FREE AGENCY: STRATEGIC (SUB) OPTIMIZATION IN TRANS-SCALAR DESIGN

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ABSTRACT: This inquiry explores the architectural habits that a priory prioritize building-scaled *efficiency* over *effectiveness* at alternative scales to define a *building*'s performance. These habits, while good intentioned, undermine the architect's agency to act on the non-linear, non-isolated networks that shape our design contexts. When operating on complex adaptive systems one cannot assume that by making an individual processes more efficient the effect on the larger system will be increased efficiency. In fact, often when a process is made more efficient in isolation, the net effect on the system, as a whole, is an increased inefficiency. Performance dictated by the energy efficiency of an individual building-scale is ineffective when optimizing performance within the realities of non-isolated systems. The shortsightedness of architects focused myopically on building efficiency has yielded a serious performance defect when considering buildings in aggregate.

As an alternative to the isolating influence of efficiency this inquiry explores the design of strategic (sub) optimizations; architectures that yield agency and energy efficiency to reinforce critical moments of feedback that optimize the system at an alternative, and often much larger, scale. The concept of "free agency" in architecture refers to a practice allowed to operate outside a building's envelope; on that intends to prioritize the "building" as (sub) component within larger, trans-scalar, design interventions. In this context, the architect manages and synthesizes an increasing amount of expert knowledge of which they are not expert. The architect, as non-expert, is ideally suited to make associations between dissimilar forms of expertise that represent potential design interventions that transcend spatial and temporal scales. These concepts are explored through a set of (sub)optimized design inventions focused on ecologic and energetic feedback loops between forested management practices, wood processing, and wood construction in North-Central Minnesota.

KEYWORDS: Architectural Practice, Non-Isolated Thermodynamic Systems, Wood, Forest Management, Construction

INTRODUCTION

In 1973, Horst Rittel and Melvin Webber coined the term *wicked problems*, referring to questions that lack definitive descriptions and problems whose solutions serve a pluralistic societies with differing goals. They have no stopping point, are one off, have no ultimate test to measure success, are not true-false, lack describable lists of problem variables, etc. Rittel and Webber wrote specifically about the problems faced by policy makers working on planning projects that affected large-scale, long-term change within the built environment (Rittel & Webber, 1973). This inquiry holds that wicked problems are also architectural norm. What follows is a strategy to engage the unwieldy, trans-scalar, open-ended, wicked problem of *building* through a framework of (sub) optimization.

The underlying position behind an architecture of (sub) optimization is a "building" is not the appropriate scale of optimization for building. It offers architects a critical discontinuity intended to disrupt current definitions of building performance that preference material optimization and energy efficiency as its primary drivers. Performance understood in this way relies on an increasingly restricted system's boundaries to "predicatively" model the "performance" of a building. This habit, of restricting boundaries, limits an architect's agency to the scope contained within a building's envelope and occludes the architect from operating on larger-scaled, more powerful, energetic systems (Moe, 2014). These boundaries provide neither a realistic representation of the matter or energy predicted, nor a useful account of the actual flows of matter and energy moving through the systems modeled (Winsberg, 2010). By excising variables that complicate quantification, these habits yield a "high performance" architecture defined by the incremental improvement of operational deficiencies. This view of performance reinforces checklist-based rating systems that at best represent a limited range of metrics for defining "high performance" architecture.

1.0 OPEN AND CLOSED SYSTEMS

From a systems standpoint *buildings* consist of *energy*, concentrated into *matter*, organized into specific *materials*, arranged through a *logic* into systems that prescribe their arrangement as *construction units*, to formations that provide *spaces* that serve social or environmental *purposes*. This characterization of a building is based on Odum's concept of transformity (Fig. 1), which describes the relationships between quantity and quality as energy is transformed across a system (Odum, 1988).

