The En-Habit Product Philosophy

Everything we make must have a Long Life Cycle and be Sustainably Re-usable long term.

Assembly must be Easy and Quick.

Everything we make must be Highly Resilient but Easily Disassembled, and Easily Modified.

Manufacturing must be Simple, Efficient, and Minimal Waste.

The Client has control of the Final Result within Broad Parameters.

The Product will be tolerant of Fire, Storm and Quake.

The Product will be Low Maintenance and Low Environmental Impact.

The Product will contribute to a Healthy Living Environment.

The Product will bring Greater Affordability to the Housing Market.

The Product is not intended to replace successful sustainable techniques in the regions in which they are employed. Rather it is intended to fill critical gaps in production. Methods intended to meet demand everywhere must do this with abundant recoverable materials that can be found globally.

Structural Frame

The structural frame of the project developed after studying Japanese Sukiya style Architecture. Sukiya draws upon traditional techniques with an aesthetic that is practical, beautiful, deceptively simple, restrained to the point of occasionally hiding, and yet, undeniably as high performance and artistic as exists anywhere in Architecture and Engineering. But Sukiya's joinery was meticulously crafted in wood at a time when Japan's population was somewhere around, estimates vary, 12-15 million, and the World's was roughly 545 million. The use of wood for structure in mass construction at a global or even national level with a World population 15 times as large (@ 8 billion), with carbon sequestering forests in decline and in flames everywhere, would be insane. For reliable joinery to be easily and precisely replicated in very large numbers, metal, if sustainably made, is a great choice.

When I began work on this project I was initially drawn to Aluminum for structure because of its remarkable ability to be repeatedly recycled without added environmentally disastrous and energy heavy smelted ore that releases, along with other harmful gases, perfluorocarbons 9,200 times more climatically detrimental than carbon dioxide. This was exciting because all the Aluminum that we would ever need may already exist without the need for continued mining or smelting or those nasty by-products. However, upon further study, Aluminum itself can be environmentally toxic, as is dross disposal from its recycling, as are certain alloying agents, like Manganese. The raw metal is incredibly soft and has a relatively low melting point so alloys must be employed. I also became discouraged by its galvanic issues with other metals, anything cementitious, and even end grains.

To my great surprise, I began to hear talk of Carbon only Steel becoming a sustainable recycled product. I grew up in Pittsburgh, and in the 1960's we lived at the top of Panther Hollow breathing in the foul toxins from the mills along the Monongahela River at the base of the hollow's draw. Anything outside painted white soon became dingy light gray, and the sky had a yellowish hue. I can only imagine what it was doing to our lungs.

Enter the Electric Arc Furnace, a technology invented in the 19th century that hadn't scaled up until recently. It has a weak spot on water use and effluent if untreated, but when wired up to a renewable source of electricity, or in the future, a Fusion Reactor, the technology has strong sustainable material potential. 100% scrap steel can now be electrically converted to structural without adding ore. All the steel required to house the world now already exists if we stop wasting it on ego projects. I noted that in Banda Aceh, after the tsunami devastation, that steel scrap was being salvaged in heavy amounts, to the exclusion of most anything else. This is a thriving business globally. Carbon only Steels are isotropic strong and just need Carbon to get that way. They are more than strong enough for light frame structure without Aluminum's galvanic issues. Oxidation is famously a problem but coat with enough Recyclable Zinc and adequately enclose the material, you will have something long term durable. Steel scrap is easily separated from other materials with a magnet. It is however very heavy.

Cold Rolled Steel is 18% stronger than Hot and is therefore 18% lighter. It can not be thick enough to be employed structurally in high rise construction but is very employable in low-mid-rise. Strip steel is easy to work in ways that can be automated, and production can be high up the material stream which saves on cost. Furthermore, the En-Habit system draws upon special folds and minimal surface geometries (thank you honey bees) to reduce material use/cost/weight by 10%, and simple cuts and tessalations that reduce waste. A simple moment connection's resistance to rotation is augmented by the deadload passing through the connection: no welding is required. Tooling, is limited to cutting, drilling, bending and laser braising where greater fixity is required. The less tooling the better. It is a significant plant maintenance cost.

