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# **YOURSPACEKIT: OFF-SITE PREFABRICATION OF INTEGRATED RESIDENTIAL FIT-OUT**

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## **INTRODUCTION**

The residential real estate and development industry will eventually recover from the 2008-2012 recession, at which time all players will seek new competitive advantage. This will be a good time for residential developers, architects, builders and supply chain agents to find new opportunities for producing a sustainable building stock. **Paradoxically, a building stock designed for high performance and endurance depends on the emergence of a FIT-OUT industry, responding to demand from households for personalized living environments.** The two go together: a long-lasting and coherent architectural infrastructure rooted in place and growing out of shared values; and dwelling environments meeting authentic and naturally evolving household preferences. A robust and competitive FIT-OUT industry is thus very important, if the creeping commodification of housing is to be overcome. In international circles, the theory and methods of realizing this is called Open Building (1).

## **HOUSING IN CRISIS**

With the dominance of scientific management before and after World War II, the production of housing as a commodity took off with a vengeance, in market-oriented and centrally controlled economies alike. While the wealthy classes use housing as a plaything, the middle class has to accept housing marketed as a commodity. The resulting alienation was powerfully pointed out in Habraken's seminal book *SUPPORTS* (2). The forces aligned to sustain this system are formidable, but may buckle under inherent inefficiencies and inequities. This essay suggests that this is already evident, and sketches what such a housing stock – and a FIT-OUT industry – would be like.

### **Housing as a commodity**

When housing is treated as a commodity, ordinary environment suffers a pathology in which households are separated from the making of material culture. Experts assert that “people” want dwellings finished and ready to occupy, an assertion based on focus groups, trend analysis and other pseudo-scientific research strategies that classify people into the latest categories.

In part, this assertion is correct. We have a kind of tyranny of experts in which professionals are closing the open society (3), and

the leisure classes are increasingly harried (4). Yet the data shows that more money is spent in an average year by households at home project centers than is spent on new construction.

Yet the pacification of citizens into consumers is troubling in respect to the health of the residential building stock and becomes self-fulfilling. Experts and consumers alike are led to objectify the everyday environment, reducing individuality to statistical averages. Some argue that this is exactly what the ruling class wants – a compliant society easily manipulated by slogans and branding. We need to ask who is served by such misguided processes, and what are the consequences of their application?

The commodification of housing is a deeply subversive activity. Just as the food industry prepares ready-to-eat packaged meals of great variety but of little nutrient value, the housing industry prepares ready-to-occupy houses of great variety but of no authenticity. At what cost do these perverse forces do their work? The practices of the food industry work against a healthy diet. The dominant mode of housing production works against a healthy built environment and the natural relationship – households in direct control of their immediate dwelling environment (2).

### **21<sup>st</sup> Century Mass Housing**

We have learned the hard way that the commoditized mass-housing estates of the last half of the 20<sup>th</sup> century resulted in social/economic distress and a slowly but inevitably decaying environment now demanding massive investments to salvage value from them. The alternative is demolition on a massive scale never seen before. This is happening in the US, Europe and Asia (5).

The housing industry now tries desperately to produce variety to replace the numbing uniformity that everyone had assumed was needed to reduce cost and produce the needed quantity of housing. Yet despite the appearance of variety, the process is still essentially a commodity process, only at higher cost because of the futile effort to produce “choice”. The variety is false, just like the proliferation of packaged food variety is no substitute for real cooking.

Housing is a complex business. Many agents are involved and no single one is at fault for the malady we now face. Consequently, no

single power can reverse the commodification process. There are many competing and conflicting interests and priorities, issues of finance, logistics, construction, standards, and community values to balance. There is time to consider and time is money. Experts assume and have persuaded everyone else to assume that the “natural relationship” is inefficient. What we assume to be correct has enormous consequences on our perceptions and actions.

