

Open-Built Systems:
New House Rules

Strategies and Innovations
for
21st Century Homebuilding

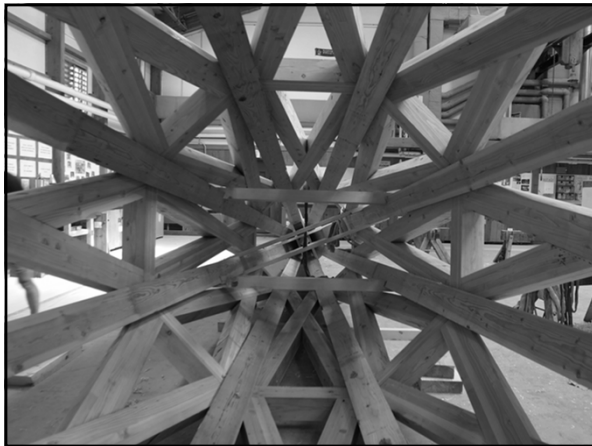
Open-Built Strategy #1:

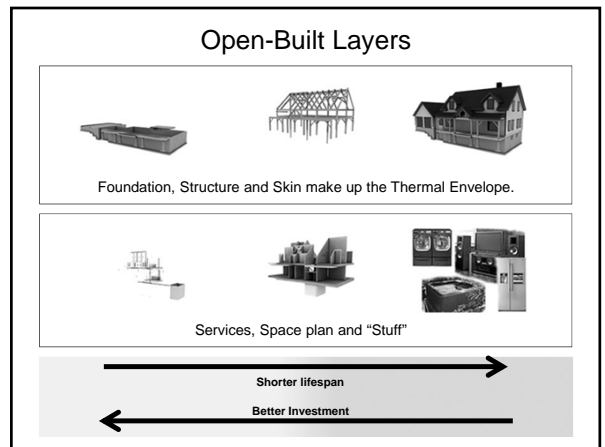
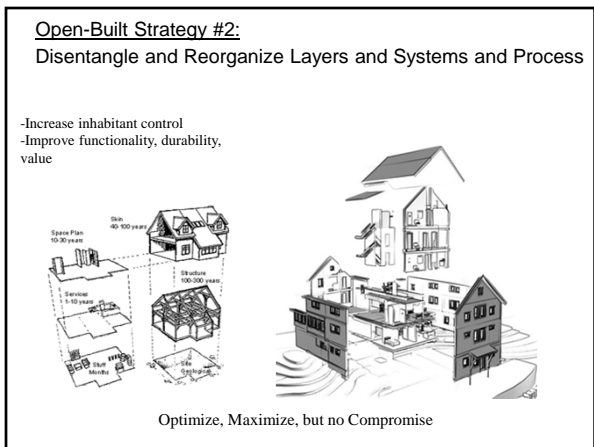
21st Century Skills, Old World Craft Attitude

- 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

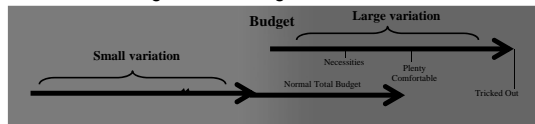


Old World Craft Attitude





Open-Built Strategy:
Disentanglement for High Performance



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



- Health and Safety code
- DIY systems & finishes
- Second hand market
- Higher interest, short-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.

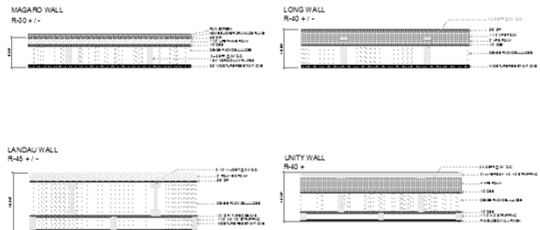
BENSONWOOD® OBPlusWall™ system

More efficient ways to build more efficient buildings

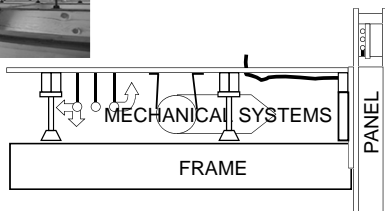


Best performance with optimized use of resources

New House Rule
Fat is hot! And Cool.



