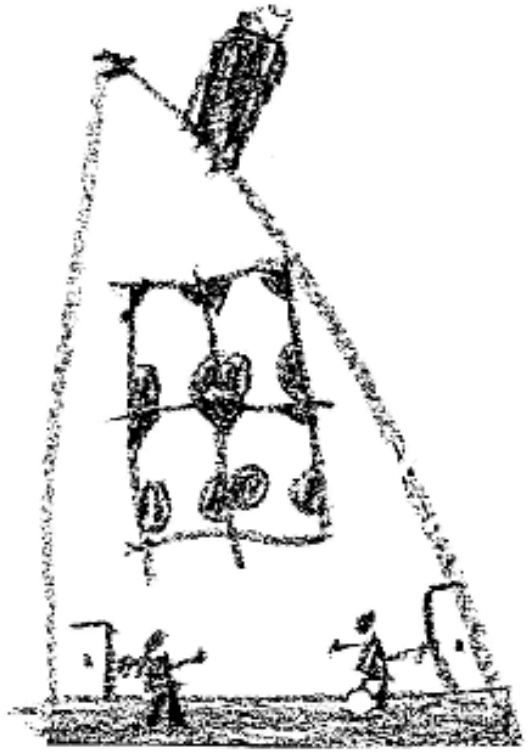
HOMEWORKS®

A New American Townhouse



Stephen Kendall, PhD

Director, Building Futures Institute
Ball State University

August 2005

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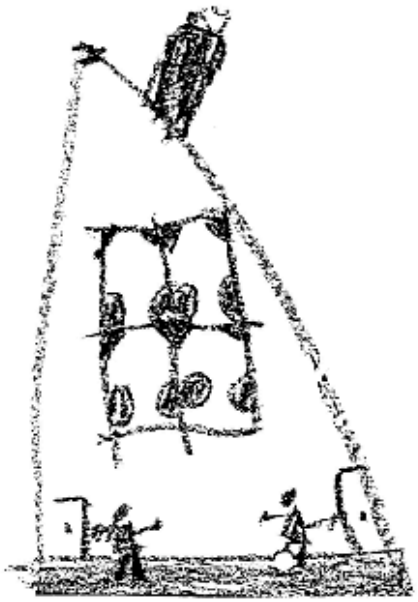

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- Homeworks' Principles
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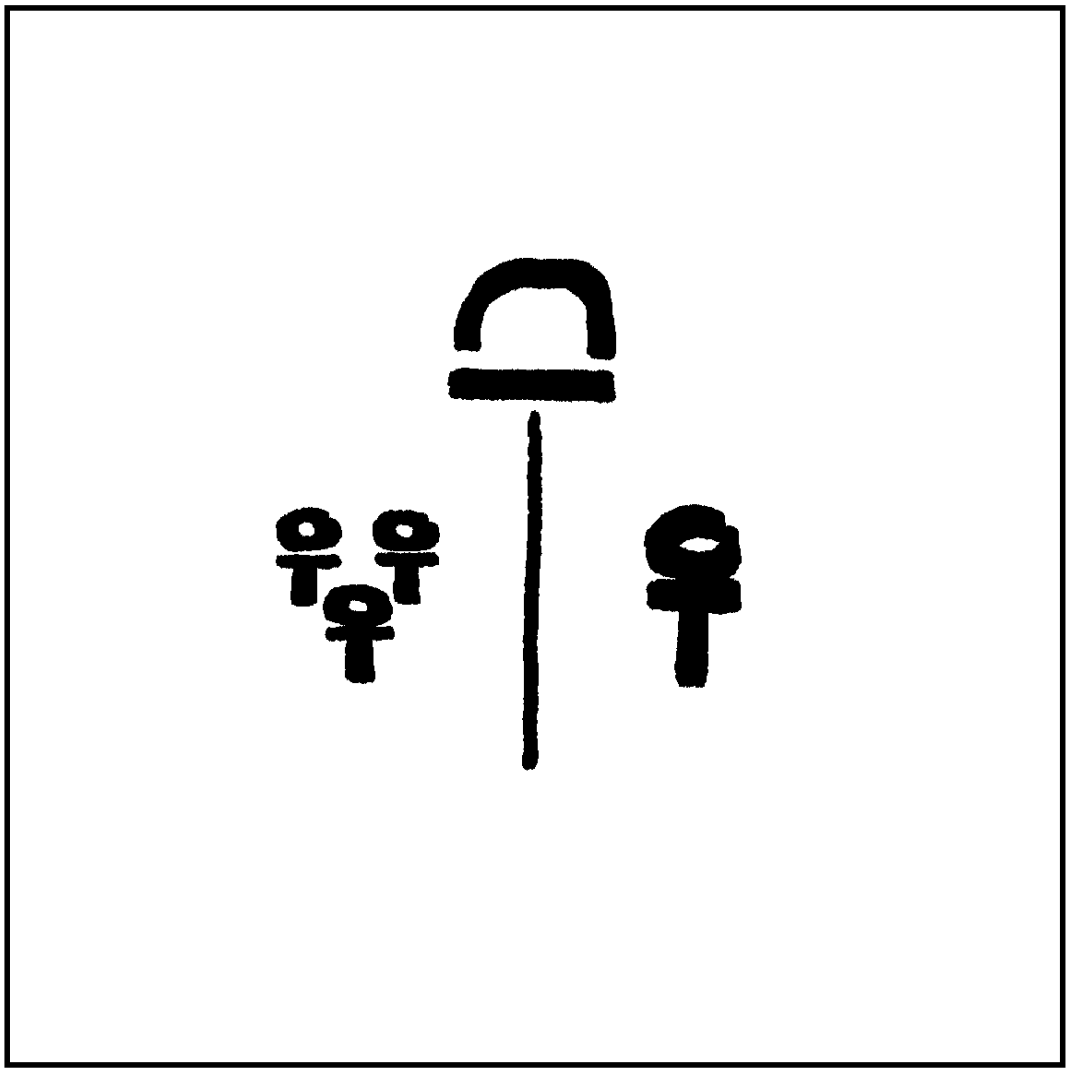
HOMEWORKS' PRINCIPLES

Housing is always the result of action by BOTH the community and the individual.

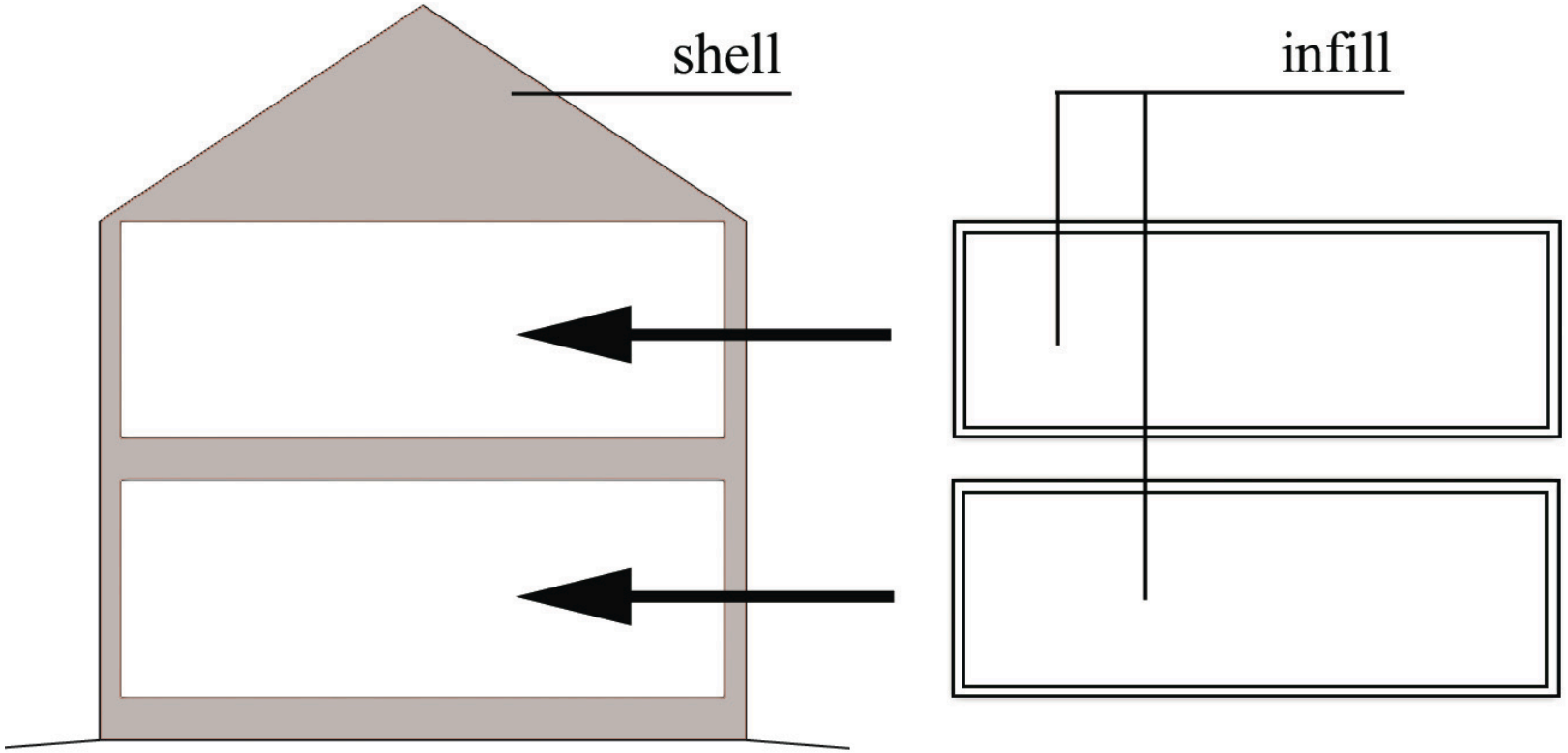
The "community" may be represented by a developer, or by an association of all the occupants.

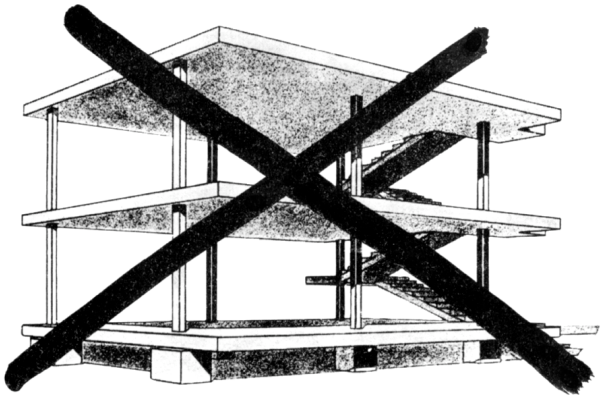
Without action by the occupant, the building is a virtual barracks or prison.

Without action by the community, the building has no coherence or shared facilities. Everyone is left to do everything by themselves.



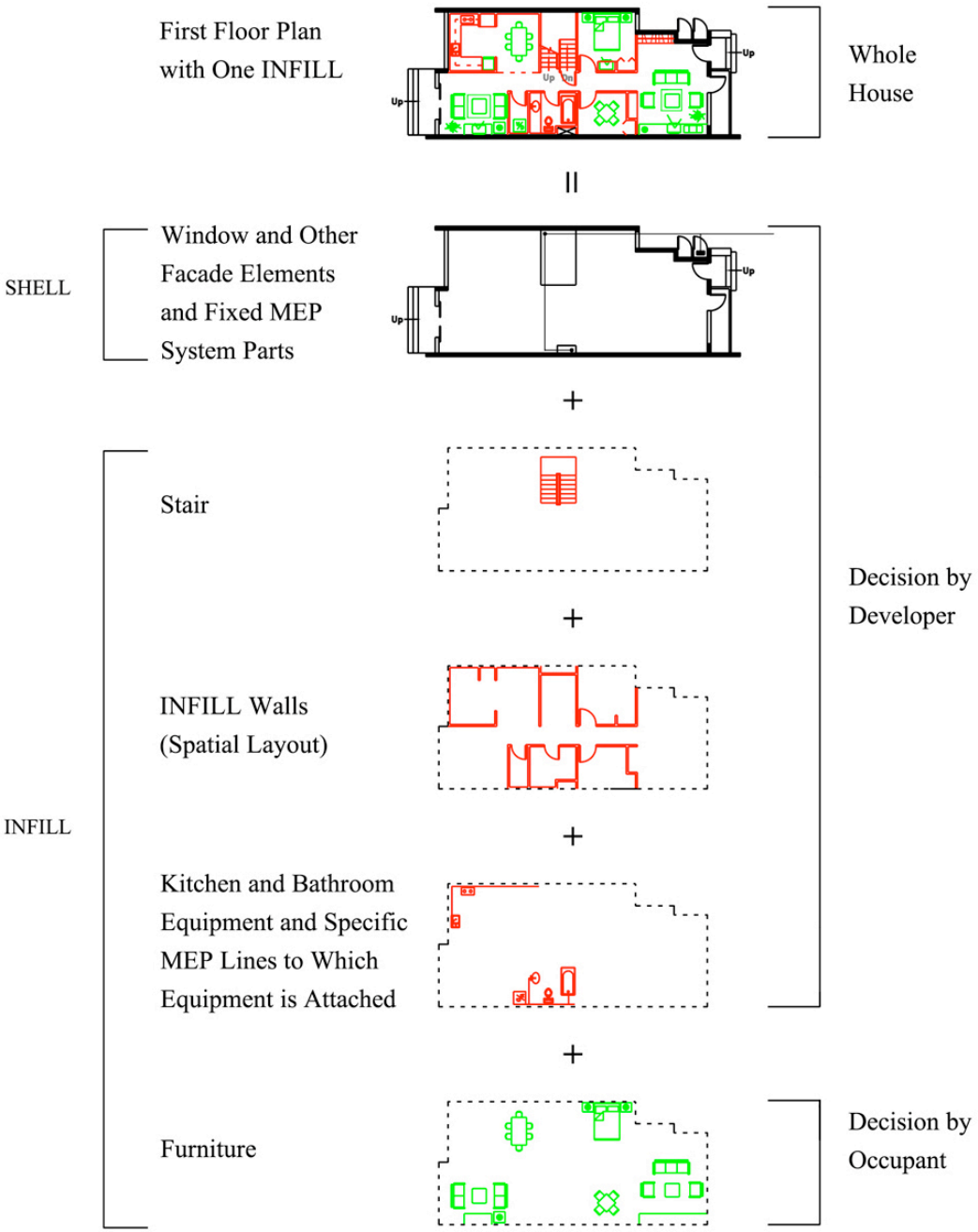
From Habraken, "The ABC's of Housing"





A shell or base building is not a skeleton, but is architecture, ready for inhabitation by means of infill, decided per dwelling unit.

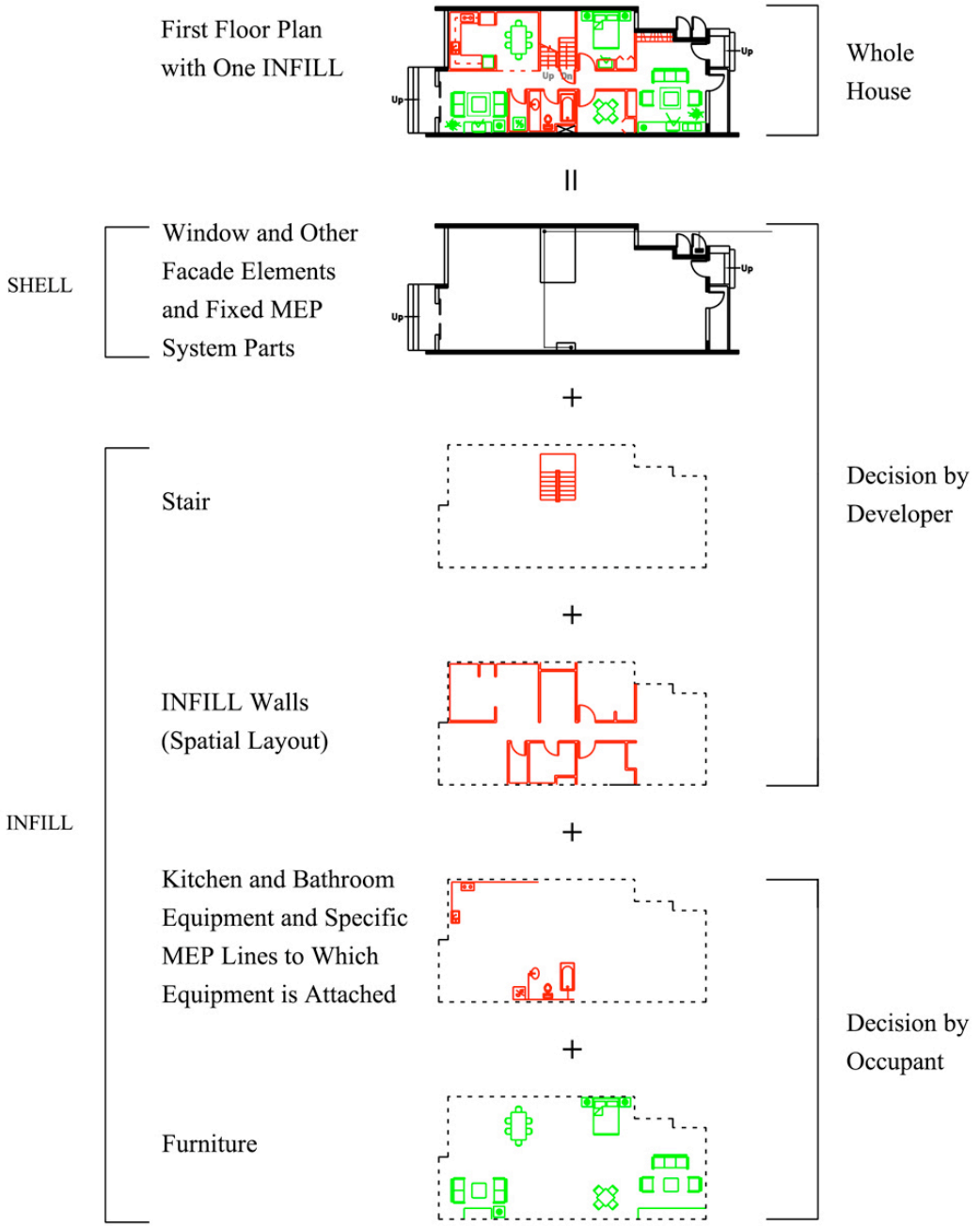
In the usual way of building, the developer decides almost everything, leaving the occupant only the furnishings to select and arrange.



