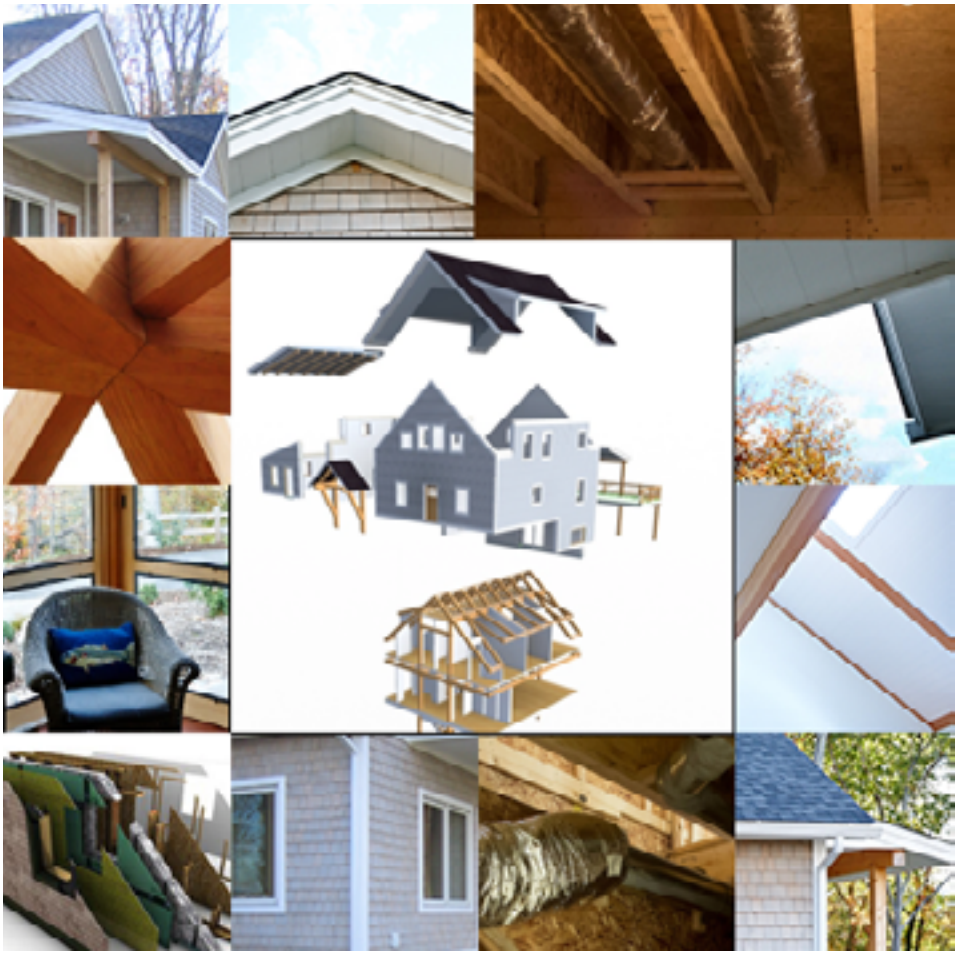
unity® homes

A Better Way to Build

WHITE PAPERS



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A Better Way to Build

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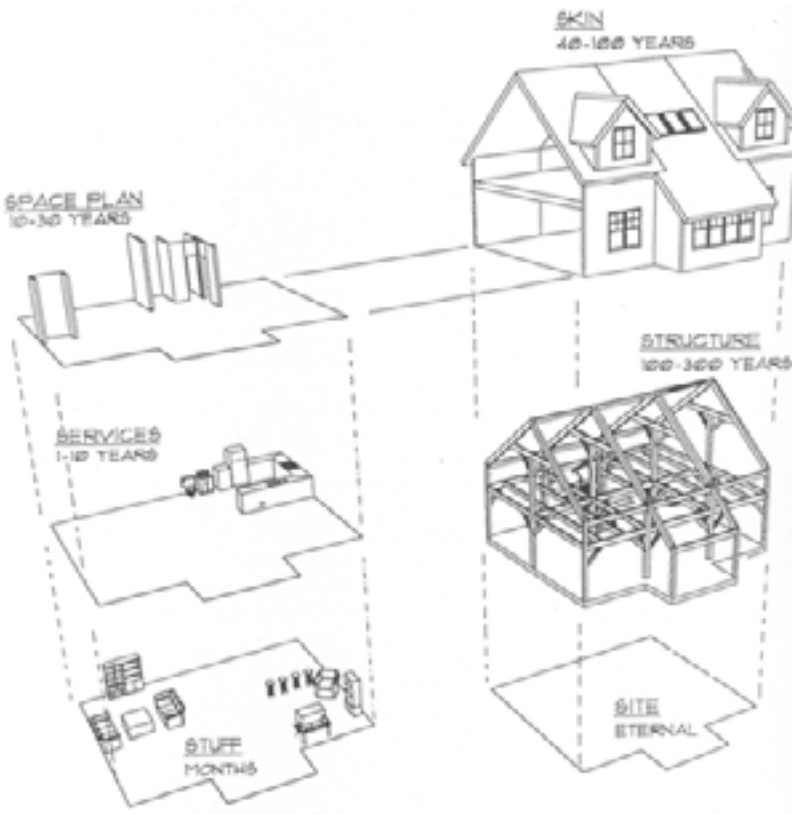
OPEN-BUILT®

All Unity homes are based on our innovative Open-Built® system that not only offers you straightforward ways to customize your house now, but also makes it far faster, easier, and less expensive to adapt your house as your needs change over the years.

Open-Built® model separates the house into six "layers": site, structure, skin, space plan, mechanical systems, and "stuff." Essentially, we build a structure that's designed to last for hundreds of years, while returning the control of your environment back to you, giving you maximum flexibility to adapt it for your own needs over time.