BENSONWOOD® PushUP™ floor system



BENSONWOOD® PushUP™ floor system



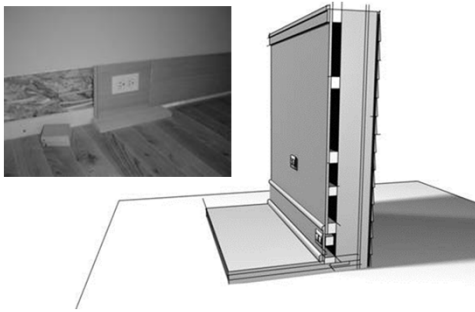
BENSONWOOD® GripT™ ceiling system



BENSONWOOD® Versa Ceiling™ panel system



BENSONWOOD® ChannelBASE™ system



ChannelBase

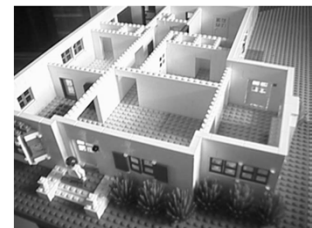


ChannelBase Partition Element



Open-Built Strategy #3: Apply Regulating 3D Grid

- Empowering, not limiting
- Predictable
 - detail
 - dimensions
 - cost
- Parts, components, and patterns can be "built to rule."



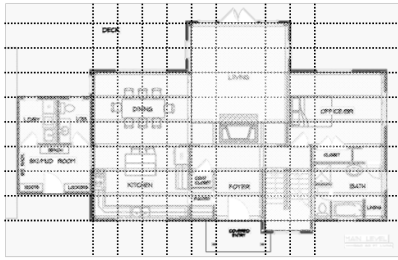
BENSONWOOD® OBGrid™ 3D Environment

Structure:
2 ft.
2 ft. x 4 ft.

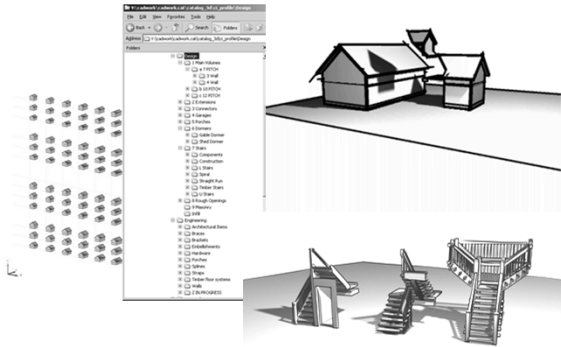
Infill:
3 in.
6 in. x 1 ft.

Vertical:
7.5 in.

Divisibles
Multiples
Margins, etc.

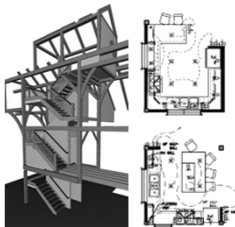


Open-Built Kit of Parts



Open-Built Strategy #4:
Design Assemblies, "Compose" Designs

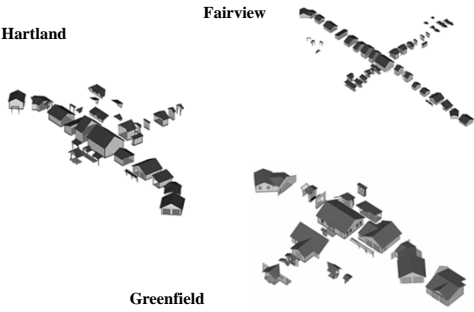
- Use proven library:
 - Design patterns
 - Building systems and components
- Structure and connections fixed, details variable
- Assure quality, variety, cost and fit



