

# Embody Ethos, Not Carbon

Research and Analysis of the Emerging Mass Timber Industry

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# Introduction

On November 15th, 2022, the United Nations announced that the global population had reached eight billion. At the same time, global greenhouse gas emissions continue to rise with little optimism among climate experts for meeting the 1.5 degrees Celsius target outlined in the Paris Agreement. In response, an urgency has arisen to build more affordable housing while continuing to reduce carbon emissions. Using CO2 emissions as the primary tracking metric of climate change impact, governments and corporations have begun investigating ways to reduce the embodied CO2 emissions in building construction and operations. To this end, a new type of timber construction called mass timber has captured people's attention. Mass timber has emerged as a carbon-negative material that may forever change the construction industry worldwide. As described in Marc-Antoine Laugier's 1753 image of the primitive hut, timber construction has existed for over 10,000 years, yet, mass timber and tall timber technologies are a product of contemporary innovations in robotic CNC manufacturing and fabrication.

In the Fall of 2022, thirty interviews were conducted with mass timber experts by the author of this paper as an independent project at Harvard Business School. These experts' experience and backgrounds range across the mass timber industry's disciplines, from carbon trading, timber harvesting, manufacturing, fabrication, development, construction, and biophilia. Due to the nature of mass timber as an emerging material and product in the market, this paper shares key insights to educate readers on the application, strategies, co-benefits, and investment opportunities for future ventures across the mass timber industry. While the subject matter of mass timber appears to be about development and construction, deeper investigation reveals a comprehensive story about visionary leaders working together and making strategic investments to keep their competitive edge. In contrast, while business-as-usual players remain fixated on creating conventional developments that meet the minimum financial returns, these leaders within mass timber share unique traits and a willingness to put in the extra effort to build long-term value. Such leaders are in pursuit of an ethos and believe in the added value created beyond the simple metrics of a pro forma. Throughout the thirty expert interviews, it is evident why people believe timber is a viable and promising solution.

In the following chapters, this paper will discuss mass timber as a game-changing material across existing industries and verticals while opening up new investment opportunities. Part One reviews the current state of the real estate construction industry and how developers using mass timber see the building material as a way to create differentiation within the marketplace. Part Two reveals the case for long-term value creation beyond the observable metrics in the pro forma, and a comparative case study between steel and timber building structures outlines the strategic advantages of timber. Part Three examines mass timber's sustainable benefits from carbon sequestration, forest fire reduction, and the co-benefits of creating forest economies. Part Four discusses the benefits of vertical integration from the forest floor through to fabrication and the need for secondary wood fiber markets. Finally, in Part Five, through examples of collaboration and leadership, the evolution of international building codes and fire prevention analysis is made possible.

## Part 01

### Breaking Business as Usual

“Tesla isn't selling you sustainability; they are selling you a beautiful high-tech quality product that also happens to be sustainable.” - Tim Gokhman, Founder of New Land Enterprise

#### **Present State of Built Environment**

As we learn about climate change, global businesses and industries are beginning to evolve, and the real estate industry is no different. The International Energy Agency 2022 Buildings Report reveals that “the built environment generates 40% of annual global CO2 emissions. Of those total emissions, building operations are responsible for 27% total emissions annually, while building infrastructure materials and construction components (referred to as a building’s embodied carbon) are responsible for an additional 13% annually.”<sup>1</sup> “There is currently very little investable building stock that meets ESG requirements,”<sup>2</sup> says Mike Brady, Director of Capital

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<sup>1</sup> IEA (2022), Buildings, IEA, Paris <https://www.iea.org/reports/buildings>, License: CC BY 4.0

<sup>2</sup> Mike Brady (Director Capital Markets, JLL Milwaukee) in discussion with the author, October 06 2022.

Markets at JLL Milwaukee. Standard copy-paste developments, which meet the minimum financial criteria, have filled the marketplace to meet the needs of the housing crisis. The industry is rushing to build more housing at lower costs yet, in many cases disregarding the need for long-term value creation and a sense of place. Yet a few developers and owners are betting on a future where people and firms want to differentiate themselves from cookie-cutter development and operate with a higher standard. The requirement for what makes a good investment has increasingly shifted over the last several years. Investors and tenants want to put their money into buildings that create and quantify value for themselves and the future in a way that goes beyond checking off lists for LEED Credit. Investors and developers are looking to mass timber as that differentiator due to its ability to reduce carbon, reduce construction time, and bring a new beautiful look and sensory experience to a building and community.

### **Hines T3 Product - Making the First Move**

In 2016, Hines opened their first T3 product in Minneapolis, where today Amazon has leased the building as its regional headquarters. The name T3 stands for Timber, Transit, and Technology. Steve Luthman developed the original idea for the T3 to create a product that embodied the sustainable ethos of the brand Gerry Hines founded in 1957. The Hines team worked with Michael Green and DLR group to create an authentically styled building with new finishes and modern technologies. “When you begin to study timber, you realize that it's an attractive model for embedding sustainability and sequestering carbon,”<sup>3</sup> says Tori Kerr, Managing Director in the Hines Atlanta office. “Hines has always sought to be a sustainability leader and reduce energy usage.”<sup>4</sup> Other examples include Hines's pursuit of LEED Certification, Energy Star partnerships, and Wire Scored ratings. Steve noticed a significant demand for the old warehouse-type buildings Hines owned in Minneapolis. These older assets had the “cool rustic vibe companies wanted, but with a high turnover.”<sup>5</sup> Hines's solution to this demand was the first modern mass timber office building in the United States. The T3

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<sup>3</sup> Tori Kerr (Managing Director, Hines Atlanta) in discussion with the author, October 25 2022.

<sup>4</sup> Ibid

<sup>5</sup> Ibid

design embodies the relaxed vibe of a classic wooden warehouse building but with a class-A amenity offering. To reduce cost and encourage public transportation use, the Hines team chose not to create any new parking for the 224,000 square-foot T3 in Minneapolis. Instead, Hines worked with local authorities for a variance from the city and provided parking for the building by contracting with a parking garage nearby. When leasing up T3 Atlanta, Tori's team flew the leasing brokers out to the first T3 in Minneapolis to experience it. Tori shares that "once the brokers experienced it, they got it. People have an interesting relationship with wood, she explains. Tenants feel that it's quiet, warm, tactile, and has a welcoming scent."<sup>6</sup>

T3 tenant Ian Reves is a Design Director at Interior Architects, whose office resides on the third floor of T3 Atlanta. Ian had never worked in a mass timber building before and shared that because of his T3 experience, from now on, he will always look for a timber building as his workplace. "Even if you're not an architect, you can appreciate the craft. You can see how the building is put together,"<sup>7</sup> explains Ian. "The construction poetics are much more evident than in a steel building where you can see the bolts. There is something special about the carpentry and wood in a mass timber building that is typically dry-walled over in other light frame buildings. Mass Timber has made great strides in technology and design, but now it's about how we can build a business case for it."<sup>8</sup> As a first mover, Hines did not have contemporary precedents to fall back on and no mass timber metrics to outline a specific return on investment; they believed there was a demand and that it was the right thing to do, based on their sustainable principles. Hines was right, and T3 Minneapolis traded at a cap rate of 3.8% compared to the 4.5% market standard. Today Hines has expanded its T3 product to Atlanta, Chicago, Denver, and Toronto with key tenants including Amazon, Haworth, Interior Architects, and many others.

### **The Ascent Tower - Reaching for New Heights**

In Milwaukee, the Ascent Tower by developer New Land Enterprise is now the tallest mass timber building in the world. Tim Gokhman and his team at New Land

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<sup>6</sup> Tori Kerr (Managing Director, Hines Atlanta) in discussion with the author, October 25 2022.

<sup>7</sup> Ian Reves (Design Director, Interior Architects Atlanta) in discussion with the author, November 22 2022.

<sup>8</sup> Ibid

Enterprise saw an opening in the market for something new. When they started their project, rental prices and income levels were high, with many people leaving Chicago and coming to Milwaukee to work remotely. There was nothing particularly special about the existing building stock and nothing to differentiate one building from another. The Ascent tower stands out beyond anything else in the market and was completed with “30% pre-leased.”<sup>9</sup> As of October 2022, the Ascent leasing team suggested they were two months ahead of their projected leasing schedule. Being the first of its kind, the Ascent Tower’s cost premium was going to be a bit higher, eventually, twenty-two cents additional per square foot, representing a 10-15% premium over other class A multifamily in the submarket. Still, the New Land Enterprise team believed that the health and biophilic components of the new residences would win out over anything else in the market. They were right. “Biophilia was the project's genesis, and then we had to figure it out from there,” says Tim.<sup>10</sup> The New Land Enterprise team has been committed to working hard and putting the right pieces together to make the project successful. Their team received a lot of support from the city of Milwaukee, which strongly desires to support more ESG (Environment, Social, and Governance) focused building stock. For the New Land Enterprise team, it isn't only about creating a sustainable product; it's a “hyper-amenitized”<sup>11</sup> and technological product. Tim Gokhman equates it to Tesla's ability to create beautiful, high-tech, quality product that is highly desirable, and also sustainable. This is what Mass Timber has provided for the construction industry.

### **Southstone Yards - A Shift Towards Quality**

As society has become more conscious about the climate and social responsibility, the market demand has shifted away from seeking cool aesthetics focused spaces for

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<sup>9</sup> Alexandra Lehnhard (Manager, New Land Enterprises) in discussion with the author, October 20 2022.

<sup>10</sup> Tim Gokhman (Owner, New Land Properties) in discussion with the author, October 19 2022.

<sup>11</sup> Ibid

tenants and employees to demanding products that align with ESG and sustainability goals. As a result, according to the international brokerage firm Jones Lang LaSalle, in the last two years, the number of “requests for proposals that include a sustainability requirement has risen to almost 100%.”<sup>12</sup> This nearly universal demand in the market has created a new opening for sustainability-building assets. As the new demand increases across the United States and North America, building owners and investors will look at the existing building stock in their portfolios and consider how they will adapt to this new demand. Crow Holdings out of Dallas is a private equity firm that saw this demand in the commercial office space on the rise and reacted to it in real-time. Their latest product offering in Frisco, Texas, at the Southstone Yards, is a 238,000-square-foot Mass Timber Class A Office Building. Crow Holdings traces its history back to Trammell Crow Company, founded in 1948, and attributes its long history of success and experience to a “spirit of partnership, a culture of camaraderie, and a steadfast commitment to doing business with integrity.”<sup>13</sup> In February of 2021, Jim McCaffrey joined Crow Holdings Development as a managing director and championed the company's resurgence into office development. “We don't believe the office is dead, but we must create successful smart buildings, and there shouldn't be sacrifices if we do mass timber,”<sup>14</sup> says Jim. “Our building is built for everyone looking for a class A office, we are one of the best buildings in the submarket, and we are timber.”<sup>15</sup> Though currently under construction and even before the website is up, the Crow Holdings Southstone Yards project is attracting the attention of notable firms who want a building that showcases to their shareholders and employees that they are serious about embodying a sustainable ethos and not carbon. The role of tenants and employees has become central in shaping the narrative and demand for sustainable building stock across the U.S. “What I love is that the tenants are calling for ESG,” says Jim. “We are constrained by what the market wants. The lenders and equity partners were willing to invest in our project during the pandemic because they are looking

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<sup>12</sup> Brent Robertson (Managing Director, JLL Minneapolis) in discussion with the author, October 03 2022.

<sup>13</sup> Jim McCaffrey (General Manager, Crow Holdings) in discussion with the author, September 27 2022.

<sup>14</sup> Ibid

<sup>15</sup> Ibid



ahead and believe it increases their ESG investment portfolio."<sup>16</sup> "It's impossible to know what you don't know,"<sup>17</sup> yet there is something so valuable about the role of gut instinct and moral ground, the belief that actions taken will lead to a better future and being willing to bet on it. First, movers and trailblazers may bear the costs for those who follow, but they are willing to do it because they believe it's right and will pay off in the long term.

### **Apex Plaza - Taking Ownership**

Charlottesville-based Apex energy was an early adopter of Mass Timber when they started their project for a new headquarters building in 2015. Apex is a tenant-turned-owner whose focus has been to invest in and create value for their employees and the future of clean energy. At the beginning of the project, the developers for Apex Plaza were working with an architect who designed a business-as-usual building, and the developers liked it because they wanted to build something cheaply. However, "after nine months of working with the previous design firm, it was evident that they weren't getting it."<sup>18</sup> Taking a leap of faith, Apex worked with the developer of their new headquarters to evolve their position from anchor tenant to co-owner of the new building that would eventually be designed by William McDonough + Partners. This new position provided them oversight and a say in what was being built. They spoke to their shareholders about the importance of this investment and the importance of having a headquarters building that would align with their values and ethos as a clean energy company. John Bahouth, Executive Vice President of Administration, crafted the deal, giving Apex 12.5% ownership with a lease for 1/3 of the building. "This allowed us to have some skin in the game and have a say,"<sup>19</sup> expresses John. "It also ended up being a great investment for us and our shareholders."<sup>20</sup> In addition, Hourigan, the general contractor for Apex Plaza, entered

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<sup>16</sup> Ibid

<sup>17</sup> Ibid

<sup>18</sup> John Bahouth (Exec. VP Admin., Apex Clean Energy) in discussion with the author, November 21 2022.

<sup>19</sup> Ibid

<sup>20</sup> Ibid

the deal as a partner. Apex's decision to invest with their developer in the new building gave them decision-making power and a return on their investment while creating a pathway for a building design that matched the ethos and belief of the company. This alignment of ethos with their building inspired their employees and created a safe, collaborative environment.