One example of Open-Built® is that we "disentangle" the mechanical systems from the structure of the house so you can do everything from installing a new outlet to adding a new bathroom fixture without tearing into walls or ceilings. (You simply remove ceiling panels or unscrew baseboards).

Using Open-Built® practices gives owners a much easier method for installation during construction, while also allowing access for future alterations, upgrades, and new technologies. In this way, the Open-Built® home can more easily adapt to the changing needs of its occupants without the waste, expense, and disruption normally encountered.

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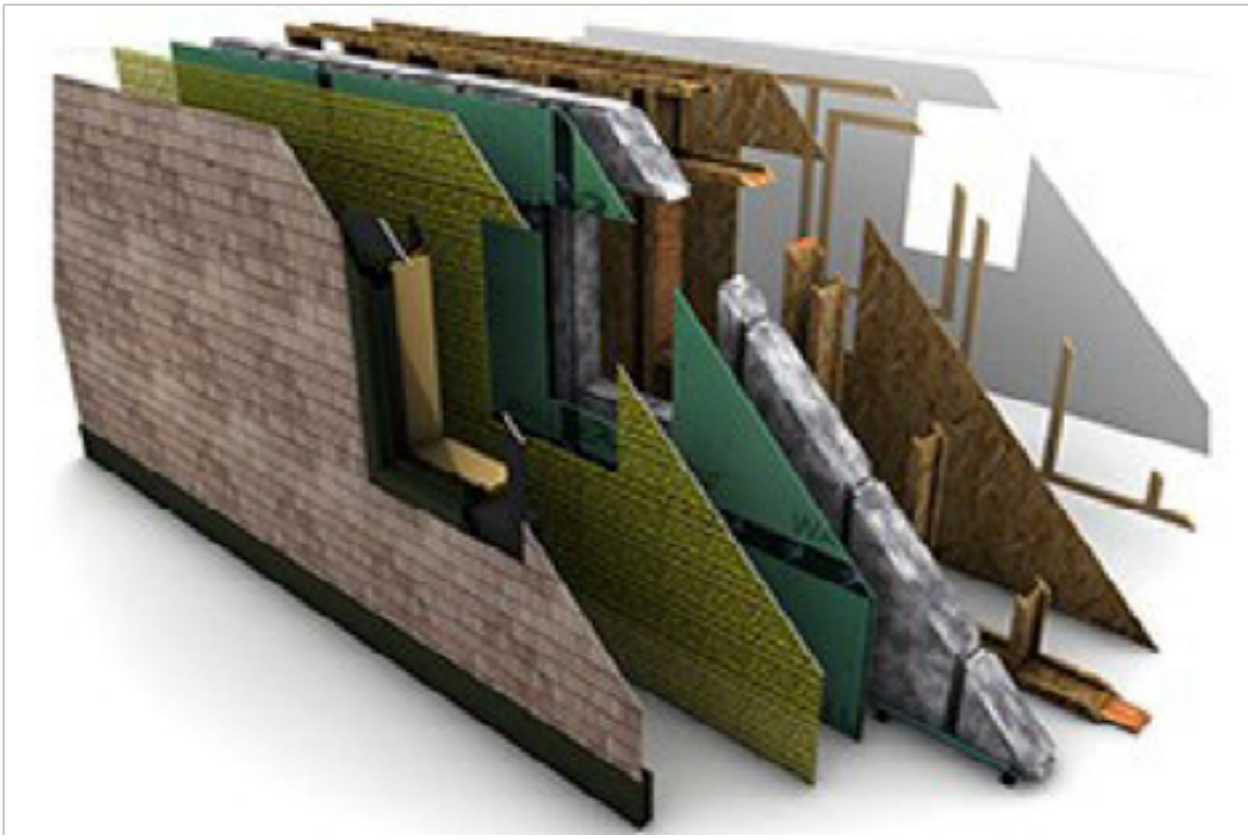
OBPlus™ Wall System