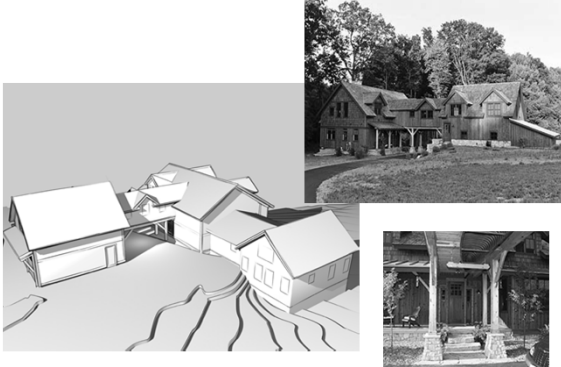
BENSONWOOD® 3BMatrix™ design system

Hartland Fairview




Greenfield



OpenBuilt compositions



Cost implications
Standardized vs. Customized

	100% standard elements Cost factor = 1.00 Time = X months
<hr/>	
From our components and patterns	
	80% standard 20% custom Cost factor = 1.25 Time = X+2 months
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	40% standard 60% custom Cost factor = 2.04 Time = X+4 months

Off Design Grid Architect

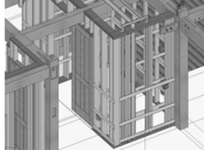
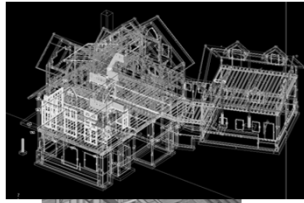
Slide adapted from Skanska Inc.

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.



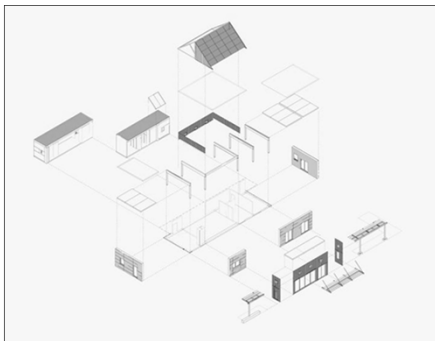
BIM information fed directly to CNC machines
(our tireless workers)



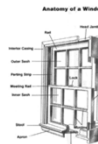
Open-Built Strategy #6:

50,000 to 50

(Distilling Parts and Pieces into high value Building Elements)



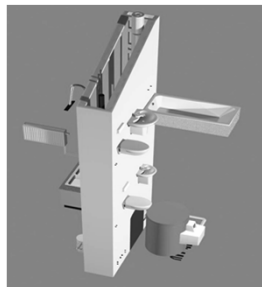
Building Element Fabrication
New Normal for Industry?



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

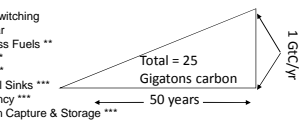
- Good houses can only be built in a culture of discipline, training and pride
- Higher expectations in skills, efficiency, values, integrity
- Better wages
- High involvement
 - Experience, craft, knowledge trumps hierarchy



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.

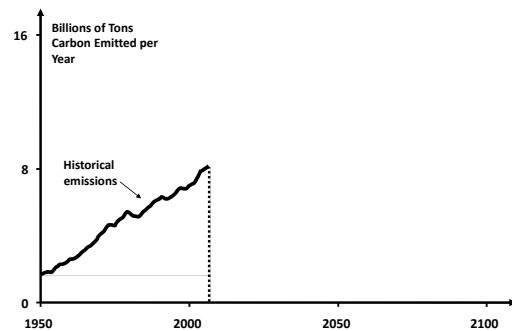


A "wedge" is a strategy to reduce carbon emissions that grows in 50 years from zero to 1.0 GtC/yr. The strategy has already been commercialized at scale somewhere.