Apex President and CEO Mark Goodwin “is a former naval officer and helicopter pilot who served three tours in the Persian Gulf. After he retired from military service, Mark traveled through the turbine fields of Palm Springs, where he was inspired to create his life's work. He wanted to focus on clean energy as a way to keep people healthy.”<sup>21</sup> “Mark has a great moral center and we do many things with incentives,”<sup>22</sup> shares John. “If you walk or bike to work, we pay you \$100 a month, and we will pay \$6,000 to our people who buy electric vehicles. It does cost a lot more money to do what we have done, but our people are happy, our turnover is low, and we get a lot of employee referrals.”<sup>23</sup> Mark refers to their new 283,000-square-foot mass timber office building as the “water cooler.”<sup>24</sup> It's open and welcoming; more collaboration happens because people see each other. The building is filled with sunlight, and there are a lot of natural gathering spaces. People are thrilled with the brightness and sustainability. The comfort of the wood is incredible, we have one floor of leasable concrete space, and you can tell the difference between the dampness of the concrete and timber spaces. One of the significant issues of the employment world right now is how we get people back into the office. Apex has seen that their employees want to return to the office because they know it's a healthy and safe environment. “The materials cost more, the labor costs less, and the result is net. Ultimately, we get this amazingly beautiful warm wood building without paying more.”<sup>25</sup>

A paradigm shift has entered the marketplace. This new paradigm rewards firms that emphasize ingenuity to deliver returns on their investments while creating

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<sup>21</sup> Apex Clean Energy, Company - Our Story, <https://www.apexcleanenergy.com>, Accessed, November 2022

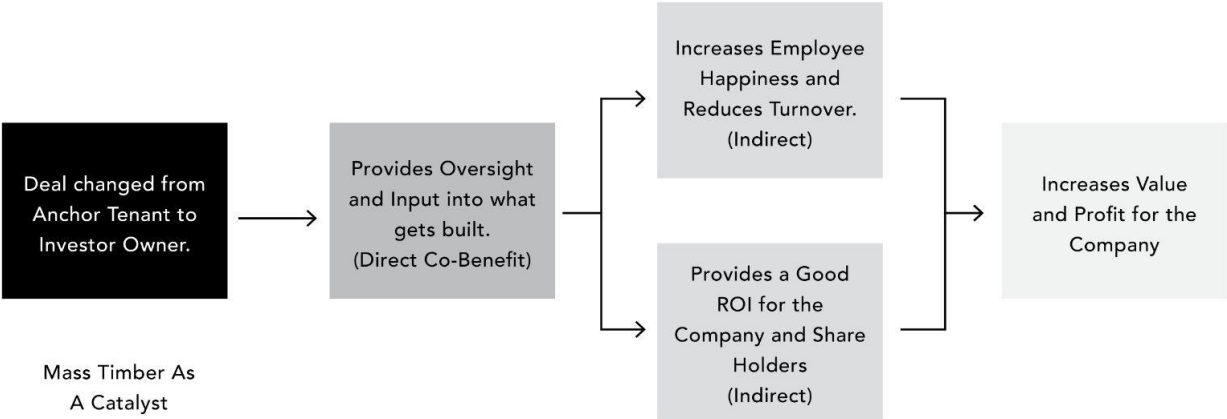
<sup>22</sup> John Bahouth (Exec. VP Admin., Apex Clean Energy) in discussion with the author, November 21 2022.

<sup>23</sup> Ibid

<sup>24</sup> Ibid

<sup>25</sup> Ibid

additional value for employees and the communities where they work and reside. The stories and examples in this chapter outline the importance of championing new ideas and working outside traditional industry boundaries. In the same way, Apex energy took an ownership stake in the development of their headquarters; leaders should be looking to make investments with multi-dimensional outcomes and co-benefits. It has always been as important for firms to invest in the communities they work within as it is to own physical assets. Yet today, we can see the evidence and outcome of such investments with a marketplace that is set up to reward these actions. Leaders must continue to be creative and look beyond the basic line checklists and spreadsheets to create long-term value beyond what can be seen in the pro forma.



**Co-Benefits Owner/Investor Model**

# Part Two

## Looking Beyond the Pro Forma

“My employer here values us and wants to create a healthy environment. In the same way, I was thinking about the kind of office building I’d want my kids to work in.” - Jim McCaffrey.

There is something extraordinary about the people working across sectors associated with Mass Timber. Everyone is passionate about their work in forest management and harvesting, manufacturing and fabrication, design and erection, or ownership and investment. The care and attention to detail are possible reasons why these buildings and products are so distinct beyond the timber itself. "Timber is an agent of disruption and change,"<sup>26</sup> says Susan Jones of atelierjones llc. "There has been a strong collaboration between the traditional industry sectors, these are extremely collaborative fields, but then you have an industry that has become so good at collaborating that things become unchangeable. So you must go outside those silos and interests to innovate and create something new. Everyone in mass timber cares about what they're doing, so you have this incredible community to collaborate with."<sup>27</sup> For Susan, Mass Timber is a vehicle for exploration, evolution, and change within the development industry.

### The Learning Curve

Just as Mass Timber has evolved the fields of design and construction, the world of mass timber real estate requires a new unique lens that looks past the standard pro forma metrics. To understand the actual value of mass timber, it is necessary to see beyond the surface of line item costs, such as installed structure per linear foot. Currently, the most significant reasons developers choose not to build with mass timber are unfamiliarity with the technology and misreading cost comparisons. As Paul Snyder of Mission Timber puts it, "some people don't build with mass timber because they can't get the numbers to work, but there isn't a reason the numbers can't work. The first

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<sup>26</sup> Susan Jones (Owner, atelierjones llc) in discussion with the author November 09 2022.

<sup>27</sup> Ibid

significant fork in the decision matrix is to build or not build a mass timber building. You cannot take a building design planned as concrete or steel and convert it; the costs will go up significantly."<sup>28</sup> An important learning from this study reveals that a commitment to mass timber as a material and product must be made from the beginning, and with this commitment follows the hard work to make it possible. The added element of the unknown may hold the largest deterrent, though increasingly, tall timber buildings are being planned and completed. Each new case study reveals that a mass timber building can be just as competitive overall as steel or concrete. However, developers and investors must support careful consideration of an intelligent programmatic design. There must be a willingness to invest more in pre-construction services to minimize time and issues on site.

The numbers alone cannot create value; within each project, teams must work hard to refine and revise each design until it meets their financial requirements and commitments. "The 10% cost premium to build with mass timber is real,"<sup>29</sup> says Alastair Reilly from William McDonough Partners; "when working with Apex, we went through many competitive bids, and all had a higher cost for timber, but the speed of construction is much faster. Mass Timber lends itself to about a 20% reduction in construction time."<sup>30</sup> As a first mover from 2015, Apex paid a higher cost premium for timber. Yet as industry knowledge and technologies have evolved within the supply chain pipeline, more recent mass timber buildings have become "cost comparative to steel."<sup>31</sup> In the same way, Jim McCaffery and the Crow Holdings team worked hard to realize their investment.. "When you get bad budget news, do you throw up your hands and quit? Or do you roll up your sleeves and talk to people to figure out how to make the project work? We dug in! We believed mass timber would have a rental premium long-term, but we didn't model that in. We wanted to capture the premium as upside."<sup>32</sup> Crow Holdings hired Gensler as executive architect for the Southstone Yards based on

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<sup>28</sup> Paul Snyder (Partner, Mission Timber) in discussion with the author, October 19 2022.

<sup>29</sup> Alastair Reilly (Design Partner, WMP) in discussion with the author, November 08 2022.

<sup>30</sup> Ibid

<sup>31</sup> Ibid

<sup>32</sup> Alastair Reilly (Design Partner, WMP) in discussion with the author, November 08 2022.

their extensive regional experience in mass timber. Dallas Gensler's Design Director, Justin Bashaw, shares that the industry standards in Dallas are so established and expected. "I think mass timber has allowed us to reinvent the wheel; you don't have to have perimeter beams, and you can shorten the floor-to-floor with the same amount of daylight. I love all the Biophilia and connection to nature, but I like shaking up the wheel too. Once these buildings get leased up with triple net lease rates, the other developers will say, " OK, me next."<sup>33</sup>

Experience and education are currently two of the largest bottlenecks for mass timber projects. Mass timber building products and price points are dynamic. Cost premiums vary dramatically based on wood type, logistics, building type, and sub-market. According to Mike Brady from JLL, "A majority of lenders turned down the opportunity to capitalize the Ascent project primarily due to the higher cost basis and relatively new building material."<sup>34</sup> While the installed structure for mass timber comes in higher, it takes a unique perspective and willingness to understand that the wood is doing many things at once. It's the structure of the building, the finish material for surfaces, and fireproofing all in one installed element, all while reducing construction waste, time, and carbon emissions. Yet, unfortunately, misinformation is fueled by resistance to timber as a structural replacement for steel and concrete. At the same time, "innovations in wood fiber threaten the plastics industry, and wood pellets threaten natural gas as an energy source."<sup>35</sup> Current issues and voices against the rise of mass timber are not fights about logging and environmentalism; instead, it's about where the dollars are flowing and to which industry they are flowing.

Jeff Spiritos of Spiritos Properties has been working in New Haven, CT, with architects Gray Organschi to build two mass timber developments, including affordable housing with passive house standards and projects that utilize existing building stock through adaptive reuse. "Mass timber enables affordable housing to be more durable, healthier, and sustainable. People say Mass Timber is too expensive and too new, but

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<sup>33</sup> Justin Bashaw (Studio Director, Gensler) in discussion with the author, November 02 2022.

<sup>34</sup> Mike Brady (Director Capital Markets, JLL Milwaukee) in discussion with the author, October 06 2022.

<sup>35</sup> Katie Fernholz (President/CEO, Dovetail Partners Inc.) in discussion with the author, October 25 2022.

that's because they don't understand it,"<sup>36</sup> says Jeff. "Many developers are agnostic about what they build as long as it meets financial criteria, and many mediocre buildings get built."<sup>37</sup> Jeff believes policy is a key driver in making these projects possible. "It's important to care about what you're doing and put effort into it. You have to be willing to put in the time."<sup>38</sup> Jeff recommends that developers designate one person in the company full-time who researches, models, and advances the team's timber product knowledge through learned best practices. Jeff and his team are working with the New England Forestry Foundation and received funding through the USDA's Climate-Smart Commodities initiative to connect New England private forest owners with sustainably harvested timber products to mass timber building focused on affordable housing.

To combat the lack of knowledge in the marketplace, the United States Forest Service has been working with municipalities to create grant programs. An active example of this can be seen in the City of Boston, run by the Boston Planning and Development Agency, whose timber accelerator focuses on funding projects and research bi-annually that will contribute to innovation and education within sectors across the mass timber industry. These grants are intended to help buffer the added cost of the learning curve and foster innovation. Kevin Naranjo of the U.S. Forest Service says they are always asking, "will this project help lead to better forest management? We are trying to stimulate wood product markets and looking for opportunities to help grow a market."<sup>39</sup> Profitable forests help fund better forest management and enable the market growth of mass timber as a primary strategy for reducing the amount of embodied carbon in building construction. The City of Boston, and many other Municipalities, are strategizing around 2030 and 2050 emissions reduction targets. In the next 20 years, Boston's emissions reduction strategy includes a 50% reduction of operational carbon and a 50% reduction of embodied emissions from construction. "Our goals for the city are more holistic in terms of using local materials and having a local

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<sup>36</sup> Jeff Spiritos (Owner, Spiritos Properties) in discussion with the author, October 14 2022.

<sup>37</sup> Ibid

<sup>38</sup> Ibid

<sup>39</sup> Kevin Naranjo (Wood Innovations Manager, USFS) in discussion with the author, October 19 2022.

impact. Such as harvesting timber locally from forests and supporting new businesses,"<sup>40</sup> says John Dalzell, the BPDA's Senior Architect. Timber is a way to introduce a negative carbon component into the equation, and the City of Boston embraces it.

### **A Comparative Case Study**

In a recent round of BPDA-awarded grants, a comparative analysis study was proposed by Elkus Manfredi and HYM Investment Group, which is currently building the Suffolk Downs development in Northeast Boston. With the support of the grant, the team of Elkus Manfredi, Thornton Tomasetti, and John Moriarty Associates embarked on a three months study for two building typologies at the same site location at Lot B16 in Suffolk Downs, using the same conditions and requirements. One building design would be steel, and another would be timber. The project's goal was "to evaluate the *value* of Mass Timber for residential block B16 and future development at Suffolk Downs."<sup>41</sup> Ultimately, the process revealed fundamental differences between the two construction methods. The mass timber building product attracted HYM's attention as a differentiator for building products within the master plan and creating a new building class within the development. Over three months, the team worked to evaluate the feasibility of architectural design, structure erection, and cost estimation and compared their findings against other timber precedents in the midwest and northwest. As the project lead Tim Talum notes, "the biggest issue arises when looking at structure cost, but this study revealed that there are other variables beyond this that need to be considered."<sup>42</sup>

Both schemes for residential block B16 share the same two-story above-grade parking podium framed with structural steel and employ slab-on-deck construction. Both schemes are designed to be eight stories with 11'-2" typical floor-to-floor height

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<sup>40</sup> John Dalzell (Senior Architect, BPDA) in discussion with the author, November 02 2022.

