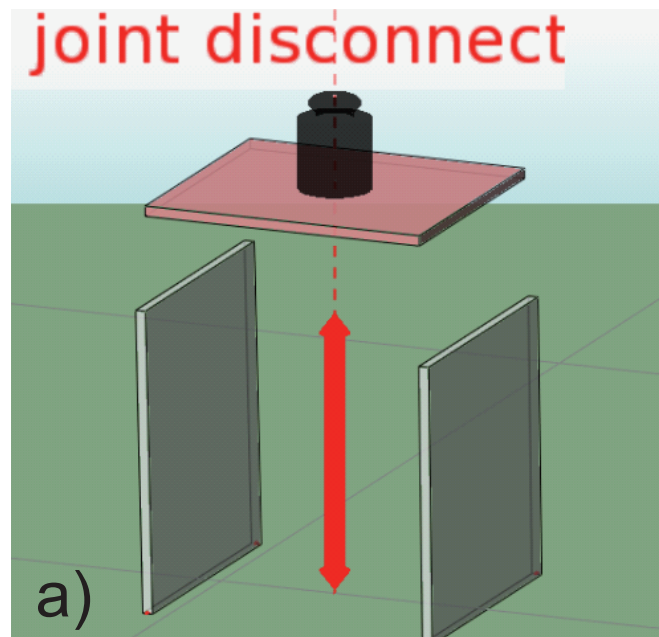
# Structural Optimization

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



[Whiting et al., Siggraph Asia 2012]