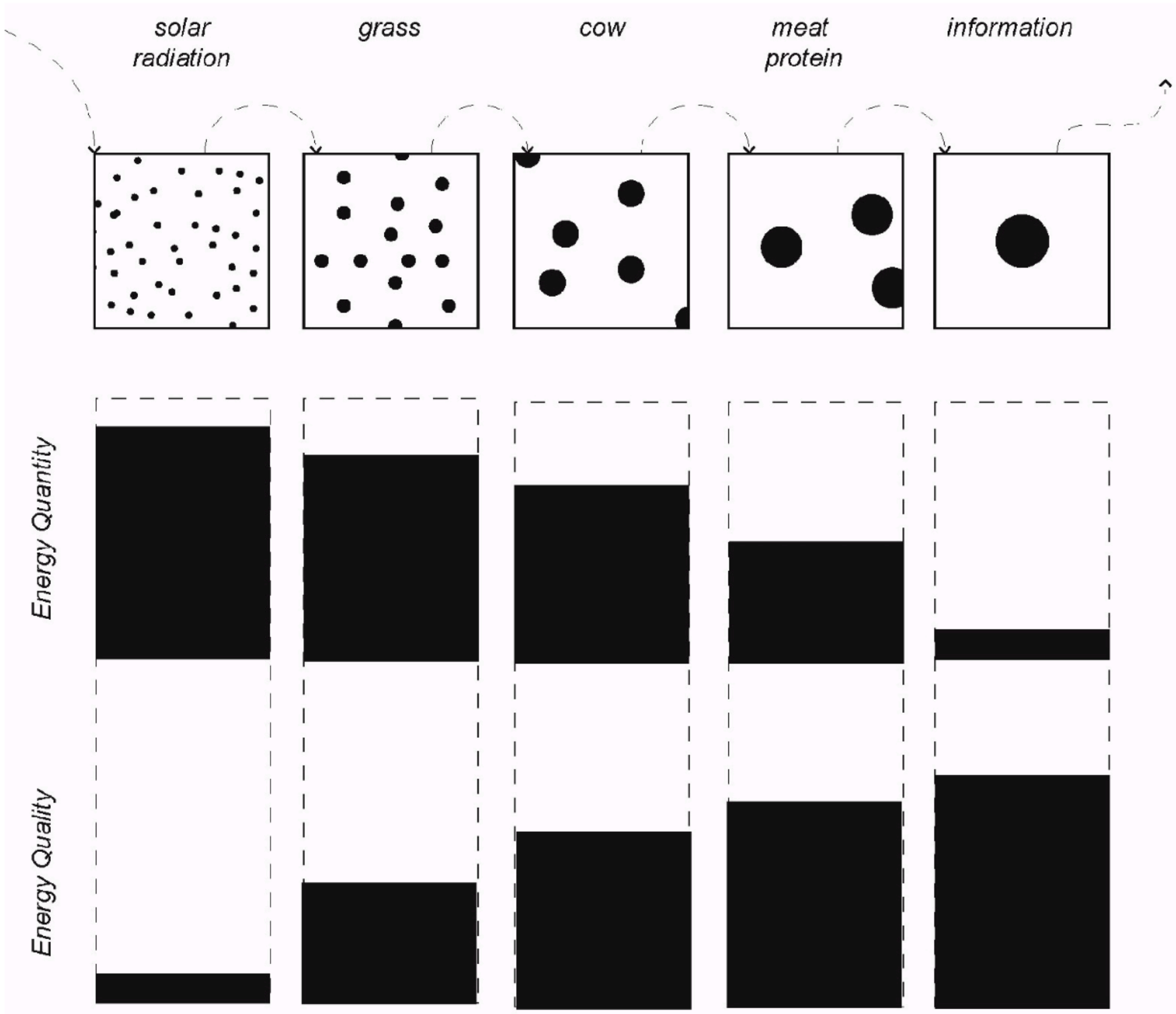

Figure 1: Energy Transformity Diagram (Based on Odum, 1988)

Characterizing a building in this way allows it to be understood as a thermodynamic system; and to understand its connectivity with social, cultural and technical systems that exist well beyond the boundaries of its envelope. There are three basic states of thermodynamic systems: (1) isolated systems, which allow neither energy of matter to transfer through its boundary; (2) closed systems, which allow energy, but not matter, to pass through its boundary; (3) non-isolated systems, which allow both energy and matter to pass through its boundary (Fig. 2).

