Brick and Mortar Silicon Manufacturing

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Industrial Affiliates Meeting
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Declining ASIC Starts

11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0

Brick and Mortar Chips

1. Bricks
   - Mass-produced ASICs
   - Standard interface
   - Fixed set of functions
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3. Assembly
   - Alignment
     - e.g. robotics, fluidic
   - Bonding
     - e.g. flip-chip, proximity
**Brick Size**

<table>
<thead>
<tr>
<th>Function</th>
<th>Area (um²)</th>
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<tbody>
<tr>
<td>USB 1.1 Physical Layer</td>
<td>2,201</td>
</tr>
<tr>
<td>JPEG Decoder</td>
<td>625,457</td>
</tr>
<tr>
<td>RISC Core + 256K Cache</td>
<td>3,111,025</td>
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Interconnect Design

Packet-Switched | Reconfigurable Wires
---|---
Topology | 4-way fat tree per 4mm², mesh between roots | 20 fully-, 64-partially-configurable switches per 0.25 mm²
Pct. of 64mm² die | 43% | 57%
Performance | 64-bit packets, 800MHz | N/A
Bisecting bandwidth | 3.3 Tbps | 0.26 Tbps fully-, 0.8 Tbps partially-switchable
## Interconnect Design

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Alignment: Fluidic Self-Assembly

- Template - brick communication via proximity communication
  - Brick type check, BIST, speed grade
- Polymer on template can grip or eject bricks
Alignment: Fluidic Self-Assembly

- Washington EE experimental system

Courtesy: Karl Bohringer
Assembly Time v. Kinds of Bricks

![Graph showing the relationship between assembly time and the number of kinds of bricks. The x-axis represents the number of kinds of bricks, while the y-axis represents the seconds per chip. The graph shows a clear upward trend, indicating that assembly time increases with the number of kinds of bricks.]
Assembly Time v. Kinds of Bricks

[Graph showing the relationship between number of kinds of bricks and assembly time.]
Assembly Time v. Brick Placement Slack

![Graph showing the relationship between assembly time and slack in brick arrangement.](image)
Conclusion

Brick and Mortar process offers ASIC-like chips without the masks and fabs

Architecture is crucial to meet the performance goals of the process

With low-cost assembly techniques, can meet the economic goal as well
Thank you