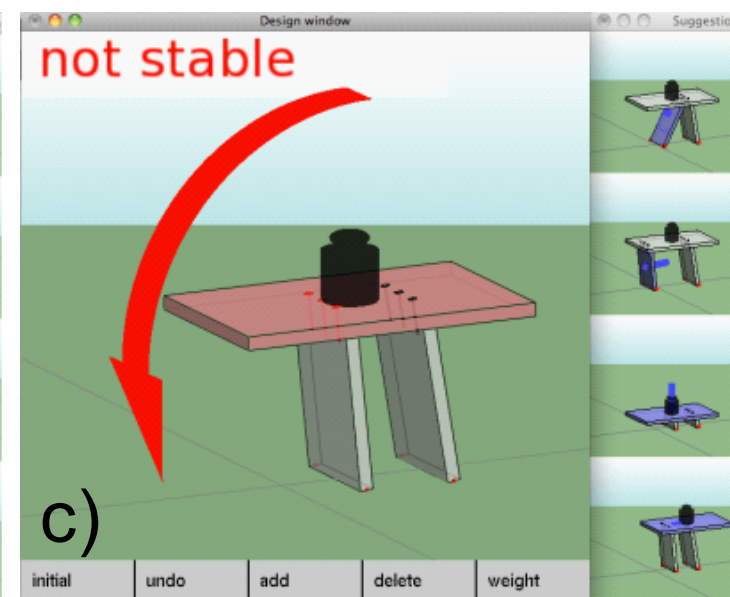
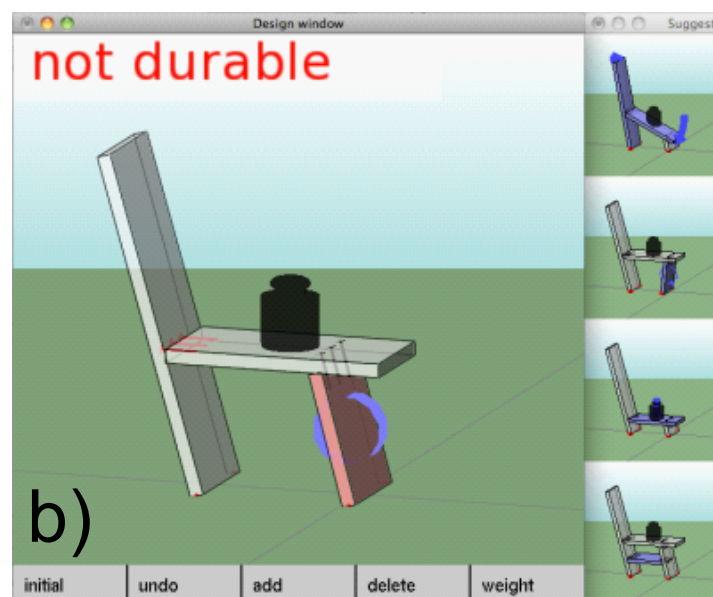
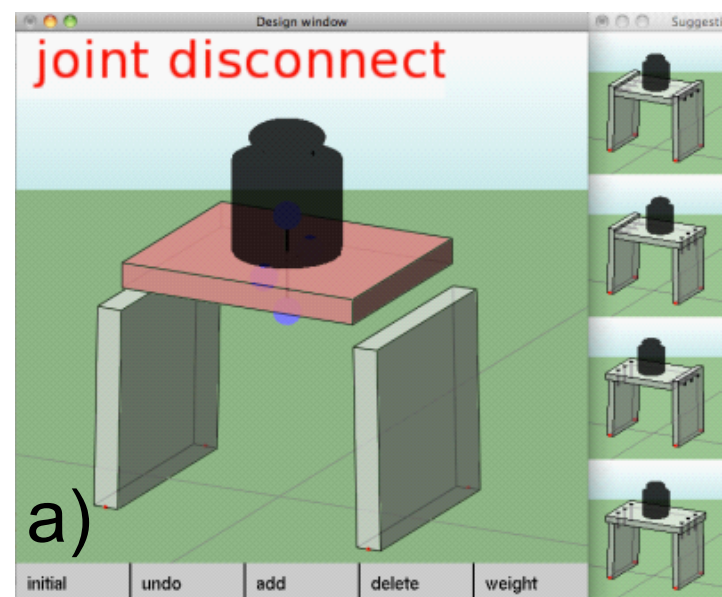