When looking at the variables we use to define the context of buildings, cities, and/or environments (historical, cultural, social, economic, ecologic, energetic, material, etc.) an irrefutable similarity is often overlooked. Namely, that all these formations behave as non-isolated thermodynamic systems. Kiel Moe describes open systems as relative to architecture in the following way:

> *"By open - a more technical way to identify a system as non-isolated - I mean that buildings and cities are open to energy and material exchange between their system and their surroundings. This is an absolute, irreducible, and uncontestable reality that must be the basis of any non-modern agenda for energy in architecture in the future." (Moe 2014, p. 20)*

The universal fact that we design in the open context should shape the techniques we use to qualify the flows of energy that travel across our built environments. Modern design practices, however, do the opposite. They align with reductive methodologies that seek to dissect and isolate objects from the larger systems of which they are subcomponents (Mans & Yamada, 2015). These methods tend to understand a system through analysis of its isolated parts and then reassemble it as a singularly legible object. While practices that isolate complex systems are temporarily needed, they should remain temporary. Finite analysis, which isolates and abstracts variables of non-isolated systems to simplify and understand them, should reintroduce this simplified analysis back into the proper non-isolated context. Not doing so results in a false understanding of the system in general. (Moe, 2014)

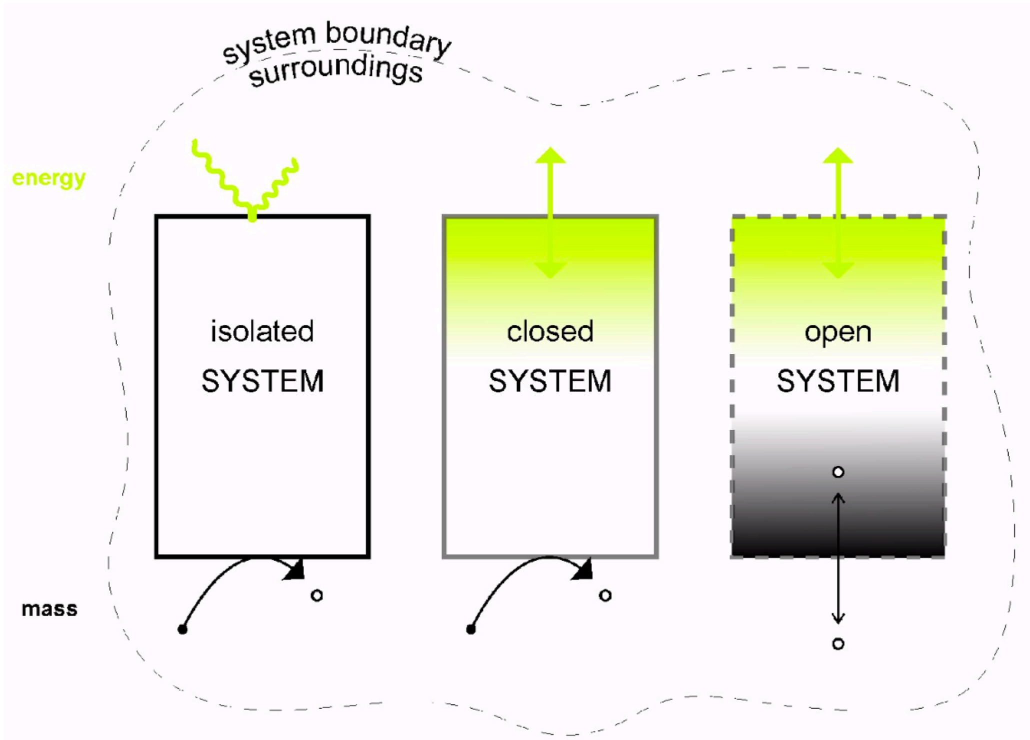

Figure 2: Thermodynamic System States (Author, 2017)