Wall and Deck Panels

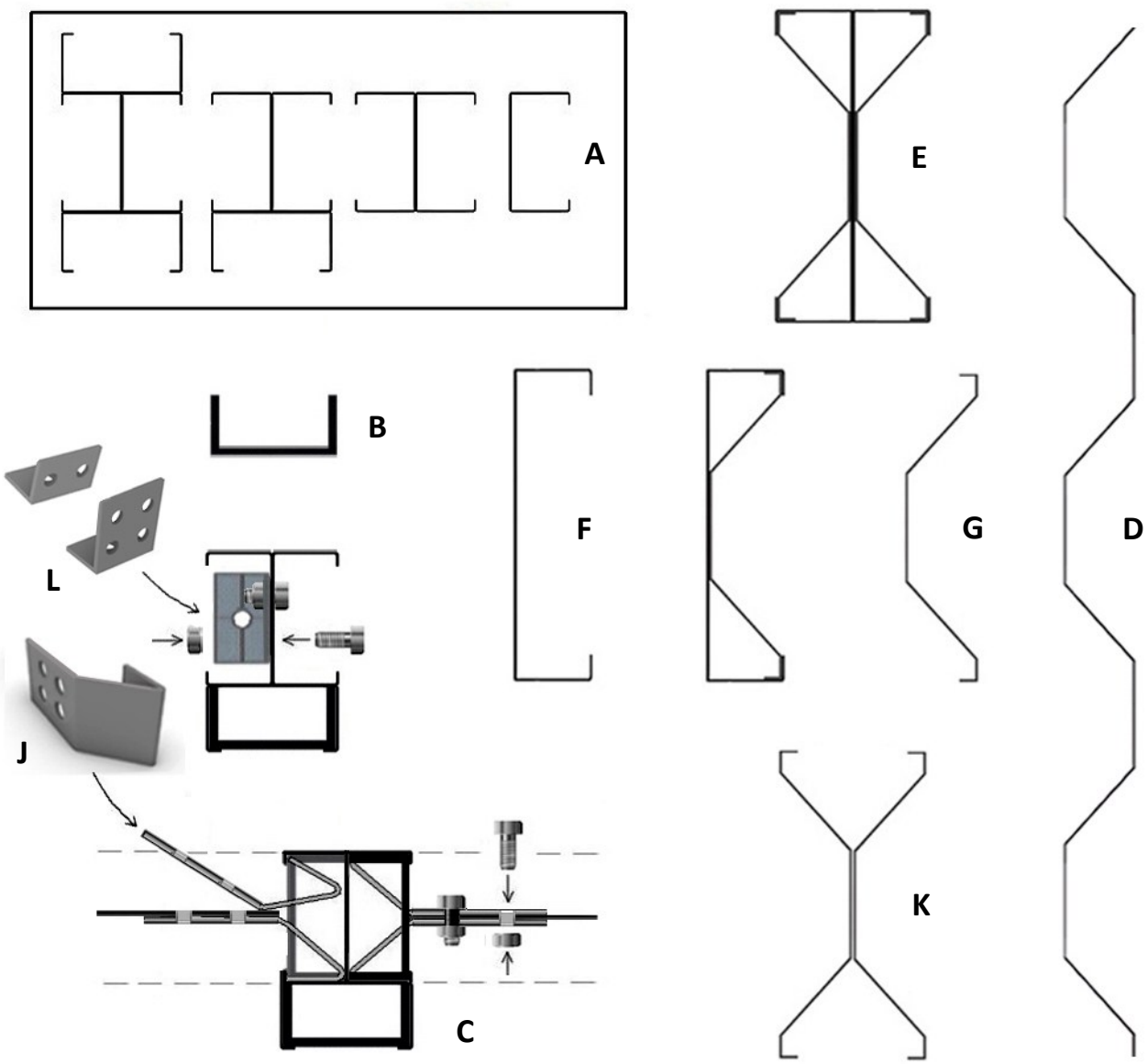
Two extremes of affluence and lack thereof are living examples of what plastics have done to the environment. Bermuda is in the Sargasso Sea, which is a collection zone for anything afloat and adrift. The beaches are often cluttered with plastic stuff, and many of them have rakes provided in an effort to keep up with it all. This has been nothing less than a disaster for marine life. Haiti is the most impoverished place that I have ever been. Subsistence farming and charcoal production have stripped the country of most of its trees, and the drinking water is so unreliable that bottled treated water is the safest option. Many waterways are cluttered in the extreme with plastic. When last I was there, nobody was doing anything about it.