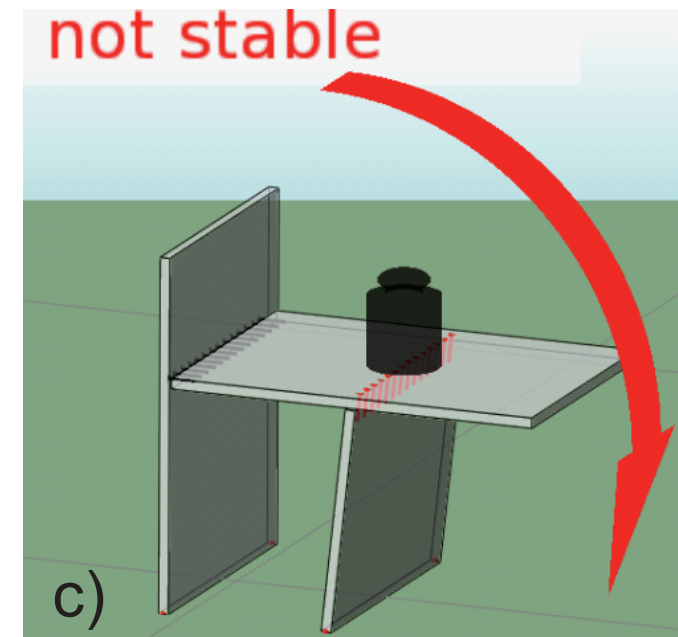
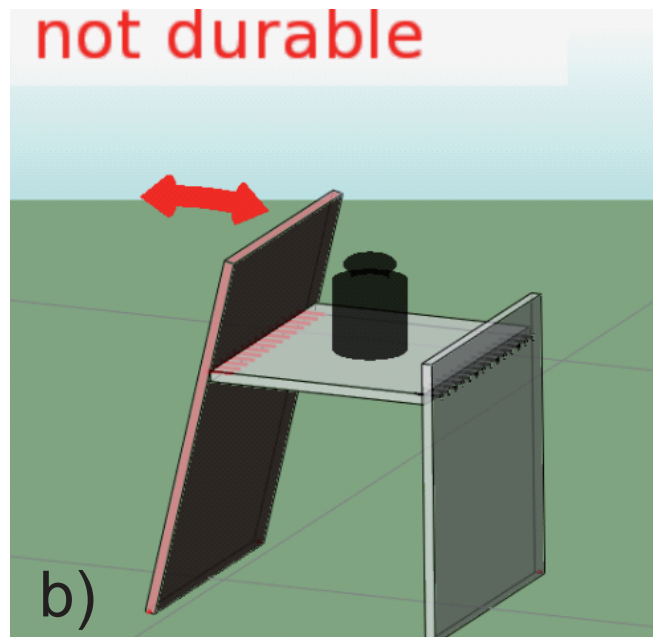
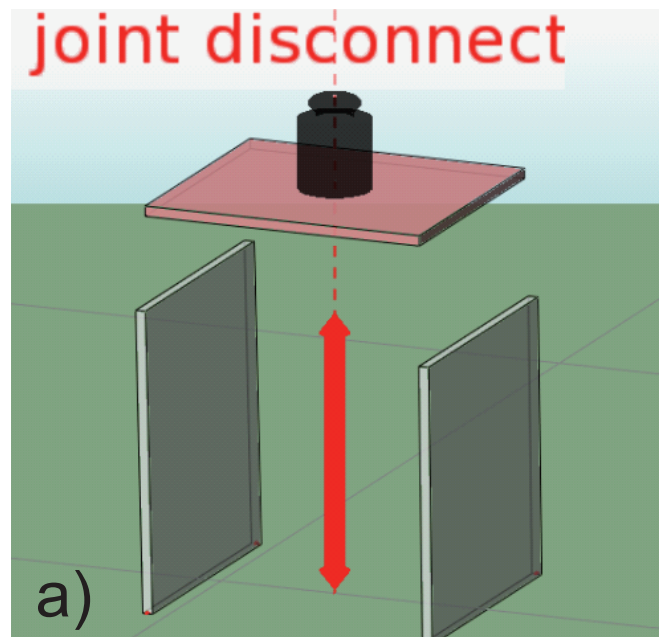
# When Forces Drive Geometry