Typical homes are built with studs every 16” and insulation in between. That insulation (typically fiberglass) has to be meticulously installed on the job site (and rarely is) just to prevent settling and air leakage; plus, the studs themselves create thermal bridges, conducting valuable heat from the inside of the home in cold weather. R-values are usually less than R-20.

The walls and roofs of Unity homes are constructed of panels we have manufactured off-site to 1/16” tolerances—including cutouts for doors and windows—and then packed with dense cellulose. These waterproof and airtight structural members have insulation values of R-35 in the walls and R-38 to R-48 in the roofs. To minimize air infiltration, we tape every joint and put gaskets at intersections. A service layer separates the mechanical systems form the thermal shell, eliminating any on-site drilling and cutting during construction or later for renovations. The result is that our homes are can be built up to 10x tighter than the industry standard.



A cross-section of Unity’s OBPlus Wall System wall panel, featuring moisture barriers, cellulose fill, and service layer.

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Cellulose Insulation

We use dense-packed cellulose insulation in our OBPlus Wall® panels because it offers many advantages over fiberglass and foam insulation.

Cellulose insulates, minimizes air infiltration, maintains humidity, and keeps things quiet.

Dense-packed cellulose delivers a greater R-value per inch compared to fiberglass batting. And, while the R-value per inch of most foam insulations is higher, foam can crack as it cures, especially around framing members, which allows significant air infiltration.

In addition, cellulose fiber maintains even humidity levels throughout the building. This is due to its hygroscopic buffering capabilities—i.e., ability to take up and release moisture. Fiberglass and foam, on the other hand, are hydrophobic, which means they do not absorb water. This can cause a home's interior to experience significant and uncomfortable swings in humidity when the weather changes.

There's an important lifestyle advantage to cellulose also: its combination of density and consistency deliver far superior sound dampening. Clients are always surprised just how quiet Unity Homes are.

Cellulose is really green.

Cellulose insulation is one of the greenest building products available, featuring up to 85% recycled content, compared to 40% for fiberglass and little or none for foam.

It also takes less energy to manufacture. If you take all the energy required to transport the raw material and then manufacture and distribute the finished product, fiberglass uses up to 10 times more and foam products as much as 64 times more of this embodied energy than cellulose.

Cellulose insulation is made from recycled paper that might otherwise end up in landfills where it will release methane as it decomposes or CO2 if it is burned. This sequestration results in a positive carbon balance that lowers the material's impact on climate change. It serves the same function in your own environment, where it sequesters carbon rather than releasing it into the home.

Finally, most cellulose manufacture is regional, providing jobs and taking advantage of local recycling programs.

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OPEN-BUILT® Mechanical Systems

One of the most significant benefits of Open-Built® is that we can strategically disentangle the mechanical systems from the structure and space plan. This makes installation easier during construction and gives easy access for future alterations, additions, and upgrades of wiring, HVAC, and new communications technologies.

