Open-Built Systems: New House Rules

Strategies and Innovations for 21st Century Homebuilding

Open-Built Strategy #1: 21st Century Skills, Old World Craft Attitude

Program, Service, Culture
- Operating System
  - 3D software automation
  - CNC cutting and shaping
  - Open-Built disentanglement
- Lean Manufacturing
  - Constant improvement
  - Custom production
  - Mass Customization
- High skills/craftsmanship
  - Discipline, Pride
- Building Science
  - High performance
  - Net Zero capable

Old World Craft Attitude
Open-Built Strategy #2:
Disentangle and Reorganize Layers and Systems and Process

- Increase inhabitant control
- Improve functionality, durability, value

Open-Built Layers

Foundation, Structure and Skin make up the Thermal Envelope.

Services, Space plan and “Stuff”

Optimize, Maximize, but no Compromise

Shorter lifespan
Better Investment
Open-Built Strategy: Disentanglement for High Performance

- High performance code
- Tax incentives
- Low interest, long-term financing

Open-Built Strategy: Disentangle the Process

Shell
- Impact: Public control, regulation
- Intent: Long term durability, sustainability
- Players: Architects, Engineers, Public agencies

Infill
- Impact: Private, freedom
- Intent: Easy change, modification
- Players: Inhabitants, interior designers, semi-professionals.

Open-Built Strategy: More efficient ways to build more efficient buildings

Best performance with optimized use of resources

BENSONWOOD® PushUP™ floor system

Mechanical Systems

Pushup

Reinforced Concrete and Steel Framing
Open-Built Strategy #3: Apply Regulating 3D Grid

- Empowering, not limiting
- Predictable
  - detail
  - dimensions
  - cost
- Parts, components, and patterns can be "built to rule."
Open-Built Strategy #4: Design Assemblies, "Compose" Designs

- Use proven library:
  - Design patterns
  - Building systems and components
- Structure and connections fixed, details variable
- Assure quality, variety, cost and fit

Cost implications

<table>
<thead>
<tr>
<th>Standardized vs. Customized</th>
<th>Time</th>
<th>Cost factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>From our components and patterns</td>
<td>X months</td>
<td>1.00</td>
</tr>
<tr>
<td>80% standard, 20% custom</td>
<td>X+2 months</td>
<td>1.25</td>
</tr>
<tr>
<td>40% standard, 60% custom</td>
<td>X+4 months</td>
<td>2.04</td>
</tr>
</tbody>
</table>

OpenBuilt compositions
Open-Built Strategy #5:
Build it Twice: Virtual before Actual

Power of BIM
- Design = Simulated building
- Automated PM information—costs, supply chain, shipping, etc.
- Automated cutting and shaping machine code.

BIM information fed directly to CNC machines (our tireless workers)

Open-Built Strategy #6:
50,000 to 50
(Distilling Parts and Pieces into high value Building Elements)

Building Element Fabrication
New Normal for Industry?

Bensonwood CoreWall
Concentrated Mechanical System Element
- Vertical mechanical chase
- Stacked plumbing
- Combine subsystems for added assembly value
- Design and build efficiency

CoreWall Installation
Mechanical Room Module

Bath and Kitchen Modules

Bathroom Pod

Gantry System
Wall Production

Flat Pack Shipping
Recycled wrapping

Open-Built Strategy #7:
Site for assembly only; avoid cutting and shaping

- Site is the worst place to attempt to control
  - Quality
  - Efficiency
  - Cost
  - Time
  - Job satisfaction
**Open-Built Strategy #8**  
The Master Builder era is gone. Play the whole team  
- Integrate all disciplines in entire process  
  - Architectural design  
  - Engineering  
  - Building specialists  
  - Trades

**Open-Built Strategy #9:**  
Good Jobs  
- Good houses can only be built in a culture of discipline, training and pride  
- Higher expectations in skills, efficiency, values, integrity  
- Better wages  
- High involvement  
  - Experience, craft, knowledge trumps hierarchy

---

**Open-Built Strategy:**  
10: Solutions! Get in a wedge; we need you in eight.  
- Fuel Switching  
- Nuclear  
- Biomass Fuels  
- Wind  
- Solar  
- Natural Sinks  
- Efficiency  
- Carbon Capture & Storage

To get on track to avoiding dramatic climate change, the world must avoid emitting about 200 billion tons of carbon, or eight 25 billion ton wedges, over the next 50 years.

A "wedge" is a strategy to reduce carbon emissions that grows in 50 years from zero to 1.0 GtC/yr. The strategy has already been commercialized at scale somewhere.

Cumulatively, a wedge redirects the flow of 25 GtC in its first 50 years. This is 2.5 trillion dollars at $100/tC.

Carbon Mitigation Institute, Princeton University & BP

---

**The Stabilization Triangle**

Historical Emissions

![](diagram1.png)

![](diagram2.png)

![](diagram3.png)

![](diagram4.png)
Billions of Tons Carbon Emitted per Year

Historical emissions

Flat path

16 GtC/y

Eight “wedges”

Goal: In 50 years, same global emissions as today

Fuel Switching

Substitute 1400 natural gas electric plants for an equal number of coal-fired facilities

Nuclear Electricity

Triple the world’s nuclear electricity capacity by 2055

The rate of installation required for a wedge from electricity is equal to the global rate of nuclear expansion from 1975 to 1990.

Biofuels

Scale up current global ethanol production by ~12 times

Using current practices, one wedge requires planting an area the size of India with biofuels crops.

Wind Electricity

Install 1 million 2 MW windmills to replace coal-based electricity, OR

Use 2 million windmills to produce hydrogen fuel

A wedge worth of wind electricity will require increasing current capacity by a factor of 13

Solar Electricity

Install 20,000 square kilometers for dedicated use by 2060

A wedge of solar electricity would mean increasing current capacity 100 times.
**Natural Sinks**

Eliminate tropical deforestation

OR

Plant new forests over an area the size of the continental U.S.

OR

Use conservation tillage on all cropland (1000 Mha)

Conservation tillage is currently practiced on less than 10% of global cropland.

Photos courtesy of NREL, SUNY Stonybrook, United Nations FAO

---

**Efficiency**

Produce today’s electric capacity with double today’s efficiency

Average coal plant efficiency is 32% today

Double the fuel efficiency of the world’s cars or halve miles traveled

There are about 600 million cars today, with 2 billion projected for 2055

Use best efficiency practices in all residential and commercial buildings

Replacing all the world’s incandescent bulbs with CFLs would provide 1/4 of one wedge

---

**Carbon Capture & Storage**

Implement CCS at

- 800 GW coal electric plants or
- 1600 GW natural gas electric plants or
- 180 coal synfuels plants or
- 10 times today’s capacity of hydrogen plants

There are currently three storage projects that each inject 1 million tons of CO2 per year — up 2055 need 3500.

---

**The New House Rules Standard**

Architecture +
Craftsmanship +
Technology +
Innovative Building Systems

High performance structure and shell +
Fast & Affordable +
Carbon Consciousness

Better Living