Given this, it is no surprise that authentic housing variety is hard to deliver. That is our challenge and opportunity: to cultivate a housing process that enables a dynamic equilibrium between the interests of the community and, on the other hand, the interests of and possibilities for each individual household to make its mark, or, as Sennett argues, to “make inner life concrete.” (6)

### Open Building has some answers

Open building has some answers to overthrowing the tendency toward housing commodification. It may be the housing industry's equivalent to the slow-food movement. But, because analogies can only go so far, a brief explanation of open building is in order.

Open building's fundamental principle is that the individual household must have a distinct and decisive role in the housing process. But shared interests must have their place as well. These two spheres of control must first be recognized and clearly distinguished. Then, they can be negotiated and coordinated. This duality of control can be fraught with conflict, but eventually requires balance, and answers to such questions as what can the individual family decide? What must be decided by the community, within which the individual dwelling is situated? In multiple dwelling buildings, where the shared infrastructure is three dimensional, sorting out this question is most difficult, but the same issues are evident even in the single-family dwelling.

### Several Principles

Open building theory and methods offer several principles. First, the “base building” - building structure, main utility systems and façade - must be designed to enable a variety of unit sizes and floor plans to be installed initially and over time. This is a process called “capacity analysis” and is intuitively grasped when we move into a new house and say to ourselves “this room would work for an at-home office” or “this would be a good room for the kids.”

Most if not all of the façade, some of the utility systems and all of the load-bearing structure belong to the “base building”, offering an architectural infrastructure satisfying shared values and technical requirements, and shaping public space, inside and outside the building. In such an infrastructure, the utility or service systems serving one dwelling must not go into the space of another dwelling: e.g. never place the outflow of the bathtub and toilet in the ceiling of the dwelling below! (7)(8)

Working this way has consequences. If the architect does not know the dwelling floor plans – or if these decisions are deferred until the

building as such is completed - how can she design the building? (9) If the number and size of dwellings is not known initially, how can the banks lend money, or the building officials approve the parking space count, or the building engineer size and locate the structure and main piping and service systems? And if the dwelling units are not built-out as the building goes up, how can they be installed after the architectural infrastructure is completed, and later as the building continues to slowly adjust dwelling-by-dwelling, over its long, sustained life?

Answers are available, as open building projects built around the world attest. The design and construction methods are well documented elsewhere as are exemplary built projects following these principles (10). Developers know how to make real estate investments without specifying uses; architects know how to design them and contractors know how to give good prices and build to high quality. While early pioneering projects were experimental, current projects are being built under real economic conditions.

Now, we see the emergence of two distinct markets: a market for base buildings, and a market for FIT-OUT. This is very similar to developments in the more mature office and shopping center markets, where the distinction between a base building and tenant work (or “fit-up”) are so conventional as to be unquestioned. Real estate, regulation, construction, design and engineering all are comfortable with this separation.

But, where residential open building projects are becoming conventional, suitable products and systems, and companies to deliver them on time and on budget, are still needed.

This points to the importance of the cultivation of a FIT-OUT industry, populated by large and small enterprises focused on merging products and services in their deliverables. These product/service companies will be similar to IKEA but will draw on the much deeper well of everyday products available at any home project center or building products distributor or advertised in leading journals and trade publications. Complete product bundles will be prepared for each individual dwelling unit in prefabrication shops and distribution centers, delivered with assembly instructions in boxes and bundles, and put together by multi-skilled installation teams inside the space to be inhabited.

### How a FIT-OUT company would operate

Once an empty dwelling unit space is sold or leased, and decisions are made about the dwelling's fit-out specifications, the cost and delivery schedule, the order goes to the FABRICATION FACILITY. Here, each order for a customized FIT-OUT PACKAGE is prepared, one dwelling-at-a-time. Inside the facility, trained workers prepare all the specified parts, using advanced fabrication methods, jigs, etc. to prepare the “ready-to-assemble” FIT-OUT PACKAGE. Each PACKAGE is a “project”, with a contract, warrantee, delivery schedule, installation instructions and a users manual. The process is organized and supported by advanced information technology.