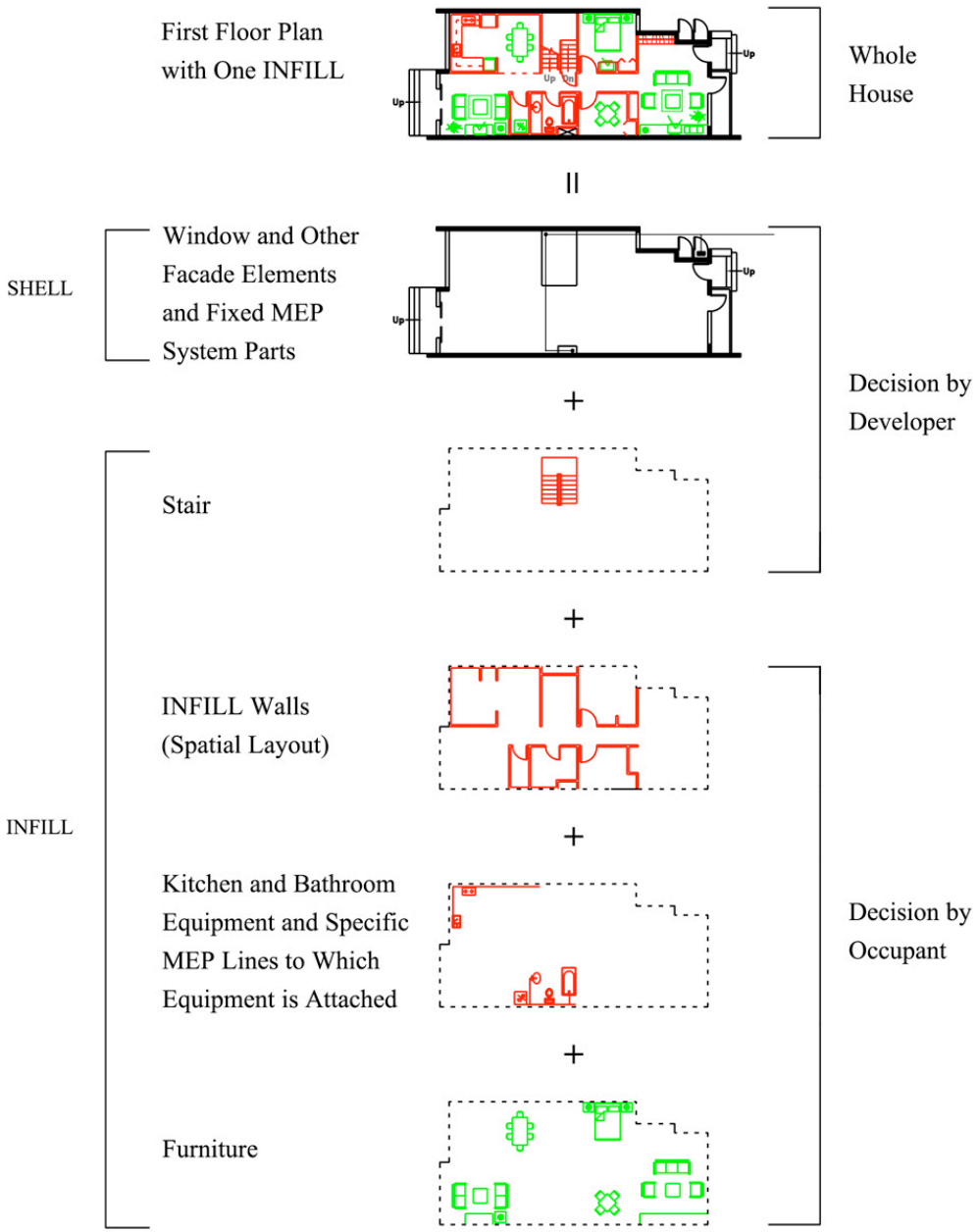
Sometimes, the developer allows the occupant to select the bathroom and kitchen equipment, cabinets and finishes.

In some exceptional cases, the developer allows the occupant to also select the layout of the kitchen and bathroom cabinets and fixtures.

This means that some of the pipes and wires connecting these fixtures are also included in the Infill.

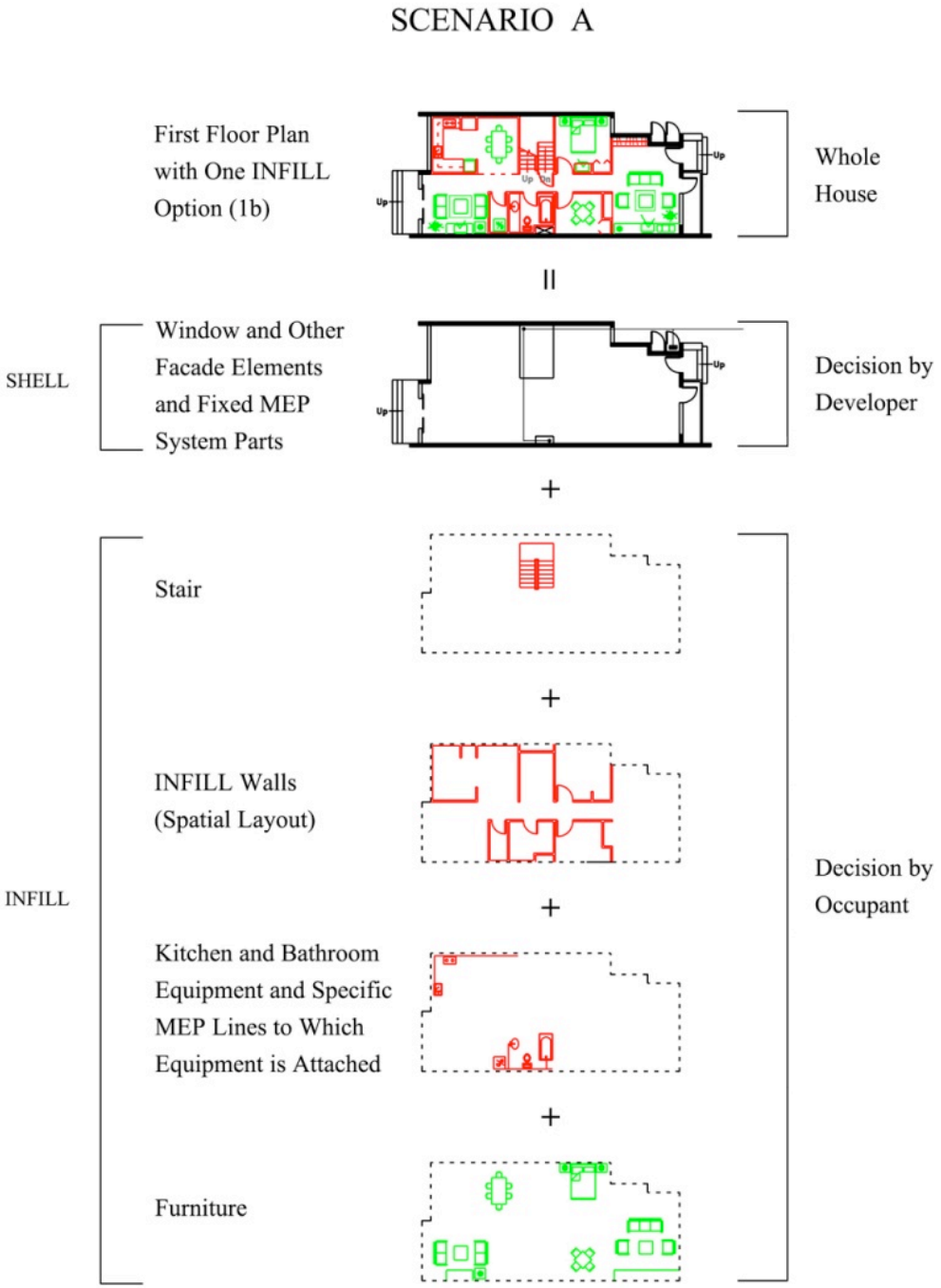


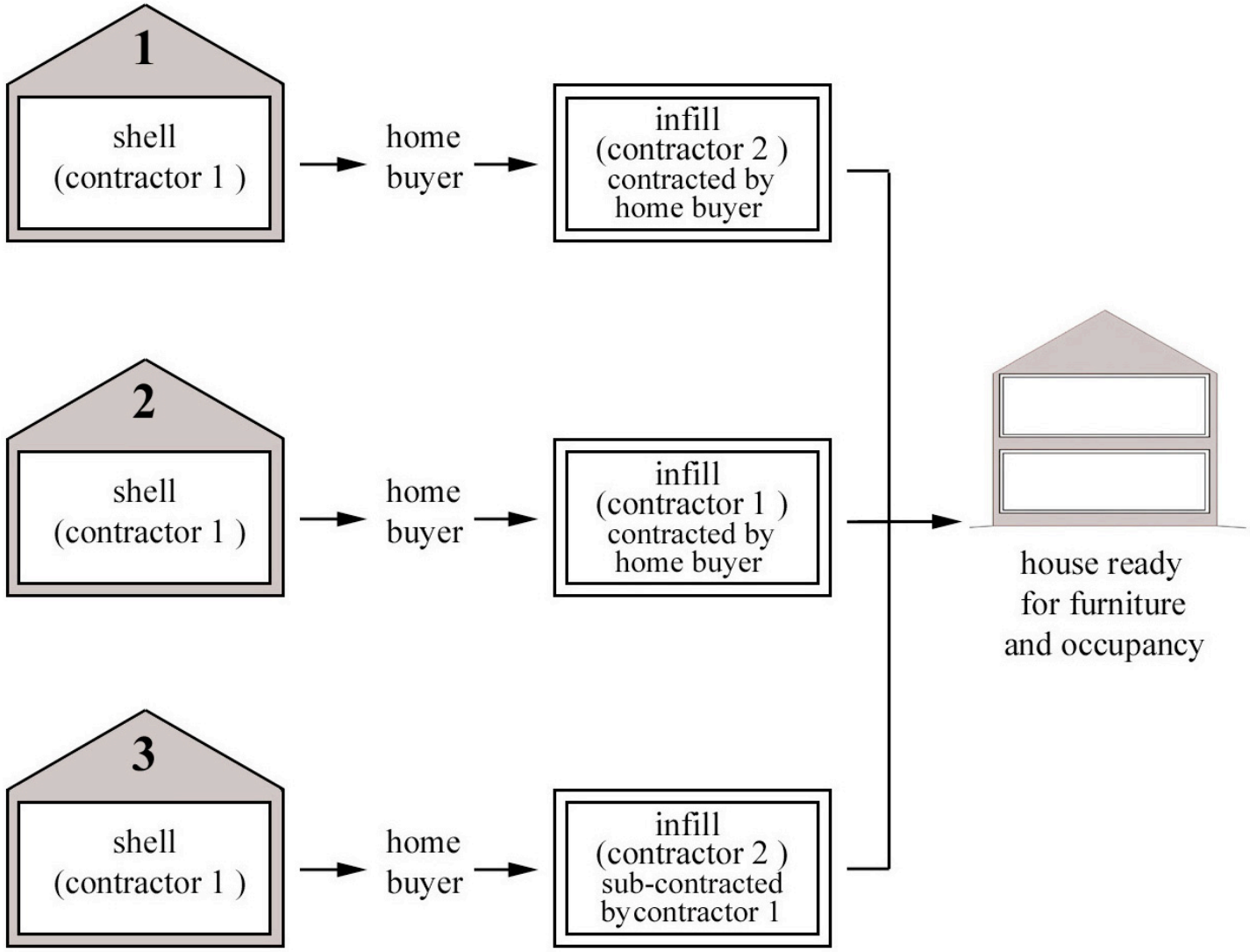
In some cases, a developer will even offer a variety of floor plans to the occupant, from a menu.



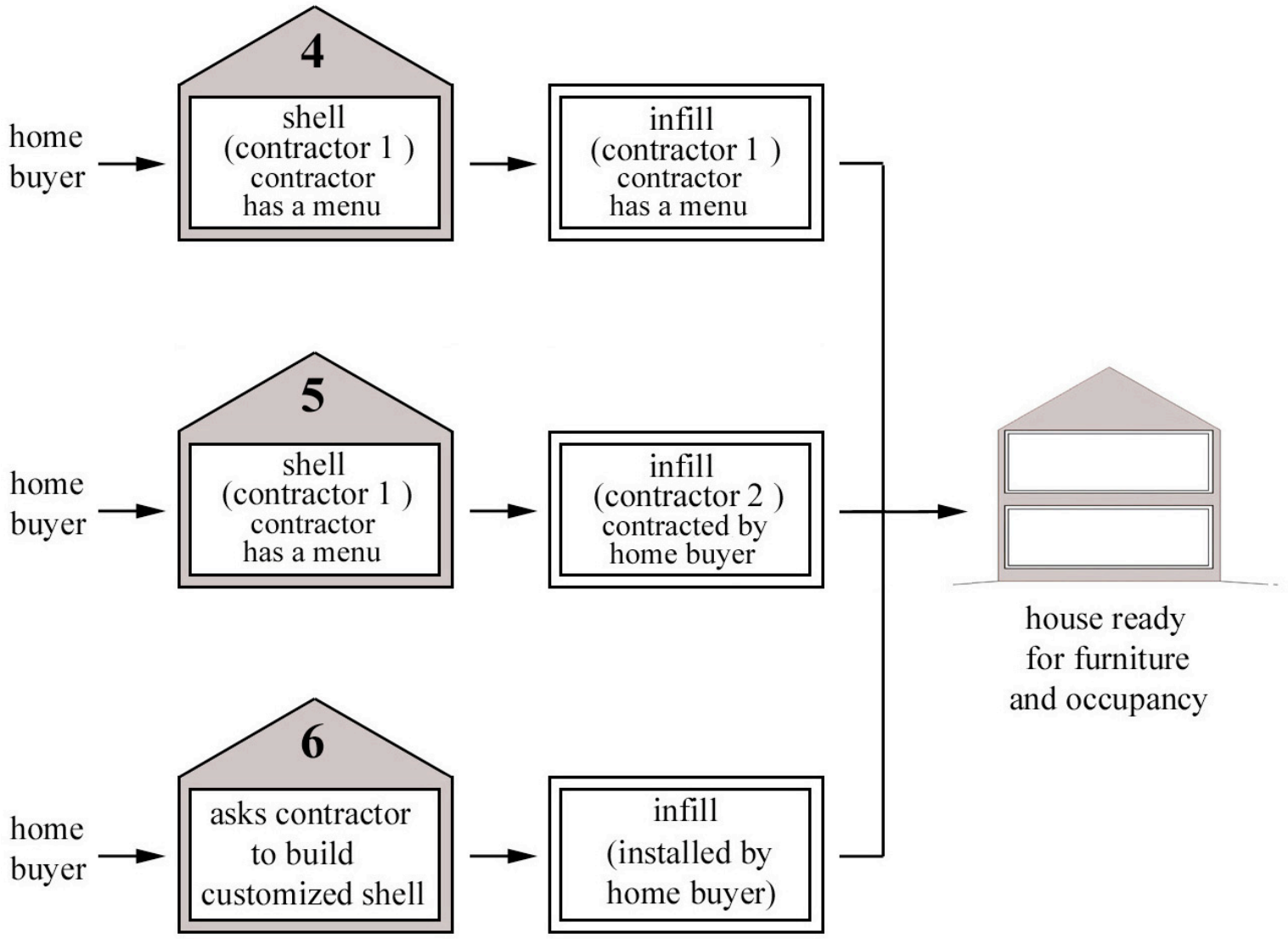
In a HOMEWORKS house, the occupant decides:

- The design of the stair (but in a given opening in the floor);
- The spatial layout of the house;
- The kitchen and bathroom layout and fixtures;
- And the furnishings, finishes and other interior decoration.