[Umetani et al., Siggraph 2012]



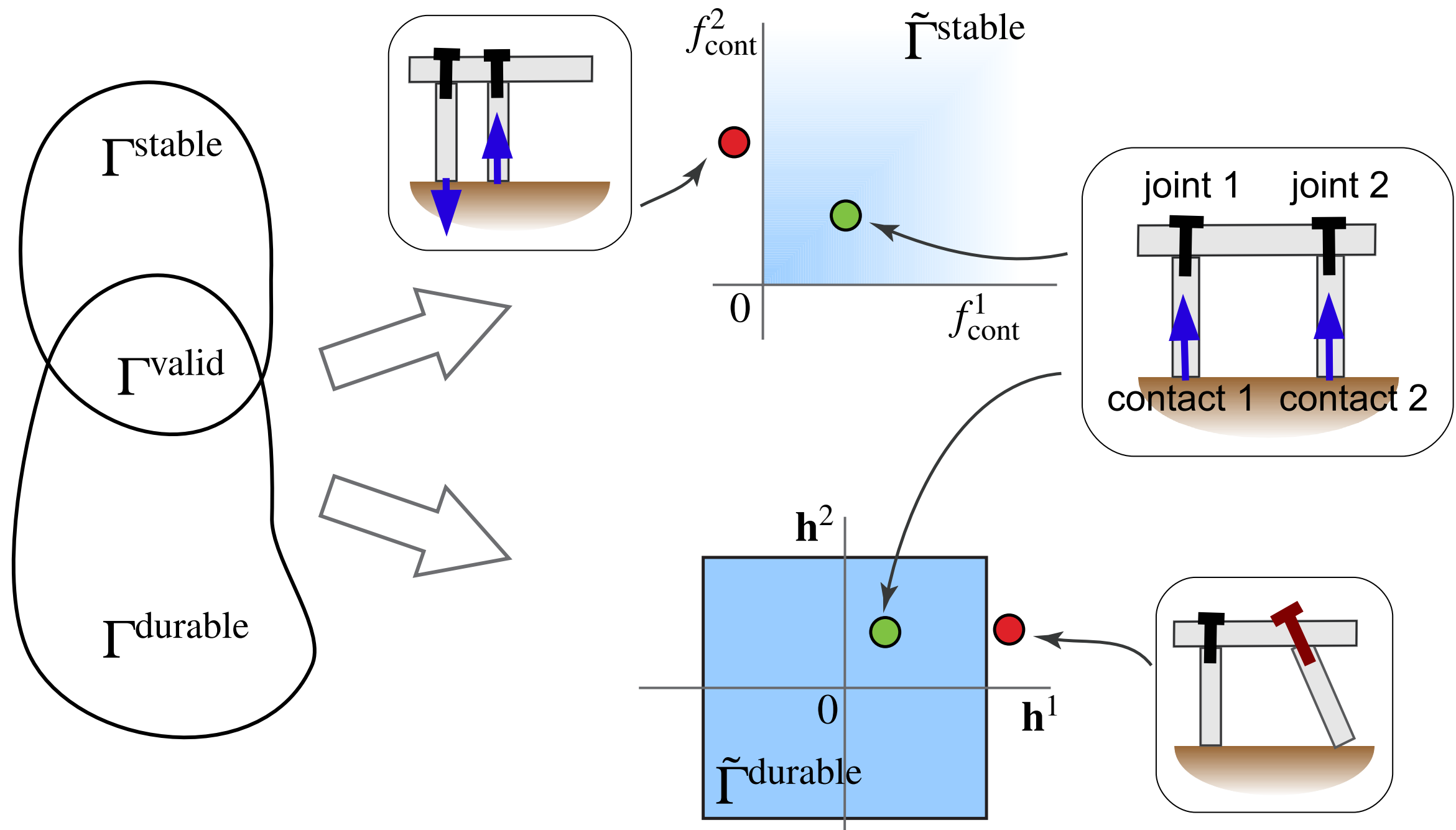
# When Forces Drive Geometry



[Umetani et al., Siggraph 2012]