<sup>41</sup> Tim Talum and Elkus Manfredi Architects Ltd, "BOSTON MASS TIMBER ACCELERATOR Suffolk Downs Building B16," (Elkus Manfredi Architects Ltd, 2022), page 6

<sup>42</sup> Tim Talum (Project Manager, Elkus Manfredi Architects) in discussion with the author, October 14 2022.



and 196 of the same residential unit mix. The project assumes the building will be Type IV B based on the new types outlined in the 10th Edition International Building Code of 2021. Additionally, the study estimates a construction start date between 2025 and 2026 and assumes the adoption of the 11th Edition of the building code based on IBC 2024, allowing the exposure of > 25% of wood structures in Type IV B. While this study's primary focus was construction cost and decarbonization, it's not surprising that the timber structure required a higher cost premium and that the steel structure produced more carbon. Yet the important takeaway from the study was how much cost premium and how much carbon. In their study, the steel structure building comes in at \$18,546,805, or \$550 per square foot, compared to the timber structure building, which came in at \$20,256,189, or \$557 per square foot. The difference between the two building typologies comes to \$1,709,384, \$7 per square foot, or an additional cost per unit of \$8,719. Based on these comparisons, careful consideration would need to be made as to whether a project such as this will be a particularly unique differentiator in the submarket and whether the roughly \$9k additional per unit and this building would be absorbed according to market conditions.

For some developers and investors looking at longer-term horizons and ESG investable portfolios, the 10% premium on the front end is worth the investment premium to create a low-carbon product where others do not already exist. The Suffolk Downs Study reveals that the most significant difference between the two building methods is the embodied carbon reduction component of the mass timber structure through the avoidance of new carbon produced by the use of steel and the sequestration of carbon within the timber. The study found that using steel construction for this building and site would produce 4,430 metric tons of embodied CO<sub>2</sub>e compared with 2,550 metric tons of embodied CO<sub>2</sub>e if building with mass timber. According to this calculation, the mass timber structure provides a 40% reduction in avoided carbon and the additional sequestration of 1,970 metric tons of biogenic carbon within the structure's timber. The 1,880 metric tons of carbon dioxide emissions avoided is equal to the carbon sequestered by 2,225 acres of U.S. Forests in one year. Tim says, "Avoided

Carbon is the key incentive for using the timber."<sup>43</sup> Since the Suffolk Downs study's completion in June of 2022, many new mass timber projects came to market and are now occupied. Thus, with each newly completed project, a steady flow of metrics has verified the Suffolk Downs study's findings as accurate.

### **Key Insights from Research Interviews**

"Timber goes up very fast." - Tori Kerr, Managing Director of Hines Atlanta,

From September 2022 to November 2022, the author of this paper conducted more than twenty interviews with developers, builders, and architects, experienced in building mass timber projects. Each interview revealed similar variables that describe an average overall project cost increase of 10% and a carbon reduction of 50%. In addition, cost premiums to build similar-sized developments of mass timber up to seven stories ranged by region from \$3 to \$7 per square foot. In each case, this premium was absorbed by an increase in lease premiums or increased efficiencies in owner operations. "The costs are always changing,"<sup>44</sup> says Jim McCaffrey. "Everyone wants you to give a simple answer to the cost premium, but this is a real challenge because it's only relevant for a short period and very regional."<sup>45</sup>

Mass timber costs have continued to come down as competition, and more efficient deliveries have been created through vertical integrations. Another divergence from traditional project delivery is the time frame when funds are being spent. Due to the lead time for timber harvest and fabrication processes, a more significant investment must be paid upfront in pre-construction. As Paul Snyder of Mission Timber describes it, "Pre-Construction work is more extensive. Timber needs to be committed toward the front end of a project; otherwise, the lead time becomes too long. From the time of awarding the timber till its arrival on site can be nine months to a year lead time. Timber is the critical path."<sup>46</sup> Spending in pre-construction is not in addition to the construction budget but rather a shift of funds from the construction budget to the

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<sup>43</sup> Tim Talum (Project Manager, Elkus Manfredi Architects) in discussion with the author, October 14 2022.

<sup>44</sup> Jim McCaffrey (General Manager, Crow Holdings) in discussion with the author, September 27 2022.

<sup>45</sup> Jim McCaffrey (General Manager, Crow Holdings) in discussion with the author, September 27 2022.

<sup>46</sup> Paul Snyder (Partner, Mission Timber) in discussion with the author, October 19 2022.

pre-construction budget. This investment in pre-construction reduces mistakes in the field during erection and accelerates the construction process. Reports from interviews revealed that an increase of 10-20% in overall construction speed could be achieved. In addition, the mass timber erection could be completed with a team of 6-12 people over 16 weeks, depending on the timber volume and scale of the build. As Mike Brady of JLL describes it, "Mass timber's prefabrication model results in significantly less time and labor to complete a project. The result is a saving in construction interest, labor costs, and change orders, compared to traditional construction."<sup>47</sup> According to John Bahouth, "a twelve-man team assembled the timber structure for 283,000 square-foot Apex Plaza building in 16 weeks. The joints aligned perfectly with very little fieldwork,"<sup>48</sup> says John. The overall speed and efficiencies of using Mass Timber can be attributed to an array of common factors described in interviews. These include eliminations, reductions, and increased efficiencies such as

- **Eliminations:**

- Elimination of Applied Fire Proofing for Structure
  - Elimination of additional labor cost
  - Elimination of additional materials
- Elimination of Waste from Structure
- Elimination of Perimeter Beams

- **Reductions:**

- Reduced foundation sizes on site (possible 20% reduction)
  - Reduced labor costs
  - Reduced waste from concrete formwork
  - Reduced costs from hauling
- Reduced crane time on site
  - Reduced staging

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<sup>47</sup> Mike Brady (Director Capital Markets, JLL Milwaukee) in discussion with the author, October 06 2022.

<sup>48</sup> John Bahouth (Exec. VP Admin., Apex Clean Energy) in discussion with the author, November 21 2022.

- Reduced Drywall and Framing
  - Reduced labor costs
  - Reduced material costs
- Reduced or Removal of Applied Fire Proofing
  - Reduced labor costs
  - Reduced material costs
- Reduced General Conditions
- Reduced builders' insurance coverage period
- Reduced construction loan interest period
- Reduced change orders
- Reduced headcount on-site
  - Reduced site liability
  - Reduced human error during construction
- Reduced overall construction traffic (possible 90% reduction)
  
- **Increased Efficiencies:**
  - Increased efficiency for:
    - project management
    - delivery and sequencing of materials on site
  
- **See Appendix I for complete project phase description of lessons learned**

"Despite challenges and the learning curve, Mass Timber is lighter, faster, more precise, and requires less on-site labor." - Tim Gokhman

These shared learnings and insights provide clear evidence that with the right team and education, mass timber is an affordable building product that significantly reduces the embodied carbon of buildings and creates a better biophilic environment for those inside while increasing capitalization. Timber becomes most cost-effective if a

building can achieve a certain height and rental premium based on the combination of density and efficiency of scale. As in all real estate, there is a clear relationship between density, land value, and project capitalization. Yet, for mass timber, these factors are amplified, and important to have either lower land costs or higher densities to help offset construction premiums. When embarking on their first mass timber building, Mortenson Construction chose Tempe, AZ, based on the lower costs of land and rental premiums in combination with adjacency to ASU, where young progressive talent would be seeking jobs in firms with climate-conscious environments. Siting was essential. The team found a site that was previously entitled to be a typical five-story concrete and steel office building. "The land was evaluated based on a five-story project, which meant that doing a CLT mass timber building was attainable,"<sup>49</sup> says George Forristall, Vice President of Real Estate for Mortenson. The team believed they could lease up quickly with their unique one-of-a-kind product offering and uncompromising design quality.

"We were thinking - how do you bring an office during COVID into a market where people work from home? Our bet proved right as we were one of the only projects to move forward in the middle of COVID."<sup>50</sup> Initially set into motion in 2019, it was one of Mortenson's only projects able to continue building through the pandemic. Mortenson's unique choice in the design phase was to increase the smaller twenty-foot grids used for mass timber and push the structure to achieve a more commercial office grid standard of thirty feet. The result was enormous beam sizes so extremely deep that it enabled the design team to create a raised plenum for air delivery and remove the ductwork from the building. The decision to achieve such a sizeable timber structure grid solved issues related to smaller leasing bays, and removed medium-pressure duct loops often left exposed. However, the larger timber beam sizes dramatically increased the overall timber volume for the build and, thus, increased the weight for logistics and installation on-site resulting in slower than-usual build times. As the first mass timber project in Tempe, Mortenson's team spent considerable time working with the city and

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<sup>49</sup> George Forristall (RE Vice President for Mortenson) in discussion with the author, November 10 2022.

<sup>50</sup> Ibid

fire department to review every joint condition of the building. "A lot of time was taken to educate the city around what mass timber vs. typical timber frame construction is," says the project executive and manager Chase Gibbs. "We spent much time doing char tests and testing joints to meet the code. I followed the project from beginning to end."<sup>51</sup>

Over time, the costs to build with mass timber will continue to come down as cities, insurance companies, and fire departments become more educated and understand the environmental value of mass timber. Previously, applying for tax credits, subsidies, grants, and variances was necessary to make mass timber affordable; that's only sometimes true as the industry is learning and maturing. If working with people who know timber, building these projects without the subsidies and grants for lower costs is very doable. For example, the new Heartwood Residences project designed by Atelier Jones in the Northwest region of the U.S. is focused on creating low-carbon, affordable workforce housing. It is significant that their project is being built without credits, subsidies, or variances. "We built Heartwood with no special Susan Clauses and no special favors,"<sup>52</sup> says Susan. Atelier Jones has even taken Heartwood a step further by removing the standard steel joints used for mass timber and has designed all wood joinery for disassembly and additional carbon reduction.

While much of the focus with mass timber buildings is on construction, it is, in fact, the design process which is ever more critical than a typical commercial project. Serious design intelligence and experience are needed to make the critical decisions that will reduce errors and create cost efficiencies. Having the proper grid layouts and reducing fire code requirements by efficiently positioning programs based on occupancy type are just a few examples of decisions that will reduce the timber volume in a build and, in return, lower the overall project costs. Reducing the timber volume will reduce costs through the entire critical path of the timber. Fewer trees will need to be harvested, less lumber will need to be transported, smaller members manufactured, and less weight will need to be managed by construction crews, all leading to lower costs throughout the project. In addition, reducing the volume and number of trees

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<sup>51</sup> Chase Gibbs (Project Associate, Mortenson) in discussion with the author, November 10 2022.

<sup>52</sup> Susan Jones (Owner, atelierjones llc) in discussion with the author, November 09 2022.

required for the building is a way to practice more responsible stewardship of the forests. Reducing the extractive intensity of buildings regardless the primary building material, should be a key aspect of the design process and conceptual thinking from the outset.

The feasibility of the mass timber pro forma is genuinely about being creative with the tools and information at hand. There is a unique common trait in each of the developers interviewed that enabled them to see beyond the initial metrics, envision something different, and work creatively with their partners to make it feasible. Beyond all else, this group understood the return on investment in creating value through innovation, quality, and amenities. In the words of Lisa Podesto, timber specialist and Senior Business Development Manager for Lendlease, "Think about this, you're in construction management, and you discover a new building technology that is fast, easy to erect, and predictable. You now have a component-based supply chain, a set Schedule, and reduced crane time,"<sup>53</sup> says Lisa. "There are so many other unitized components that work so well with mass timber. This isn't fuzzy B.S. that designers are pushing on you. Typically with most things, there is a Yin and Yang, and you need to compromise or give something up, but with Mass timber, you don't have to give anything up."<sup>54</sup>

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<sup>53</sup> Lisa Podesto (Senior BizDev Manager, LendLease) in discussion with the author, October 19 2022.

<sup>54</sup> Lisa Podesto (Senior BizDev Manager, LendLease) in discussion with the author, October 19 2022.

