From Sun Mao to Emergent Structure

Yang Song

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From Sun Mao to Emergent Structure
With the exploration of the cultural meaning and structural capacity of the traditional Chinese joinery, Sun Mao, the intent of this thesis is to propose a joinery-driven design system, which merges architecture and structure, and bridges the vernacular Chinese culture with the contemporary fabrication technology.

Key Words:
Tectonic; Joinery-Driven; Computational Design; Geometry Rationalization; Typology Optimization; Material Behavior; Robotic Fabrication; Algorithm-aided Design.
1. Diagrams from the building manual Yingzao Fashi (published in 1103) of the Song Dynasty

2. Traditional Chinese Architecture Diagram
Dou Gong is the building component that connects a beam and a column, passing down the load.

Sun Mao is the joining technique.

Dou Gong is the best expression of Sun MAO.
Dou Gong
1. Bracket system

4. Residential building in Yunnan Province

2. Ornament

5. Colourful dougong supporting a structure at Saga-mi-ji, Japan

3. Symbol

6. Complexity/ Decoration/ Cantile-
Statement

Background

History

Furniture Design

Fabrication Tools

Precedent, Kengo Kuma

Precedent, Shigeru Ban

Emergence

Typological Research

Testing Ground

Algorithmic Design

Digital Fabrication

4. Joint- Structure

Joint + Structure

Screwed Butt Joint

3D Printing Joint

Sun Mao

Sun Mao
Statement

Background

History

Furniture Design

Fabrication Tools

Precedent, Kengo Kuma

Precedent, Shigeru Ban

Emergence

Typological Research

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Algorithmic Design

Digital Fabrication
Stockholm-based Reed Kram and Munich designer Clemens Weisshaar have devised, coded and built a pop-up robotic plant for CODE_n, a digital innovation platform.

Complex form from 3D Printing

Chinese woodworking tools
Statement

Background

History

Furniture Design

Fabrication Tools

Precedent, Kengo Kuma

Precedent, Shigeru Ban

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Digital Fabrication

Tamedia Office Building, Zurich / Shigeru Ban Architects

Aspen Art Museum, Colorado / Shigeru Ban Architects
Icon

China Pavilion, Shanghai EXPO 2010 / He Jingtang

Venice Biennale 2014 / OMA
<table>
<thead>
<tr>
<th>Romanesque</th>
<th>Gothic</th>
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<tbody>
<tr>
<td>One would be broadly aesthetic outlook that tends to 'impose' form on building materials, according to some pre-ordained 'template' (And here one immediately thinks of the role of 'proportions' and other systems of visual ordering.)</td>
<td>The other would be a broadly structural outlook that tends to allow forms to 'emerge' according to certain programmatic requirements.</td>
</tr>
<tr>
<td>Pre-ordained 'Template'</td>
<td>Programmatic requirements</td>
</tr>
<tr>
<td>Static</td>
<td>Dynamic</td>
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<tr>
<td>Process</td>
<td>Process</td>
</tr>
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<td>Top-down</td>
<td>Bottom-up</td>
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- Diagrams from the building manual Yingzao Fashi (published in 1103) of the Song Dynasty


- @TheJoinery_jp Twitter Account

- Photos from Internet
Typological Research

Testing Ground
Algorithmic Design
Digital Fabrication

Axon

Section
1. Tugite and Shiguchi.

Tugite and Shiguchi are traditional architectural techniques of Japan.

Tugite is the technique to connect materials to augment the lack of length of available materials.

Shiguchi is a technique to connect materials at an angle.
2. Number of Joint Members

- 2 Members
- 3 Members
3. Position

Statement
Background
Emergence
Typological Research
Resource
Typology
Categorization
Testing Ground
Algorithmic Design
Digital Fabrication

Corner

Housing
4. Structural Performance

Friction

Friction + Interlock
4. Structural Performance (Tugite)

Compression
2 Axes  3 Axes
4. Structural Performance (Tugite)

Tension
4. Structural Performance

Stress Pattern

Principle Stress
5. CNC Milling Axes

- Statement
- Background
- Emergence
- Typological Research
- Resource
- Typology
- Categorization
- Testing Ground
- Algorithmic Design
- Digital Fabrication

3 Axes

> 3 Axes
3 axes <
6. Matrix
7. Filter

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<tr>
<td>1 8 15 22 29 36 43 50 57 64 71 78 85 92 99</td>
</tr>
<tr>
<td>2 9 16 23 30 37 44 51 58 65 72 79 86 93 100</td>
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<tr>
<td>3 10 17 24 31 38 45 52 59 66 73 80 87 94 101</td>
</tr>
<tr>
<td>4 11 18 25 32 39 46 53 60 67 74 81 88 95 102</td>
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<td>5 12 19 26 33 40 47 54 61 68 75 82 89 96 103</td>
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<tr>
<td>6 13 20 27 34 41 48 55 62 69 76 83 90 97 104</td>
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<tr>
<td>7 14 21 28 35 42 49 56 63 70 77 84 91 98 105</td>
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Connecting Minds, Creating the Future.

- Grasshopper for Rhino
- Grasshopper Python Component
Statement
Background
Emergence
Typological Research
Testing Ground
Algorithmic Design
Digital Fabrication
Statement
Background
Emergence
Typological Research
Testing Ground
Algorithmic Design
Digital Fabrication
Preliminary Test
Digital Fabrication

File Set

Form Labs
Form 2
Axonometric
Exploded Axon
Principle Stresses
Bibliography


Image Citation

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