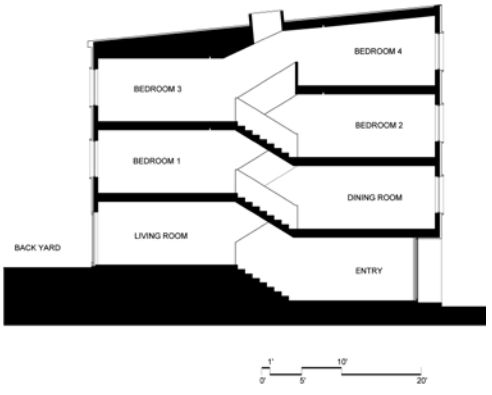
WILLIAM P. MACHT

Space-Efficient, Energy-Efficient Design

A vertical system of flexible spaces within a townhouse design maximizes space and energy efficiency while minimizing development and operating costs.

When architects turn developers, many gain new insights into how to produce more space, more efficiently and at lower cost. Portland, Oregon–based architect Ben Waechter trained with architect Renzo Piano in Genoa, Italy, and worked with Brad Cloepfil, principal at Portland's Allied Works Architecture, known for his museum work, e.g., the Seattle Art Museum extension, the Museum of Arts and Design in Manhattan, and the Contemporary Art Museum St. Louis in Missouri. Armed with this exposure, when Waechter recently came to design his own development project, he combined a European and minimalist aesthetic sensibility with a developer's sense of how to build more space for less money.



A series of seven interlocking spaces, offset at each half story, are smoothly joined by a series of half-flight stairs. In alternating fashion, the rooms occupy front and rear portions of the building, giving rise to the "Z" pattern that gives the houses their name, Z-Haus. Six of the seven levels are all identically sized universal rooms that can be used for any set of functions—living room, dining room, bedrooms, office space/studios—that the owner chooses.

Waechter found a single 50-by-100-foot (15-by-30-m) lot in Portland's newly trendy North Williams area and divided it into two 2,500-square-foot (232-sq-m) fee simple–ownership lots. Rather than build narrow, detached single-family houses, he eschewed side yards of minimal utility and designed a single structure containing two nearly identical townhouses, identifiable only by two single-car garage doors.

From the street, the building's spartan facade belies the spaciousness of the interiors. The land slopes up to the west a half level, permitting, with a simple and economic west-sloping shed roof, houses with four stories in the front and three stories in the rear. The height allows for views of both Mount Hood from the front and downtown from the back. Each townhouse contains 2,814 square feet (261 sq m), but appears larger.

Two distinct spatial orders of the houses visually enlarge internal space. The first order is a series of seven interlocking spaces, offset at each half story, smoothly joined by a series of half-flight stairs. The split levels afford simultaneous views to the level below and to the one above. In alternating fashion, the rooms occupy front and rear portions of the building, giving rise to a "Z" pattern. At any level, daylight is visible through the house and it is possible to converse with people on different levels, giving a transparency to what could otherwise be a visually opaque space.

The flow of spaces into each other is reinforced by the stair design. The white oak floor spirals back and forth up through the building, connecting each room in a vertically open plan. Emphasizing this continuity, the stair treads are cut flush and sanded smooth to give the appearance of a folded floor plane rather than a series of stair parts. Each level remains free of doors. Yet each level can be closed for flexible privacy by sliding a massive, full-height eight-by-eight-foot (2.4-by-2.4-m) sliding wall panel to achieve acoustic and visual separation from room to room when closed, yet seamless flow of space when open.

Six of the seven levels are identically sized 19-by-14-foot (5.8-by-4.3-m) universal rooms that can be used for a variety of functions—dining room, living room, bedrooms, offices, studios, or any combination desired. The seven levels are joined by the second spatial order of the house, which is a vertical stair and wet core of service rooms, kitchen, bathrooms, and mechanical spaces. What makes the primary spatial order space-efficient is that it totally eliminates internal hallways, thereby making all of the built space usable. The second spatial order's energy efficiency stems from the stacking of all mechanical, electrical, and plumbing functions in the center of the open floor plan, with the only utility runs beyond that being the radiant tubing and electric lines under the sustainably harvested white oak floors.

The vertical organization of the edifice lends itself to natural stacked ventilation. The operable skylight at the top of the stairway acts like a chimney in the warmer months—drawing air up through the building and providing gentle airflow passive cooling, eliminating the need for energy-consuming mechanized cool-

ing. Ductwork and pipes run through a single vertical chase exiting at the roof. All mechanical equipment is located centrally at the top. Both domestic hot water and radiant floor hot water are heated with high-efficiency gas equipment. All exhaust venting, including bathroom fans and kitchen cooktop hood and dryer exhaust, are vented through the roof. This eliminates unsightly vents on siding, making for a clean, uncluttered facade. A central vacuum system was installed in the central chase to ensure clean and dust-free air.

The structures are heated throughout with a radiant hydronic floor heating system. Radiant floor heat provides numerous benefits, including even temperatures, cleaner air without

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cold drafts, and the elimination of intrusive ductwork and floor vents, while being quieter and more energy efficient than forced-air heat. The water in a radiant system has the capacity to transport 3,500 times as much heat as air, so it can heat using less energy than a forced-air system.

The windows are placed at corners of rooms where they can bounce sunlight deep into interior spaces. The windows have tilt-pivot hardware that can tilt inward for ventilation or open completely like a standard casement window. The patio door has tilt-glide hardware that can tilt for ventilation or slide open similar to a van door. The window frames are made of uPVC, which is unplasticised poly-vinyl-chloride, a thermal product made from petroleum byproduct and salt that is colorfast, ultraviolet, and impact resistant.

The demising walls between the two houses have been engineered to eliminate sound transfer from one side to the other. The system is made up of a double-framed wall with a one-inch (2.54-cm) air space between them to acoustically isolate one from the other. The outside of each wall is clad with one layer of half-inch (1.27-cm) plywood and two layers of 5/8-inch (16-mm) Sheetrock, an assembly that creates acoustical separation. Plywood sheathing was used for all exterior walls rather than oriented strand board (OSB); plywood is substantially more expensive than OSB but was chosen for its resistance to moisture damage.

The exterior walls have a breathing rain-screen, in which the siding is held away from the building wrap and sheathing to allow air to circulate behind the siding, thereby minimizing any potential moisture buildup. This air space also provides an additional thermal buffer, increasing the performance of the building envelope system. The circulating air also helps prevent mold and mildew growth that may cause sick building syndrome. By attaching the two houses, energy efficiency is also increased because about a third of the wall area envelope is not in contact with the exterior elements.

A small building footprint maximizes outdoor living space and reduces the amount of stormwater runoff from the roof. The roof membrane is made of thermoplastic polyolefin (TPO), a rubberlike material that can be reprocessed and is 100 percent recyclable. The white TPO membrane roofing has a high level of reflectivity, maintaining a cooler interior temperature, helping to meet Energy Star performance levels. The driveway is a series of individual concrete pavers alternating with green voids that allow water to percolate into the ground, reducing the amount of stormwater runoff.

The townhouses are Energy Star rated, ensuring that they are 30 percent more energy efficient than a standard newly constructed house, resulting in lower operating expenses. UL

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