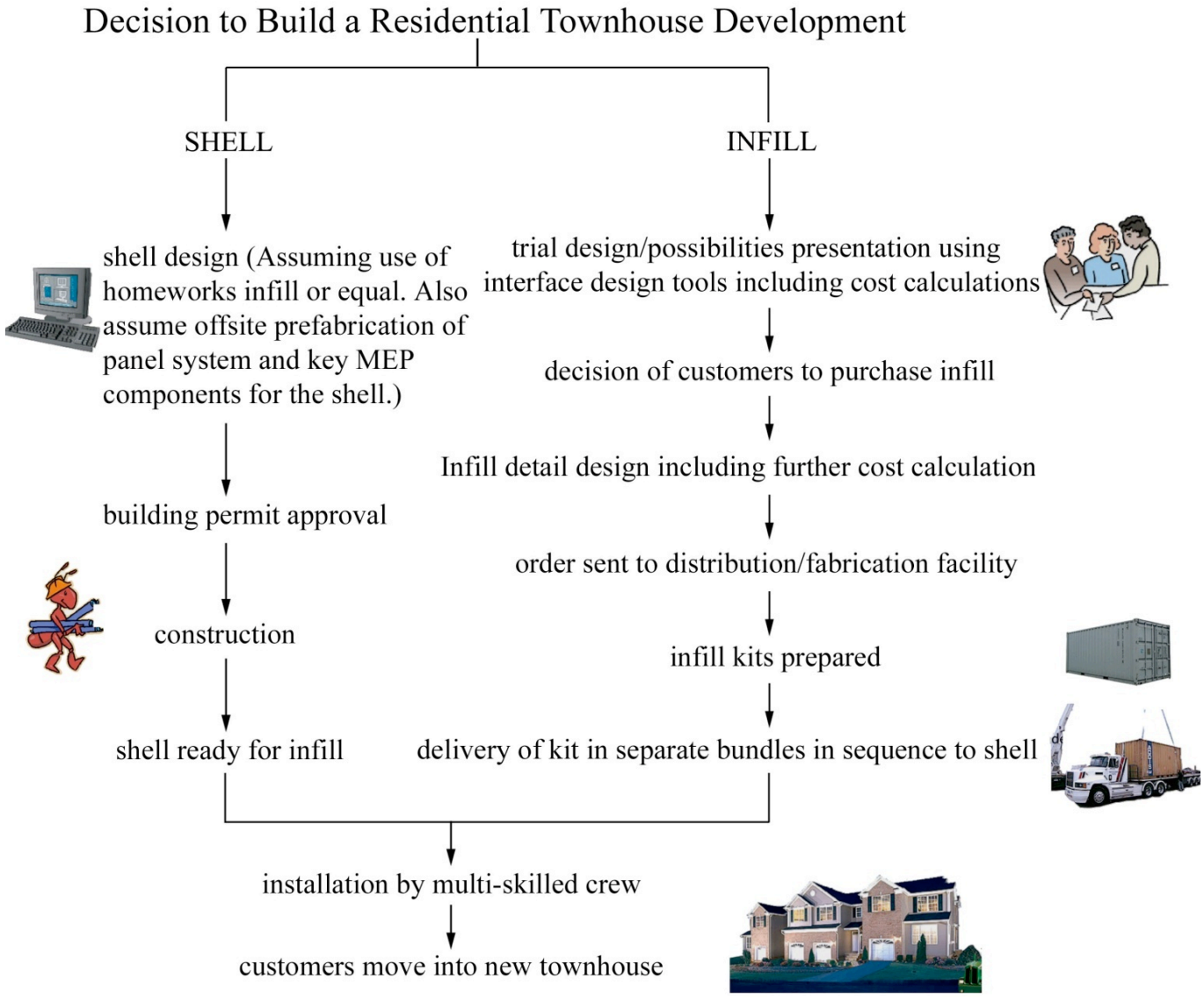




When the developer takes initiative to build, the occupant has several possibilities to have infill installed.



When the occupant takes initiative to build, several possibilities are available to have the house shell built and infill installed.



This chart shows the two decision sequences for a HOMEWORKS process: the SHELL and the INFILL.

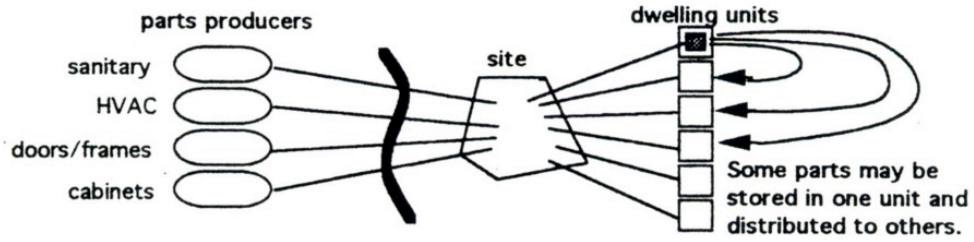
A HOMEWORKS process means that the traditional supply chain is no longer suitable.

Some developers use an "intermediate" strategy.

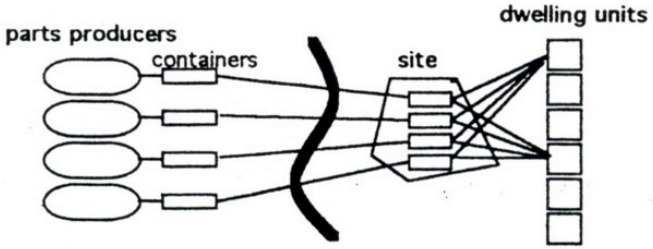
A HOMEWORKS process introduces an entirely new stage: the Distribution Center.

Comparing Logistics Strategies:

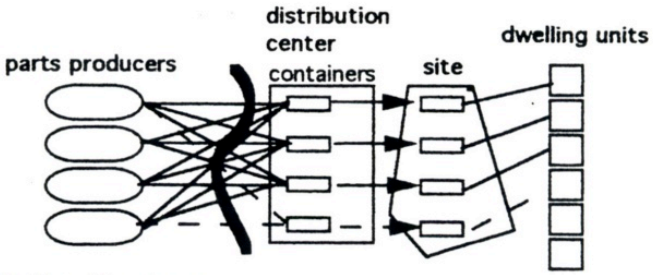
Traditional vs. Fit-Out



The Traditional Supply and Logistics Chain



Intermediate Strategy



New Logistics Strategy

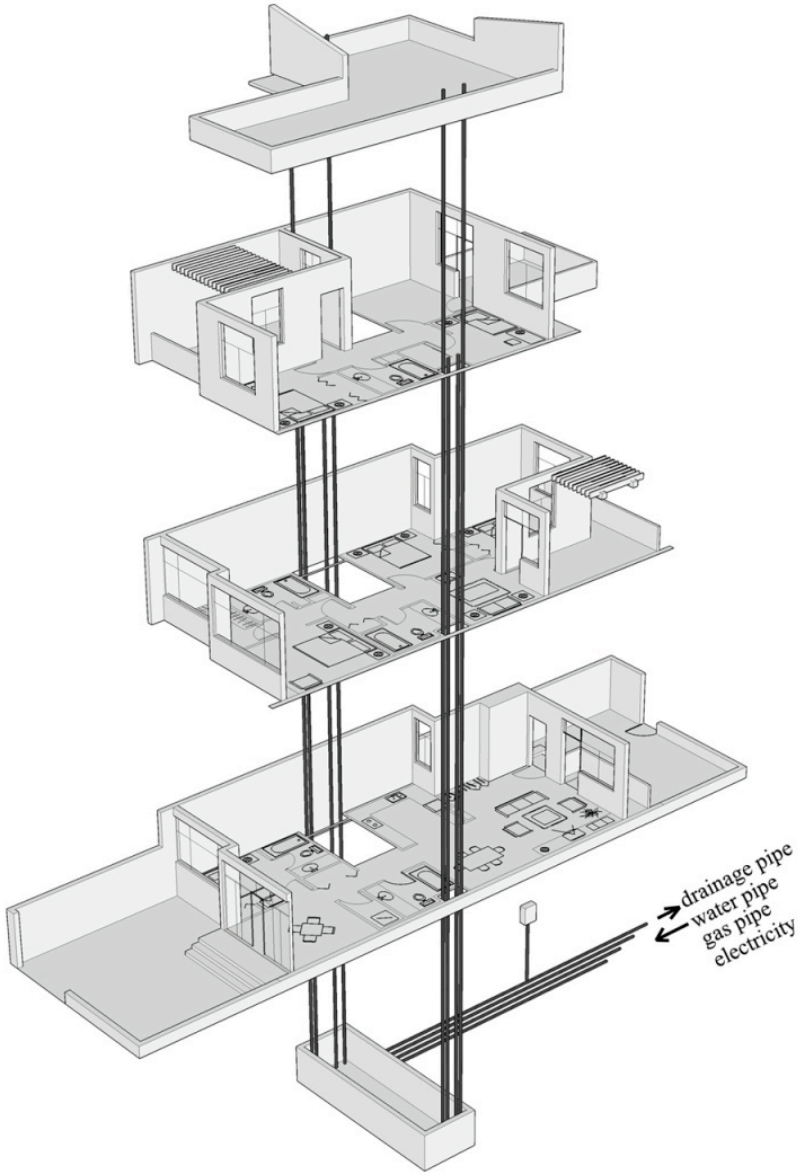
(source: Matura Netherlands BV)

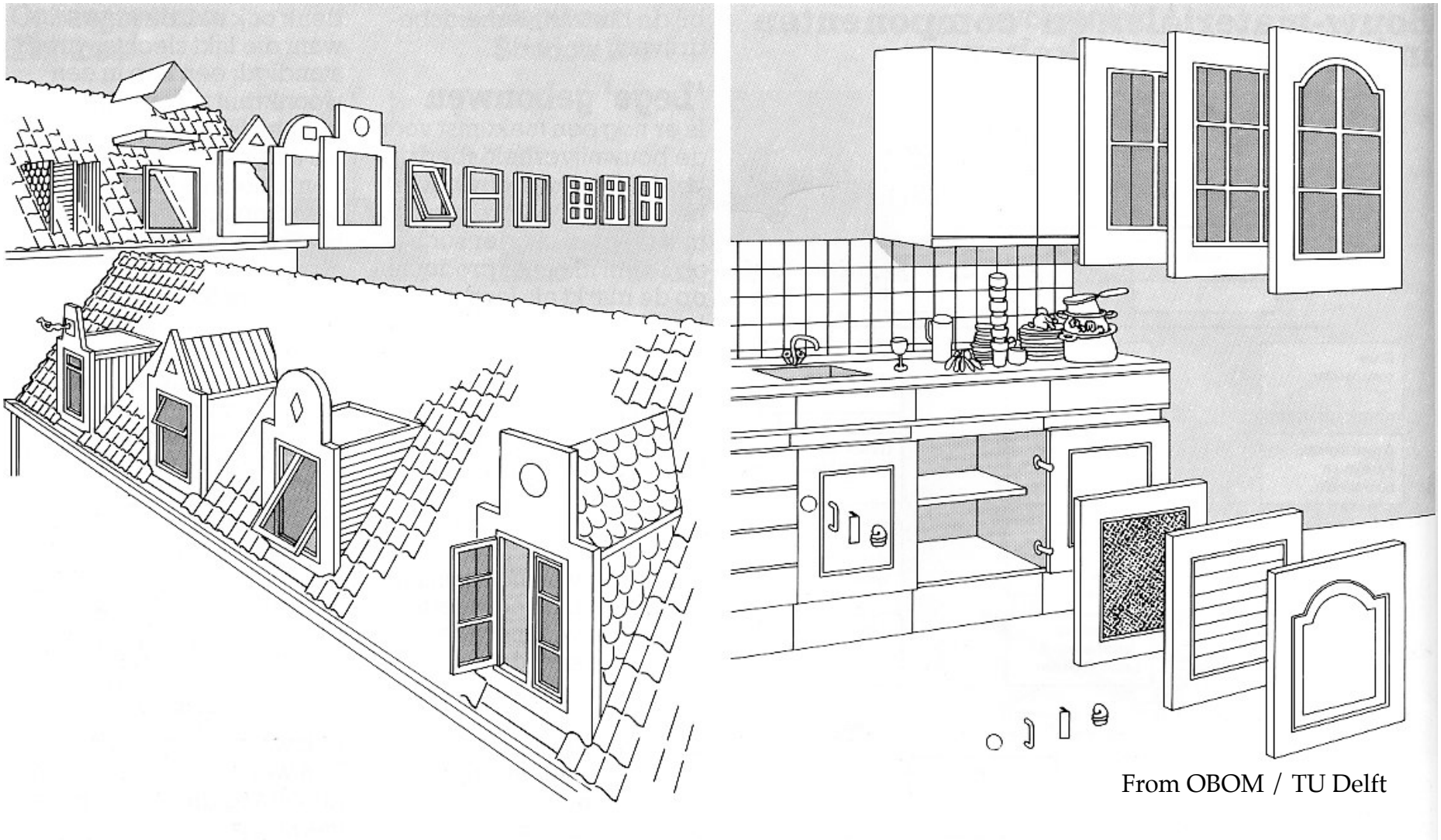
This is a schematic drawing of a HOMEWORKS Shell.

The Shell's vertical utility lines are connected to the public part of the utilities.

These include drainage, water and gas piping, and the electricity and communications cabling.

From the outside, the Shell appears to be a finished house, but it is empty inside.





From OBOM / TU Delft

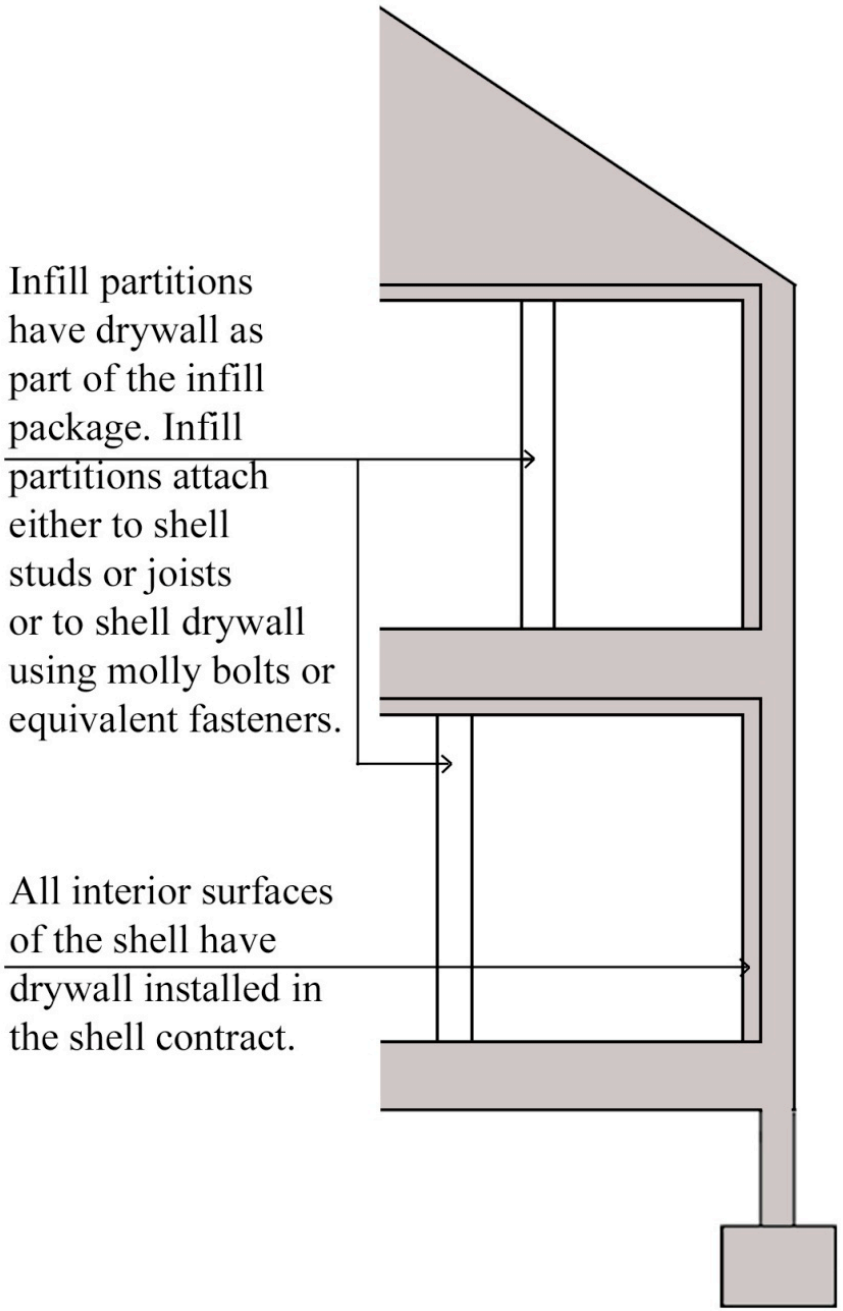
One of the most important principles is called FIXED/VARIABLE. For example, with any “Fixed” part of a house (a cabinet) cabinet doors are “Variable”. For a “Fixed” roof dormer, windows are “Variable”. And so on…

Infill Partitions

Infill partitions are delivered as ready-to-assemble parts, and attach to the Shell. The kind of partition system used depends on a number of criteria including initial cost, quality, ability to hold horizontal MEP lines, ability to be recycled, and so on.