# Part 03

## Creating a More Sustainable Future

"Working in mass timber opened up a huge world of forestry." - Susan Jones, Atelier Jones

### Talking Carbon

Mass Timber is a multi-dimensional negative emissions structural building material. When looking at a mass timber building, initial reactions may be that it's warm, beautiful, structural, and natural. Yet, behind all of it is a complex story leading from the forest floor to the carbon markets. A mass timber building plays a vital role in sequestering biogenic carbon within trees before they decay, avoiding fossil fuel carbon by omitting steel and concrete, and reducing fugitive emissions from forest fires through fostering profitability for better forest management. The co-benefits of building with mass timber are numerous and help to bring equilibrium to a system that has grown out of balance. Today, "global society burns 10GtC (giga tons of carbon)"<sup>55</sup> per year, with global CO<sub>2</sub> emissions still rising. According to the Keeling Curve created by Ralph Keeling, in the last 30 years, we have increased the parts per million of carbon in the atmosphere by 25%, currently 420ppm, almost double pre-industrial levels, and no sign of slowing. With an increasing global population, more construction is necessary to meet demands, yet our current "construction practices account for 40% of the embodied and operational carbon footprint."<sup>56</sup> While new technologies are being developed, a change to bio-based materials for construction is necessary as "improvements in carbon reduction per ton of material are thought to be limited to "24% for steel and 13% for cement."<sup>57</sup> "Timber construction can have significant benefits in reducing the embodied carbon footprint of buildings. If sourced from sustainably managed forests and produced locally, these building components can store more carbon than is emitted in

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<sup>55</sup> Daniel Schrag "Environmental Science Professor and Director the Harvard Center for the Environment, Director of the Science, Technology, and Public Policy Program, HKS" The Great Anthropogenic Experiment: The Carbon Cycle Class Discussion, September 13th, 2022, Factually of Arts and Sciences at Harvard, Boston, MA

<sup>56</sup> IEA (2022), Buildings, IEA, Paris <https://www.iea.org/reports/buildings>, License: CC BY 4.0

<sup>57</sup> Müller, D. B. et al. Carbon emissions of infrastructure development. *Environ. Sci. Technol.* 47, 11739–11746 (2013).



their production.”<sup>58</sup> Mass Timber plays an important role in reducing carbon in two key ways. First, timber sequesters carbon as it grows through photosynthesis, and when it’s harvested, that biogenic carbon is captured in the timber until it burns or decays. Secondly, using mass timber removes, or avoids, the carbon that would have otherwise been added to the atmosphere by creating steel or concrete structures. Because of timber’s carbon benefits, cities like Boston are beginning to change building codes and create carbon zoning to promote timber construction. Mass Timber is a key strategy that the city of Boston uses to reduce embodied carbon in buildings. Senior Architect for the City John Dalzell shares that “Boston’s carbon plan is focused on transport, infrastructure, and buildings. In the first 20 years, the reduction of carbon comes from 50% reduced operations and 50% from construction. The goal is to both Minimize and Mitigate Embodied Carbon using local materials and having a local impact, such as harvesting timber locally from forests.”<sup>59</sup> Alan Organschi, who is also working with Developer Jeff Spiritos, recently released research entitled *Buildings as a Global Carbon Sink* outlining how “the fraction of future urban buildings designed with timber and their floor area per capita will determine the rate of carbon transfer from forests and total storage of carbon in those buildings. The total carbon stored over thirty years would sum up to 2–20 Gt in the 90% timber scenario, 1–11 Gt in the 50% timber scenario, and 0.25–2.3 Gt in the 10% timber scenario.”<sup>60</sup> While a 90% timber scenario would be difficult to achieve, it is important to identify the possibilities for carbon sequestration with these methodologies. The most significant driving force behind mass timber investment has been the material’s ability to reduce the embodied carbon within buildings, thus creating new investable assets that meet ESG reporting requirements. “Today, many clients are coming to us for the carbon reduction story.”<sup>61</sup> says Alastair

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<sup>58</sup> King, B. (2018). *The New Carbon Architecture, Building to Cool the Climate*. Gabriola Island, BC Canada: New Society Publishers.; and Davies, B., Diaz, D., & Loreno, S. (2017). *Climate Smart Forestry for a Carbon-Constrained World Carbon storage and timber production under alternative management strategies in the Pacific Northwest*. September 12, 2017, Ecotrust, Portland, OR.

<sup>59</sup> John Dalzell (Senior Architect, BPDA) in discussion with the author, November 02 2022.

<sup>60</sup> Churkina, G., Organschi, A., Reyer, C.P.O. et al. *Buildings as a global carbon sink*. *Nat Sustain* 3, 269–276 (2020). <https://doi.org/10.1038/s41893-019-0462-4>

<sup>61</sup> Alastair Reilly (Design Partner, WMP) in discussion with the author, November 08 2022.

Reilly at WD+P, who has built a name for their firm in sustainability, life cycle assessment, and mass timber buildings.

Google, a major tech giant, has made serious commitments toward carbon neutrality and to reduce its embodied carbon footprint in construction by 50%. Google is taking significant steps to achieve this, and “mass timber is a key strategy for its success; CLT is now the baseline building material for the company.”<sup>62</sup> “Google is committed to lowering its carbon footprint; they want to know where all its material is coming from. They are willing to put their money where their mouth is and pay more for sustainable local materials. They have a carbon accounting guide and are now thinking about carbon storage. They are trying to be disrupters and motivated by a culture of sustainability. Google approaches timber through two perspectives, the first is industry disruption through construction technology, and the second is about creating market volume to open new pipelines.”<sup>63</sup> For Google and other companies investing in mass timber, the Carbon story of timber can help them address Scope One, Two, and Three. In Scope One and Two, Biogenic fuel becomes a source of energy in some locations and removes the need for steel and concrete processes. Still, in Scope Three, Mass Timber and Secondary Timber products are where the large gains are made for embodied carbon in products. Scope 3 emissions reduction asks firms and users to consider material acquisitions, processing, distribution, usage, and end-of-life circularity. In each case, timber has an answer as an organic and circular material able to be used throughout the energy, structure, and finish spectrums. In addition to Green House Gas Scope Reduction, ESG standards are another aspect where mass timber can play a large role and attract significant investment.

ESG is the acronym for Environmental, Social, and Governance standards used for reporting. Within each category, some subcategories outline specific requirements and goals. Mass Timber, byproducts, and forestry practices needed to support mass timber fulfill many ESG subcategories, including

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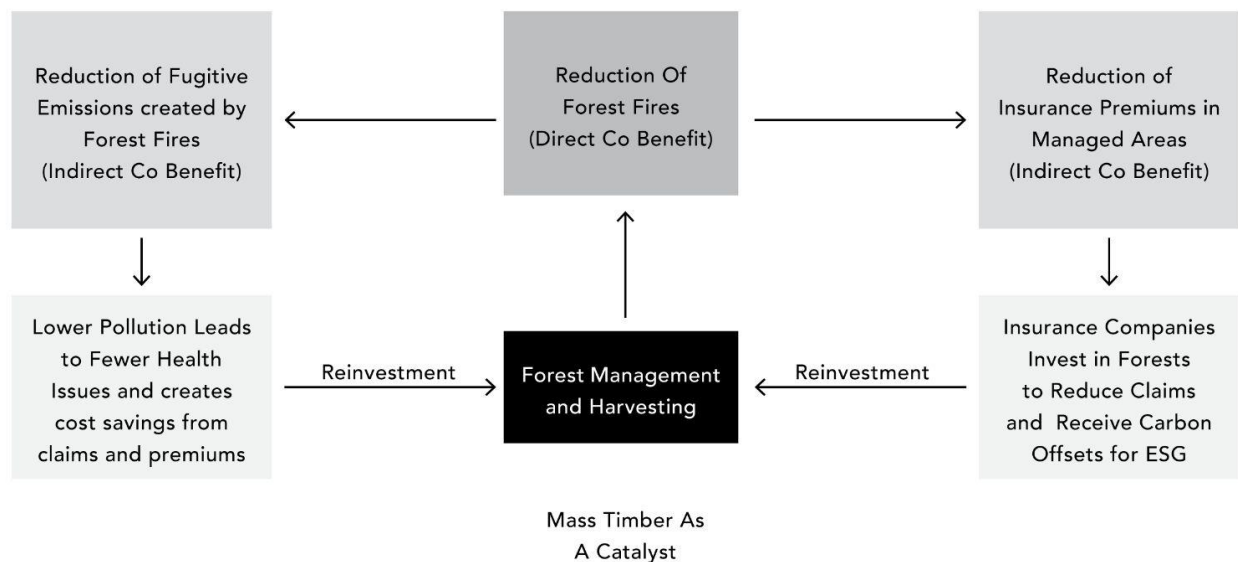
<sup>62</sup> Ibid

<sup>63</sup> Lisa Podesto (Senior BizDev Manager, LendLease) in discussion with the author, October 19 2022.

- **Environmental Pillar**
  - Climate Change
    - Carbon Emissions
    - Product Carbon Footprint
    - Financing Environmental Impact
    - Climate Change Vulnerability
  - Natural Capital
    - Biodiversity & Land Use
    - Raw Materials Sourcing
  - Pollution & Waste
    - Toxic Emissions Waste
    - Packaging Material & Waste
  - Environmental Opportunities
    - Green Building
    - Renewable Energy
- **Social Pillar**
  - Human Capital
    - Supply Chain Labor
  - Product Liability
    - Responsible Investment
  - Stakeholder Opposition
    - Controversial Sourcing
- **Governance Pillar**
  - Corporate Behavior
    - Business Ethics

Because of the ESG benefits embedded in mass timber buildings, interviewees for this paper noted that investors and banks were willing to put money into long term mass timber investment horizons to build out their physical asset portfolios with sustainable products. Mass timber brings with it the additional effect of making timber

more valuable, thus making forests more valuable. Helping to make forests economically viable means there is more money for forest management afforestation (creating more forests), the reduction of wildfires, and the avoided carbon from those fires while keeping forests as forests. “Mass Timber helps the forests, helps our built environments, and economically incentivizes the right decisions. There aren't any yeah-buts.”<sup>64</sup> say Lisa Podesto



### Co-Benefits Model of Economical Forests

#### Cutting Trees to Save Trees

In the last decade, the United States has seen Mega fires grow and ignite more frequently than ever. “Recent record-breaking events, unprecedented losses, and escalating suppression costs have raised concerns over a new normal of increased fire activity and the onset of an era of mega-fires. In the contiguous United States, burning between 2011 and 2016 resulted in ~3.5 billion USD of property and crop damage, ~12.4

<sup>64</sup> Lisa Podesto (Senior BizDev Manager, LendLease) in discussion with the author, October 19 2022.

billion USD in suppression efforts, and the loss of 162 lives."<sup>65</sup> A critical factor related to the increase in Mega Fires has been attributed to human interference with the natural systems of ecology in a warming climate over the last 150 years. "Historical records of forests provide visual and narrative evidence for a patchwork system of forestry spaced out and divided into clusters by an extensive "patchy" network of grasslands. How the forest grew shaped how forests behaved"<sup>66</sup>—the ecosystem curated between the different forest types and grasslands. The patchwork of forests and grasslands previously helped maintain and manage the smaller fires, while burnt patches would stop out-of-control fires and allow forests to remain as forests. "In 1905, the U.S. Forest Service was founded, and in 1910, the fire service was tasked with putting out fires in the United States."<sup>67</sup> As a result, "the Forest Service has effectively put out 95% of forest fires"<sup>68</sup> for the last hundred years until now. From 1910 onward, fire suppression, not natural fires, shaped our forests. Today, we see dramatic fires due to human interference in the natural ecosystem and rising temperatures. "Forests in the U.S. have become a dense carpet of similar tree species, ages, and sizes. As a result, fires not only move easily but so do diseases and infestations."<sup>69</sup> After a century without natural patchwork fires, dead branches, and dead trees fall to the forest floor, creating layers of dry powder. Among all of it, we have been building homes where insurance companies have stopped insuring. "I love to take people through Vaagen Timbers' forests; some are public, and some are private, and you can see how they are managed,"<sup>70</sup> says Josh Cabot, an architect, engineer, and mass timber expert at SERA Architects. "The private forests are much better managed. It's more likely that wildfires will happen and spread faster on public land since they let the undergrowth overgrow."<sup>71</sup>

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<sup>65</sup> Iglesias, Virginia, A Balch, Jennifer K., A Travis, William R., U.S. fires became larger, more frequent, and more widespread in the 2000s, 2022 Science Advances, eabc0020

<sup>66</sup> Paul Hessburg, "Why wildfires have gotten worse -- and what we can do about it," TedTalk, Nov 29, 2017, <https://www.youtube.com/watch?v=O6Vayv9FCLM>.

<sup>67</sup> Gerald W. Williams, Ph.D., "THE USDA FOREST SERVICE—The First Century", USDA Forest Service, July 2000

<sup>68</sup> Paul Hessburg, "Why wildfires have gotten worse -- and what we can do about it," TedTalk, Nov 29, 2017, <https://www.youtube.com/watch?v=O6Vayv9FCLM>.

<sup>69</sup> Ibid

<sup>70</sup> Josh Cabot (Senior Associate, SERA Architects) in discussion with the author, November 09 2022.

<sup>71</sup> Ibid

Understanding the current issues we face with our forests in North America is essential to understanding mass timber's vital role in this broader picture. According to John Dalzell, 50% of the funding for Mass Timber Grants from BPDA comes from the U.S. Forest Service. "It sounds funny, but we have to cut trees to save trees,"<sup>72</sup> says Kevin Naranjo, the Wood Innovations Lead for the U.S. Forest Service. Forests can become too dense, and not all forests are the same. Forests need to be managed, and sustainable harvesting is one of the primary ways to do this and can lead to better biodiversity. It's not about stepping back and letting the forest do whatever, but much closer to the act of Gardening. Forests are more populated today than in 1900 in the United States, and there is a difference between sustainable and healthy ecological forests. Kevin explains, "at least with the national forests, we focus on forest health. And to do that we cut trees. We are trying to return to knowledge that existed over 100 years ago."<sup>73</sup> Kevin is referring to the knowledge called Silviculture. Forest science, research, and place-based knowledge are continuing to develop and inform the practice of forestry in the U.S.

### **Forest Economics**

"The basic mode of forest management is to decide which trees to keep. But, then, we have to roll up our sleeves and be there day in and day out working with the land,"<sup>74</sup> says Katie Fernholz, President and CEO of Dovetail Partners, a 501(c)(3) nonprofit corporation founded in 2003 as an environmental think-tank. In 2019, Katie was named the President and CEO and continued to carry on Dovetail's legacy as a trusted source for environmental information. Dovetail provides authoritative information about the impacts and trade-offs of environmental management, including consumption choices, land use decisions, and policy alternatives. In forest gardening and curation, Katie describes how some foresters believe it's essential to never cut the tallest tree in the forest. The tallest trees set the bar for all others, stretching for the light. However, you cannot only thin from below either; "for example, Spruce can grow in the shade, but

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<sup>72</sup> Kevin Naranjo (Wood Innovations Manager, USFS) in discussion with the author, October 19 2022.

<sup>73</sup> Ibid

<sup>74</sup> Katie Fernholz (President/CEO, Dovetail Partners Inc.) in discussion with the author, October 25 2022.