Base Chase

The Open-Built® base chase is used in all Unity walls. It has enough room to run AC power and other wiring such as telecommunications. The baseboard is designed to be easily removed which simplifies changes. No more tearing things apart to put in a new plug. The base is finished with millwork that matches the finishes in your home.

Tradd Push-Up Second-Floor System

On Tradd two-story homes, the floor is supported on a series of metal stand-offs, creating an eight-inch tall space. This space is used to run mechanical systems, ducting, and wiring. The anti-vibration pad on each standoff has the added benefit of reducing noise transmission from people walking on the floor above.

Ceiling System Option

In some homes, we use a method we developed called Grip-T™. It allows the ceiling to be hung from the I-joists, using special hangers and wooden t-bars. The mechanical systems are then run as normal through the joist layer or below in the hanger layer.

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OPEN-BUILT® Mechanical Systems (cont.)

Easy Access Ceiling Panels

Our ceiling panels are crafted from shiplap pine or MDF, and are finished to match your interior design choices. The panels fit together seamlessly, yet are easily removable to give you fast access to the mechanical systems above. These access panels also make repainting far easier.

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Indoor Air Quality

You can live 21 days without food, seven days without water, but only a few minutes without air. Every day we take 21,600 breaths; that's nearly 8 million breaths of air a year. By weight, we take in more air than food: 4,500 times our own weight in an average lifetime.

On average, we spend 90% of our lives indoors, and approximately ²/₃ of that time is spent at home. Today's health-conscious consumers will pay a premium for healthy, natural foods, but often give less thought to indoor air quality or the overall healthiness of their homes.

However, homebuyers are increasingly concerned about the Indoor Air Quality (IAQ) of their homes. Pollutants like mold, radon, carbon monoxide and toxic chemicals are receiving greater attention than ever as poor IAQ is linked to a multitude of health issues. Some pollutants cause health problems such as sore eyes, burning in the nose and throat, headaches or fatigue. Other pollutants cause or worsen allergies, respiratory illnesses, heart disease, cancer, and other severe long-term health issues. At high concentrations, pollutants such as carbon monoxide, can be fatal.

Given how important air is to life, let's examine perhaps the most important attribute of Unity Homes, and properly built high-performance homes in general, which is how they can help you breathe easier and live healthier.

Air Pohoda's Ultima 240E i-ERV uses an Enthalpy heat exchange core

To start, only low VOC (Volatile Organic Compounds) materials and finishes are used in the construction of Unity's highly-insulated, tightly-sealed, energy-efficient homes, resulting in exceptional levels of indoor air quality. Because of their extraordinary air-tightness, the indoor air is continuously replenished with fresh and conditioned air, reducing the energy losses that typically come from whole house ventilation. This is accomplished by the use of a standard Heat Recovery Ventilator (HRV) or optional Energy Recovery Ventilator (ERV) with adjustable humidification and dehumidification controls.

Regardless of which ventilation system is chosen, Unity homes come standard with air-source heat pumps (for heating and cooling). When properly installed, an air-source heat pump can deliver one-and-a-half to three times more heat energy to a home than the electrical energy it consumes, according to the U.S. Department of

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Indoor Air Quality (cont)

Energy. This technology loses less humidity in the winter than with forced hot air/furnace systems that scorch the air at high temperature—driving off its moisture, often making it necessary to incorporate a humidifier inot the heating system. Finally through filtration, allergens and other pollutants can be removed, making indoor air considerably healthier than outside air.

Why build tight houses that require sophisticated ventilation systems, you ask? There are many myths held by the public (and by many builders as well) surrounding the false notion that houses need to breathe. This bogus theory holds that houses can be too tight and that air leakage or "natural ventilation" dries everything out and keeps the air quality healthy. But as Green Building Advisor.com points out, "…air leaks mean you've lost control of air movement…air and moisture can be forced into wall and ceiling cavities where water vapor condenses and fosters the growth of mold."