We fundamentally must stop producing PET and HDPE without providing an end game and we must remove what already exists from the environment. The very thing that makes these materials an environmental disaster, their durability, abundance, formability and low cost, makes them useful in our construction system here. Both materials are thermoplastic which makes them reusable and vibration weldable. PET foam is a lightweight, high R-Value panel that can receive fasteners. It is strong in compression but easily ignited. HDPE is used in exterior cladding sandwich panels but has ignition issues of its own.

Glass does not ignite and the materials necessary for making it are abundant.

Glass foam aka FOAMGLAS® can contribute to a LEED ® v4 rating. It is a lightweight, high compression building product with a useful R-Value (~10.32). You can park a car on it. It will not melt below 1000 degrees Centigrade. According to the USDA wildfires can reach or exceed temperatures of 1000 C but are typically ~ 800 C at the high end. The autoignition point of wood varies and is the subject of debate, but a working number is ~ 250 C. FOAMGLAS® insulation is intended to reduce heat input, and extend the time it takes for the temperature of the protected media to reach the critical temperature in industrial applications. FOAMGLAS® will not rot, and can withstand chemical attack. The panel size is limited to 1200 x 600 x 177 mm, but can be profiled to adhere with heat or vibration to PET Foam (autoignition ~350 C) which can weld to itself to create a lightweight monolithic core (as it is used in wind turbine blades). The hot glass panels will expand like space shuttle tiles. A sandwich panel of FOAMGLAS® protecting PET Foam contained within a protected steel frame in full contact with the plastic edge will be very ignition resistant, but further testing is required to determine a working number.

Western Africa is drowning in plastic. Petroleum companies in the region are burning off natural gas directly into the atmosphere. Two environmental disasters that can be diverted to beneficial productive use.

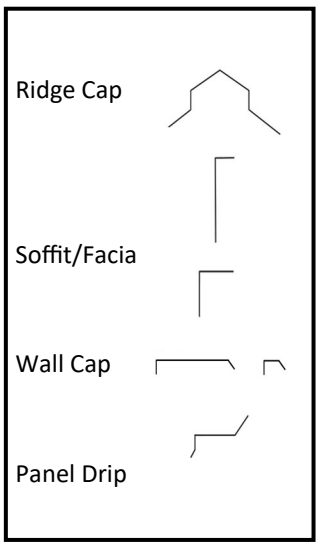


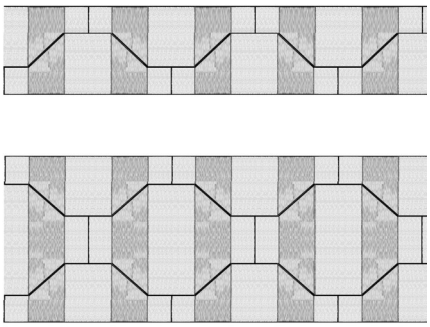
Frame

The framing system is fabricated by 6 work stations that:

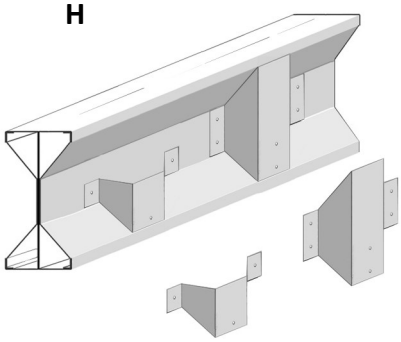
- Form galvanized 100% EAF (always) recycled steel channels **ABF**
- Form galvanized steel decking **D**
- Slice the profiles into parts
- Form the compression angle **L**, moment connector **J** and docking variant **N** (see page 5)
- Drill holes
- Zinc friendly laser braze to add fixity as required