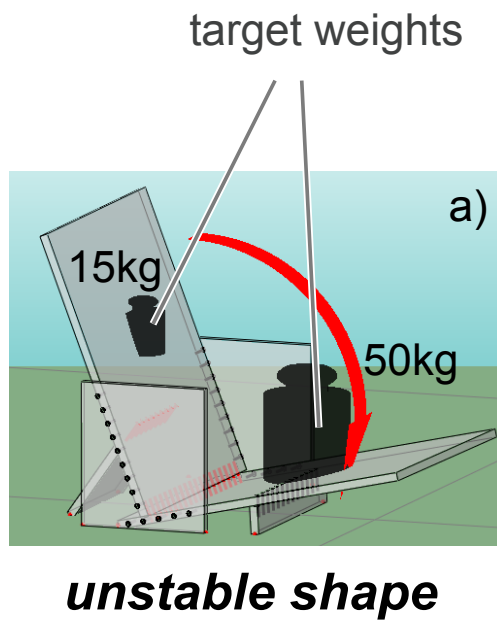


# Guided Exploration

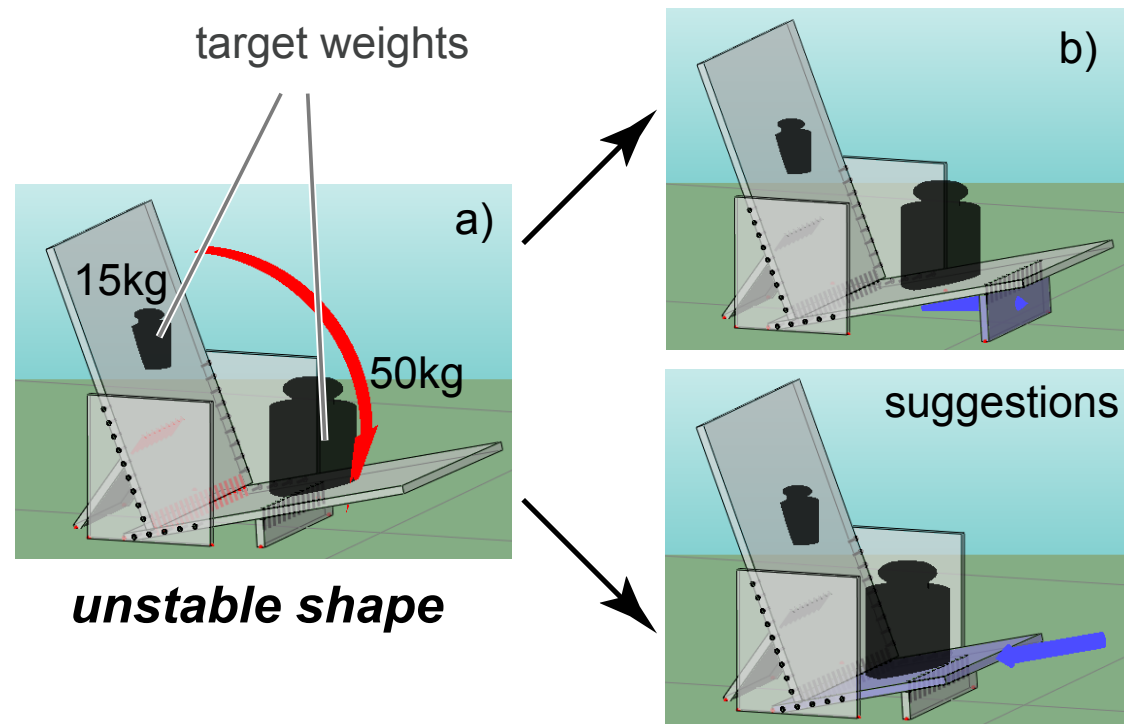


# “Forms are Force Diagrams”

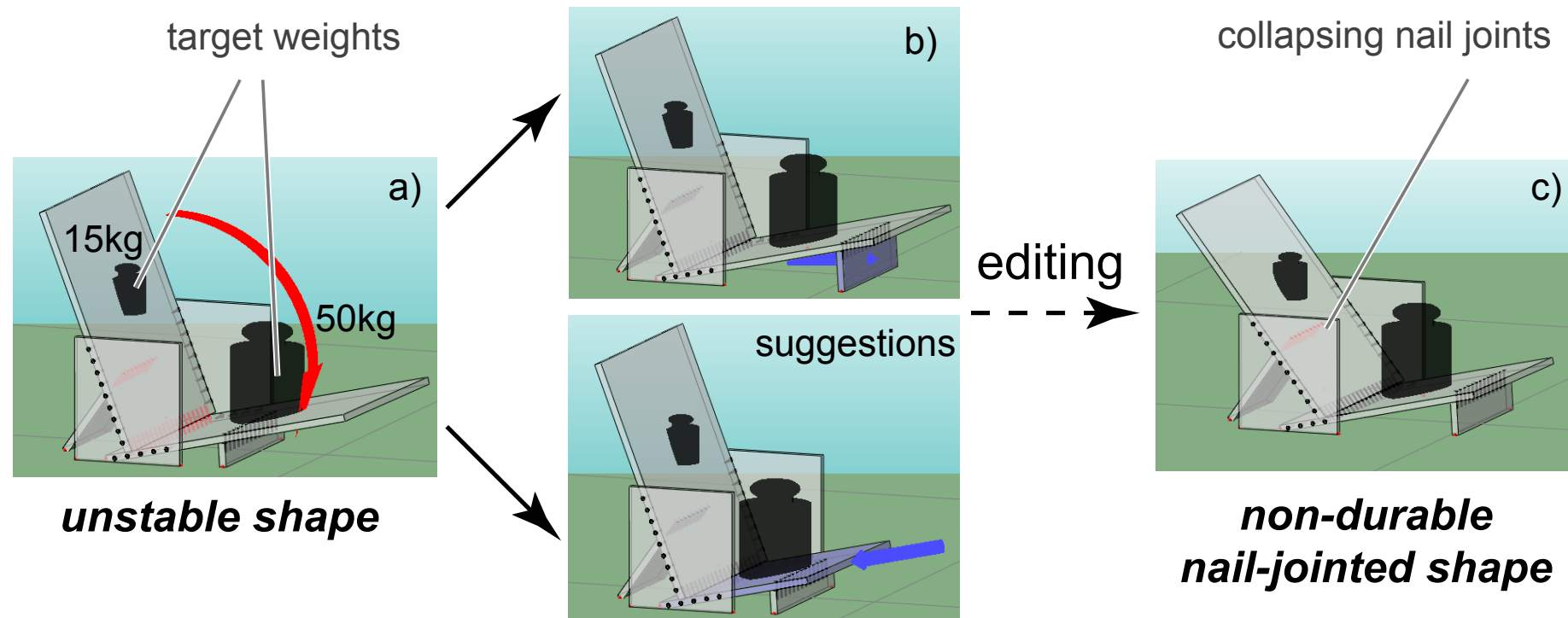
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# “Forms are Force Diagrams”