Additionally, according to Green Building Advisor.com:

> *"Warm air exiting the top of the house can draw in cold air to replace it, wasting heat and energy. In many ways, uncontrolled air movement wastes energy and increases the risk of long-term damage to building components. Effective air and moisture barriers reduce those problems, but they come with a few caveats: Tight houses need mechanical ventilation to ensure a supply of fresh air to keep people healthy."*

And while we're on the subject, what exactly is "fresh air?" Most would assume outside air is fresh air, but whether you live in the city or the country, outdoor air carries pollutants in the form of gasses, droplets, and particles. This includes pollution from cars, trucks, airplanes, industry, tractors plowing fields, wood and crop fires, ground level ozone, and allergens like pollen. Indoor air, too, can contain a host of pollutants from combustion sources like stoves and furnaces, to high VOC building materials and furnishings, to household cleaning products and radon, to name a few. All of these pollution sources can cause health problems if not mitigated through green building practices and sophisticated air handling technology.

Unity Homes, and other high-performance homes, help you breathe easier and live healthier by using only green materials and finishes, by sealing out unwanted moisture, dirt, dust, insects and allergens that can lead to health problems and costly repairs, as well as by conditioning and filtering incoming air. At the same time, Unity's well insulated and tight building envelope reduces overall heating and cooling costs, and adds comfort by eliminating drafts and temperature variations.

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Indoor Air Quality (cont)

Moreover, while a Unity Home conditions your indoor air, its low-waste, precision off-site fabrication and super-efficient energy performance thereafter works to lower its impact on the outside air—which we all share—as well.

Read more about what steps to take both to reduce the risk from existing sources of indoor air pollution and how to prevent new problems from occurring in EPA's *"Care For Your Air: A Guide to Indoor Air Quality."*

**Source:* http://minkukel.com/visualize-it/every-breath-you-take/

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1972
Before Bensonwood

Tedd's first company was B&B, named for Benson & Benson: Tedd and his brother, Steve. Together, the Benson brothers start out doing renovation, remodeling, and cabinet making. Later, they start disassembling falling down timber frame structures for clients in exchange for the materials. Steve Benson dies tragically in 1974, and B&B later becomes the Benson Woodworking Company.

October 1973
Bensonwood's first shop

Tedd builds a 5,000 SF woodworking shop in Alstead, NH out of recycled timber frame barns and silos. The shop, with its simple but strong timber-frame joinery, gives Tedd the confidence to move forward with more sophisticated forms of timber framing.

May 1974
Smith House: Bensonwood's first prefab

Tedd works with friend, Mike Burke to build a new stud-built house with a timbered French country kitchen and dining area. He elects to prefabricate the construction elements in his newly finished woodworking shop for the added control and precision it allows. This seminal project cements Tedd's early belief in the advantages of off-site fabrication.

October 1975
Taft House: First modern timber-frame house

Tedd and Dave Bryant build what the Concord Monitor refers to at the time as "…the first full timber frame house built in NH in over 60 years." From there, Tedd and his dedicated craftsmen go on to create the home's exterior & interior doors, stairway, cabinets, built-ins, paneling, moldings and furniture — all in the new Alstead Woodworking Shop. From this influential project, the importance of control and influence on finishes is realized. This Greene & Greene holistic ethic, arising out of the Arts and Crafts movement, continues to be part of the DNA of the company and informs the way the all projects are approached.

August 1978
SIPS

Tedd realizes the potential applications for residential structural insulated panels (SIPs) after seeing aluminum-skinned insulating panels at a walk-in freezer manufacturer.

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September 1979
Tedd's first book published

Tedd Benson (with Jim Gruber) publishes first book, *Building the Timber Frame House: The Revival of a Forgotten Craft* (Scribner's, 1980; Simon & Schuster, 1995). Instrumental in the revival of this centuries-old form of building with heavy timber, the book serves as a manual for builders and designers of timber frame homes. Today, it is still considered the bible by timber frame enthusiasts around the world.

August 1980
Simsbury House: First stress-skin panel home

Tedd and Amos Winter develop some of the first stress-skin panels for residential use. With the timber frame providing for the structural loads, the two develop a way to incorporate Bun stock, a rigid foam insulating material, to create a structurally uncompromised, built-up enclosure system. The company continues to produce its own closed panel walls, though with greener materials and greater sophistication than in this early prototype.

May 1984
Masahiko Ishikawa teaches at Bensonwood

Masahiko Ishikawa brings Japanese temple building skills, infusing Bensonwood employees with knowledge about fashioning ultra-precise timber frame connections and ancient techniques of making compound joinery.

July 1984
Timber Framers Guild of North America founded

Tedd and a small group of timber framers form the Timber Framers Guild of North America knowing that the timber frame revival needed a vital, well-connected industry to establish a forum for learning and standards.