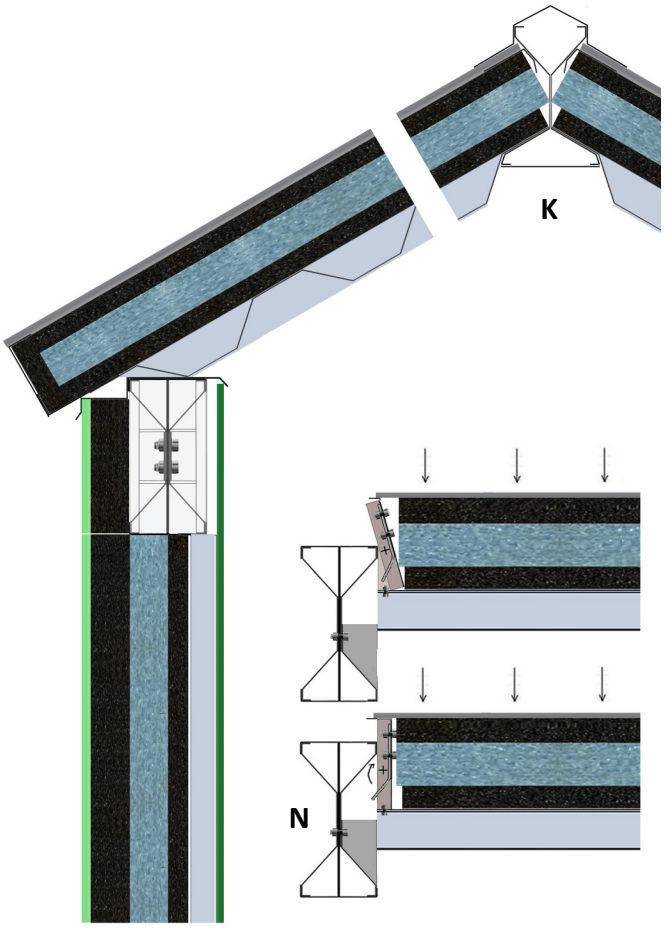
The assembly is built from bundled 3” x 6” (inside clear dimensions) channels **A** (~16 ga± TBD) to create columns **C** (20’ - 30’ max height typ.) within which 3” x 6” (outside to outside dimensions) jack channels **B** (~3 ga± TBD), which can be doubled with a narrower insert, carry compressive loads through moment connections **J** (see below) to leveling plates on piers at grade. The tops of the columns have 3”x 3”x 6” angles **L** (~14 ga± TBD), which receive setting bolts which bear upon 3” x 6” plates at the top of the jacks. Beams **E** (16’ max length) are bundled of 3”x 12” (inside clear) channels **F** (~16 ga± TBD) and cut and formed lengths of profile **G** (~18 ga± TBD), 3” x 12” (outside to outside). Columns receive beams via a 4” wide moment connection profile **J** (~3 ga± TBD) upon which compressed and set jacks bear within the column slots above and below. The beams are fastened to the moment profiles with bolt assemblies **C**. All gauges indicated are to be refined and specified for general use by analysis by a testing facility.