1.2. Energy efficiency and system boundaries

In reality, the buildings, cities, and environments we create exhibit non-isolated behaviour; formations all depend on the exchange of energy and material with the larger systems that they are a part (Prigogine & Strengers, 1984). These exchanges are non-linear, and often catalytic, with tipping points and thresholds that are unpredictable. However, the approach taken by most architects when operating on these formations is to isolate and simply – to design within a pseudo reality. How is it, given our non-isolated reality that the default approach to building performance is to minimize the amount of energy cycled through the building, i.e. to isolate it? This logic contradicts both common sense and basic theory. This type of architectural agenda is based on the 1st law of thermodynamics, where by definition, energy can neither be created nor destroyed (100% efficient). If buildings were isolated systems, they would be inherently efficient, which of course they are not. A more productive architectural agenda focuses on the quality of energy as it degrades across a system (Moe, 2016). This approach is based on the 2nd law of thermodynamics and is focused on the production of entropy within a system and the quality of *exergy* (usable energy) entering and leaving a system (Moe, 2013). This distinction has a significant impact on an architect's agency when dealing with wicked problems. Architecture conceived of as an isolated system reinforces habits to reduce existing deficiencies through continuous improvement; whereas, architecture conceived of as a non-isolated system reinforces habits to reconsider the original architectural problem and to design a discontinuous solution for it.

1.3. Ineffective efficiencies

This characterization of architecture, based on transformity and the articulation of architecture as belonging to a non-isolated system's state, expands the range of variables that an architect can consider when establishing a solution for a wicked problem. Key to recognizing an extended system boundary is acknowledging the role of an individual building as a (sub) component within the "at large" system under design consideration. Just as system-state affects agency, system-scale impacts our approach to wicked problem. Scale determines the specificity with which we view a system, and affects our perception of that system. Zooming out, Bataille asserts that, "On the Surface of the globe, for *living matter in general*, energy is always in excess; the question is always posed in terms of excess" (Bataille, 1988,21). In other words, as a whole, our terrestrial eco-system receives far more energy than it can effectively use. On the other hand, zooming in, poverty manifests when we constrict our system boundaries and find ourselves isolated within a context scaled to a (sub) component level of our much larger terrestrial eco-system. Bataille would describe this isolated system's boundary as a framework for a *particular economy*. Within this (sub) component context - a context of poverty - it seems logical to base decisions on optimization because of the limited access to resources at this scale of the systems design.

However, this form of optimization is fundamentally ineffective. It solves for deficiencies within a limited context as opposed to solving to reposition oneself within a context of resource excess. When operating within a trans-scalar system it cannot be assumed that by making deficient processes more efficient, it will increase the overall efficiency of the system at large (Ackoff, 1991). In fact, most often when singled out process is made more efficient in isolation, the net effect on the system, as a whole, is an increased inefficiency (Kay, 2002). Improving the performance of the large-scale systems requires that we (sub) optimize at the (sub) component level. This means that buildings can, and should, be (sub) optimized to improve the performance of large-scaled urban, ecological, economic and/or cultural systems.