May 1985
Rees Acheson fabricates portable mortising machine

Tedd hires Rees to fabricate a portable mortising machine, making it possible to rapidly create timber frame joints with great precision. It is still use today on the largest timbers. Rees continues to innovate at Bensonwood for several years.

April 1986
Bensonwood purchases first PC

Company purchases early computer for $6,000 and asks Rees Acheson for a whole new strategy for mastering complex compound joinery. Rees develops a trigonometry program with AutoCAD output of Hawkindale angles, thus creating specialized software where none existed before. This allows timber framers to layout and cut the many compound angles in hip and valley roof structures.

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September 1986
Robert 'Ben' Brungraber, Ph.D. hired

Bensonwood becomes the first company to have a professional engineer dedicated to timber frame design and engineering. Ben elevates the company's engineered timber frames to new levels, proving to building inspectors the efficacy of his sophisticated compression & tension joinery. From Ben's extraordinary talent and experience, begins the company's legacy of timber frames as fine-engineered structures.

April 1987
First appearance on This Old House

Bensonwood first featured on PBS Television's *This Old House.*

August 1987
Brian Smeltz hired

Lucky for Bensonwood, Ben Brungraber brings Brian Smeltz into the company. A Renaissance man and Jack-of-all-trades, Brian proves to be an excellent timber framer, artist, designer, teacher, salesman, and project manager. His enthusiasm and creativity leave an indelible mark on the company.

March 1988
Spline joinery developed

Bensonwood develops spline joinery to strengthen timber frame connections and allow for more varied timber design, while increasing the load capacities of the structure.

October 1988
Tedd Benson's second book published

Tedd publishes second book, *The Timber-Frame Home: Design, Construction, Finishing* (Taunton Press), providing a comprehensive guide to building a timber framed home.

May 1989
Blitz-build in Pennsylvania

Tedd Benson and Bensonwood lead a Blitz Build of two Habitat for Humanity homes in Pennsylvania, the first of many such Blitz Builds.

September 1989
Second appearance on This Old House

Bensonwood featured for the 2nd time on PBS's *This Old House* on the Wickwire Barn series.

June 1991
CAD comes to Bensonwood

Bensonwood begins modeling timber frames using 3-D CAD software.

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May 1993

Boris Noel, first international intern, joins Bensonwood

Boris Noel begins long line of talented, international interns. Unlike tradespeople in the United States, those in the European and Asian building trades are highly educated and revered for their mastery. Hungry for outside knowledge, Bensonwood invites these interns from abroad to simultaneously learn and share the skills of master craftsmen. Collectively, these interns from countries such as France, Germany, Switzerland, and Japan bring a wealth of information to the company's growing bank of knowledge.

April 1994

Open-Built® created

By merging the best thinking of open building proponents like John Habraken and Steward Brand with his own concepts, Tedd develops a practical, digitally-based design, fabrication and construction system that revolutionizes how homes are designed and built. Open-Built allows for the disentanglement of mechanical systems from the structure of the house and organizes them for more efficient installation and long-term access. With Open-Built, Bensonwood designers electronically catalogue every design element they create. The 3D Open-Built grid system allows existing design elements to be quickly and easily adapted to any new home design.

August 1995

Bensonwood builds floating timber frame.

Bensonwood works with the Alexandria Seaport Foundation to build a boat-building shop/classroom for at-risk youth. Through the building and use of wooden boats, full time apprentices earn their GED and prepare for a career in the building trades.2004 Bensonwood builds floating timber frame.

June 1997

Bensonwood begins CNC timber milling

Bensonwood adds a computer driven, numerically controlled (CNC) high-speed timber cutting machine that crafts timbers and joinery with accuracy to 1/32 of an inch. Driven by Bensonwood's Open-Built®, rule-driven software the automated machine, improves efficiency, reduces cost and improves accuracy.

November 1997

Tedd Benson publishes third book

Tedd Benson publishes 3rd book, the *Revised and Updated Timber Frame Home* (Taunton Press). This extensively updated and reworked book takes an in-depth look into the process of building a timber frame and making it into a comfortable home. In the book, Tedd showcases his latest advances: from new design, engineering and joinery to wiring, plumbing and glazing.