Figure 1. Display models/fabricating/loading/ delivering

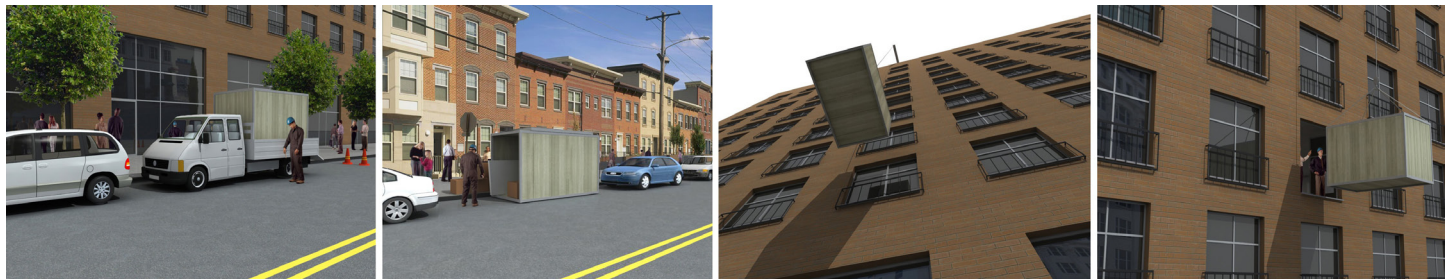


Figure 2. Unloading



Figure 3. installation/dwelling ready to occupy

Following the parts inventory prepared by the integrated software system, the bar-coded parts, in their boxes or bundles, are loaded into containers, the number of containers depending on the size of the dwelling to be fitted-out. Some products (e.g. bathroom fixtures, or kitchen cabinets) may be off-loaded at the FABRICATION FACILITY already palletized by the supplier, a process that is already familiar. Along with the parts prefabricated in the FABRICATION FACILITY, everything is loaded into the containers, in reverse order of their on-site installation.

The containers are delivered to the site where the FIT-OUT PACKAGE will be installed. Some few, specialized products may by-pass the FABRICATION FACILITY and be delivered directly to the site. A trained, multi-skilled work team is there, ready to receive the delivery and to begin installation work. The sequencing of these deliveries is planned to match the speed of on-site work.

When the container reaches the building, the container is dropped near the front door, hoisted up to the window or balcony door, or

the parts are loaded into a freight elevator. This way of handling materials and equipment using boom delivery trucks is familiar, but some considerations of the architecture may be required. Everything must be small enough to go into the empty unit through a doorway or large window opening. Once all the parts have been brought in, the container is returned to the FABRICATION FACILITY for the next delivery, with packaging debris and other waste products resulting from the installation process. In some cases, a portable toilet may be included in the delivery.

The multi-skilled installers, operating as an integrated team, complete the phases of the fit-out, following detailed installation instructions that come with the PACKAGE. Since each FIT-OUT PACKAGE is different (but part of the same system), the installation team performs as a learning organization, taking full responsibility for completing a FIT-OUT PROJECT, one at a time. The same multi-skilled team works on the job until it is completed as a “turn-key” design/built project at which time it is assigned to another FIT-OUT PROJECT, in the same building or another.



In most cases, the entire FIT-OUT process – from signing the contract to finishing the installation punch list – should take no more than three or four weeks for an average sized dwelling unit, once the space is demised. Since all of the plumbing, wiring and air conditioning equipment and installation lines for a dwelling's FIT-OUT PACKAGE are contained inside the dwelling unit's legal and fire separation walls and floors, the installation of each dwelling's fit-out is independent of other dwelling units. If one unit's FIT-OUT costs more than the next, no one has to know, except the occupant. The average cost will equal the cost of the cars the household drive.

### New Business Forms

Architects tend to become focused on technical issues when architectural innovation or changes of practice are the subject. Those are important, but equally important to technology is the business model and business plan needed to bring something new to market and to survive. In fact, something new will generally have the most difficult time coming to market, because there are no comparable products or methods to refer to. It is always far easier to develop a business plan, attract investors and enter a market with something – a method or product – which already has a name in the formal and informal classification system. This is especially the case in the building industry, where risk aversion is deep-seated for good reason.

