Spaceframe Housing Concept

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March 29, 2021

Dear Mayor Wheeler, City Council and S2HC Project Staff:

I urge you to consider 'spaceframe' building technology as an additional tool for providing deeply affordable housing.

Spaceframe theorists and architects like Alexander Graham Bell, Buckminster Fuller, Konrad Wachsmann and Peter Pearce have set the stage for applying spaceframe technology to housing. Whereas they generally focused on large structures, I propose that we can purpose spaceframe concepts to small structures to create micro-villages in urban areas where it is unfeasible to build with conventional construction methods.

When viewed through the lens of conventional housing methodology, our urban landscape looks fully developed. However, when viewed abstractly as a three-dimension space, without preconception of what housing should look like, we realize there is a lot of developable open space in, above and around this gridwork of residential and commercial enclosures. Through the lens of spaceframe technology, we can 're-see' the urban landscape and realize that there are many spaces where we can build clusters of durable, aesthetic, deeply affordable, 1 to 2 person living units.

A spaceframe can be generally characterized as a set of tubular steel struts that are bolted at their endpoints to a 'connector joint' to create a three-dimensional geometric network of nodes in patterns of triangles and squares. In geometric terms, a space frame is a Tetrahedral-Octahedral Lattice. Bucky Fuller called them 'OctTet Trusses'. Every node in a spaceframe is 'triangulated' giving the overall structure exceptionally high load bearing stability across long spans at lower cost than wood, steel I-beam, or reinforced concrete solutions. From a small standardized set of strut and panel components a wide variety of spaceframe shapes and sizes can be built. Spaceframe structures can be 'truss planes' (platforms), 'polyhedral enclosures' (living units) or 'linear tubes' (connectors/walkways). Herein, I focus mainly on platforms, inspired by the design of the building pad of Peter Pearce's Eco-House[1]

Unlike conventional buildings where a load-bearing concrete foundation generally corresponds to the perimeter of the house and requires many interior supports, because of the high spanning and load-bearing capabilities of an Octet truss, support-to-ground can be concentrated onto a comparatively small number of augured-and-poured concrete columns. This key characteristic makes it technically and economically feasible to 'harvest' open space in the residential and commercial urban gridwork that conventional construction methods cannot.

There are infinite potential ways to create spaceframe housing units. Polyhedral domes have been dabbled with for some time. However, I think that the most effective strategy is to concentrate on using spaceframe truss 'platforms' to literally create new buildable land. Upon stable and flat spaceframe

[1] See: https://www.amazon.com/Beyond-Green-Century-Architecture-Ecohouse/dp/151764027X for a visual. Note that Peter's website http://pjpearcedesign.com is not working unless you disable Flash.

platforms, with areas in the range of 1-2K ft², multiple prefabricated tiny housing units, with areas in the range of 100-200ft², can be anchored. For example, on a 1500ft² (50ft x 30ft) platform, four 200 ft² (20ft x 10ft) prefab housing units could be sited with ample access pathways and privacy patios, creating a tiny neighborhood. Depending on the site, multiple such neighborhoods could be interconnected by spaceframe walkways. While a spaceframe platform could support various kinds of housing units, a prefabricated metal Quonset-style unit (with a door and a window placed in the end panels, with a kitchen counter, a bed platform, a bathroom, and a small sitting area) strikes me as a cost effective, aesthetic choice.

A standard floor panel on a spaceframe platform would be an equilateral triangle (with approximately 3ft edge lengths) made of sturdy sheet-metal with an anti-slip, rust-proof coating, and perforations to allow water through. Floor panels would be designed to easily affix to the plane of spaceframe struts, creating flat, walkable 'artificial land' on which to place housing units.

Overall Vision

The versatility of spaceframe building technology allows us to 'harvest' urban space that is not possible or economically feasible to build on with conventional methods. There is a spectrum of space harvesting opportunity, from easy to bold, potentially yielding significant amounts of buildable space:

Easy

- The immediate low-hanging fruit is sloped or craggy land where it is unfeasible to excavate and build elaborate concrete foundations required by a conventional building, i.e., hilly private lots, sloping roadway aprons, etc.
- Irregularly shaped areas where an inter-connected series of narrow spaceframe platforms can be laced through.

Bold

- Elevated platforms: 1 to 1.5 story high platforms could be located above and across alleyways or unusable commercial open spaces.
- Elevated platforms could run above and along residential property boundary lines.

Spaceframe Value Summary:

- **Low material cost:**
  - Construction kits, comprised of standard struts and panels, can be factory-produced, resulting in lower materials cost and fast assembly.
  - Components can be factory coated to ensure that finished structures are permanently weather-resilient resulting in ultra-low maintenance costs.
- **Low construction cost:**
  - Excavation and foundation work minimized. Environmental impact minimized.
  - All components can be handled by a human worker minimizing the need for heavy lifting equipment.
  - On-site assembly of struts and panels is a repetitive uniform operation that can be performed by workers with low to medium construction skill. Relatively simple training requirements.

- Platform sub-sections could be prefabricated in a factory and shipped to the site for assembly thereby speeding up overall assembly of platforms.
- Prefabricated finished housing shipped to site after the platform is up and then easily attached onto the platform.
- With plenty of space under and within the spaceframe platform, hook-up of electrical, data and plumbing utilities is easy.
- No specialized tools or onsite welding is required. Conventional mobile cranes and boom buckets, conventional hands tools, etc. can be used in the assembly process.
- Metal Quonset-style enclosures, like spaceframes, are simple to assemble, inexpensive, lightweight, and weather-resilient with ultra-low maintenance. They can be factory prefabricated in sections then trucked to site where they are bolted onto the platform.
- The most cost-effective foundations would consist of reinforced concrete columns that are poured into augured holes.
- After the foundation columns are set and water and electrical utilities are in place, truss components and housing kits are delivered to the site. From then on, platform assembly, anchoring the enclosure huts and getting a village into a move-in state is likely in the range of a few weeks.

- Intrinsic Value of Geometry:
  - The magic of spaceframe lies in the repetition of uniform connections of simple parts yielding a fully triangulated stable platform with large span capability.
  - The geometry of spaceframe, i.e., size and shapes of struts and panels, the design of connector units, has been determined. It is established art. No need to invent novel methods.
  - The stability and load-bearing capability of spaceframe trusses meets most building codes and requirements.
  - High-wind and earth-quake resilience.
  - High flexibility to fill a variety of open spaces, with minimal impact on the environment and to surrounding structures, due to fewer touchpoints to ground.

The above is a brief sketch of a bold proposal, but I believe that meeting Portland's immediate housing needs requires bold thinking and bold action. Considering that existing neighborhoods and industrial areas have utility and transportation infrastructure in place, and have proximity to stores, services, schools, and parks, we all recognize the enormous economic value of infilling within the urban area. It is thus imperative to consider, debate and act upon all reasonable infill strategies.

With this testimony I want to get spaceframe building technology 'on the table' for consideration. I regard spaceframe as a credible candidate for infill and extremely low-cost housing. I believe that undertaking a 'proof of concept' project represents a tremendous opportunity for Portland to show leadership in urban development innovation.