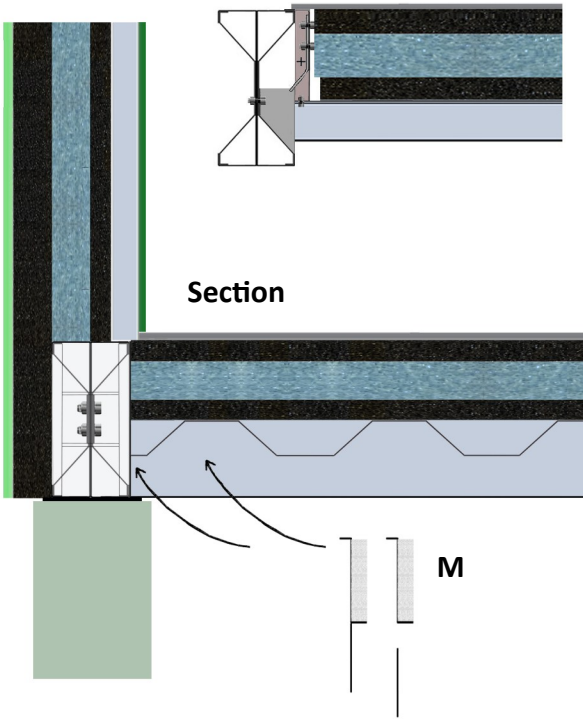


H

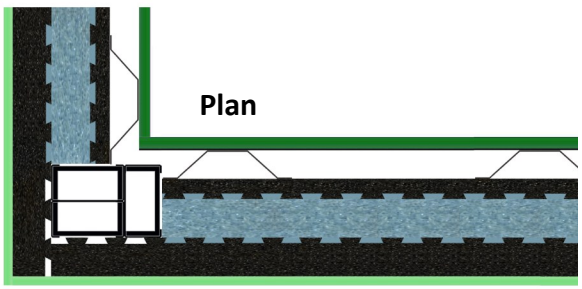




Section



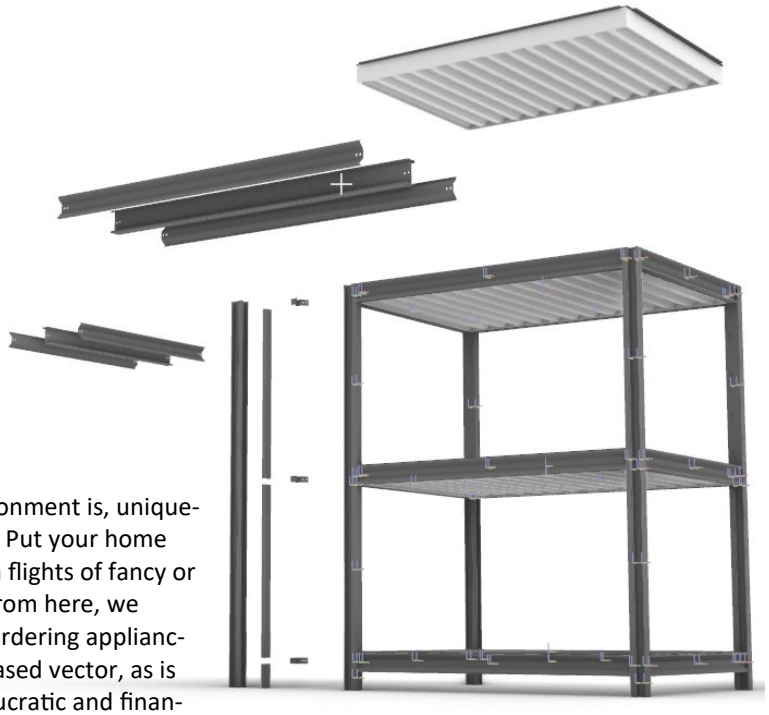
Plan



Panels and Prototype

Panels are made of a 100% recycled high performance P-Foam core laminated (heat, possibly from friction) to and enclosed by a 100% recycled fire tolerant up to 1000C G-Foam. The outer cladding and interior finish may be of a variety of materials but in this Prototype case, the vertical exterior surface is Fiber Cement, and the interior surface panel is made from recycled fibers, fly ash, and recycled cement. Panels for flooring and roofing have Steel Pan Decking **D** supporting the foam assembly and either fast growth cycle Plyboo or PlantD Subfloor, or Steel Pan Roofing above. Profile assembly **K** (see previous page) is useful as a ridge beam that receives panels and readily adjusts to the intended pitch.

Horizontal or Pitched Panels, 12' x 16' (typical), are banded with profiles **M** (16 ga±) which can fasten to the beams from above and to web-stiffener-hangers **H** cut from minimal waste tessellations in the decking profile. These shapes **H** nest clean into the beam's web coplanar with the vertical face of the flange and receive the docking profile **N**, a modified **J** within a channel fastened to a yoke shaped profile that permits rotation during installation and disassembly that is fastened to the deck pan. The 1/2 cut **H** will receive the bearing tab/foot of the **N** assembly. The angle at the top is secured to the beam's flange with self tapping screws. The **H** opening of the half cut will also permit the passage of wiring or forced air. The larger, full **H**, tessellation will be useful in cantilevers, and special load and end conditions.