1.4. Effectiveness over efficiency

Shifting optimization regimes from efficiency toward effectiveness is the final agency altering adjustment in this (sub) optimization strategy. It represents a transition from design aimed at affecting the smallest amount of harm, toward designs aimed at affecting the largest amount of positive change. Ackoff states that, "In designing a system, the primary criterion the designer uses in changing the structure or the behaviour of part of the system is not the effect on the efficiency of the part but the effect on the effectiveness of the whole system" (Ackoff, 2003, 81). The fundamental difference between efficiency and effectiveness is rooted in the content of a design question and whether the question asked, is asking the right thing. Ackoff describes it in the following way, "To do the wrong thing right is to do it efficiently but not effectively. Effectiveness is evaluated efficiency. Therefore, effectiveness is obtained only when the right thing is done right." (Ackoff, 1995, 45). Ackoff uses the example of continuous improvement in the automobile industry over the last century. Improvements are rampant in handling, safety, mileage, towing capacity, etc. but none of these "improvements" negate the large-scaled impact the automobile has had on pedestrian systems, urbanism, and pollution. The continuous improvement of the automobile's efficiency generates enough momentum to support automobile designers to continue asking the wrong question. Substitute "building" for "automobile" within Ackoff's example and a similar set of problems persist, namely that an isolated focus on individual building efficiency does not address the performative challenges of the larger environments in which we live.

1.5. Free agency

Misguided adherence to energy efficiency and material optimization has caused architects to ask the wrong question at the wrong scale with the wrong performance goals in mind. An "agent", by AIA definition, act in the owner's interest, providing professional services for compensation (AIA, 2007). From a contractual point of few, (sub) optimization at the building scale, the scale to which an architect is typically contractually obligated to act as an agent for their client, could present a contractual conflict if the client is not directly feeling the "effectiveness" of the design solution. An architect operating as a free agent would require both a different kind of client as well as a different kind of practice. As enablers and organizers of social capital, architects provide value and services to communities beyond the design of a building have the potential to leverage local assets as a vehicle for economic development. Communities are complex socio-economic systems nested within even larger socio ecologic systems. This research deploys a material sub-optimization strategy geared toward the discovery of novel local economic development strategies. The urban theorist, Jane Jacobs, referred this kind of strategy as "import replacement" which drives financial activity, jobs, innovation and city focused wealth (Jacobs, 1985). This focus on local material production and consumption of materials extends the architect's agency to specify construction materials for projects based on the ecological, economic and social implications of local extraction, processing and use (Hutton, 2013).

2.0. PRACTICING FREE AGENCY

The strategies outlined above are being explored through a *construction logic* design project that (sub) optimizes material efficiency at the building-scale to enhance local economic performance at the community-scale and forest habitat resilience at the regional landscape-scale, in North Central Minnesota. These ideas build on an initial (sub) optimization project, similarly focused on wood utilization, in New England, located at the New England Forestry Foundation headquarters in Littleton, Massachusetts (Mans, 2017).

2.1. Minnesota Made Transitional Nail Cross-Laminated Timber (nCLT) Panels

The project looks to leverage existing nCLT technology to improve and diversify market-utilization of under valued and/or high risk (pest or fire prone) species such as Oak, Maple, Ash, Pine and Tamarack, as well as low-quality and small diameter lumber, through the structural properties of cross lamination. Given the quality of material, and the structural limitations of nail lamination, the panels are materially inefficient at the building-scale when compared to more traditional glue cross-laminated timber (CLT) panels made from structurally graded softwoods. However, by exploiting this inefficiency the panels become more effective at larger scales: (1) improving local wood markets, (2) generating local economies, and (3) improving the resilience of Minnesota forest resources.

Figure 4: Low quality Aspen / mixed hardwood forest - Hinckley, MN (Author, 2017)

2.2. Improving Local Wood Markets

Response to existing wood markets in Minnesota, the project was designed not to create direct competition with currently highly-utilized species (i.e. aspen), but instead focused on the less used species listed above to develop a more "diversified portfolio" for Minnesota's wood economy. Panels are being designed to incorporate a multitude of species (both hard and soft) and the initial commercial market that product hopes to supply are industrial equipment mats. This is in part due to the current acceptance of mass timber construction in Minnesota and in due to the reality of producing a high enough quality product to meet structural standards for CLT panel products in early production with (sub) optimized materials. Equipment mats are a low quality gateway to a much more robust forest resources utilization plan that will provide material for emerging mass timber construction markets - a strategy deployed by Smartlam, a CLT manufacture in Columbia Falls, Montana (Tudhope, R., 2016). By positioning our project between existing industrial and emergent construction markets we position ourselves on the front edge of nCLT technology where we can deploy the applied knowledge gained through repeated manufacturing to tap more value added markets. The design is optimized to addresses specific land-use and economic needs of Aitkin County as well as fire management programs for the Chippewa and Lake Superior National Forests.