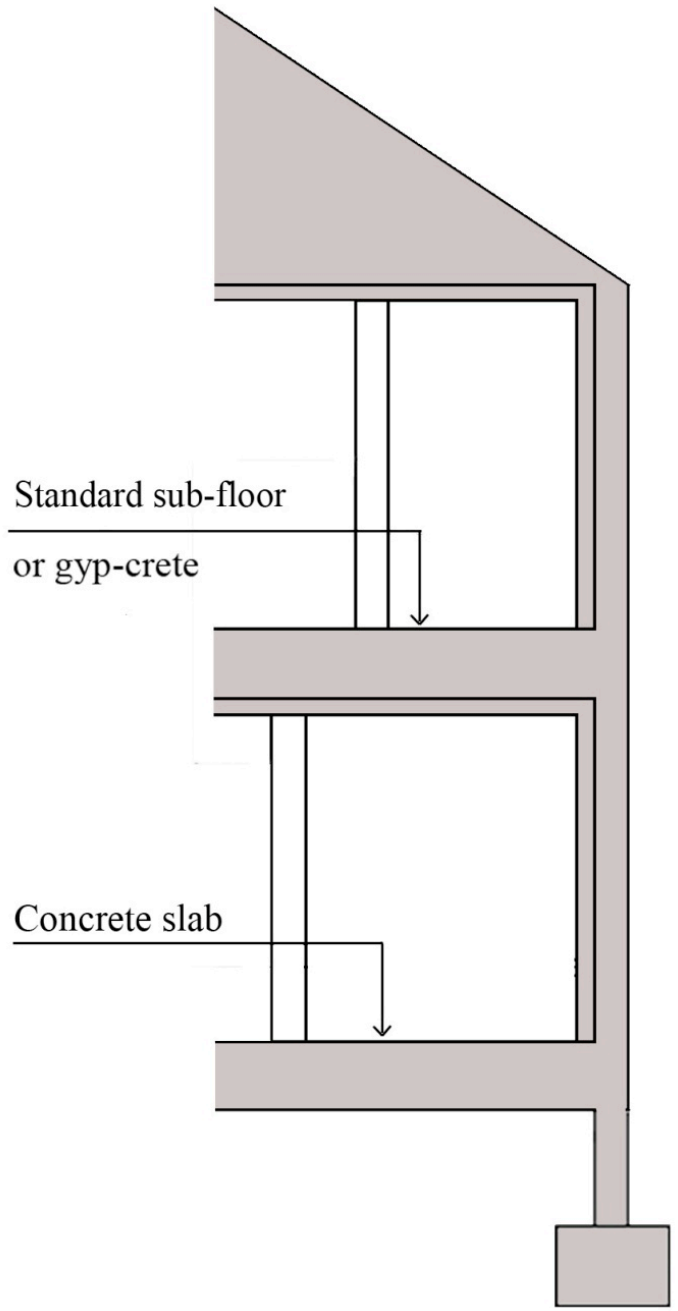
Interior of the Shell

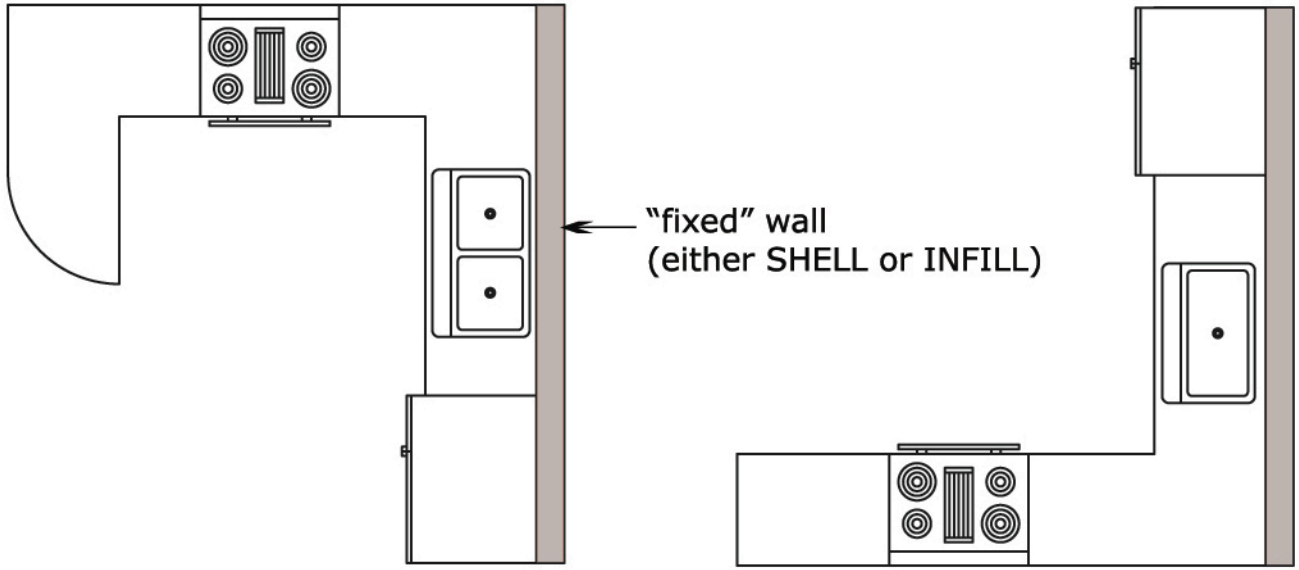
The interior of the Shell is finished, usually with drywall. This includes walls and ceilings (in most cases). The Shell's thermal insulation is part of the Shell contract.



The floors of the Shell are walk-able surfaces.

The specific material used depends on a number of criteria including cost, structural and acoustical performance, and so on.

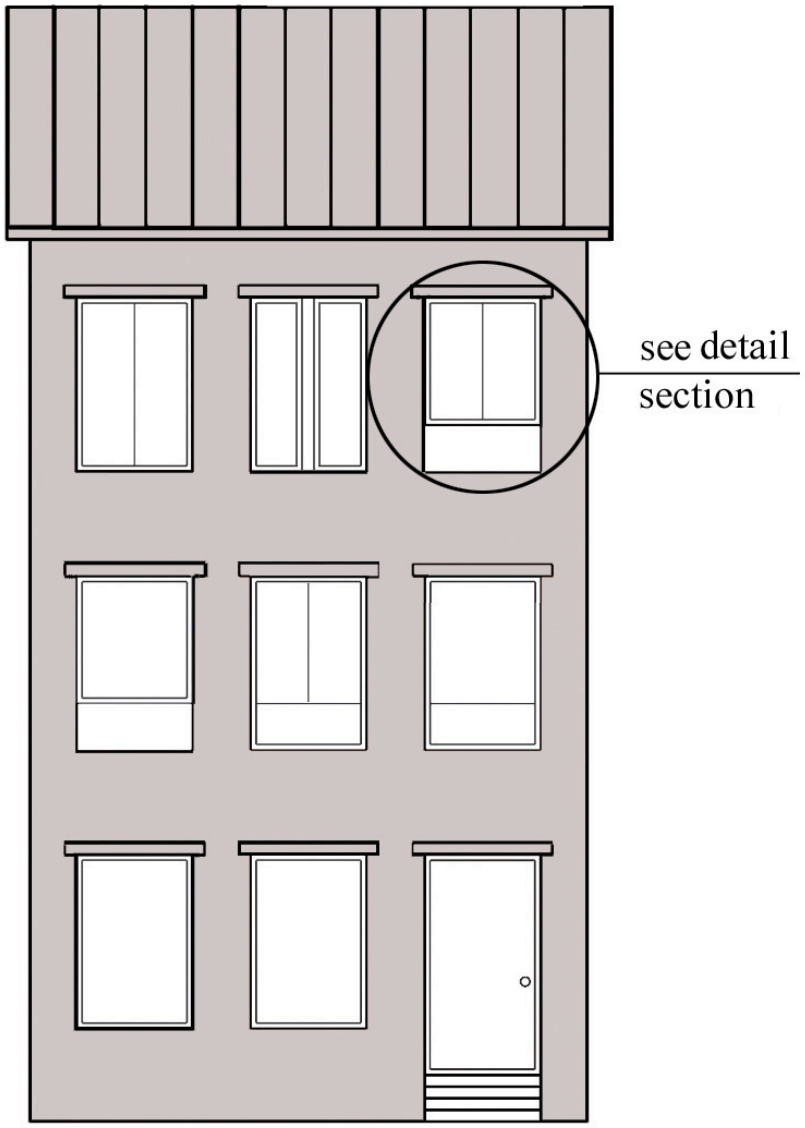




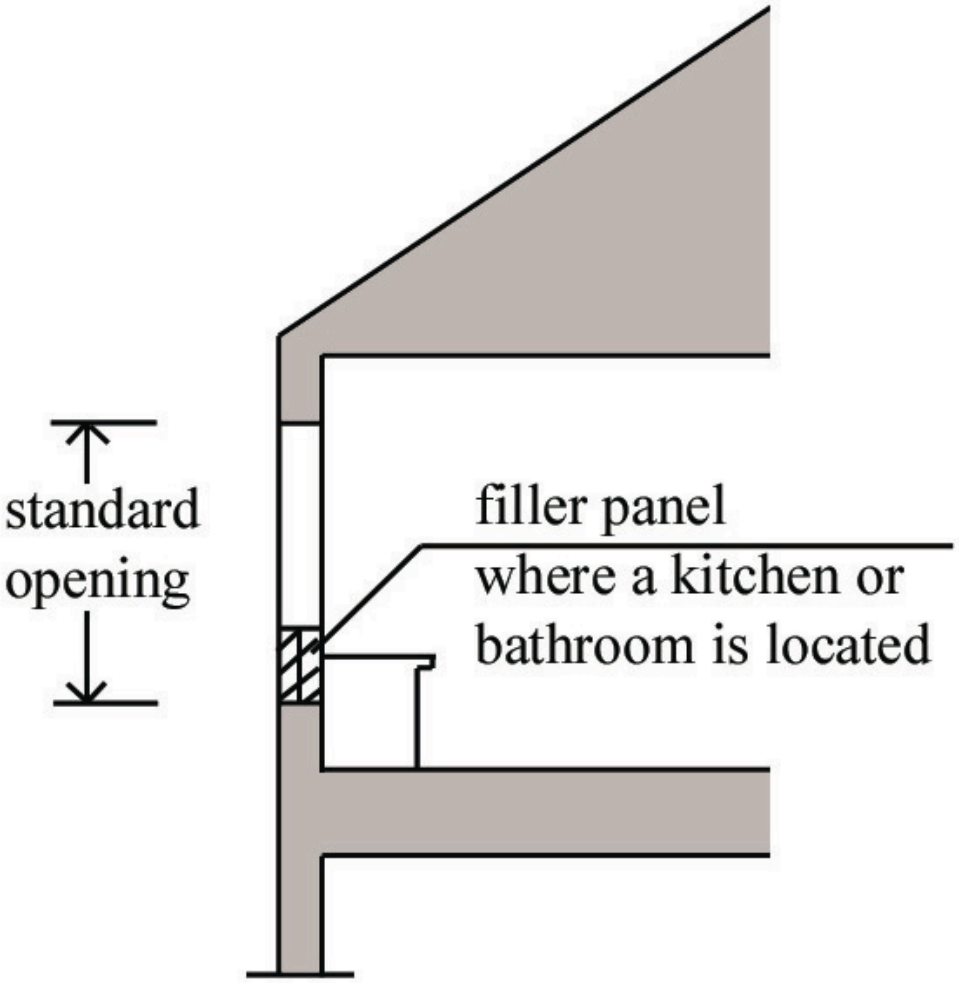
This diagram shows that given a “Fixed” wall, with an attachment point for water and drainage, the layout of the kitchen can vary.

The façade of each HOMEWORKS townhouse can be partially customized for each occupant from a menu developed by the architect.

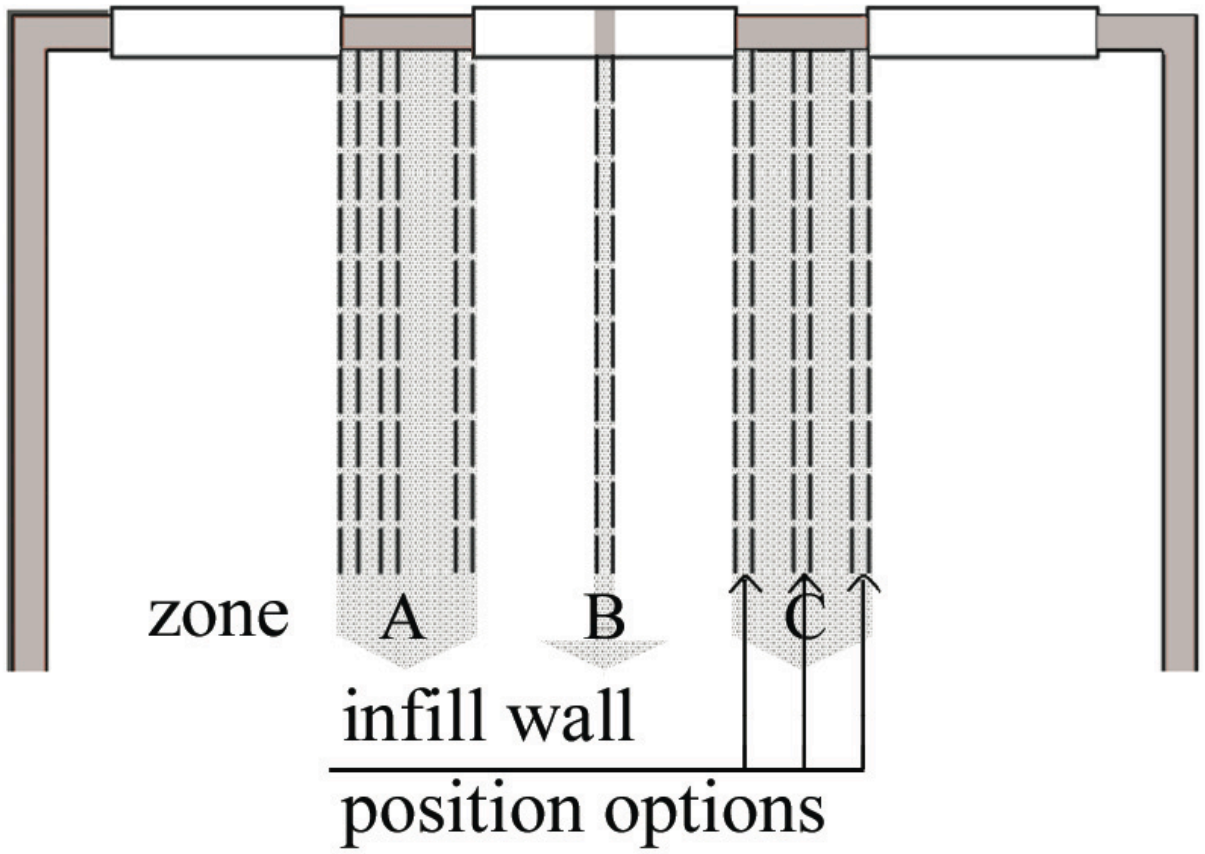
For example, windows filling in Shell openings may need to be customized for the floor plan chosen.



Here is an example of how a standard Shell opening may require a filler panel to accommodate a kitchen counter or bathroom cabinet against the exterior wall.

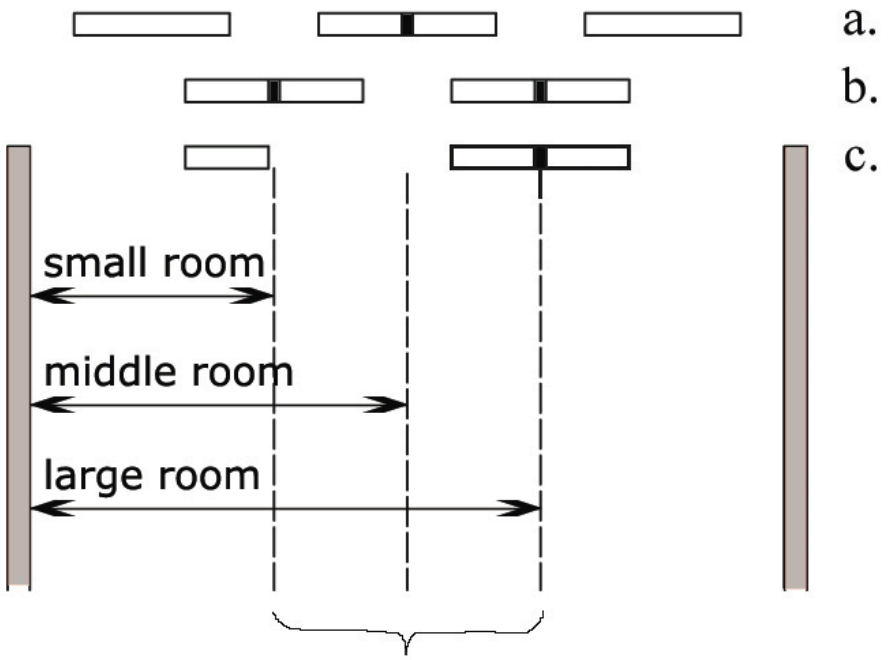


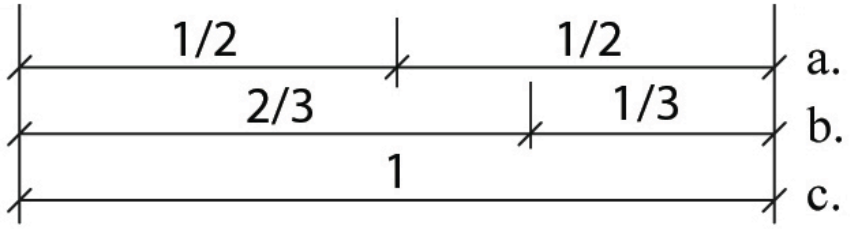
Here is an example of how this could look.



Shell openings must be placed to enable a range of good floor plans inside. Then, Infill walls meeting an exterior façade of the Shell can be placed in a variety of positions. Windows filling in the Shell openings can be designed to accommodate still further variations in partition placement, as in position “B”.