Oak needs light, so if you only thin from below, you don't let the light in, and one type of tree becomes dominant."<sup>75</sup> Therefore, taking out co-dominant trees in a curated way can create openings to let light in and manage the biodiversity. This process of curated tree harvesting is fundamentally different from pulling stumps and planting corn. The most important thing is to keep forests as forests. "The definition of a sustainable forest could be societal, cultural, or even legal, but the important thing is to ask the question about what is sustainable for a specific community,"<sup>76</sup> says Katie. The biggest threat to a forest comes from humans wanting to use the land for something other than forests. Keeping forests economically viable helps keep them healthy and affordable to manage. "We often need to harvest trees to make trees and forests economical. There is real competition, and they compete based on economics. Landowners will look at the value of timber vs. corn."<sup>77</sup> Kevin Naranjo shares a very similar sentiment with Katie and is working to keep forests profitable while growing markets for innovations in wood products. "The forest service wants to invest in wood products and invest in forests again. So we are trying to stimulate wood product markets and look for opportunities to help grow a market."<sup>78</sup>

"We think a lot about how to make forests economically viable. We want to help forest owners make the forest profitable through tax offsets or forest management practices,"<sup>79</sup> Says Marissa Spence, Forest Manager at Climate Action Reserve. MCAR is a nonprofit organization focused on creating transparency in the carbon trading market and developing new methodologies for carbon credit development. Most carbon credits are generated in the voluntary carbon markets, and there are no requirements to purchase them. Because voluntary credits are more like a consumer good, there has to be a real tangible value assigned to them that people can understand and that shareholders will believe in if companies purchase them. "Forestry credits are natural credit solutions. These are popular because they are tangible for the public to

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<sup>75</sup> Katie Fernholz (President/CEO, Dovetail Partners Inc.) in discussion with the author, October 25 2022.

<sup>76</sup> Ibid

<sup>77</sup> Ibid

<sup>78</sup> Kevin Naranjo (Wood Innovations Manager, USFS) in discussion with the author, October 19 2022.

<sup>79</sup> Marissa Spence (Manager, Climate Action Reserve) in discussion with the author, December 07 2022.

understand. They are not just offsetting; they invest in natural landscapes and co-benefits such as biodiversity, clean water, small farmers and ranchers.”<sup>80</sup> As 40% of forest land in the United States is owned privately, it’s essential to help smaller farmers and land owners afford the forest maintenance, management, harvesting, and taxes associated with keeping forests as forests. “Working with the private landowners is awesome; it’s great to hear their stories and think about how the projects will last for generations.”<sup>81</sup> says Kelly Martichuski, Forest Data Collection Manager at Forest Carbon Works. If credits are not perceived as high quality, then the market won’t buy them. “There is a preference for what we call removal credits (removing carbon) rather than credits for avoided removals (removing trees). It’s important to understand whether the actions being taken to make the credits would have been taken or not if the credits did not exist. If a forest was already going to grow, then we need to establish what the additionality is.”<sup>82</sup> For example, how much more is growing because of better management from the fund provided by the credits? “There are five factors for developing good carbon credits: Tangibility, Additionality, Verifiability, Permanence, and Measurability.”<sup>83</sup>

Moving beyond the forests; new opportunities are coming to the forefront for mass timber assets to receive carbon credits for the sequestered carbon in the harvested timber used to create the building. Verra, the carbon trading standards and reporting group, is working on a project to develop carbon credits for mass timber carbon removals with South Pole, the credit developer. While currently, carbon credits for mass timber physical assets do not exist, it is likely that they will further amplify the value of mass timber projects to owners and society in the near future. The basis for the credits comes from the idea of using a “removal theory.” Carbon is being removed from the air at both the timber source and steel and concrete production site through avoidance. (This is a difference avoidance from timber avoidance, which refers to the avoidance of cutting trees.) Tangibility for mass timber carbon credits is understood through

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<sup>80</sup> Marissa Spence (Manager, Climate Action Reserve) in discussion with the author, December 07 2022.

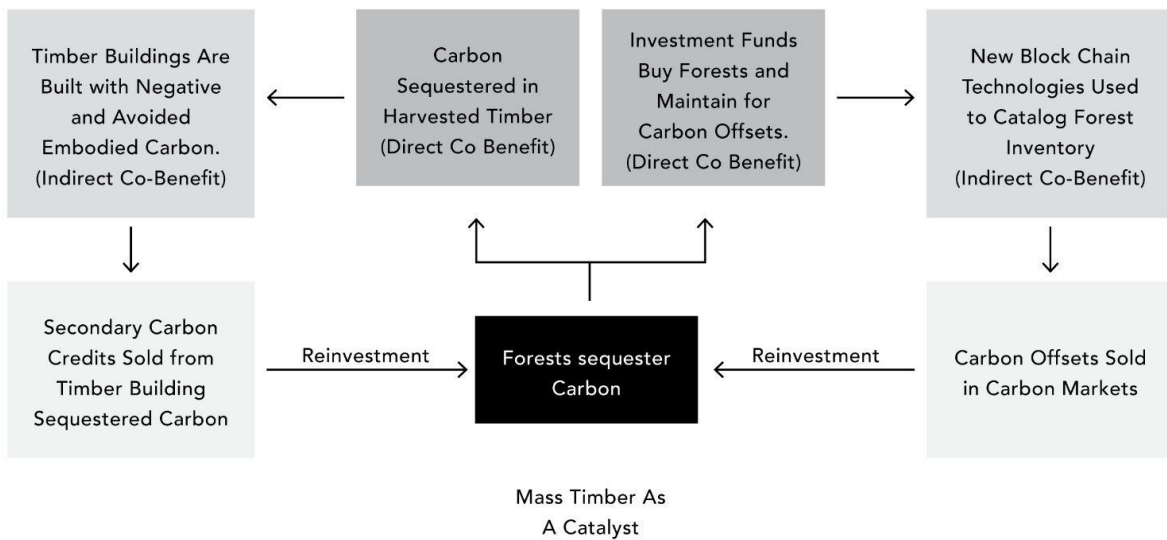
<sup>81</sup> Kelly Martichuski (Manager, Forest Carbon Works) in discussion with the author, December 09 2022.

<sup>82</sup> Marissa Spence (Manager, Climate Action Reserve) in discussion with the author, December 07 2022.

<sup>83</sup> Kelly Martichuski (Manager, Forest Carbon Works) in discussion with the author, December 09 2022.



supporting an innovative sustainable building product with the permanence of sequestered carbon and longevity of timber’s lifecycle life as a vessel for that carbon. For many carbon credits, a cycle of more than 100 years must be agreed to; therefore, timber as a building structure is well suited to this timeline. "There is a lot of room to grow. If I were on the business's timber side, I would be looking into carbon capture credits," says Jim McCaffrey.



**Co-Benefits Model of Forests and Carbon Sequestration.**

## Biophilia

While the benefits of carbon sequestration and carbon avoidance are the most quantifiable environmental benefits for ESG metrics relating to mass timber, there is another more qualitative component known as Biophilia, “a phenomenon in which humans seem to have an innate affinity for nature.”<sup>84</sup> The Biophilic aspects of mass timber and mass timber environments are equally as important for creating a more equitable and socially responsible world. “This human connection to nature affects humans both physiologically and psychologically, leading to the recognition that designing elements of nature into the built environment can have health benefits,

<sup>84</sup> Wilson, E. O. (1984). *Biophilia*. Cambridge, MA: Harvard University Press.

including stress reduction, improved cognitive performance, enhanced moods, and increased preference for spaces."<sup>85</sup> In 1983, the first indoor air quality act was passed. Yet, it has only been in the last decade that commercial development and firms have taken workplace wellbeing seriously and invested heavily in it. New rating systems such as Well, Reset, Fitwell, and Living Building Challenge help firms to track health metrics and create a direct link between cognitive performance, employee happiness, and aspirationally increased revenue from productivity to biophilia. As described by leading researcher and biophilia advocate Bill Browning, experiences of nature in the built environment tend to fall into three broad categories; *nature in space*, *natural analogs*, and *nature of place*. *Nature In Space* refers to direct experiences of nature and natural processes in the built environment. These experiences include landscape views, the presence of living plants, animals, water, sunlight, breezes, and the changing seasons.

The nature of wood is that it is a living and real product. "As humans, we are drawn to real and alive things. Wood is connected to life and nature. It's the difference between Living flowers and the disappointment with fake flowers or even fake wood veneer. In the same way, we see wood, and the brain follows a cognitive process of Wood, Tree, Alive. Studies of people in nature saw that cortisol levels stayed low while study participants were in nature."<sup>86</sup>

In Japan, employees will go out to take a stroll in the forest and practice, Shinrin-yoku (Forest Bathing). Japanese scientists have been studying "the effects of forest bathing in conjunction with impacts on stress reduction and immune system function."<sup>87</sup> "The brain recognizes things that come from living nature and desires them,"<sup>88</sup> says Bill Browning. The science of Biophilia is really quite logical in how our senses inform our experiences. Sight, smell, sound, touch, and taste signal our brains in real-time and tell us if our experience is good or bad. The optical experience is most evident from the

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<sup>85</sup> Ryan, C. O., Browning, W. D., Clancy, J. O., Andrews, S. L., & Kallianpurkar, N. B. (2014). Biophilic design patterns: Emerging nature-based parameters for health and well-being in the built environment. *Archnet-IJAR: International Journal of Architectural Research*, 8(2), 62-76

<sup>86</sup> Bill Browning (Founder, Terrapin Bright Green) in Wood Best Practices Forum, October 13 2022.

<sup>87</sup> Li, Q. (2010). Effect of forest bathing trips on human immune function. *Environmental Health and Preventive Medicine*, 15(1), 9-17. <https://doi.org/10.1007/s12199-008-0068-3>

<sup>88</sup> Ibid

perspective of color temperature. Yet, studies have shown that "When the brain is looking at wood, it's looking at a collinear pattern, and it makes the brain work less hard, and as a result, we are more at ease and less stressed."<sup>89</sup> These patterns are processed by a specific set of neurons in the brain; the less they work, the less stress and fatigue we feel. "This intuitive sorting occurs with our other senses as well. Sounds associated with nature are processed in a different part of the brain than sounds from machines, influencing which is a preferred experience."<sup>90</sup>

Luke Higgins, managing director at Accenture in Sydney, describes their office's mass timber space and how the "warm feeling is the most stand-out experience working in a mass timber office building. The smell of the timber as well makes you feel relaxed. You are drawn to work in the office as you feel naturally relaxed in this space versus the colder typical office space. More people are happy to come to the office, and it seems like people take fewer sick days. I have yet to quantify this fact, though. As the wooden pylons hold the weight through the center of the building, it lends themselves naturally to an open plan space. Additionally, the noise in the space seems to be much less; the wood absorbs the noise and provides some natural acoustic benefits."<sup>91</sup>

Another example of mass timber acoustic performance is at the Apex Plaza in Charlottesville, where the site is situated near train tracks. When trains come through, a lot of vibration is produced in the surrounding area, and the management was concerned that this would become an issue and disturbance. Yet, once the Apex Plaza was inhabited, the occupants noticed that the building absorbed much of the vibration. "It's a quiet building,"<sup>92</sup> says John. The timber absorbs the vibrations from passing trains, removing that added stress from the human occupants.

The nature of a mass timber building envelops the occupants warm and comfortingly. Timber helps to regulate the environment and creates human experiences most frequently described as comforting and relaxing. Research has shown that "rooms with (about 45% of the) surfaces being wood have been shown to boost perceptions of

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<sup>89</sup> Ibid

<sup>90</sup> Bill Browning (Founder, Terrapin Bright Green) in Wood Best Practices Forum, October 13 2022.

<sup>91</sup> Luke Higgins (Managing Director, Accenture) in discussion with the author, November 10 2022.

<sup>92</sup> John Bahouth (Exec. VP Admin., Apex Clean Energy) in discussion with the author, November 21 2022.

comfort and lower blood pressure."<sup>93</sup> Wood is not a conductive material, and the environmental comforts of timber spaces are attributed to wood's ability to manage the space's moisture, sound, and light color temperature. IA Design Director Ian Reeves shares that in the IA office in Hine T3 Atlanta, "there is a lot of warmth in the lighting. We talk a lot about the color of the lighting and how the color index matches circadian rhythms, but also about the color rendering of people to ensure that people are appropriately represented. We have a very chill studio, and people are calm in our space at T3. It's impossible to bounce cold light off these surfaces."<sup>94</sup> Adding wood surfaces in a room with white walls has been shown to lower stress more effectively than adding a few plants.

"I love the regional qualities of timber,"<sup>95</sup> says Susan Jones. A key aspect of biophilic design is creating spaces where the mind and body feel a sense of peace and security with comfort and familiarity. Localization is a unique part of Timber selection. Sourcing from nearby a project site will create familiarity for project occupants and users. Humans are drawn to life and beauty and avoid danger and discomfort. "Timber is regional; a Douglas fir in the Northwest is very different from a Southern Yellow Pine in the east,"<sup>96</sup> says Josh Cabot, Mass Timber expert at SERA Architects. "People are really focused on talking about creating local stories and want to be able to connect their projects with specific forests."<sup>97</sup> For example, Justin Bashaw, Design Director at Gensler's Dallas office, shares that First United Bank has "built its branches in Texas with CLT and Glulam as a part of their DNA."<sup>98</sup> The bank wanted to use Mass Timber to connect on a warm and regional level with their clients, many of whom have been banking with them generationally and were originally farmers. Google is another firm investing in biophilia. Though Google has been primarily focused on mass timber as a product for decarbonization, Google feels that Biophilia is also "one of the most important aspects of

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<sup>93</sup> Herz, R. S. (2004). Neuroimaging evidence for the emotional potency of odor-evoked memory. *Neuropsychologia*, 24(3), 371-378. doi: 10.1016/j.neuropsychologia.2003.08.009

<sup>94</sup> Ian Reeves (Design Director, Interior Architects Atlanta) in discussion with the author, November 22 2022.