### New Products

A number of new products are available to make FIT-OUT work proceed faster.

Several performance measures are common to all products and systems in the FIT-OUT repertoire: 1) They contribute to avoiding the entanglement of different units of occupancy (e.g. no drainage pipes serving one dwelling penetrate into the ceiling space of dwelling units below); 2) They uncouple parts with long service life from parts needing to be changed more frequently; 3) They are relatively simple products and lend themselves to the DIY market.

An international survey of such products results in identifying two of the most important. They are CABLESTUD (to provide flexible wiring solutions) and the MATRIX TILE SYSTEM (with 0-slope gray water drain piping). (11)

### CABLESTUD

**CABLESTUD** is a patented product made of fiber reinforced fire retardant plastic, and has passed acoustical and structural/stress tests. It inserts into the bottom of typical non-structural metal studs, or in a notch at the bottom of a wood stud, providing for rapid installation of electrical and data cabling with connections made behind a removable baseboard. Installation of the electrical and data cabling, boxes and devices can take place in one efficient operation following erection of the metal studs and gypsum board. "MINI" struts are used with 1½" hat channels; "MIDI" struts are

used in 2 ½" metal studs as "wall liners" against demising walls; "MAXI" struts are used in typical 3 5/8" stud walls. A "MICRO" strut is available for use in wood frame construction. Electrical and data cables and devices can be repositioned quickly and easily, at much lower cost and disruption than in typical electrical installations. The product is classified as a building product, and performs as part of the partition. **CABLESTUD** is compatible with standard, code approved wiring and data technology in the United States and Canada (such as MC or NM cables and boxes), using either standard junction boxes or such quick-connect products as Molex's self-contained power connector and tap, depending on the occupancy and construction classification.



Figure 4. CABLESTUD version for non-loadbearing metal studs, using a MOLEX self-contained power connector and tap

The standard practice of installing cabling within a demised space – buried in walls – is obsolete. Conventional methods require several visits by the electrical and data subcontractors (with associated mobilization/coordination/scheduling issues), and result in installations where no one knows where cables are after drywall is installed. Conventional installation practice also means that decisions about where to locate convenience outlets, switches,

wall lights, and data ports must be made early, sometimes before preferred equipment and furniture specifications are known. Burying cables and outlets in walls makes changes costly and disruptive, even during the construction phase.

### The cablestud solution

CABLESTUD provides a good solution. While adding a small up-front material cost (each strut costs about \$10.00), this cost is small compared to the time saved in installation and the possibility to easily relocate and add new outlets and data ports.

### The MATRIX TILE System

The Matrix Tile system assures rapid and accurate piping installations and maximum floor plan variety within a demised space, with no interference with spaces below because its use avoids floor penetrations except at the building's vertical pipe shafts. Applications include both new construction, adaptive reuse of entire buildings, and one-unit-at-a-time transformation/renovation, for residential projects (particularly townhouse and multifamily buildings); nursing homes; office buildings, medical offices; commercial and retail uses.

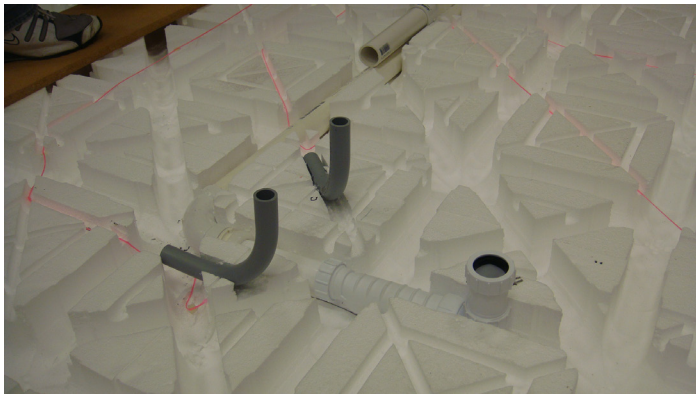


Figure 5. The Matrix Tile with O-slope drainage piping in place using a WAVIN waterless waste valve instead of a low-profile water trap