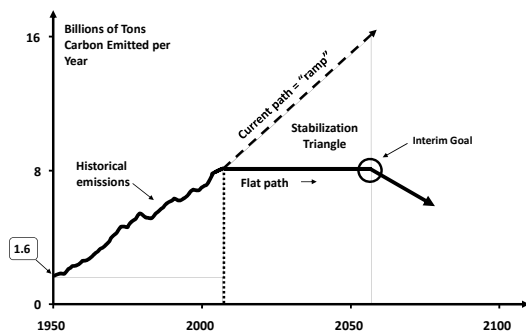
Cumulatively, a wedge redirects the flow of 25 GtC in its first 50 years. This is 2.5 trillion dollars at \$100/tC.

Carbon Mitigation Institute, Princeton University & BP

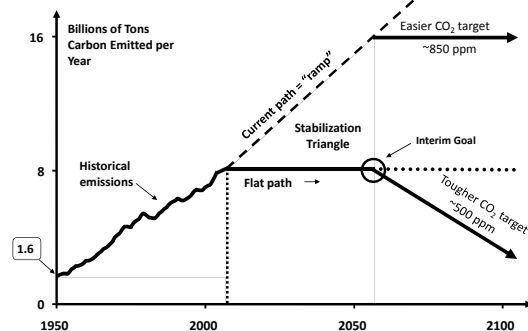
Historical Emissions

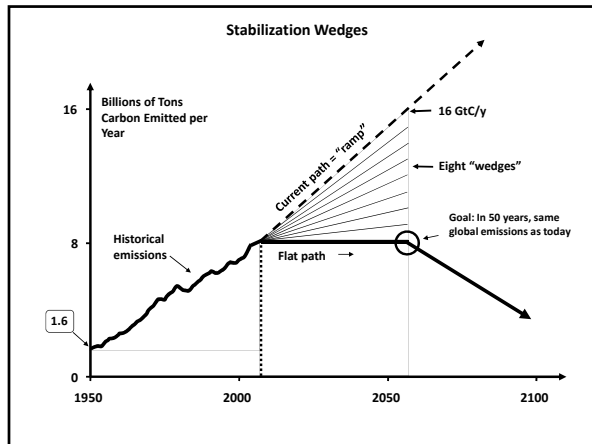


The Stabilization Triangle



The Stabilization Triangle





Fuel Switching



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



Photo by J.C. Willett (U.S. Geological Survey).

E, H / \$

A wedge requires an amount of natural gas equal to that used for all purposes today

Nuclear Electricity

Triple the world's nuclear electricity capacity by 2055



Graphic courtesy of NRC

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

E/ \$\$

Biofuels

Scale up current global ethanol production by ~12 times



Photo courtesy of NREL

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

T, H / \$\$

Wind Electricity



Photo courtesy of DOE

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 10

E, T, H / \$-\$\$

Solar Electricity

Install 20,000 square kilometers for dedicated use by 2060




A wedge of solar electricity would mean increasing current capacity 100 times

E / \$\$\$

Photos courtesy of DOE Photovoltaics Program

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 (1600 Mha)

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


B / \$

Photos courtesy of NRIEL, 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



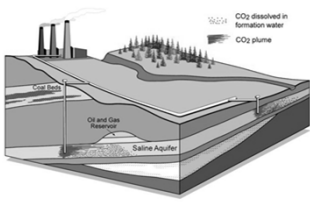
Use best efficiency practices in all residential and commercial buildings
Replacing all the world's incandescent bulbs with CFL's would provide 1/4 of one wedge

E, T, H / \$

Sector s affected:
E = Electricity, T = Transport,
H = Heat
Cost based on scale of \$ to \$\$\$

Photos courtesy of Ford Motor Co., DOE, EPA

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

Graphic courtesy of Alberta Geological Survey

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

E, T, H / \$\$


How many wedges can we build?





The New House Rules Standard

Architecture
+
Craftsmanship
+
Technology
+
Innovative Building Systems

+
High performance structure and shell
+
Fast & Affordable
+
Carbon Consciousness
=
Better Living