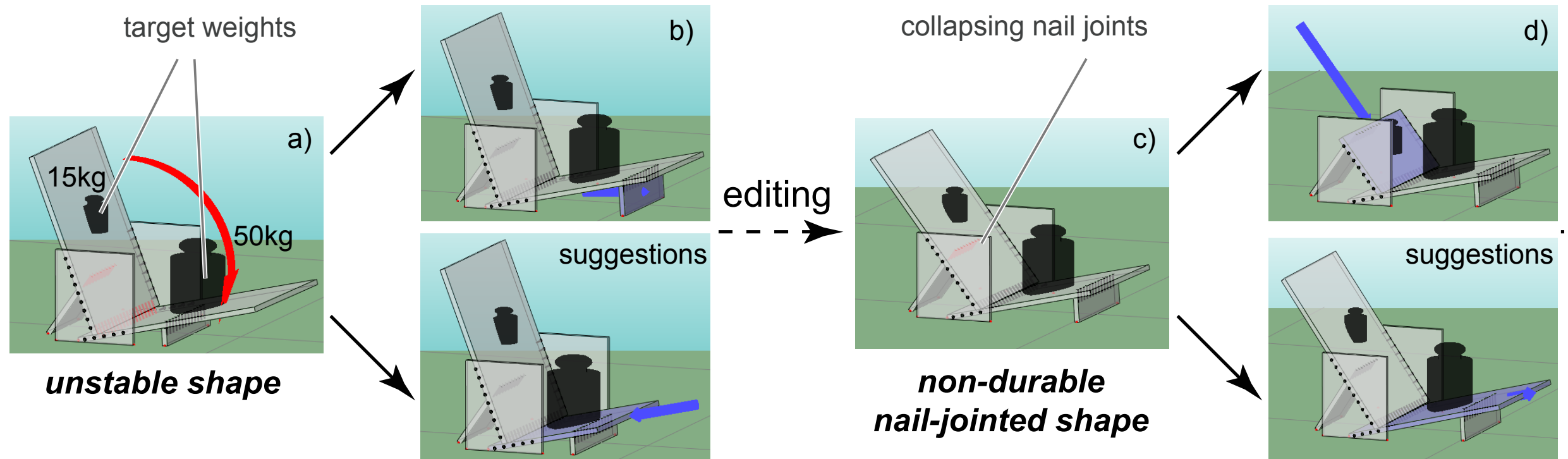


# “Forms are Force Diagrams”

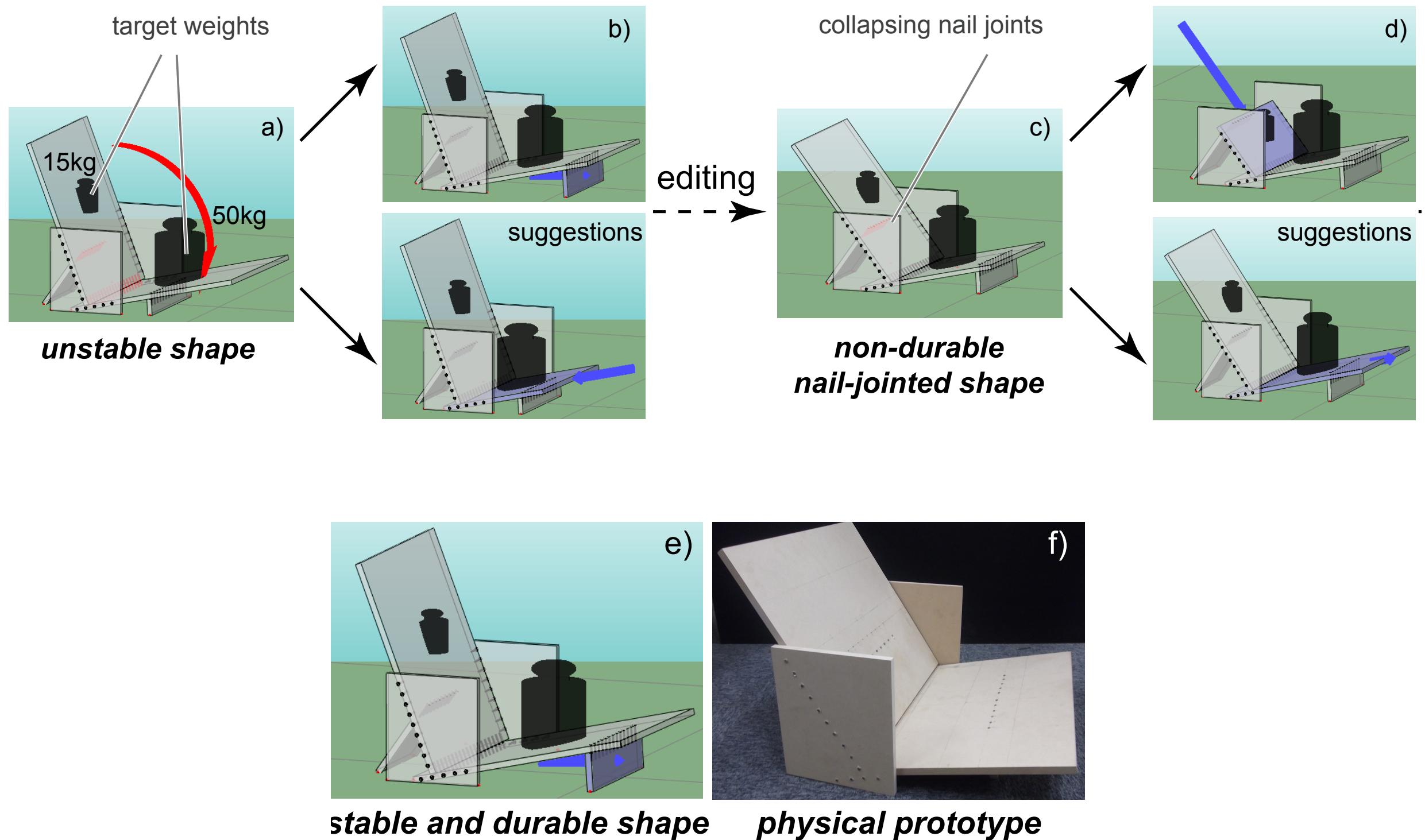




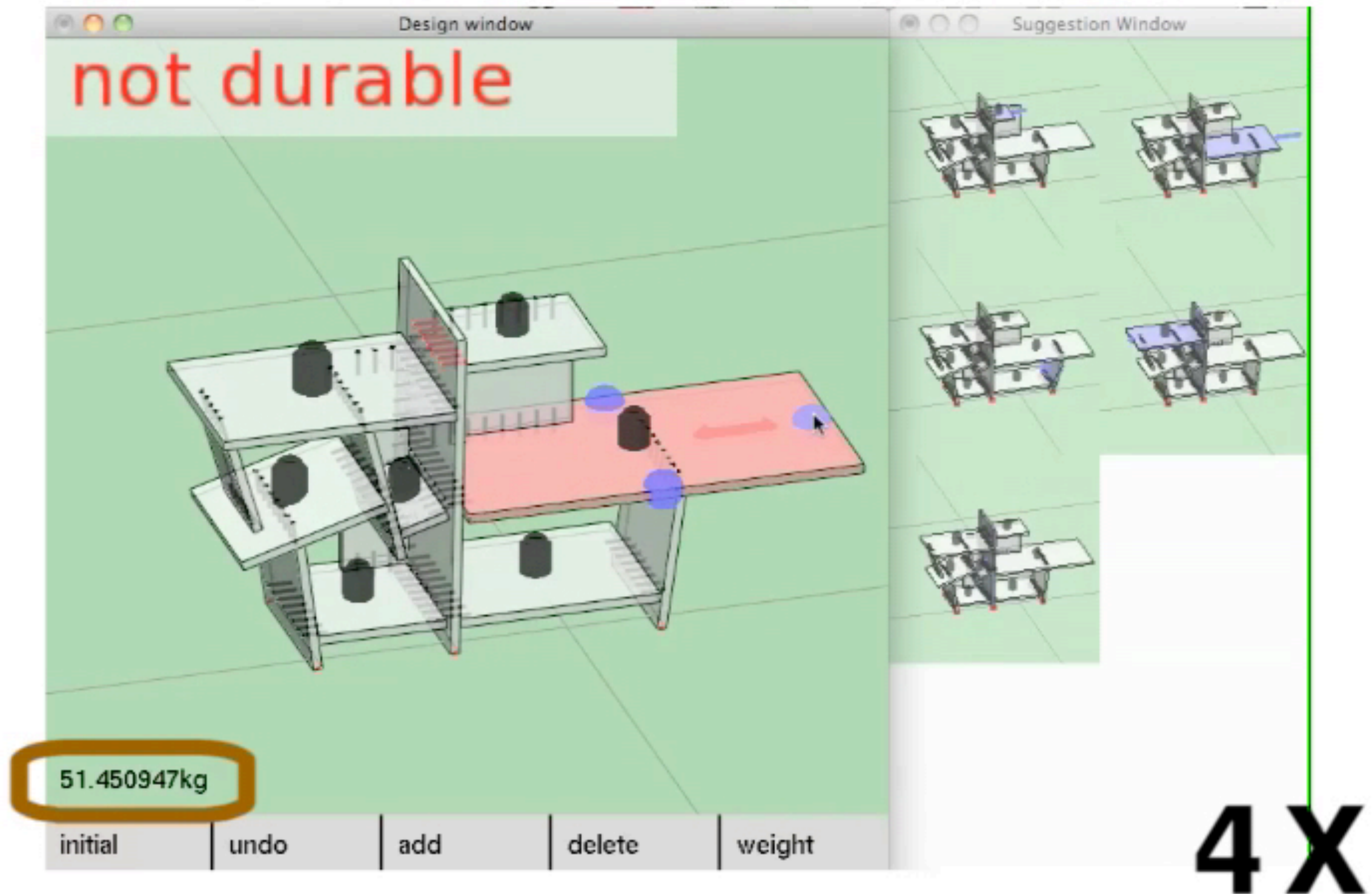
# “Forms are Force Diagrams”