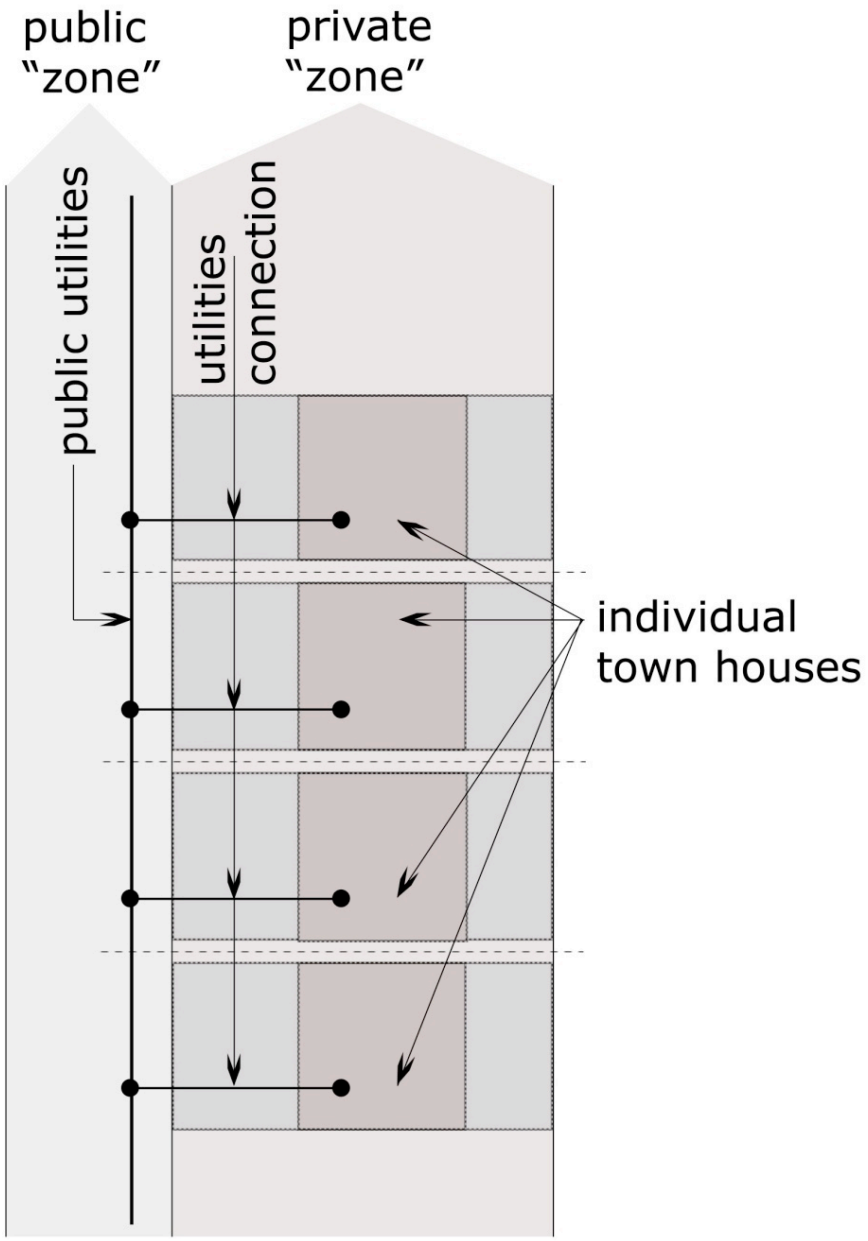
This diagram shows the relationship between Shell openings (e.g. a, b or c) and windows, and small, middle and large sized rooms against the façade.

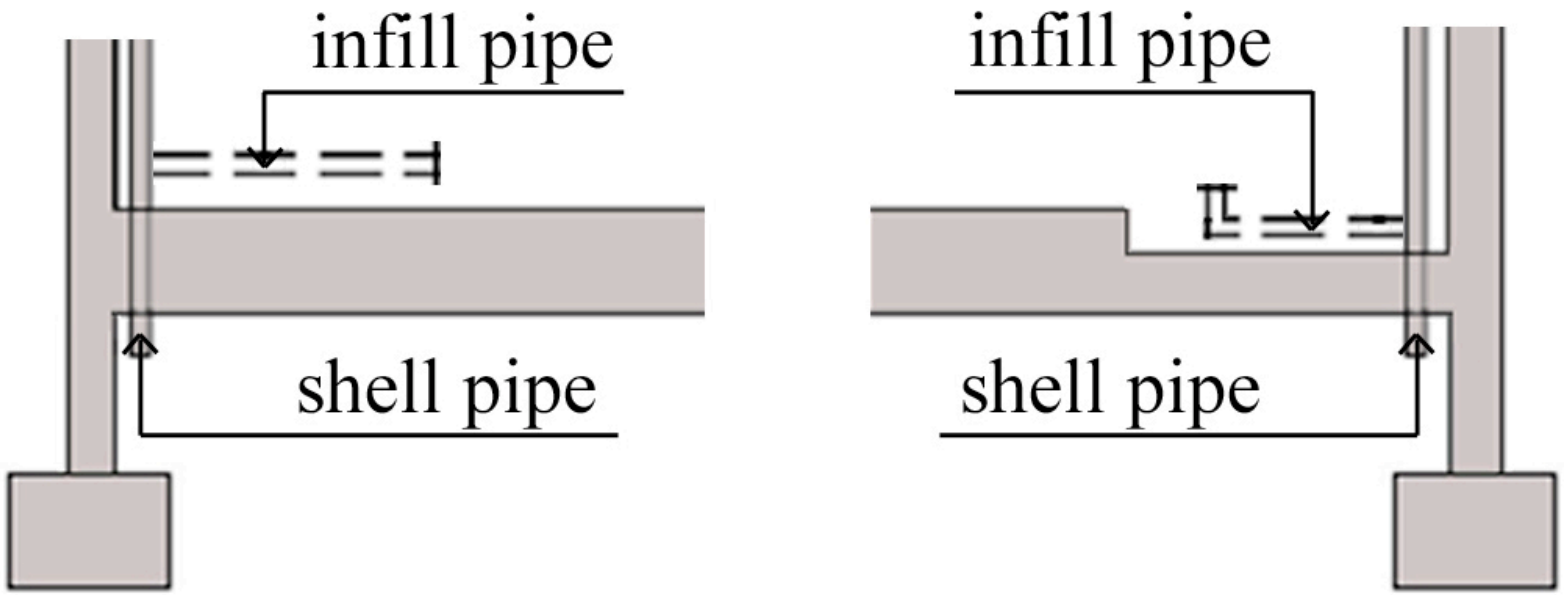




Principles for laying out
HOMEWORKS Installation Services

In laying out public utilities (piping and cabling), the most effective long-term distribution of these systems is as shown - each individual townhouse has its own individual connection directly to the utilities in the “public zone”.

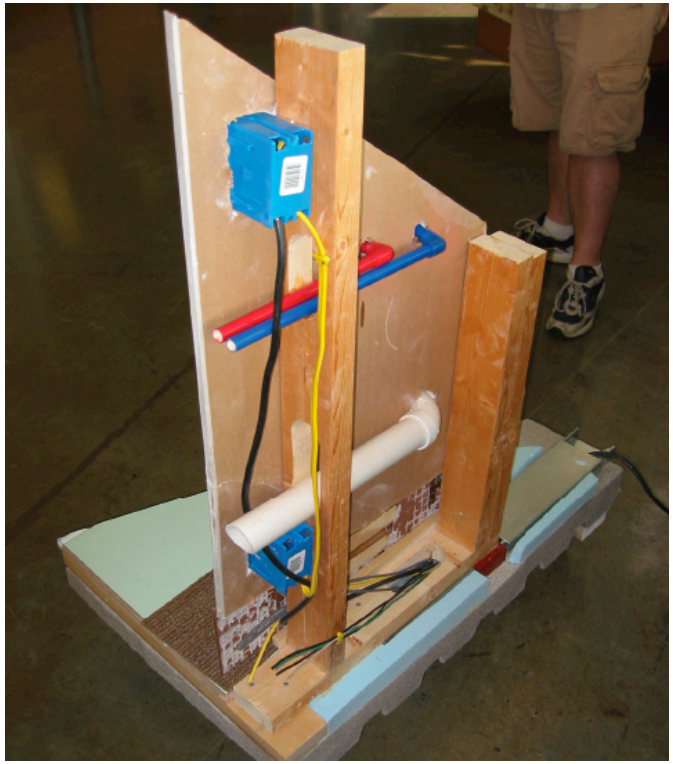


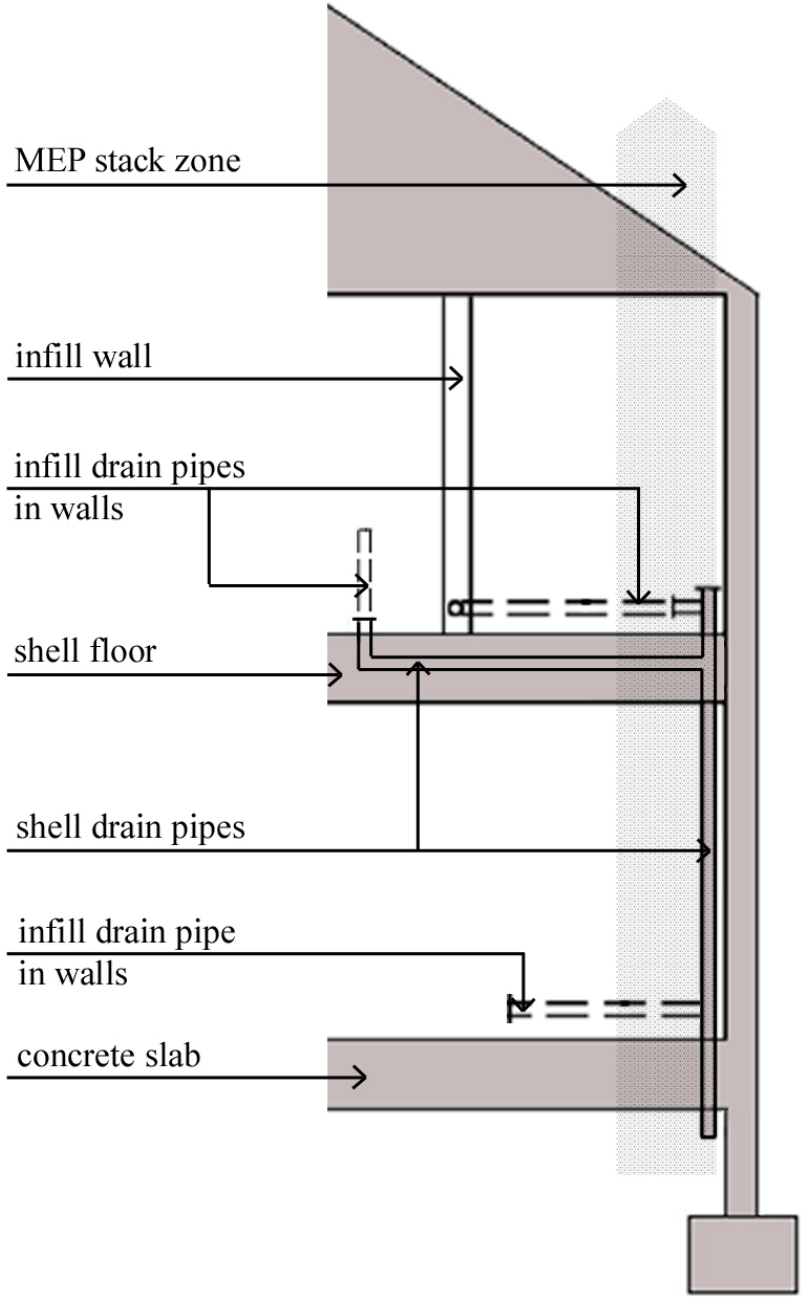


For horizontal Infill MEP lines (pipes, cabling and ducts), two basic alternatives are available. One is to allow the lines to be carried inside Infill partitions. The second is to place them in Trenches in the Shell floors. It is also possible to use a combination of the two.

This diagram shows both **Shell and Infill Drainage** piping.

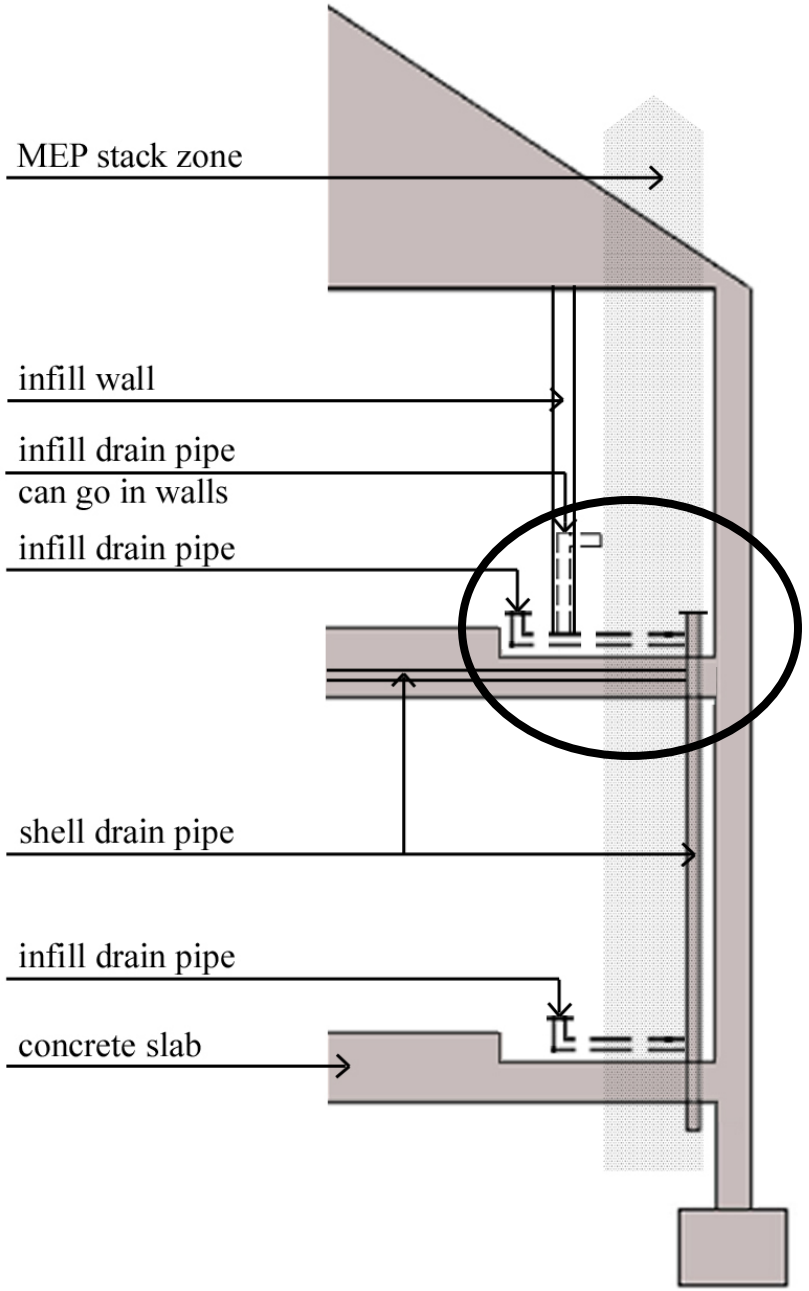
Shell Drainage piping is in the MEP "stack" and also in the Shell floors, emerging at points from which it can be carried further inside Infill walls.



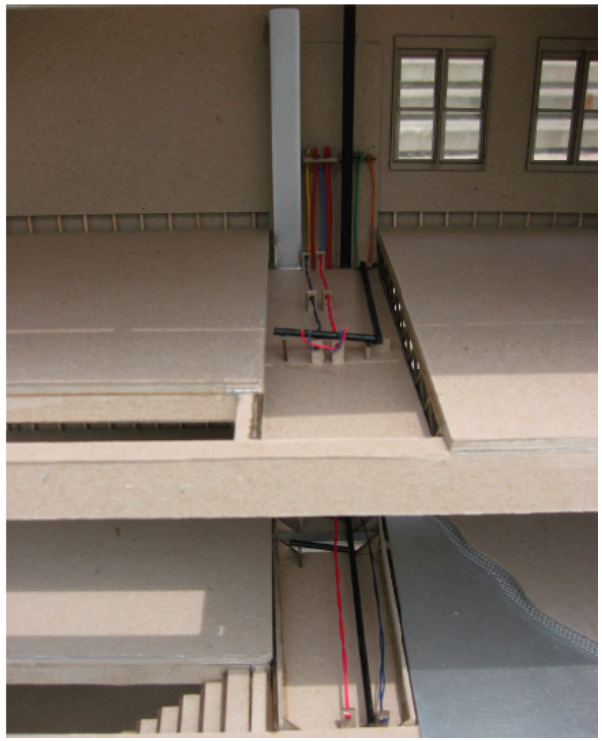


This diagram shows both **Shell and Infill Drainage** piping using the concept of **Trenches** in the Shell Floors.

Shell Drainage piping is in the MEP "stack" and also in the Shell floors, emerging at points from which it can be carried further inside the Shell **Trenches**. Drain lines can also be carried inside Infill walls as shown.



These are examples of a Shell **Trench**.