<sup>95</sup> Susan Jones (Owner, atelierjones llc) in discussion with the author, November 09 2022.

<sup>96</sup> Josh Cabot (Senior Associate, SERA Architects) in discussion with the author, November 09 2022.

<sup>97</sup> Ibid

<sup>98</sup> Justin Bashaw (Studio Director, Gensler) in discussion with the author, November 02 2022.

Mass Timber,"<sup>99</sup> says Alastair Reilly. In 2022 Google and the Living Future Institute world with leaders in biophilia, including Bill Browning of Terrapin Bright Green, to create the firm's global biophilia guidelines to be used throughout all of their physical space.

Throughout the interview process for this paper, the author found that people who began working with mass timber were drawn in and continued working with mass timber. A case could be made that biophilia draws people in and ignites a passion for working with nature's natural beauty. When asked if there were other reasons to build with mass timber other than decarbonization, Boston's Senior Architect John Dalzell said, "It's beautiful."<sup>100</sup> This phrase has been repeated almost unanimously through all thirty interviews. Access to beauty is an integral part of the Biophilic experience.

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<sup>99</sup> Alastair Reilly (Design Partner, WMP) in discussion with the author, November 08 2022.

<sup>100</sup> John Dalzell (Senior Architect, BPDA) in discussion with the author, November 02 2022.

# Part 04

## Innovation through Value Creation

### A New Type of Timber

What was once an ancient building material and technique has made a resurgence as a contemporary marvel of engineering. The emergence of contemporary mass timber creates new frontiers for entrepreneurs and opens opportunities for new start-ups, vertical manufacturing integration, and supply chain efficiencies. These opportunities are spurred on by contemporary technologies such as blockchain, automation, robotics, and digital twins, which amplify mass timber's ability to innovate and scale. These innovations also create value for the forests and those whose livelihoods are tied to the forests. As the US Forest Service has evolved its forest management practices and now supports tree harvesting to manage wildfires, new economies are being created, and old economies are being renewed in logging communities. A common theme that has continued to surface throughout interviews is the idea of enough timber to scale the construction of timber buildings in the United States from public, private, and tribal lands. Currently, there are not enough forestry workers and not enough mills to meet the demand at this time. With an economical and sustainable strategy for forestry, there is an opportunity to create new high-paying jobs with increased management awareness and a pipeline for timber to be used sustainably. According to a 2021 report from the U.S. Bureau of Labor Statistics, within the Fish and Game Industry, Forest Harvesters and Front-line Workers in Forestry are the highest paid, with many jobs still unfilled. Additionally, much-needed new investment is being made in milling, manufacturing, and fabrication. It is the resurgence and relearning of old skills in combination with new technologies. The knowledge needed to care for the land sustainably is ancient, yet the knowledge needed to utilize the land efficiently is ever-evolving. As the mass timber industry scales, so do the secondary markets for timber by-products and the further added job creation. Secondary products could include nanocellulose products, biochar, wood energy, fuel pellets, paper products,

cardboard, or pallets. For the timber industry to remain sustainable new and old mills must become modernized with fiber-utilizing facilities and a careful cascade of wood use integrated into operations and supply chains. Mills and factories should utilize the waste as biofuel and vertically integrate their cellulose waste into other forms of manufacturing for the secondary markets. “We need a strong secondary market for sawdust and wood chips,”<sup>101</sup> says Katie Fernholz. “There needs to be a disposal process where nothing is wasted. Products and processing facilities need to be co-located near forests. “You can't haul a truck of sawdust very far down the road without losing money.”<sup>102</sup> As a material, the nature of timber enables a zero-waste opportunity if mills and sites are managed properly. When a log is milled, only 50% of the log will be used in a lumber capacity for construction. The other 50% goes into the by-product pipeline; in many cases, the sawdust is just as valuable as the lumber. “The pulp mill down the street uses all our waste and turns it into paper and other products. So 100% of the timber gets used, and nothing is wasted in the end,”<sup>103</sup> says Mitch Warren of Kalesnikoff. “Even the waste from the mass timber gets chipped and used as biogenic energy in our plant. We have a responsibility to steward and care for our forests. We need to manage our resources better and, as a result, care for the earth.”

## **Verticals and Collaborations**

Started as a family company, “the Kalesnikoff company history is an 80-year legacy. In 1922, as Russian immigrants, the Kalesnikoffs first moved to the West Kootenays to join a communal Doukhobour settlement called Champion Creek.”<sup>104</sup> There, they received a Crown License in 1939 to manage and harvest a portion of forest in Canada; today, they are one of the largest vertical integrations in North America. Three years ago, Kalesnikoff was a family sawmill that wanted to expand its product into mass timber and launched a new start-up to manufacture CLT and Glulam. “They were transitioning from product delivery into project delivery. Everyone was learning

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<sup>101</sup> Katie Fernholz (President/CEO, Dovetail Partners Inc.) in discussion with the author, October 25 2022.

<sup>102</sup> Ibid

<sup>103</sup> Mitch Warren (Sales Manager, Kalesnikoff) in discussion with the author, November 23 2022.

<sup>104</sup> Kalesnikoff, “Kalesnikoff - About”, 2022 <https://kalesnikoff.com/history-lumber-mass-timber-community/>

something new, and it was an exciting time to join,”<sup>105</sup> says Mitch. “We have learned quickly and come to scale about three years ahead of where we had planned. But, again, this is because of our vertical integration, where we have a lot of levers to pull. We can play our hand a little more aggressively and manage our opportunity costs. It’s not unusual that developers will ask you to hold their price for ten months. But who can do that? Only integrated suppliers can do that. This gives us value. Today we are sizable, from log sourcing and harvesting to site delivery and sequencing. We have to work very closely with the builders.”<sup>106</sup> Mitch describes the case to be made for vertical integration between harvesting, milling, and manufacturing. Together the risk-reward can be balanced and reduce the volatility in the lumber market with mass timber simultaneously. “The lumber business can be feast or famine. You might have some opportunity cost in a high lumber market if a portion of your lumber is going to mass timber, but in a down lumber market, we can stay profitable with a continued stream of mass timber clients and resources.”<sup>107</sup> Vertical integration and collaboration create increased efficiencies within the mass timber industry even when there is, at times, direct competition. An example of this can be seen in the relationship between Kalesnikoff and Timberlab. “Timberlab is one of our biggest customers,”<sup>108</sup> says Mitch. “We have more synergy with other fabs than our own because there is enough work out there to feed our CNC and still feed Timberlab. Timberlab allows the product in our factory to be more efficient and keep flowing. We want to collaborate with the other fabricators and feed our product to them rather than compete. It’s just a better way of doing business. We can work together back and forth to deliver the best product for our clients.”<sup>109</sup>

Within the pipeline of mass timber production, milling and manufacturing are only half the story. The other half is fabrication and erection. Mass timber fabrication is the point where a timber beam or column will be CNC’d with a special joint or

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<sup>105</sup> Mitch Warren (Sales Manager, Kalesnikoff) in discussion with the author, November 23 2022.

<sup>106</sup> Mitch Warren (Sales Manager, Kalesnikoff) in discussion with the author, November 23 2022.

<sup>107</sup> Ibid

<sup>108</sup> Ibid

<sup>109</sup> Ibid



connection that allows it to be seamlessly joined together on site. This process is often called “final fab” before the timber is taken to the construction site for erection. Automated Fabrication is one of the newest technologies enabling rapid innovation within the industry. Timberlab has been a rising star in the fabrication world since 2019 and collaborates with many factories to ensure the best price for their customers. Swinerton Inc. founded Timberlab as a separate company to increase their quality of delivery, reduce mistakes on site, and ultimately remove the growing bottleneck in the industry. “We realized many people were making glulam, but the bottleneck was the fabrication side of things,”<sup>110</sup> says Taylor Cabot, a project manager at Timberlab. “The goal is never to cut anything in the field; without CNC, tall timber would not exist. There are not that many companies that can CNC Timber to receive a knife plate and bolt. The companies that were capable of fabricating could only do 12-20 projects a year. Timberlab realized to grow the number of mass timber structures it could build in a year, it had to CNC fabricate as well.”<sup>111</sup> Taylor originally trained as an architect but fell in love with timber when working on the Carbon12 project in Portland, North America’s first multi-family timber highrise building. “When I joined in 2019, Swinerton did not have Timberlab; they were Swinerton Mass Timber. At first, people thought it was a rebranding, but Timberlab is a new company and PnL.”<sup>112</sup> This independence enables Timberlab to collaborate with other contractors and consult with their clients early. Early consultation through the design process can help clients keep the timber affordable by using lower volumes of timber and by avoiding too many unique sizes or connection details that only a single supplier could offer. “From the minute a design begins as a napkin sketch, we want to be involved in creating efficiencies throughout the design process,”<sup>113</sup> says Taylor. “There was a two-year period when the industry relied on architects alone to design and model timber. But the nuances of timber and the level of modeling requires specialists.”<sup>114</sup> Once the design

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<sup>110</sup> Taylor Cabot (Project Manager, Timberlab) in discussion with the author, November 16 2022.

<sup>111</sup> Taylor Cabot (Project Manager, Timberlab) in discussion with the author, November 16 2022.

<sup>112</sup> Ibid

<sup>113</sup> Ibid

<sup>114</sup> Ibid

process is complete, Timberlab completely rebuilds an exact digital twin of the timber structure for fabrication. “If it’s wrong on site, it’s wrong in the model.”<sup>115</sup>

## **Driven by Technologies**

Generate is a firm out of Boston and MIT seeking to boost architects' timber design tool kit by designing new software. Not everyone understands that timber structural grids differ from steel and concrete. This lack of knowledge is often a reason not to take on a timber project or propose one. With Generate’s software, architects will be able to work with it as a guide and utilize predesigned structural members and joints. “Generate launched as a licensed architecture firm while growing its reputation as timber consultants on projects before starting their software component,”<sup>116</sup> says John Fechtel, a partner at Generate. Generate is passionate about timber and understands that educational software is the key to helping people gain knowledge faster and cost-effectively. John is also trying to educate municipalities and reporting systems about the fact that the mass timber lifecycle differs from what reporting systems currently use for reuse calculations. “Current lifecycle analysis looks at Mass Timber as if it's light wood frame construction which is 55% wasted, but this is not true,”<sup>117</sup> says John. “Mass Timber Beams, Columns, and Slabs are all reusable and different from a typical frame.”<sup>118</sup> One of the key values of mass timber is its ability to act as a carbon vessel, and the longer we can use and reuse mass timber members, the longer that carbon is stored. It’s also important to understand that at the end of a glulam or CLT’s lifecycle, it does not organically become a part of nature again. As Alastair Reilly describes, Biological things can return to nature, but technical products often cannot. Because of the glues, CLT becomes a technical product (like an iPhone).<sup>119</sup> This is why reuse is a key strategy for mass timber and why many designers and fabricators are working to bring back the craft of wood joints. By removing the steel joints and

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<sup>115</sup> Ibid

<sup>116</sup> John Fechtel (Co-Founder Director, Generate) in discussion with the author, November 07 2022.

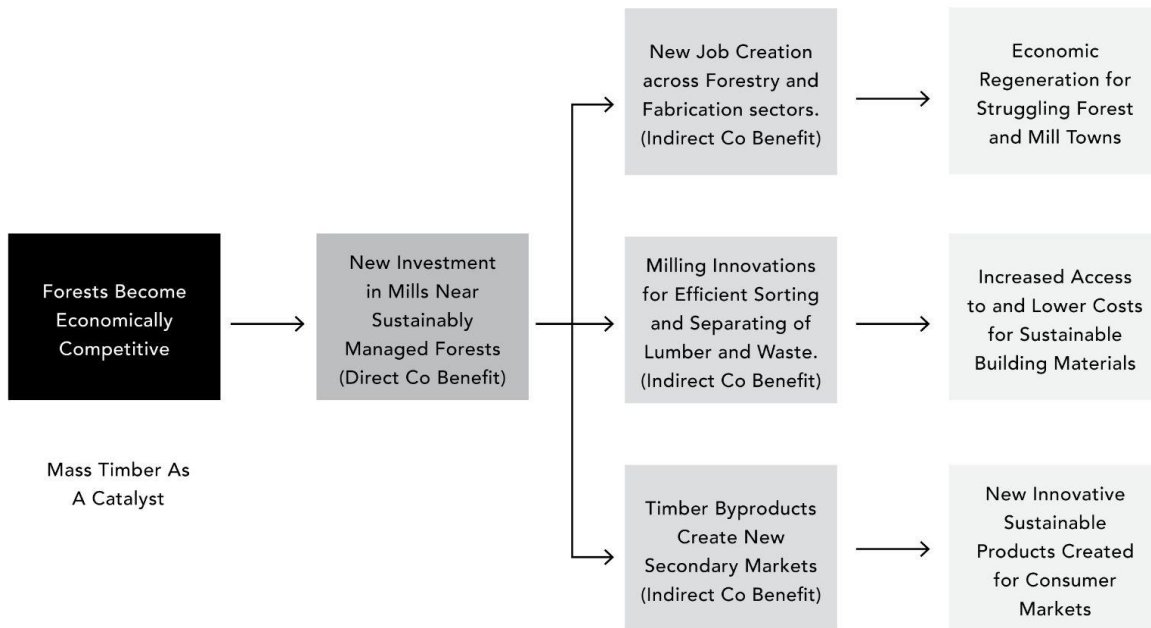
<sup>117</sup> Ibid

<sup>118</sup> Ibid

<sup>119</sup> Alastair Reilly (Design Partner, WMP) in discussion with the author, November 08 2022.

connections between the timber, the carbon from the steel is further removed. Those wood joints can be more easily disassembled and reassembled in another location. At Susan Jones' Heartwood project, beams and columns only have a hand full of screws, as the beam and columns interlock together and have a 10% improvement in carbon reduction. This design for reuse and disassembly extends both the life of the timber and its value. John Bahouth from Apex describes how they secured a better construction loan due to their design for next use. "The Bank was interested in how we designed the building to be converted later into apartments or disassembled."<sup>120</sup>

As time goes on and technology and inspiration drive innovation, mass timber as a product will see costs come down across the industry in the same way that solar and wind have done due to increased supply chain efficiency and a critical mass in the marketplace. The door is open, and possibilities are abounding for this pivotal place within the mass timber supply chain. Investing in the critical infrastructure and technology needed to open the bottlenecks and create efficiencies will only create value for the built environment and communities.