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March 1998

Bensonwood develops keyed beams

Bensonwood engineers and timber framers develop keyed beams, a new laminating method that allows greater spans with relatively small timbers and makes the connections visible and aesthetically pleasing.

February 1999

Bensonwood begins wall fabrication

Bensonwood begins building its own wall panels for improved energy efficiency, electrical routing and design flexibility. The new panels greatly reduce waste, compared to SIP panels, because window and door openings are built in place rather than cut out and discarded.

July 1999

Bensonwood builds timber frame on Washington Mall

Bensonwood demonstrates a timber frame barn raising on the National Mall in Washington, D.C. as part of the Smithsonian Folklife Festival. The festival educates the public about cultural traditions that contribute to the American and human experience.

October 1999

Tedd Benson publishes third book

Tedd Benson publishes 4th book, *Timberframe: The Art and Craft of the Post and Beam Home* (Taunton Press). The book presents 25 years of Bensonwood's craft and practice, with examples ranging from the Rocky Mountains to New England and from traditional to contemporary, taking its readers on a tour of the most beautiful post and beam homes in North America.

June 2000

Bensonwood relocates, expands

Bensonwood builds state-of-the art design, fabrication and assembly facility in Walpole, New Hampshire.

April 2002

Smithsonian Magazine features Bensonwood

Bensonwood is featured in Smithsonian Magazine ("*Building to a Different Drummer*") for its Walden Cabin, a timber framed replica of Henry David Thoreau's simple 10'X15' cabin on the shores of Walden Pond. Timber framing parallels are drawn from this Spartan, diminutive cabin to the exquisite high-end homes that Bensonwood became known for.

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August 2004
Open-Built Floor System Developed

Bensonwood invents a floor system that allows the complete separation of structure and service layers, while providing easy access to plumbing, wiring and HVAC. It is the culmination of several years of product development and becomes the Open-Built second floor system, which eventually becomes standard on all two-story Unity Homes.

March 2005
Bensonwood partners with Huber Engineered Woods, LLC

Bensonwood enters into a joint development agreement with Huber Engineered Woods LLC to develop new wood-based products and applications for home design and construction, and to develop new technologies in home design, subassembly design, modular design and related processes.

May 2006
Bensonwood Partners with MIT

Bensonwood begins long-term partnership with MIT on the Open Prototype Initiative, with the goal of developing affordable, flexible, high-performance houses. Utilizing Open-Built technologies and prefabricated building systems, the initiative results in Open_1, a multi-use rehab center/home, and OPEN_2, an environmentally friendly, multipurpose present's home for Unity College.

July 2006
Bensonwood builds Loblolly House

Using waste-saving 3D BIM modeling and visualization software, Bensonwood engineers, fabricates, and constructs the award-winning Loblolly House, one of the most talked about houses of 2006, designed by Kieran Timberlake Architects. Featured in Wired Magazine and Treehugger.com, the shore home's Bosch aluminum frame is held together with Bensonwood designed and engineered connectors.

December 2006
Bensonwood named Small Builder of the Year

Bensonwood wins 2006 Small Builder of the Year award from the Partnership for Advanced Technology in Housing (PATH) for its ground breaking work in Open-Built design and building systems.

September 2007
Habitat Blitz-Build

Bensonwood, along with over 500 regional volunteers, completes the local Blitz-Build of a Monadnock Habitat for Humanity home for a New Hampshire family of 10 in need. The 2100 SF home is built in just eight days.

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October 2008
Bensonwood builds home on This Old House

Bensonwood featured in all seventeen episodes of PBS's *This Old House* fall season.

December 2008
Bensonwood awarded 'Small Builder of the Year' by Residential Contractor.

Residential Contractor names Bensonwood 'Small Builder of the Year' for 2008.

June 2009
Bensonwood partners with Dow Chemical to develop new building systems.

Bensonwood enters into a joint development agreement with Dow Chemical Company to develop new and improved home building products through the development of new technologies related to products, structural systems and insulating systems.

December 2009
Unity Home certified LEED Platinum, Net-Zero.

Unity House earns LEED Platinum Rating for the president's house at Unity College. A year later the home and welcome center are Net-Zero certified.

September 2010
Vermont totally passive house built

Bensonwood builds a Passive House in Vermont that requires no heating system.