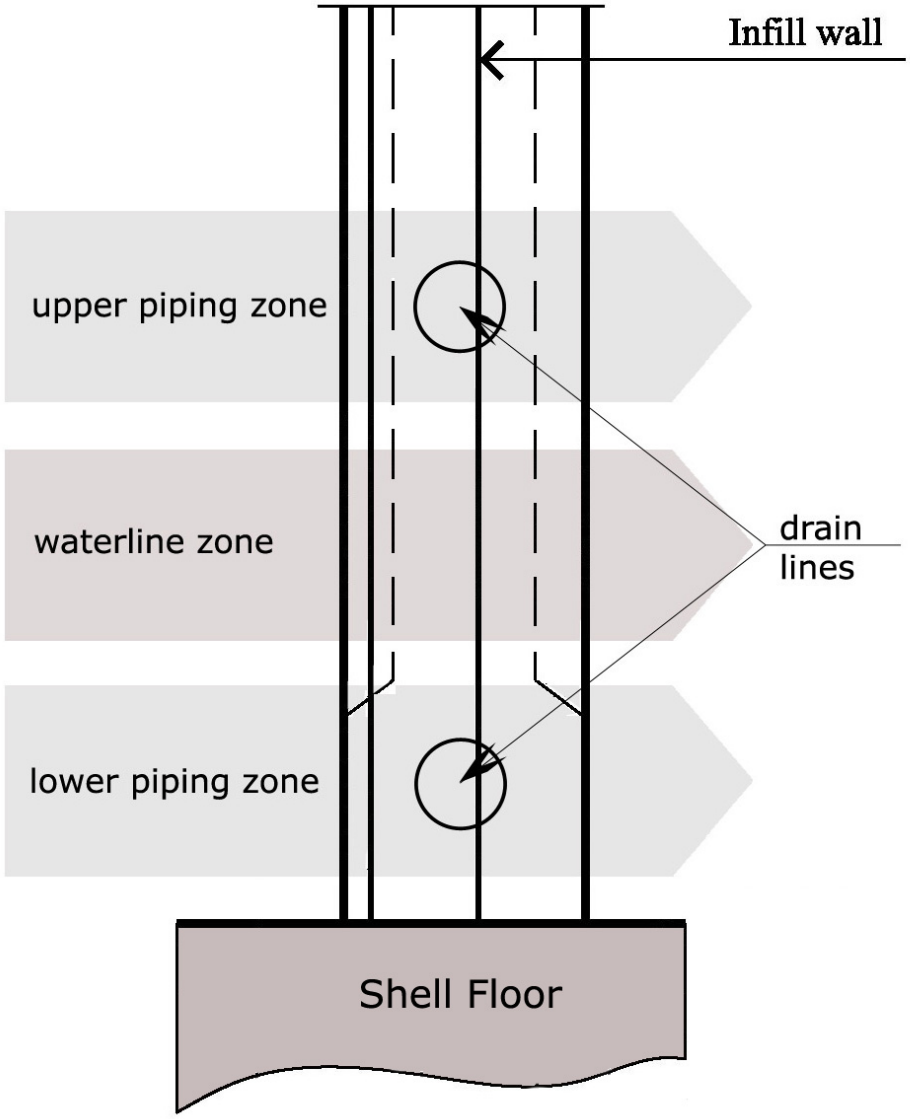


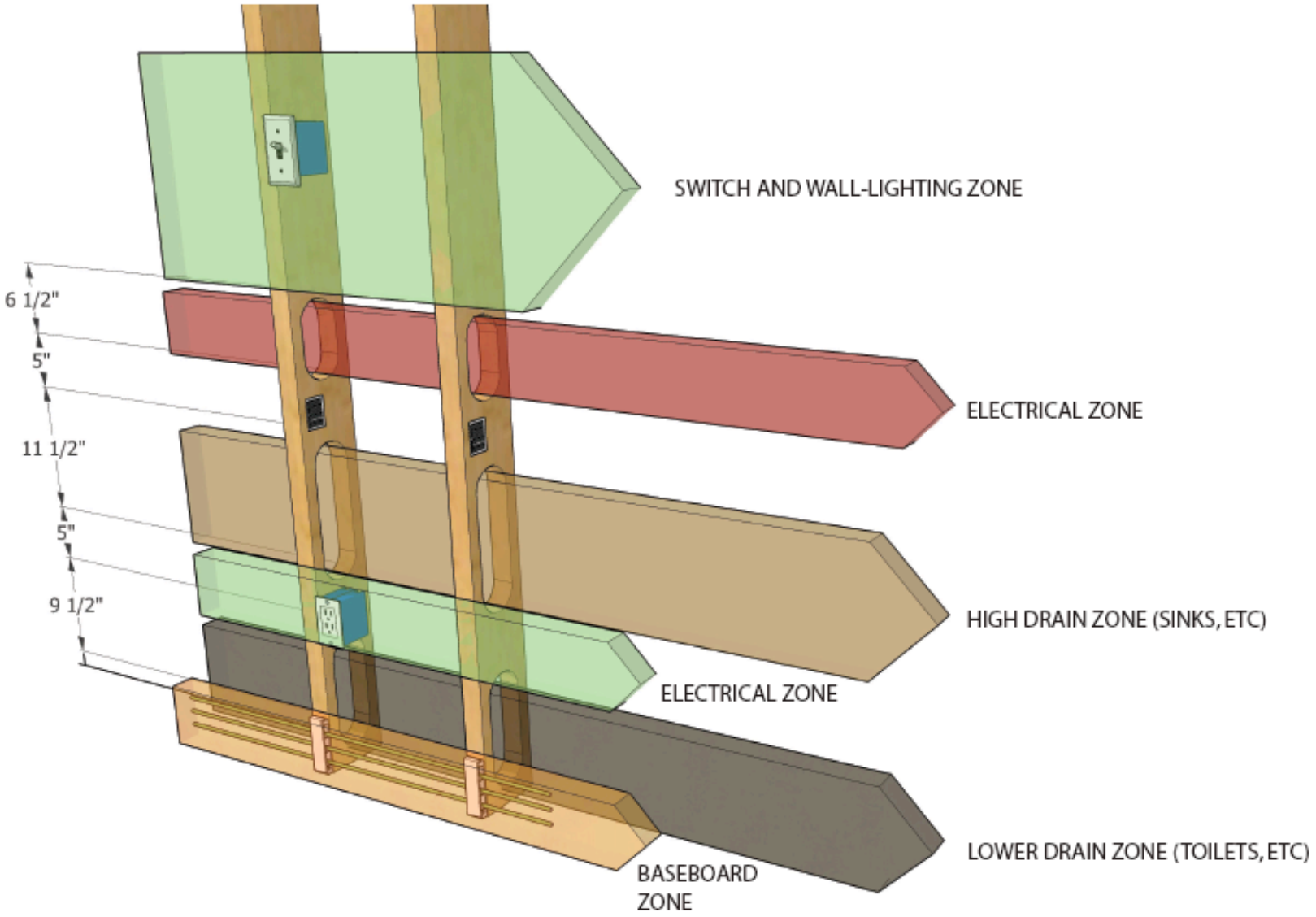
When horizontal MEP lies are routed through Infill walls, we use three “zones”:

An **upper zone** for drain lines from kitchen sinks and bathroom lavatories, washing machines;

A **lower zone** for showers, bathtubs and toilets;

A **waterline zone** for domestic hot and cold water lines.

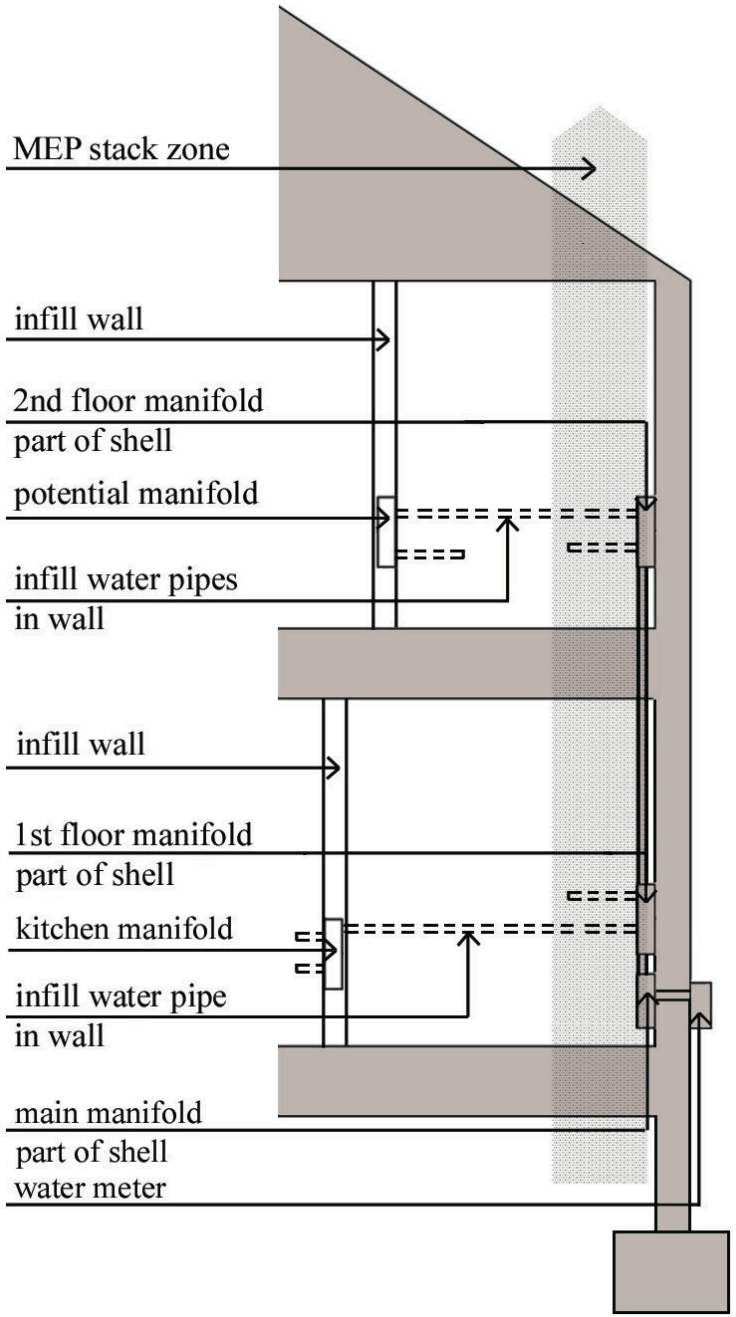




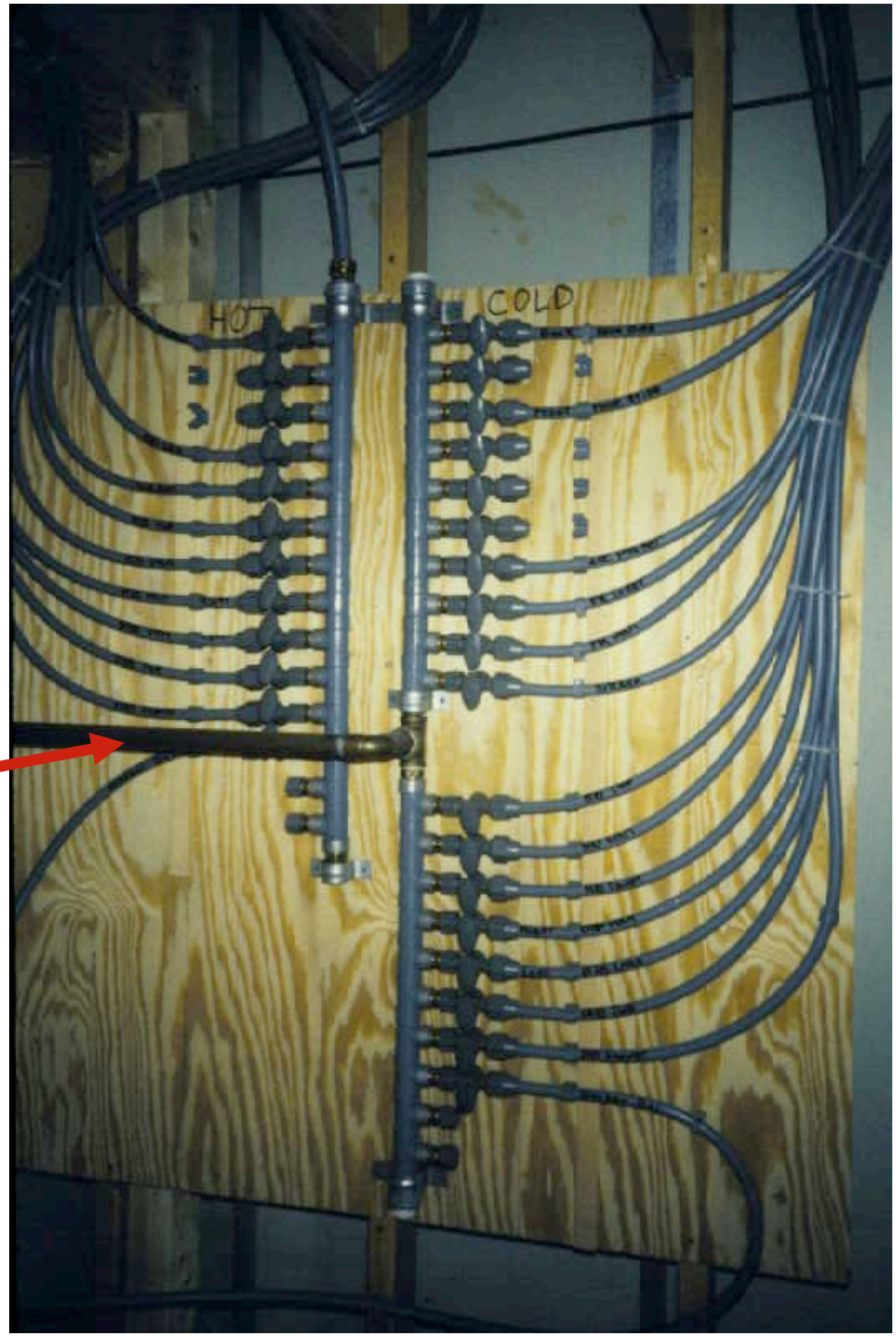
This is a variation on the idea of routing installations in INFILL walls

When water lines are routed in **Infill** walls, we use a hierarchy of supply "**manifolds**".

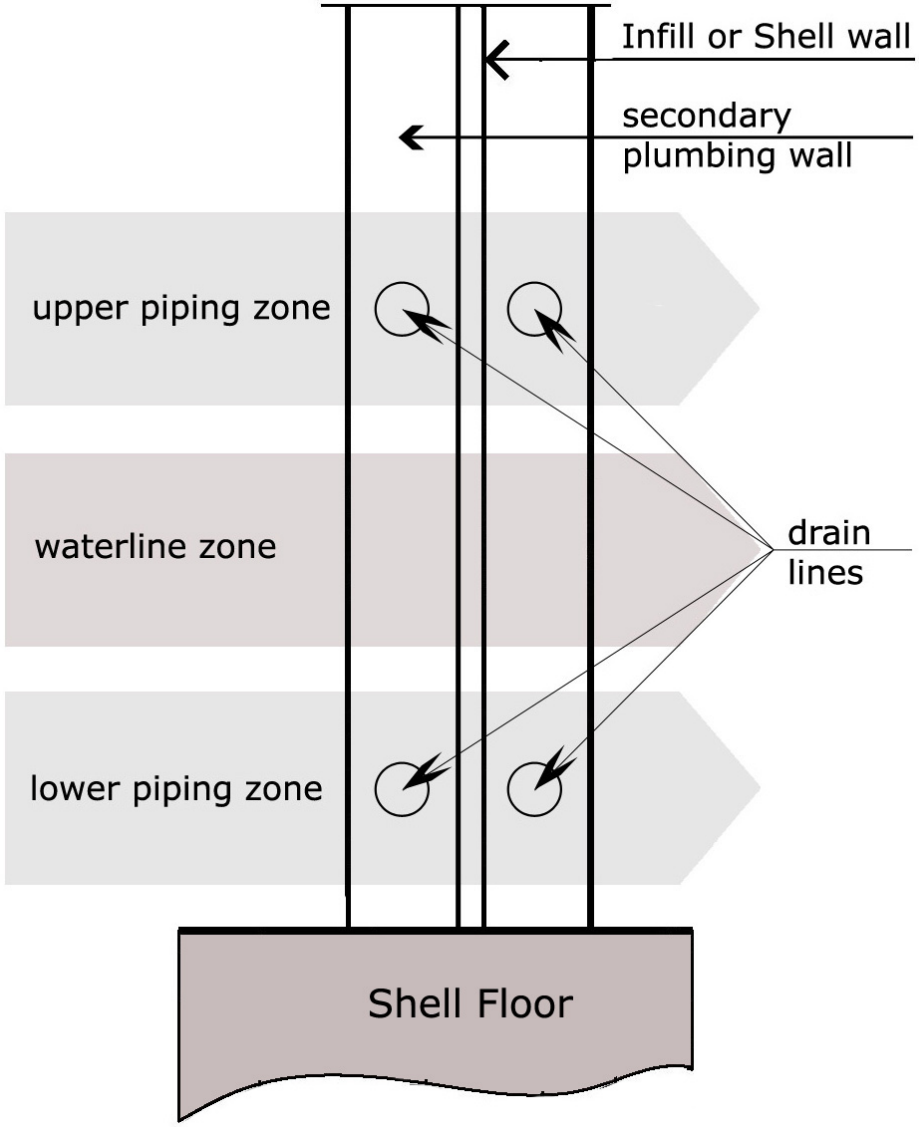
Each "manifold" is attached to one supply line, reducing the number and diameter of supply pipes in any given Infill wall location. From each manifold, "home-run" smaller diameter pipes reach each fixture or appliance, each with a shut-off valve at the manifold.



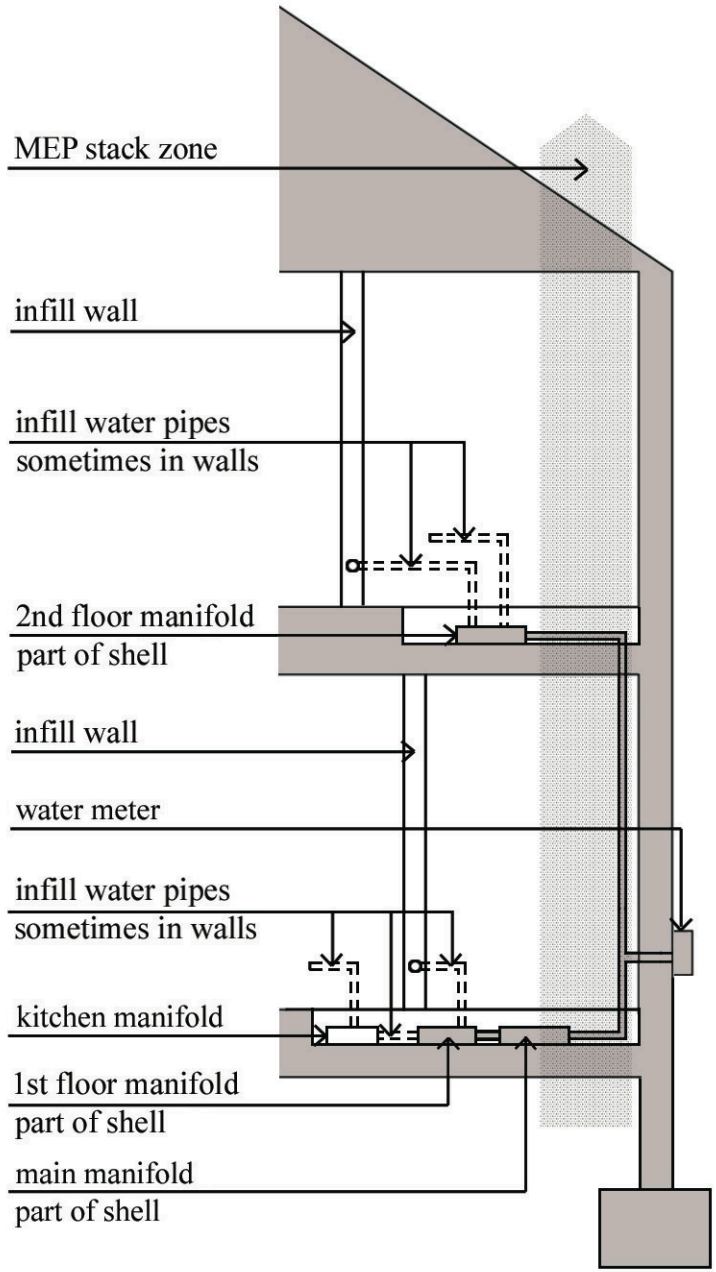
The cold water “manifold” is attached to a supply line, reducing the number and diameter of supply pipes in any given Infill wall location. From each manifold, “home-run” smaller diameter pipes reach each fixture or appliance, each with a shut-off valve at the manifold.