### Co-Benefits Model of Making Forests Competitive

<sup>120</sup> John Bahouth (Exec. VP Admin., Apex Clean Energy) in discussion with the author, November 21 2022.

# Part 05

## Leaders who Champion With Vision

### Why Building Codes Matter

Much of the excitement and financial feasibility for mass timber has been generated by the new 2021 International Building Codes, which allows for 18 stories of tall timber to be built with new rules according to the new classification called Type 4. The ability to build eighteen stories of timber benefits the project metrics and pro forma through economies of scale. As a result, the potential for larger-scale office, multi-family, and mixed-use buildings has begun to attract the attention of more investment in the mass timber industry space from dirt to fabrication, and many new projects are exponentially taking off. John Dalzell, the Senior Architect for the City of Boston, explains that "the New IBC Code for Type 4 Tall Timber will be adopted on Jan. 1st. in Boston. The city is already seeing mass timber projects anticipating this adoption early in the permitting process, and the city is helping these projects move forward."<sup>121</sup>

People in the industry are excited about Type 4 because it exposes more of the timber ceiling, further reducing costs and allowing the timber's beauty to be showcased on the interior. With his new increase in exposed timber and tall timber being built, it will be important for people to be educated on the benefits of timber during a fire. "The general perception that a tower made of wood can be built eighteen stories and remain structurally safe from environmental catastrophes and fires is important,"<sup>122</sup> says Josh Cabot. In Milwaukee, the New Land Team describes how when speaking with potential tenants, 75% of them have come to Ascent because it's a luxury building first and foremost, but when they realize it's mass timber, they will say, "You're telling me it's made entirely of wood; what if it burns?"<sup>123</sup> So, to showcase the story of mass timber and its reaction to fire, there are slices of the original structural timber char tests all around the Ascent lobby. In some ways, it feels like an educational museum for

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<sup>121</sup> John Dalzell (Senior Architect, BPDA) in discussion with the author, November 02 2022.

<sup>122</sup> Josh Cabot (Senior Associate, SERA Architects) in discussion with the author, November 09 2022.

<sup>123</sup> Alexandra Lehnhard (Manager, New Land Enterprises) in discussion with the author, October 20 2022.

Biophilia and char tests of timber structures. Hines' Atlanta Managing Director, Tori Kerr, describes that “people think of timber as something that's going to burn, but char is considered something that's even a bit safer by the fire department.”<sup>124</sup> “The char tests are one of the most interesting things about Mass Timber,”<sup>125</sup> says Mike Brady of JLL. “If you talk to firefighters, they will tell you they would rather run into a timber building. They understand how fire and timber interact; it's more predictable.”<sup>126</sup>

## **Negotiation and Sacrifice**

In 2019, Susan Jones, founder of atelierjones llc, joined the International Building Code Advisory Board. The board worked together to write new building codes and revisions for mass timber in the 2021 International Building Code. Over the years, Susan became a timber expert by exploring mediums of design yet to be dominated by mainstream industry and in which she could intentionally experiment and grow in her craft. She describes the interactions with others on the board as “collaborative yet contentious.” It was challenging yet rewarding to work in this environment throughout the two years needed to negotiate, present, and vote on the new changes. “This level of collaboration, trust, and dignity of communication felt like a little group of confederated interests becoming a model of how people can challenge each other without questioning the integrity or sanctity of the process. It reminds me of what the dialogs surrounding our constitution might have looked like. I don't know if we would be building Type 4C or 4B today if we had not gone through this process.”<sup>127</sup> Susan’s story about how the codes were written is a story about how change happens at a large scale when entrenched interests push back. The story begins with her on a board with four firefighters, an engineer, an architect, and four others who are being paid to represent their respective interests in gypsum board, steel, concrete, and Canadian Wood. “I thought to myself, how am I supposed to speak in front of all these people who don't know the difference between stick frame and mass timber? People say it was so cool

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<sup>124</sup> Tori Kerr (Managing Director, Hines Atlanta) in discussion with the author, October 25 2022.

<sup>125</sup> Mike Brady (Director Capital Markets, JLL Milwaukee) in discussion with the author, October 06 2022.

<sup>126</sup> Ibid

<sup>127</sup> Susan Jones (Owner, atelierjones llc) in discussion with the author, November 09 2022.

that I changed the codes, and I think if they only knew the whole story and the hard work it took."<sup>128</sup> Susan shares that the room had a totally different type of respect. The group would negotiate with someone who had a hard no, and instead of getting angry or accusatory, they asked, what would change your mind?

While there are many precedents already in Europe for tall timber buildings, the U.S. experience with timber has not been as mature. A major challenge for the board was understanding the experience level of U.S. fire departments and how building layouts differ for fire exiting. As members of the board shared stories of colleagues lost in firefights and worked together toward each next step of the process, they realized that full-scale mock-ups were needed to do burn tests and collect actual data on the nature of fire, timber and rated partitions. With one million dollars in grants raised, including funding from the U.S. Forest Service, Susan began her next exploration to design and build the full-scale compartment tests to be set ablaze and analyzed. This process took over one year and looked at radically different perspectives. After reviewing all the data, the team began to draft their first set of new codes. "It was like a giant word-smithing negotiation, and the question was who would get weary first. The board eventually doubled the allowable number of timber stories from seven to eighteen. "We were introducing a whole new level of scrutiny to the IBC,"<sup>129</sup> says Susan. The final vote on the board to recommend the new codes they'd written was fifteen for and three against, with comments such as, I am getting paid not to allow this to move forward. The role of the special interests on the board made the journey through the legal and jurisdictional logic issues very challenging. Their final code language was presented to the ICC committee, which voted 10 - 3 to pass the recommended code changes. These changes then went on to another public comment process, final hearings, and online voting before they could be ratified. Susan looks back and describes her experience on the IBC subcommittee as incredibly painful and one of the hardest things she has ever done in her life. "I lost great people, lost great projects, and was on the board pro bono, but then change happened, and change is happening, and I

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<sup>128</sup> Ibid

<sup>129</sup> Susan Jones (Owner, atelierjones llc) in discussion with the author, November 09 2022.

am so grateful that I went through that process. After the codes were passed and adopted, a spark occurred, and the industry changed. I would do it all over again,"<sup>130</sup> says Susan.

### **Change through Collaboration and Openness**

To solve the intractable challenges facing our climate and society today; we need more leaders like Susan, who are willing to roll up their sleeves and do the hard work, ask the tough questions, and be willing to collaborate across interests and industries. Collaboration is the key to future innovation. "When steel, concrete, and timber leaders work together, we know we are moving forward,"<sup>131</sup> says Katie Fernholz. "We cannot be naive about the stakes we have with climate change. We need a collaborative partnership. It's the collaborators amongst us that are going to break down the walls."<sup>132</sup> Mass timber is one of the fastest-growing industries in the U.S., and projects remain covid proof, and this is highly attributable to the industries' collaborative and open nature. A willingness to share, learn and try new things while leveling up each time. "The door is opening to a new frontier moving in all directions, and it's open to all,"<sup>133</sup> and the opportunities are there for anyone to lead.

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<sup>130</sup> Ibid

<sup>131</sup> Katie Fernholz (President/CEO, Dovetail Partners Inc.) in discussion with the author, October 25 2022.

<sup>132</sup> Ibid

<sup>133</sup> Susan Jones (Owner, atelierjones llc) in discussion with the author, November 09 2022.

# Conclusion:

Mass Timber is an everybody-wins model for business. (See Appendix II). The rewards are there for investment, society, and the environment if people are willing to put in the concerted effort to make it happen. Through the research interview process, it was clear that each subset cared about something specific. Designers cared about the design, developers the investments, and foresters the timber. In the end, caring about people and the environment was the single common denominator that connected each interview.

Key insights from this research revealed that because of its natural quality, mass timber is a differentiator in a marketplace filled with much of the same products, but also because of timber's carbon sequestration properties that enable assets to qualify for ESG investments. Additionally, insights revealed that mass timber's differentiation in the marketplace was, in most cases, capable of achieving higher lease premiums for commercial products. These higher lease premiums, combined with intelligent design strategies and investment in pre-construction services, enable mass timber construction costs to be reduced, manageable, and even competitive with other structures such as concrete and steel. These efficiencies were gained through best practices and a matrix of good decision-making at the project's outset. When looking at the project flow diagram (Appendix I) and key decisions, it was discovered that the short-term benefits of good decisions lead to increased efficiency and speed. Midterm benefits lead to overall cost savings from these efficiencies, and long-term benefits come from value creation beyond the project itself for its inhabitants and embodied social good.

Each of the projects shared in the interviews highlighted the importance of strategic vision in combination with creativity and a commitment to ethos. Developers in this research took a leap of faith as first movers and changed the industry while investing in the products to create better, healthy environments for tenants. Health is a key impact of mass timber for both inhabitants of timber buildings who experience the benefits of biophilia, but also important is the health of the forests and the need to create economically viable forests through forest gardening and harvesting. This new



perspective for forest management will require change and openness. Mass timber is an agent of change across industries and asks those who have become set in their ways to try new things and collaborate with others to bring new knowledge and innovation to the forefront. Mass timber is an industry that is regenerative for society and climate with multiple co-benefits, including wildfire prevention, job creation, industry innovation, startup creation, community renewal, carbon sequestration, market creation, and proven returns on investments.

The research in this paper reveals that mass timber is technologically cutting-edge, embodied carbon-reducing, and beautiful. It's a material and technology that draws in those who work with it and provides numerous co-benefits for society spurred on by new ESG investments and 2050 CO2e target commitments. There is an almost emotional and passionate commitment to this work throughout the timber industry and the entire supply chain. Everyone knows everyone, from the dirt to building occupants. These players not only know one another, but they respect one another. They are cheering for each other on a national and even global scale because they truly believe what they do is important for people and the environment. This is a group of leaders who see a unique vision and invest in creating openings for new markets, startups, and innovation to occur. Momentum and volume create affordability, and there is a strong movement to help lead growth for mass timber. The product and subject matter are vast, there is a steep learning curve, and it takes fortitude, but the results are life-changing for many and the environment.

# APPENDIX I:

## Step by Step Lessons Learn for Mass Timber Projects

### **Phase 1 - Decision to Build with Timber**

#### *Decide:*

An owner or development team must decide if the building with mass timber is a genuine commitment. Mass timber building typologies bring a learning curve. Ownership and consultant teams must be ready to roll their sleeves up and work together from the outset of the project. If developing mass timber is a first-time experience for team members, then the team should spend additional time ramping up on best practices and learning about potential challenges based on built precedents.

#### *Learn:*

For teams new to timber construction, the learning curve is steep but manageable if the time and desire are put in to understand the nature of timber. It's essential that all team members, and if possible even investors have a basic understanding of mass timber products. Learning should begin with forestry and move on to the supply chain, fabrication, and erection perspective. With such knowledge, achieving a successful and cost-effective product will be easier.

#### *Differentiate:*

The project team must research any existing Timber precedents within the vicinity of the site and municipality. If not, the project team will need to work extra hours with the municipal leaders to provide additional education. If there are, then the project team will need to determine if they are within the competition in the submarket and how they will maintain their competitive edge. As more and more timber buildings are erected, this will become a key factor. It will no longer be enough to be timber, and the building will need to offer more, and this is where one-of-a-kind amenities and services play a role.

#### *Analyze:*

Take time to study the sub-market and the building codes for mass timber in the site municipality. The project team should connect with the city and assess whether they have adopted the 2021 IBC, which allows for a Type 4 tall timber up to eighteen stories. Additionally, time should be spent to connect with the local fire department and assess whether they are advanced enough and willing to understand and approve a Mass Timber building. Even though the new 2021 building code allows for eighteen stories of timber, some municipalities still need to adopt these rules.

## **Phase 2 - Land Purchase and Capital Raise**

### *Purchase a Site:*

Mass timber buildings have a height restriction. The taller the building, the more profitable the project will be based on economies of density, scale, and speed. It's crucial to find land that economically can support a mass timber building with factors such as the potential premium lease rates and lower land costs that will help to improve the cap rates.

### *Plan ahead for Timber:*

It's important to consider where timber will be sourced early in the project and how logistics will impact the site and surrounding neighborhood. For example, sites co-located near forests and fabricators have a stronger connection to the material and ease of timber delivery through the supply chain.

### *Get Consulting:*

For less experienced teams, an architect with mass timber building experience should be brought into the project to help create quick test fits and tease out the pro forma with the ownership. Simple Test fits, a visual, and a clear pro forma will help to gain early interest from investors for the project.

## **Phase 3 - Project Team Formation**

### *Budget Differently*

One of the unique characteristics of a mass timber project budget is the need to shift costs and budgeting forwards from the construction phase into pre-construction. If the proper pre-construction team is selected early in the project, it can more easily avoid significant mistakes and create more cost-saving through an experienced team.