Figure 4: wood components at Savanna Pallets; Whole Log = Pallet Components + Pallet Components + Tailings + Sawdust (Author, 2017)

2.3. Generating Local Economies

Minnesota boasts over 15.5 million acres of timberland, covering over a quarter of the state's total area. Timberland is defined as forested land that is productive enough to produce a commercial crop of trees and is not reserved from harvesting by policy or law. Minnesota's timber resources are incredibly heterogeneous, characterized by the USDA through sixteen distinguishable forest types (USDA, 2014). The settler economies of the state were founded on the timber industry, and the current condition of Minnesota's vast timber holdings is a result of a historical decisions made around the economy of wood products. Economic opportunities in Northern Minnesota are limited, with wood being one of the few sustainable natural resources readily available. The development of systems that leverage local material and labour, while less efficient in both processing and material utilization, improve effectiveness at the community-scale when compared against more efficient remote systems that leverage centralized economies of scale and are higher material quality. In many rural communities the design of systems that generate local economies, as opposed the design of buildings that require capital investment, is more effective at affecting positive change. This project anticipates successful production to generate eight (8) new jobs. The improved production capacity of our local manufacturing partner not only allow them to make a value added products, it also makes the company more resilient to market shifts and helps secure the long-term employment of its existing employees.

Figure 5: large and small diameter mills process Birch and Aspen logs, Savanna Pallets (Author, 2017)

2.4. Improving the Resilience of Minnesota Forest Resources

The project's initial production goal is to process 5,000,000 board feet of wood annually, and anticipates extracting approximately 22,000 tons of stumpage from forest lands each year. We hope to source a quarter of our first year's material, roughly 5,000 tons, from the Chippewa and Superior National Forests, and to increase this percentage moving forward once relationships are established and the quality of the material is better known. The utilization of low quality and small diameter material in our value added timber panel also increase the effectiveness of forest professionals in fire management at the regional landscape-scale. Without viable wood markets it is not commercially feasible to proactively manage forest lands.

Once we transition production toward longer-lived building panels, our products will effectively operate as carbon sinks. Assuming carbon constitutes approximately 50% of the dry mass of trees and an average density of 40lbs/ ft^3 for the wood processed into our products, we will sequester approximately 4,150 tons of carbon each year. The Decentralized Design Lab Minnesota (DDL MN), a design-build workshop at the University of Minnesota, is exploring how a (sub) optimized panel system could work. The project focuses on leveraging the structural advantages of mass timber panels to improve the utilization of both heavy timber and balloon framing materials. Three variations of this system will be constructed and tested at the Anoka Heritage Lab in Hugo, MN in the summer of 2017. These structures are programmed as portable learning shelters for the Anoka County Parks and Recreation department and for the local YMCA.