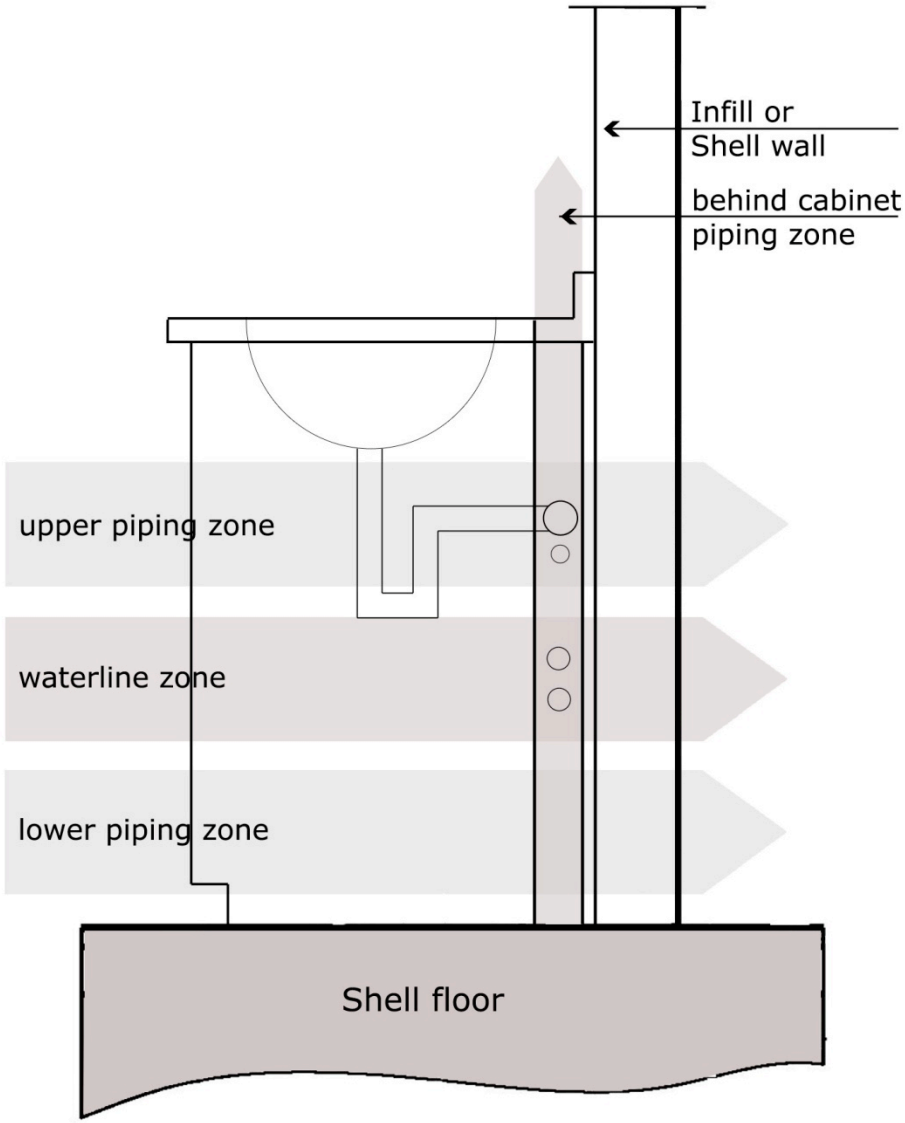
In some cases, a secondary plumbing wall is needed to carry all of the horizontal pipes from nearby fixtures to the MEP vertical stack.

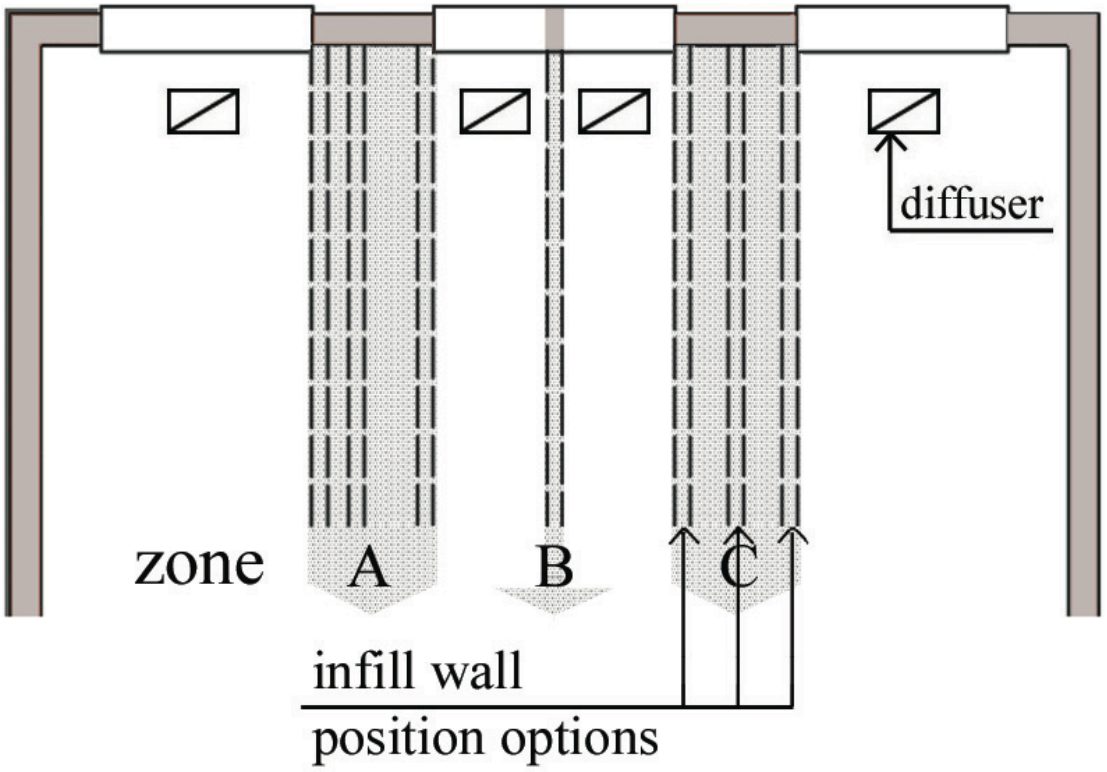


This diagram shows the use of a hierarchy of Shell water supply manifolds in Shell trenches, feeding infill lines routed through Infill walls. Some Shell manifolds feed Infill manifolds.



A piping zone can be located behind the kitchen cabinets for Infill piping and ducts.





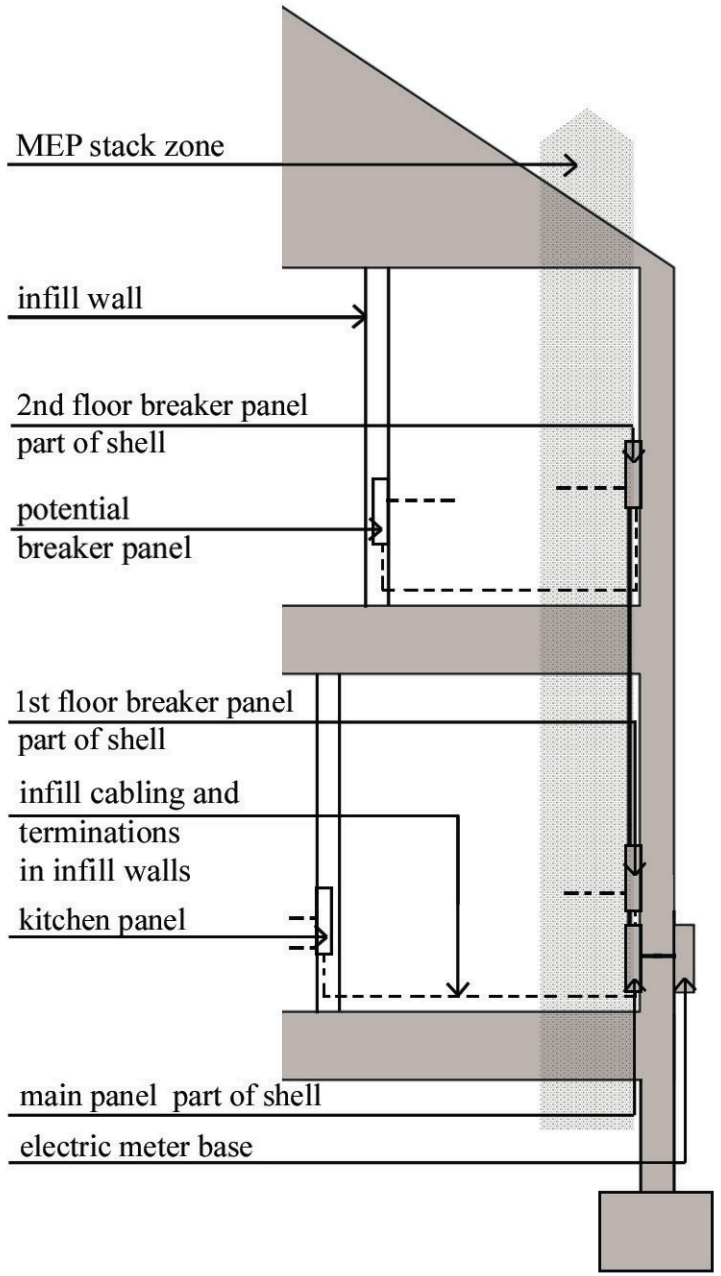
If forced air conditioned air distribution is used to heat and cool the house, most of the horizontal ducts can be fixed as part of the Shell. This is justified because the heat gain and loss are constant for the Shell independent of the floor plan chosen. Therefore the location of air **diffusers** is, to a large extent independent of the Infill layout, and can be located optimally at the most significant heat gain and heat loss positions (usually under exterior windows and doors)

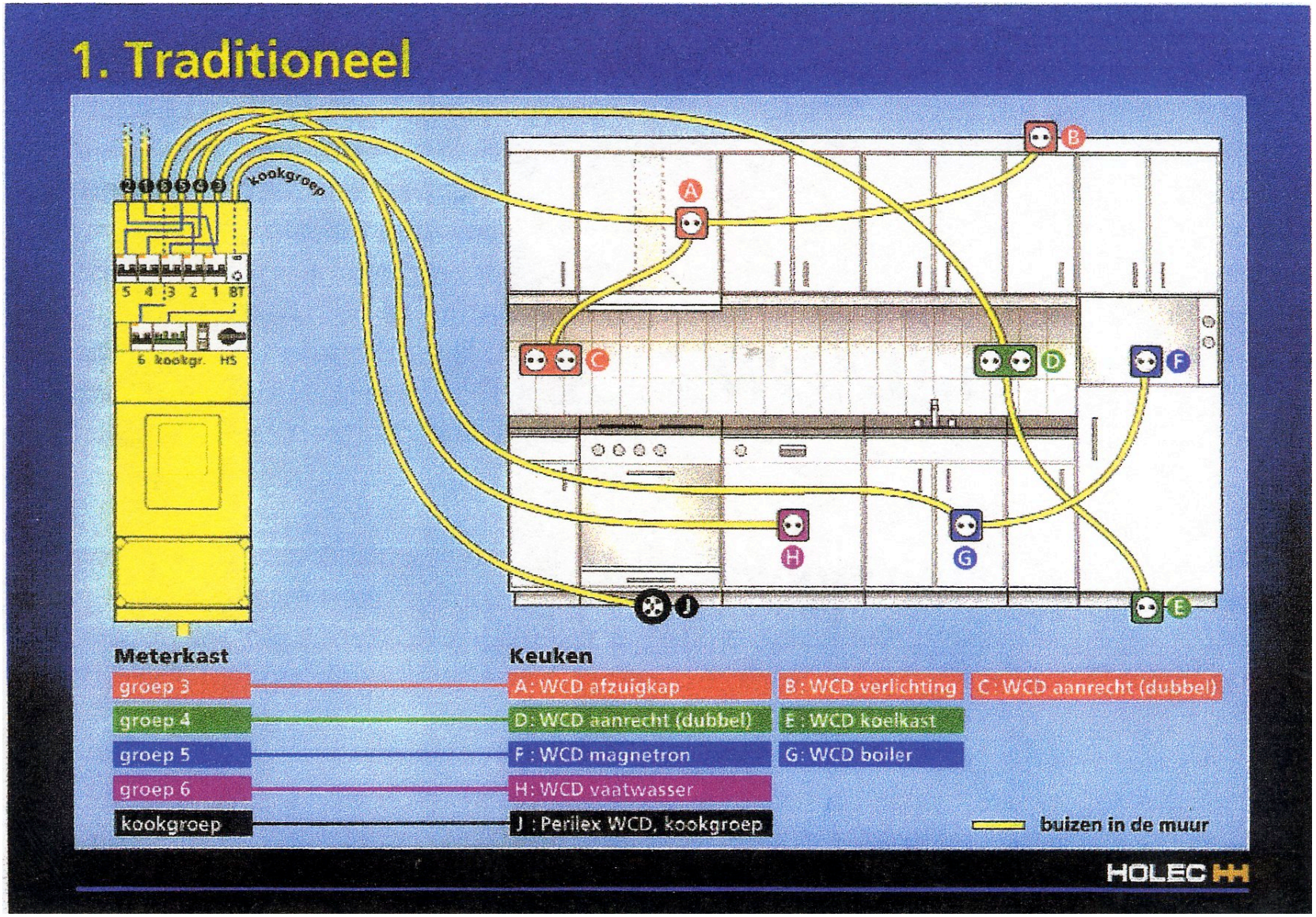
This is an example of an air distribution duct in the floor

Electrical and Data Services

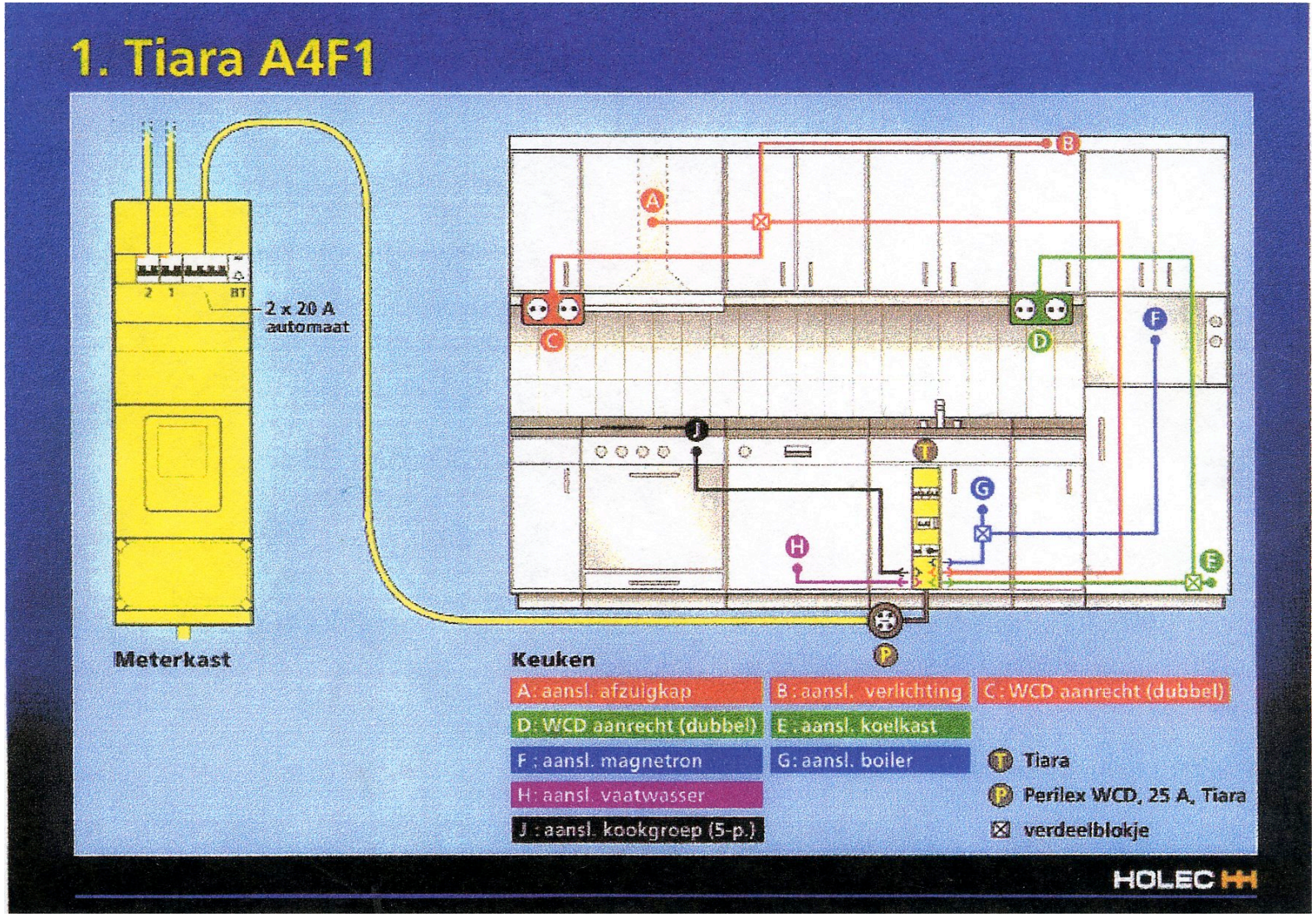
To reduce the density and volume of cabling at any given point in the Infill, we recommend a hierarchy of "circuit breaker panels".