### *Build the Team Early*

Early team members may include the general contractor, a timber consultant, the design and architecture team, and the engineering team. In many instances, consultants combine roles into verticals, such as forest managers who manufacture, fabricators who erect, or all of the above. Such vertical integration can help streamline the project and lock in a reasonable timber price early on. However, it's essential to keep your competitive pricing options open by not specifying the timber species that only one supplier offers or creating details that only one fabricator can make.

### *Pre-Construction*

One of the most beneficial aspects of mass timber construction is the ability to design out potential surprises using a digital twin of the project. This digital twin evolves from the design phase and is recreated by the fabrication team for direct use in automated robotic fabrication. Therefore, if there is an issue on site, then there is an issue in the model.

## **Phase 4 - The Design Phase**

### *Design Differently*

Designing for mass timber is unlike any other building type. There are important nuances to mass timber buildings, such as tighter column bays with smaller structural columns, the color, species of timber, and the maximized use of timber as a three-in-one for structure, finish, and fireproofing. Additionally, subtle decisions such as determining which programs should be placed according to the intensity of fire code regulations can significantly reduce the timber volume and, thus, the price. It's also essential to leverage the ability to reduce floor-to-floor heights and total material costs based on removing the standard perimeter beam, all without losing daylight. Finally, a timber building is lighter and has a much smaller foundation requirement.

### *Find Timber Options*

After the initial schematic design and engineering of the building have been signed off, it is possible to assess the total volume of the timber. Next, begin seeking a source for the timber and designing a potential harvest. The typical lead time from harvest to the site can range from 18-24 months. Therefore, timber is a critical path and must be paid attention to, or a project will lose money while waiting for timber to be delivered.

## **Phase 5 - Debt Equity Financing**

### *Get Funding*

After completing construction documentation and tendering, shopping for debt-equity financing can begin.

### *Timber Commitment*

Sign off on a final commitment with the timber provider and manufacturer. A timber price should be reserved by this point at the latest, though this may depend on the project scale.

## **Phase 6 - Design Analysis**

### *Testing*

Joints and building systems should be tested and completed by working with the consultant team in collaboration with local fire departments—budget for full-scale analysis using full-scale mock-ups. Char Test will be conducted to confirm the timber selection with the local municipality.

### *Suggest Revisions*

A full round of value engineering should occur, and revisions should be suggested to the ownership team.

## **Phase 7 - Revisions and Fabrication**

Final revisions should be completed, and final project information should be sent to fabricators to create a digital twin for final fabrication before erection.

Subcontractors should be engaged at this point.

## **Phase 8 - Preparation and Transportation**

### *Prepare the site for erection.*

Site general requirements should begin implementation, followed by foundations and level one if designed as concrete or steel to prepare for timber erection.

### *Timber delivery sequence*

Logistics should begin for Mass Timber CLT and Glulam to be transported to the site in a phased delivery.

## **Phase 9 - Construction and Timber Erection**

### *Install Timber*

Erection of timber should begin with a crew of six to twelve, capable of installing timber within an estimated 16 weeks.

### *Follow Project*

The client team, design team, and consultants should continue to follow the construction administration process through to the handover.

### *Begin Leasing*

Deposits for pre-leasing or pre-sale can begin to be collected around the 90% completion mark.

## **Phase 10 - Completion and Occupancy**

### *Final Handover*

The building is handed over, and the construction loan is taken out.

Final design photography should be taken.

### *Move In*

Management and Leasing team move-in.

Occupants move into the new mass timber building.

## **Phase 11 - Validation and Marketing**

### *Study*

Conduct site occupancy surveys six months after tenants have moved in to evaluate the Biophilic properties and experiences within the building.

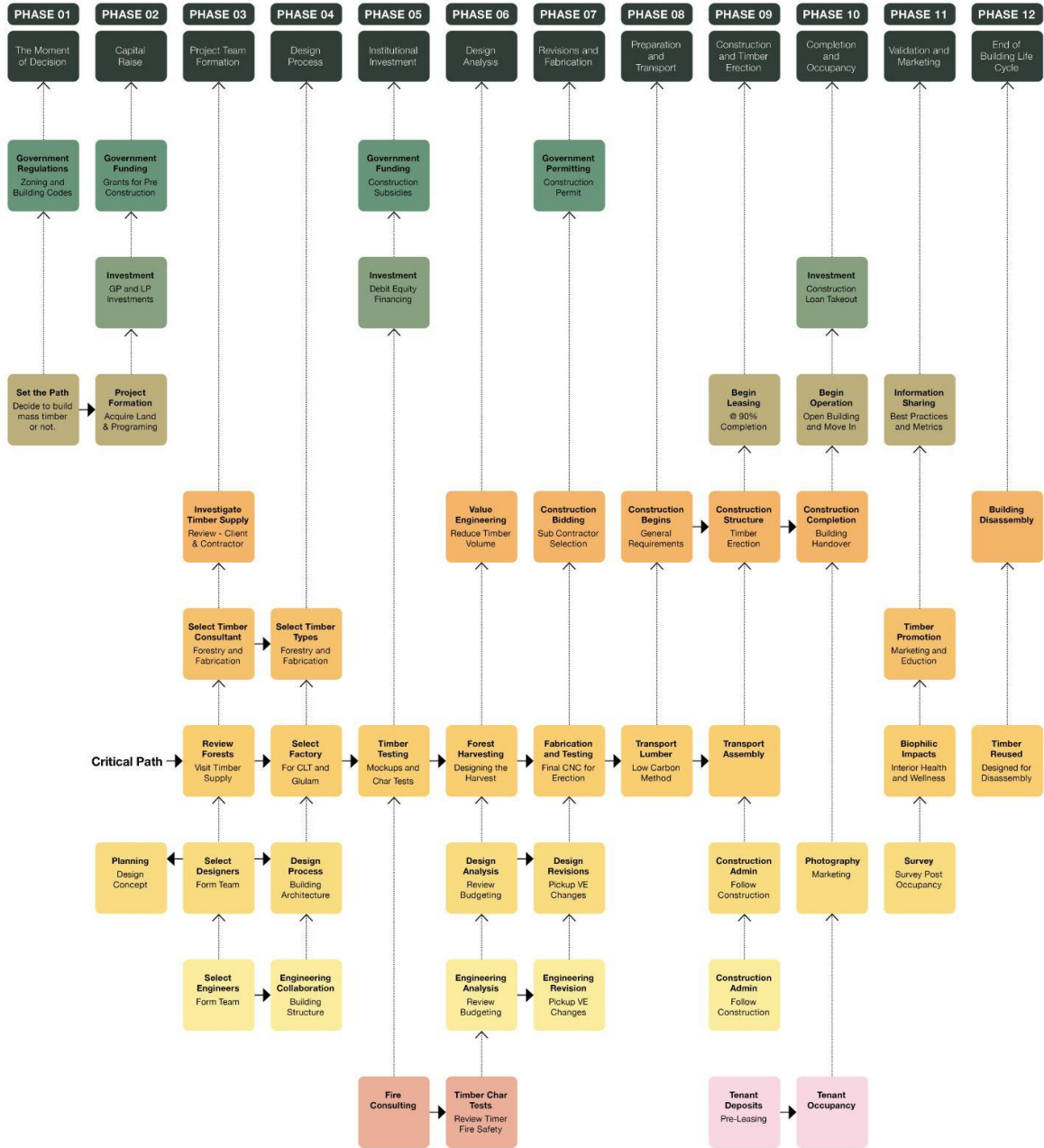
### *Promote and Share*

If the project is successful, the owners and property managers should collaborate to document and share knowledge with the development community.

## **Phase 12 - End of Building Lifecycle**

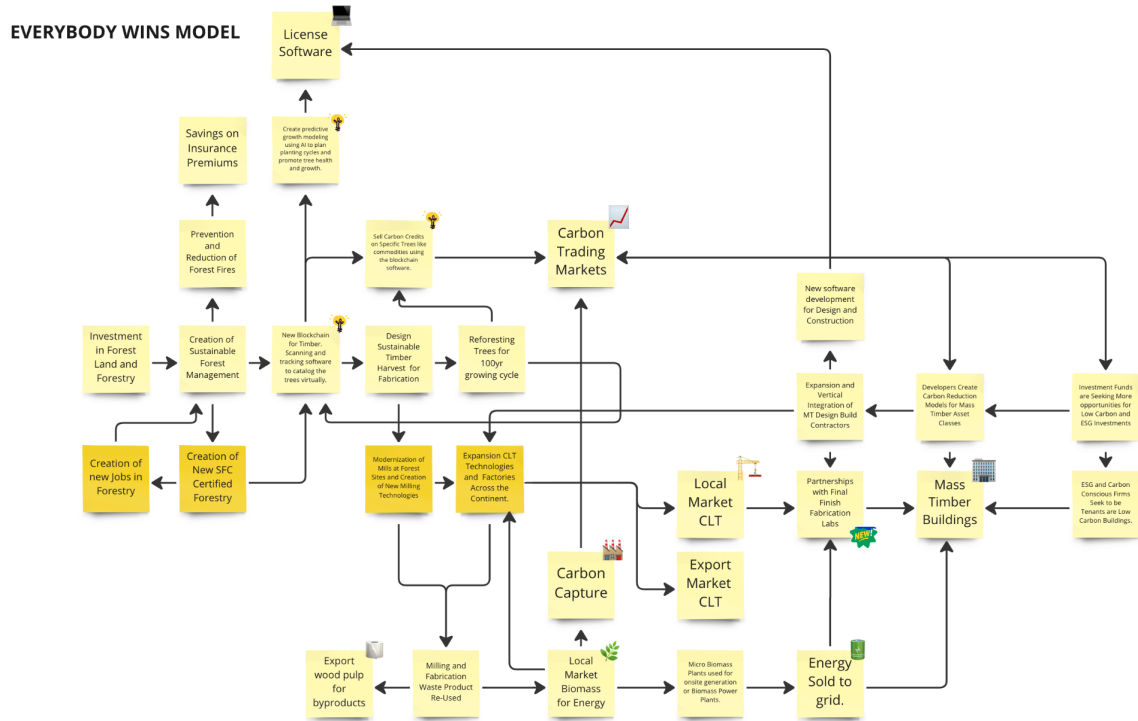
The building is deconstructed at the end of its lifecycle, and 95% of all timber is re-useable

# Project Flow Model for Mass Timber



# APPENDIX II:

## The Mass Timber Industry Verticals and Collaboration Opportunities





# Interviewee Reference Information

## In Order of Date Interviewed

Jim McCaffrey (General Manager, Crow Holdings) in discussion with the author, September 27 2022.

Brent Robertson (Managing Director, JLL Minneapolis) in discussion with the author, October 03 2022.

Mike Brady (Director Capital Markets, JLL Milwaukee) in discussion with the author, October 06 2022.

Bill Browning (Founder, Terrapin Bright Green) in Wood Best Practices Forum, October 13 2022.

Mark Rivard (Regional Manager, WoodWorks) in discussion with the author, October 11 2022.

David Johnson (Principal, SERA Architects) in discussion with the author, October 14 2022.

Clark Brockman (Principal, SERA Architects) in discussion with the author, October 14 2022.

Tim Talum (Project Manager, Elkus Manfredi Architects) in discussion with the author, October 14 2022.

Jeff Spiritos (Owner, Spiritos Properties) in discussion with the author, October 14 2022.

Kevin Naranjo (Wood Innovations Manager, USFS) in discussion with the author, October 19 2022.

Paul Snyder (Partner, Mission Timber) in discussion with the author, October 19 2022.

Tim Gokhman (Owner, New Land Properties) in discussion with the author, October 19 2022.

Lisa Podesto (Senior BizDev Manager, LendLease) in discussion with the author, October 19 2022.

Alexandra Lehnhard (Manager, New Land Enterprises) in discussion with the author, October 20 2022.

Tori Kerr (Managing Director, Hines Atlanta) in discussion with the author, October 25 2022.

Katie Fernholz (President/CEO, Dovetail Partners Inc.) in discussion with the author, October 25 2022.

John Dalzell (Senior Architect, BPDA) in discussion with the author, November 02 2022.

Justin Bashaw (Studio Director, Gensler) in discussion with the author, November 02 2022.

John Fetchel (Co-Founder Director, Generate) in discussion with the author, November 07 2022.

Alastair Reilly (Design Partner, WMP) in discussion with the author, November 08 2022.

Josh Cabot (Senior Associate, SERA Architects) in discussion with the author, November 09 2022.

Susan Jones (Owner, atelierjones llc) in discussion with the author, November 09 2022.

Chase Gibbs (Project Associate, Mortenson) in discussion with the author, November 10 2022.

George Forristall (RE Vice President for Mortenson) in discussion with the author, November 10 2022.

Luke Higgins (Managing Director, Accenture) in discussion with the author, November 10 2022.

Sean Meyers (Director of Dev, The Neutral Project) in discussion with the author, November 16 2022.

Taylor Cabot (Project Manager, Timberlab) in discussion with the author, November 16 2022.

John Bahouth (Exec. VP Admin., Apex Clean Energy) in discussion with the author, November 21 2022.

Ian Reves (Design Director, Interior Architects Atlanta) in discussion with the author, November 22 2022.

Mitch Warren (Sales Manager, Kalesnikoff) in discussion with the author, November 23 2022.

Marissa Spence (Manager, Climate Action Reserve) in discussion with the author, December 07 2022.

Kelly Martichuski (Manager, Forest Carbon Works) in discussion with the author, December 09 2022.

Stephen DiGiovani (Fire Engineer, Clark County, NV) in discussion with the author, December 09 2022.