November 2010
Bensonwood Wall named as Top 10 Product of the Year by Building Green

Bensonwood's OBPlusWall™ is designated as one of Building Green's Top-10 Products of the Year by the editors of Environmental Building News and GreenSpec®.

November 2011
Bensonwood's Lifestyle custom home built

Bensonwood builds its first Lifestyle home featuring its award-winning, R-35 Bolus Wall™, the highest rated standard wall system available in North America.

October 2012
Unity Homes Launched

Bensonwood launches Unity Homes, an outgrowth of the Open Prototype Initiative, Unity Homes offers a wide range of architecturally diverse, ready-to-build, high-performance homes based on four distinct building platforms.

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December 2013

Tedd Benson Named Co-Chair of Vision 2020 Design+Performance Panel

Tedd will work with other members of the Vision 2020 panel to re-imagine home design and construction in the US and to map a clear path towards sustainability in residential construction by the year 2020.

Open Prototype Initiate (OPI)

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In 2006, Bensonwood collaborated with *House_n*, a Department of Architecture research group at Massachusetts Institute of Technology and other industry partners to launch the Open Prototype Initiative (OPI). The goal was "to improve homebuilding across the country and to make homes more affordable, adaptable, and environmentally friendly."

The Open Prototype Initiative planned to test its ideas through a series of four prototypes homes, each to be built in 20 days. A new house would be built every 18 months. Bensonwood led the design, prefabrication and on-site construction of the home, utilizing their Open-Built software to design the structures. The first house built by OPI, named OPEN_1, emphasized the environmentally friendly aspects of the building. As a Net-Zero home, it would produce as much energy as it consumed, ultimately reducing its environmental footprint to zero.

Kent Larson, the director of the MIT *House_n* Research Consortium, commented:

> *There are countless examples of green homes, but the industry has not developed a process to affordably mass produce these homes. The Open Prototype Initiative has developed scalable processes, such as prefabrication and the separation of core services that, when followed, enable builders to create thousands of customizable Net-Zero homes that are being made more affordable right now.*

"UNITY HOUSE"

The second prototype built in 2008. Dubbed "Unity House," the 1,930 square foot house became the on-campus home for the president of Unity College, a small school in Unity, Maine with an environmentally focused curriculum. It was to serve as a single family residence for Mitch Thomashow, the president of Unity College, and includes a classroom, as well as space for on-campus meetings and events.

Thomashow commented:

> *Unity House and the OPEN Prototype Initiative embody the principles of Unity College, including environmental leadership, sustainability, and collaborative and experiential learning. We are America's environmental college, and with Unity House we are proud to be a part of an effort to reframe America's building industry, making the mass-production of custom environmentally friendly homes a reality.*

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BOOKS by TEDD BENSON

1979 Building The Timberframe House:The Revival of a Forgotten Craft

Illustrated by Jamie Page. In collaboration with James Gruber.

Synopsis: For centuries, post-and-beam construction has proved to be one of the most durable building techniques. It is being enthusiastically revived today not only for its sturdiness but because it can be easily insulated, it is attractive, and it offers the builder the unique satisfaction of working with timbers. Building the Timberframe House is the most comprehensive manual available on the technique. In it you will find a short history, of timberframing and a fully illustrated discussion of the different kinds of joinery, assembly of timbers, and raising of the frame. There are also detailed sections on present-day design and materials, house plans, site development, foundation laying, insulation, tools and construction methods.

1988 The Timberframe Home: Design, Construction, Finishing

Synopsis: Learn to adapt the sturdy elegance of timberframe construction to the needs of modern life. Hundreds of color photos and drawings showcase the latest designs, methods, and materials.

1997 The Timberframe Home (revised)

Synopsis: The revised version showcases and catalogs the latest advances in timberframe constructions. It includes the latest advances from Bensonwood's own work such as design, engineering, joinery, wiring, plumbing and glazing.

1999 Timberframe: The Art and Craft of the Post-and-Beam Home

by Norm Abram (carpenter of *This Old House* and *New Yankee Workshop*)

Synopsis: Timberframe shows that time-honored timber construction has unlimited design possibilities. The book provides a case-by-case overview of 29 American homes across the country, cataloging the variety of styles that a timberframe home can offer, from traditional homes to contemporary classics.