Marketing, Design and Manufacturing

In our case, they are interlinked because the marketing environment is, uniquely, also the free and deliberately entertaining design website. Put your home anywhere, invite friends' avatars, or a consultant's. Indulge in flights of fancy or design something for real. We track and retain everything. From here, we could go, if the design works, directly to manufacturing and ordering appliances, windows etc. because the RPG-esque program is object based vector, as is CAD, and on to CAM. No fabrication occurs until every bureaucratic and financial box is ticked. Once fabrication is initiated, the individualized home could be occupied in less than a month. The kitchen is provided by "others", although we can install if they keep up.

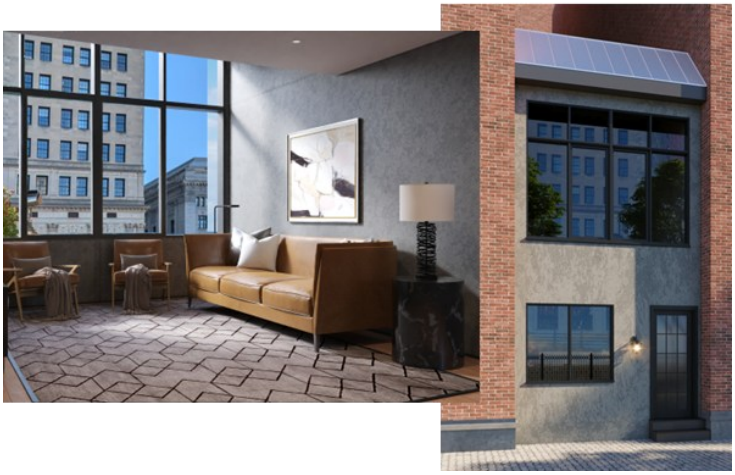
The machines cited on Page 4 will be housed in a re-purposed 'Big Box' store or equivalent with access to demonstrably fertile markets active on our website. The home-site will initially need to be within range of a half-day's drive unless the client is willing to pay added accommodation. Every effort will be made to enable final assembly using sub-contractors to affordably extend that range, and so that this point in the process may become more of a matter of delivery and supervision. Every assembler will be trained by us, use approved (by us) and regularly inspected (by us) equipment, and wear a centrally monitored (by us) body-camera/communications device.

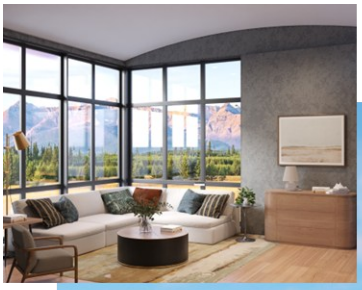
Adding a facility locally will accelerate production significantly. Adding a facility in another active market will expand market presence. This arrangement will be capable of offering much to those regions that have suffered great loss of housing.

Our innovative utility core design keeps the costly licensed specialists in a central location working on multiple projects simultaneously. Inspection, a bottleneck known well to all contractors may occur at the plant. Inspection in the field of everything else is simplified by easily removable interior surface panels. In the future, it is conceivable that, in the United States, interstate HUD codes will no longer require the absurdity of a permanent chassis with wheels.

The Prototype Service Core is an 8' x 8' x 20' (20'-30' high typ.) shipping container anchored into a service and foundation pit. The core contains an upstairs bath with plug and play laundry hookups, and a downstairs powder room, utility room with plug and play kitchen hookups. The core stiffens the frame and has the potential of being a refuge of last resort. It feeds the plug and play wiring, HVAC, plumbing, and will supply wireless service and 0,0,0 point of origin transmitter to aid robotic navigation and smart screen displays during assembly or modification. Final Punch will employ VR. We will actively develop robotics longterm for all points in the process.

En-Habit is a sustainable, durable, efficient, versatile, more affordable method of design and construction, with thousands of variations and applications.





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