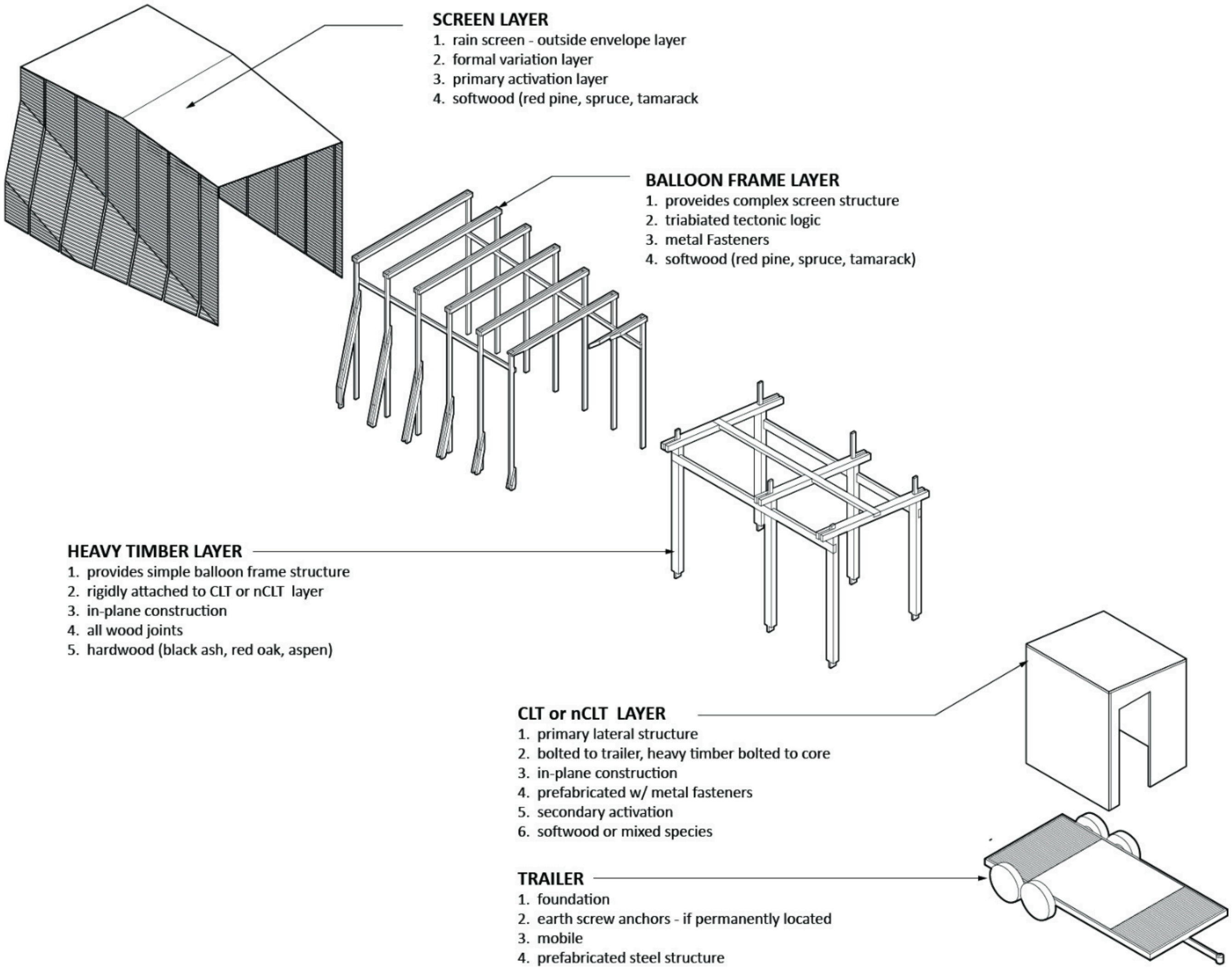

Figure 6: DDL MN construction logic diagram of the Anoka County Heritage Lab design (Author, 2017)

CONCLUSION

(Sub) optimization operates as a critical discontinuity intended to disrupt current definitions of building performance. Shifting optimization regimes from efficiency toward effectiveness is critical if we are to address the wicked problems attached to the built environment. For this to happen we need to acknowledge that the architecture, cities, and landscapes we design are non-isolated systems. In addition, we need to consider the scale of the system we are attempting to improve and position our design interventions as (sub) components within this larger system. A building can no longer be the sole scale of response to the question of building. Lastly, we need to consider the differences between efficiency and effectiveness to insure that we are asking the correct questions. These principles have helped to guide the Minnesota Made Transitional Nail Cross-Laminated Timber Panel project as well as DDL MN in shifting their architectural agency toward creating systems that can effectively improve local markets, local economies, and local ecologies.

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