The Matrix tile is loosely laid on top of the leveled base building floor. Grooves of various sizes and located in several horizontal “zones” allow the secure placement of pipes or conduits for various services, such as hot and cold water lines, gray-water drainage lines, heating pipes to radiators, floor heating, flat ventilation ducts, gas pipes and so on. This “tile” is covered after lines and conduits are installed by a fireproof subfloor. Of particular significance is the opportunity to install O-slope gray-water drain lines, in specific relation to the Matrix Tile, a method certified by KOMO-KIWA in the European Community in 2009.

The Matrix Tile system solves a number of problems and offers a number of advantages.

### Developers/ project investor benefits

1. Allows project investors to avoid premature decisions tied to floor plans and equipment – the “decision deferment advantage” – thus offering significant decision flexibility initially and over the life of the building;
2. Allows building owners to meet individual occupants’ floor plan layout preferences, independent of other units of occupancy above or below;
3. Allows building owners to manage multi-occupant buildings with fewer disputes and conflict between occupants, because piping serving one occupant space is no longer in the ceiling space of the occupant below.

### Advantages for Contractors/Installers:

1. Using low-profile water-seal traps or waterless waste valves in the Matrix Tile eliminates floor penetrations or core-drilling at each plumbing fixture;
2. Reduces coordination and interface problems between subsystems and trades: 1) between base building floor pipe sleeves and fit-out equipment positions; 2) most piping is removed from walls, reducing installation sequencing and scheduling problems);
3. Increases on-site efficiency and technical control of piping installations;
4. Reduces pipe maintenance and space rearrangement costs because access to neighboring spaces is avoided.

### Advantages for Inhabitants/Users:

1. Enables customization of floor plan layouts initially and during later changes to floor plans;
2. Helps avoid conflicts and disputes between neighbors;
3. Increases sound isolation between units of occupancy.

Infill Systems BV (Delft, The Netherlands) holds the patent for CABLESTUD and the MATRIX TILE System. INFILL SYSTEMS US LLC has the exclusive license for CABLESTUD for the North American market.

## CONCLUSIONS

The trend toward commodification of housing - to which Open Building and a FIT-OUT industry offers an antidote - arose not out of a pernicious effort, but by many convergent forces none of which is to blame. It is therefore difficult for corrective measures to take hold, because no single party can appropriate the benefits of the new paradigm. But new realities bring new necessities, and the convergence of three dominant characteristics of contemporary built environment point inevitably toward the adoption of open building and the emergence of a new industry discussed in this paper. First is the increasing size of building projects, sometimes serving thousands. Second is the dynamics of the marketplace where use (function) is increasingly varied and changing. Third is the availability of, and demand for, an increasing array of equipment and facilities serving the inhabitant/user, all made by

sophisticated manufacturing processes in which the producer takes the initiative independent of any specific project, and where large volume production reduces per-unit cost.

In that convergence, large-scale real estate interventions make simultaneous design of the base building and the user level impractical. Social trends toward individualization of use make functional specificity increasingly personalized. Greater complexity and variety of living environments demand adaptation by way of architectural components with shorter use-life, such as those shown in this paper. The separation of base building from fit-out includes utility systems as YOURSPACEKIT shows. Adaptable piping and wiring systems on the fit-out level, for example, connect to their counterpart and more fixed main lines in the base building, which themselves connect to the higher level infrastructure operating in the city.

Thus we see a significant contrast between what is to be done on the user level on the one hand and what is understood to be part of the traditional long-term investment and functionality of the building on the other hand.

This is the reason for the emergence of the base building as a new kind of architectural infrastructure and the slow but steady growth of demand for the kind of product/service outlined in this essay. These are some of the reasons that the commodification of housing can no longer be excused on the grounds that centralization of control is more economical. YOURSPACEKIT shows that variety can be efficient.

## ENDNOTES

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