# “Forms are Force Diagrams”

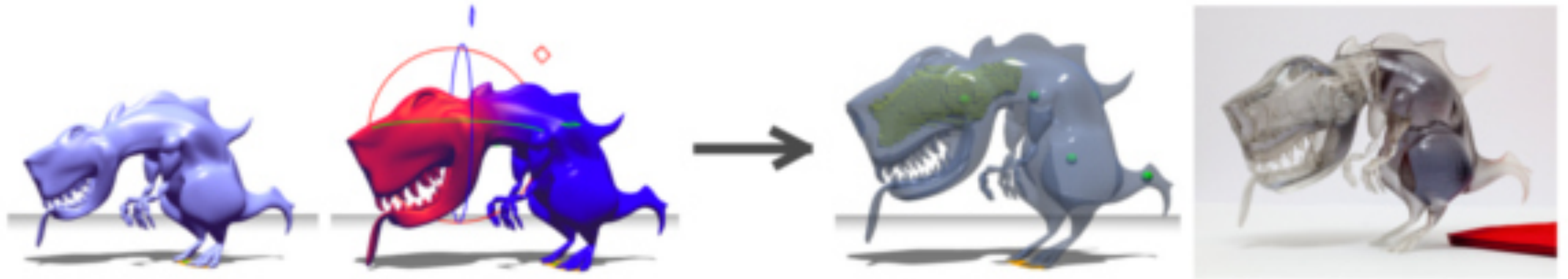


# “Forms are Force Diagrams”





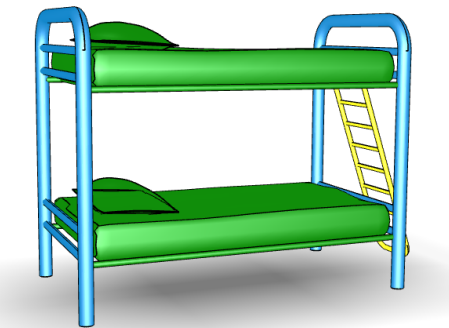
# Make it Stand



[Prevost et al., Siggraph 2013]

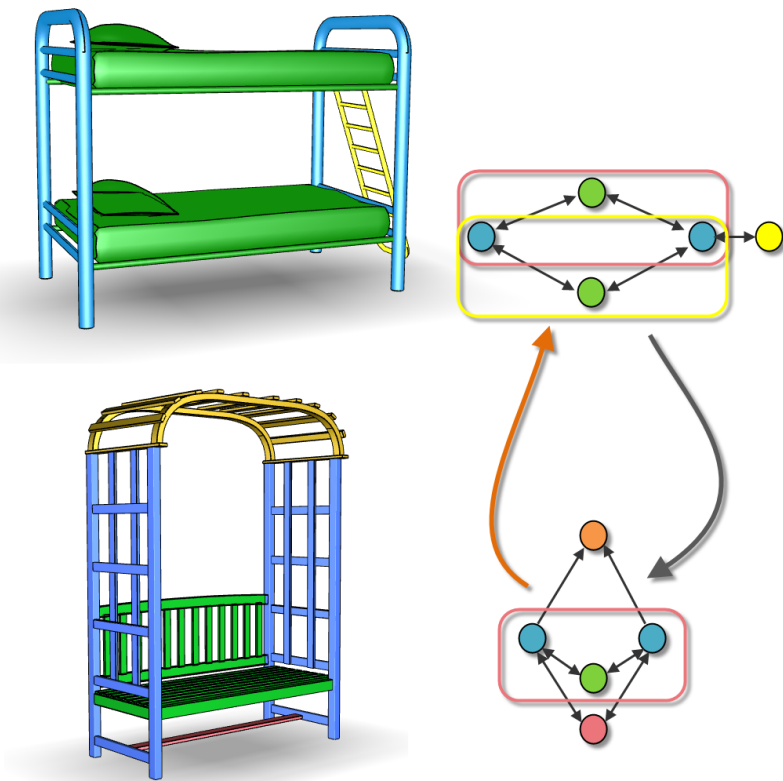


# Part-based Modeling



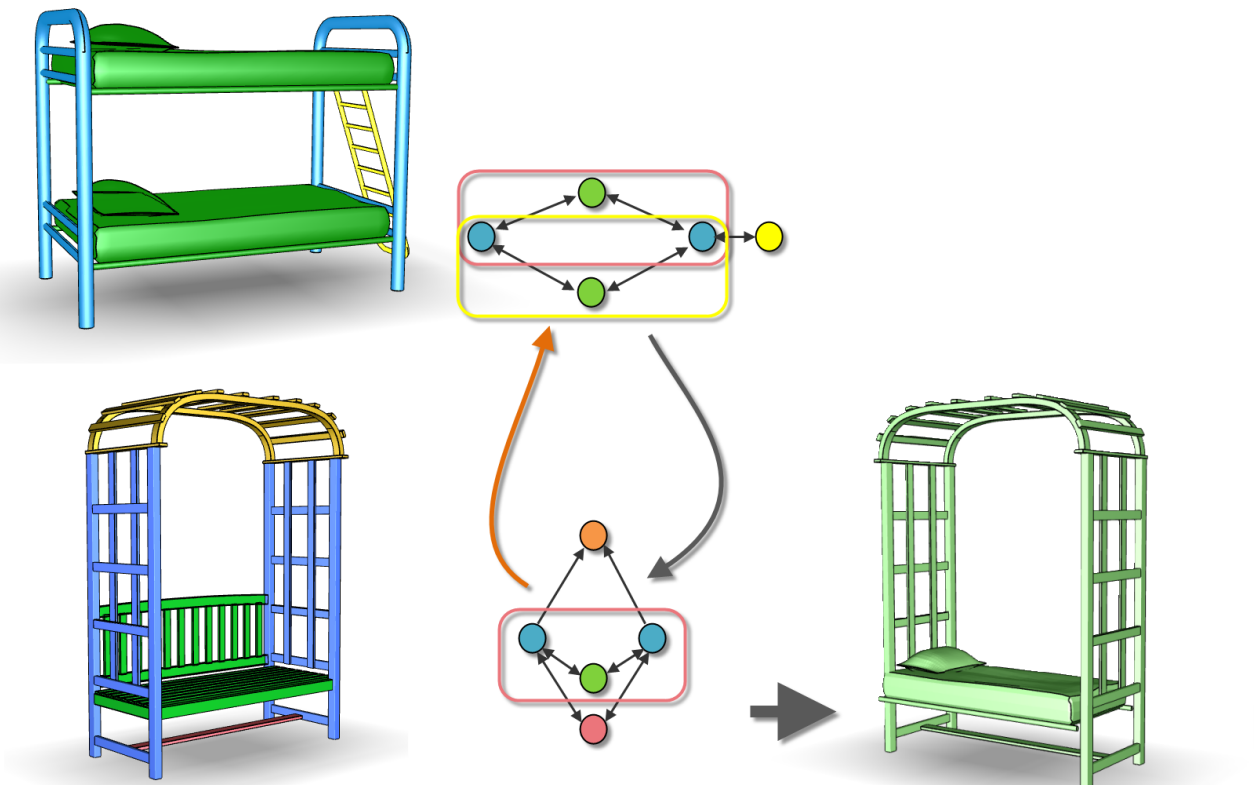
[Zheng et al., Eurographics 2013]

# Part-based Modeling



[Zheng et al., Eurographics 2013]

# Part-based Modeling



[Zheng et al., Eurographics 2013]

# Part-based Modeling



[Zheng et al., Eurographics 2013]



# Synthesized Variations