In part this is necessary because we are using a cabling raceway for Infill wiring distribution that has restricted capacity. Second, we want to rationalize the use of wiring and thus reduce waste and assure safe and clearly documented distribution lines.

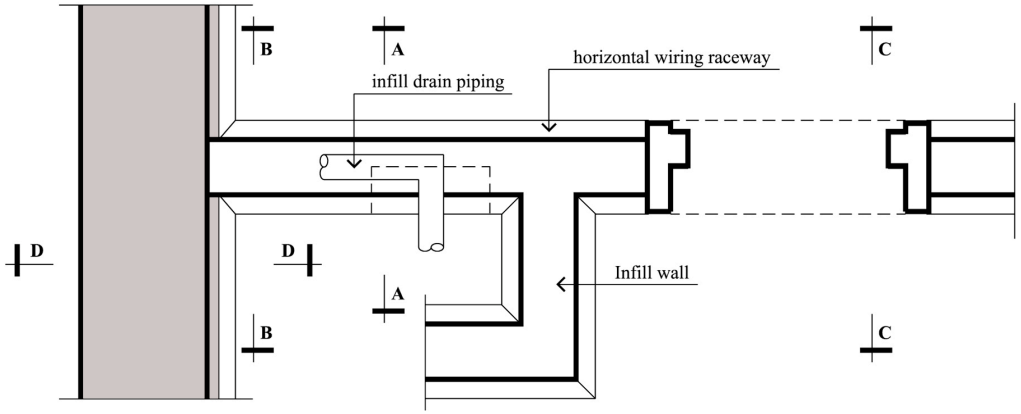




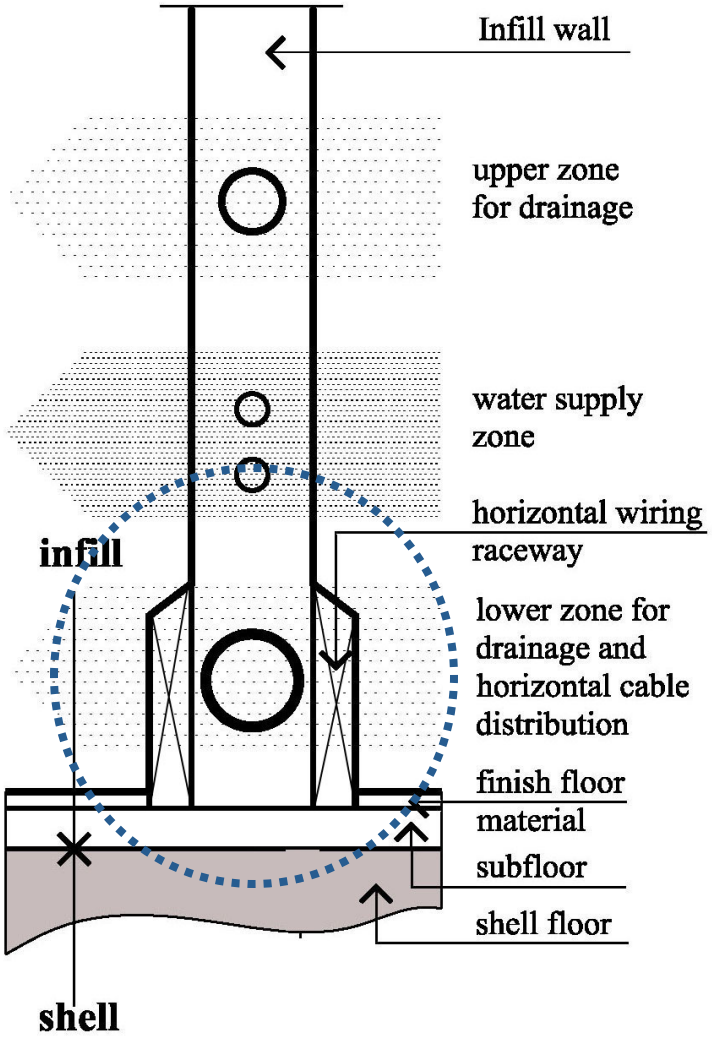
In a traditionally wired kitchen, many wires are used as shown here, each running some distance from the main circuit breaker box to service an individual termination, fixture or appliance.



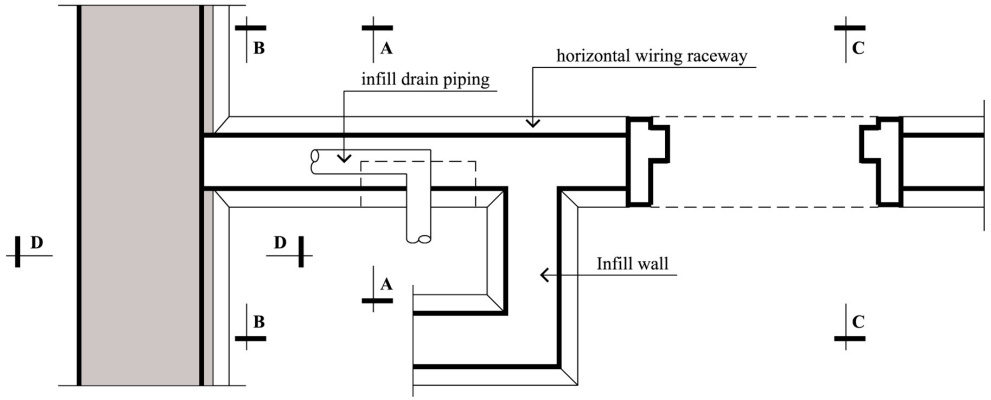
This is an example of products using the idea of a hierarchy of cabling. The “Tiara sub-panel” (symbol T) is fed by a single cable from the circuit breaker box (Meterkast). Wiring for kitchen appliances and outlets are part of the cabinets.



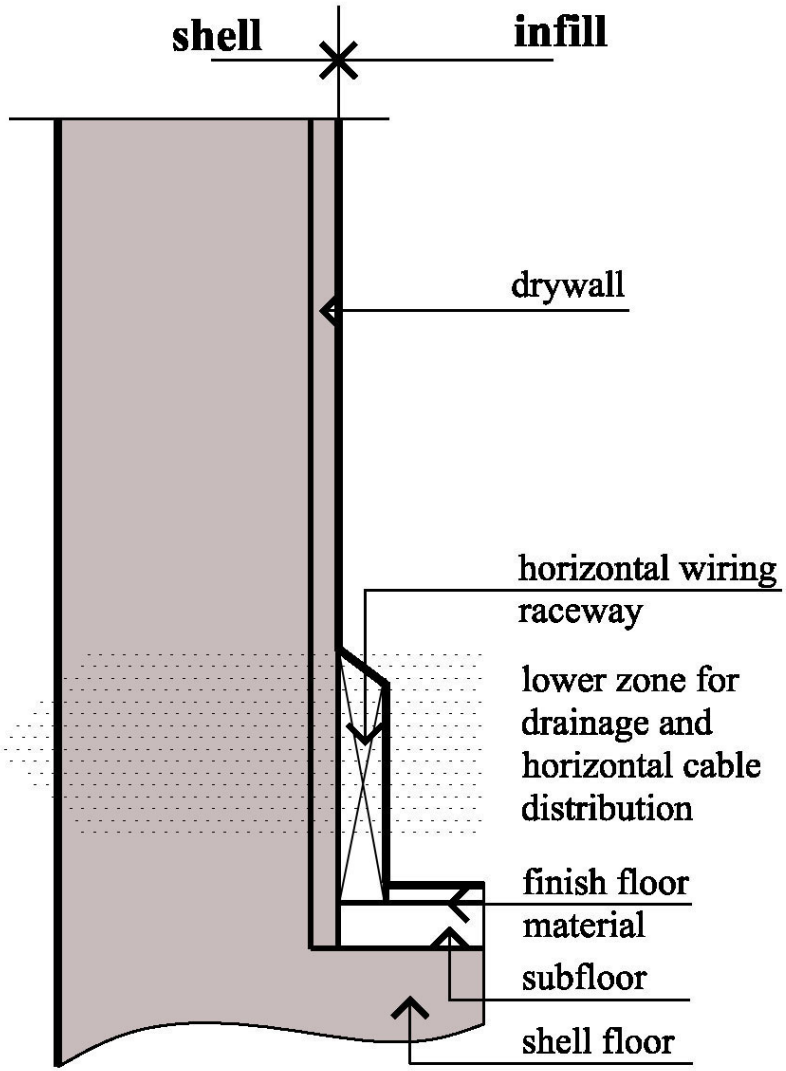
Section B-B cuts thru an Infill wall where a horizontal drain line, water supply pipes and an upper drain line are located. In this case, the horizontal wiring raceways on each side of the Infill partition are uninterrupted.



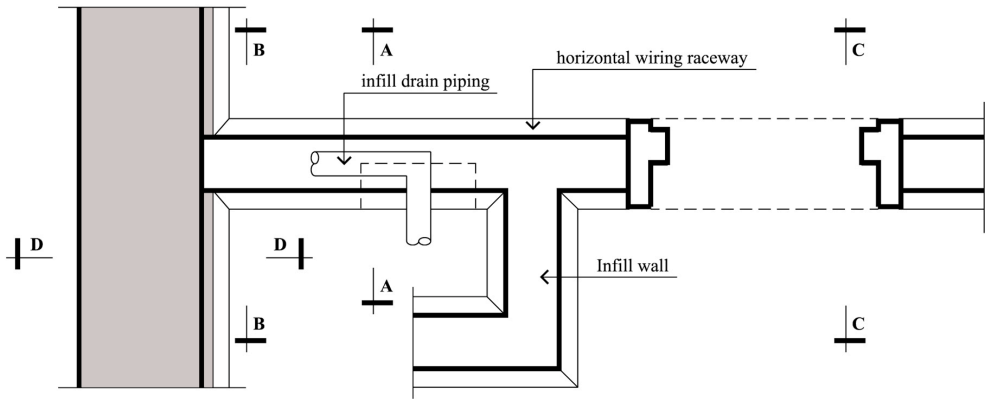
Section B-B



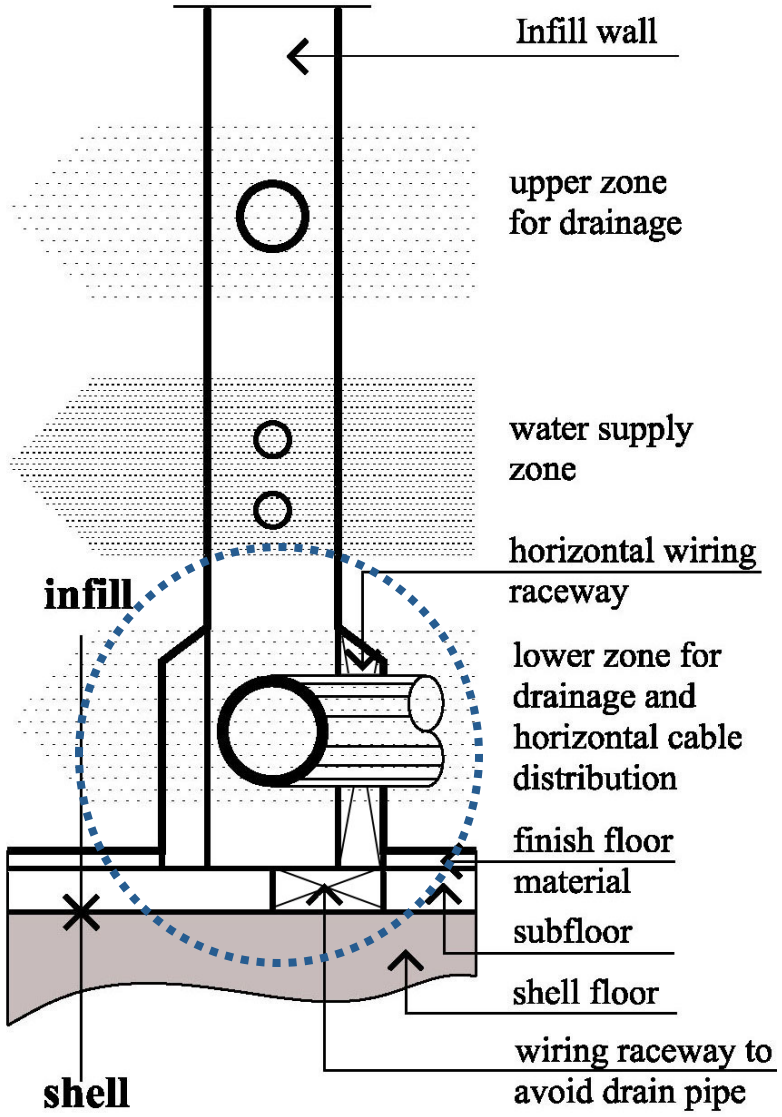
Section D-D is cut through the Shell wall and shows the horizontal wiring raceway as part of the Infill.



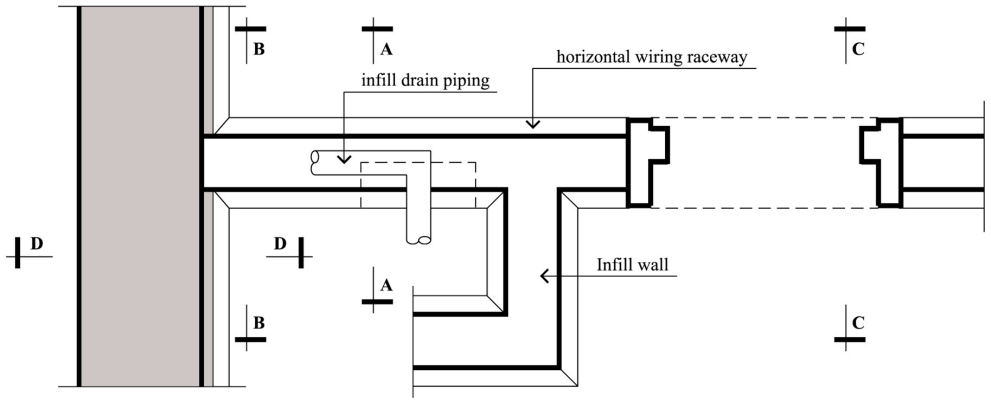
Section D-D



Section A-A cuts thru an Infill wall where a horizontal drain line enters the wall, and where water supply pipes and an upper drain line are located. In this case, the horizontal wiring raceway on one side of the Infill partition is interrupted. The concealed raceway in the thickness of the sub-floor provides a cabling "bypass" of the pipe.

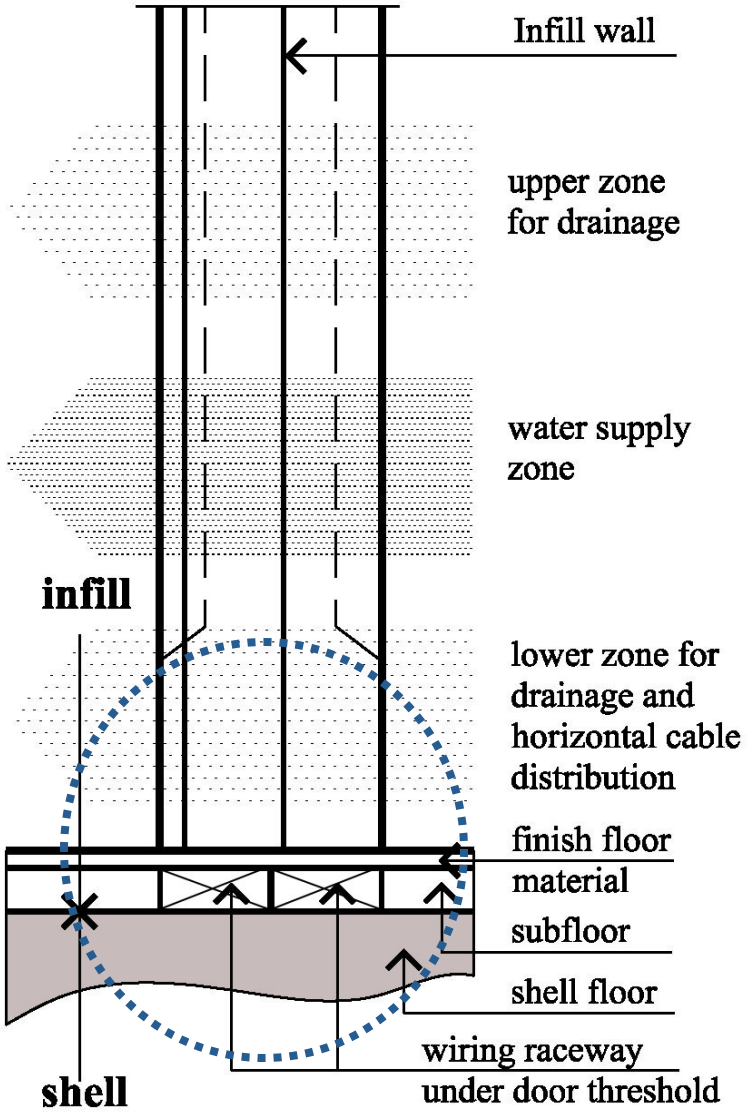


Section A-A



Section C-C is cut through the doorway opening and shows the concealed horizontal wiring raceway under the door threshold.

Two channels are shown, one for cables from each of the surface-mounted raceways, one on each side of the Infill wall.



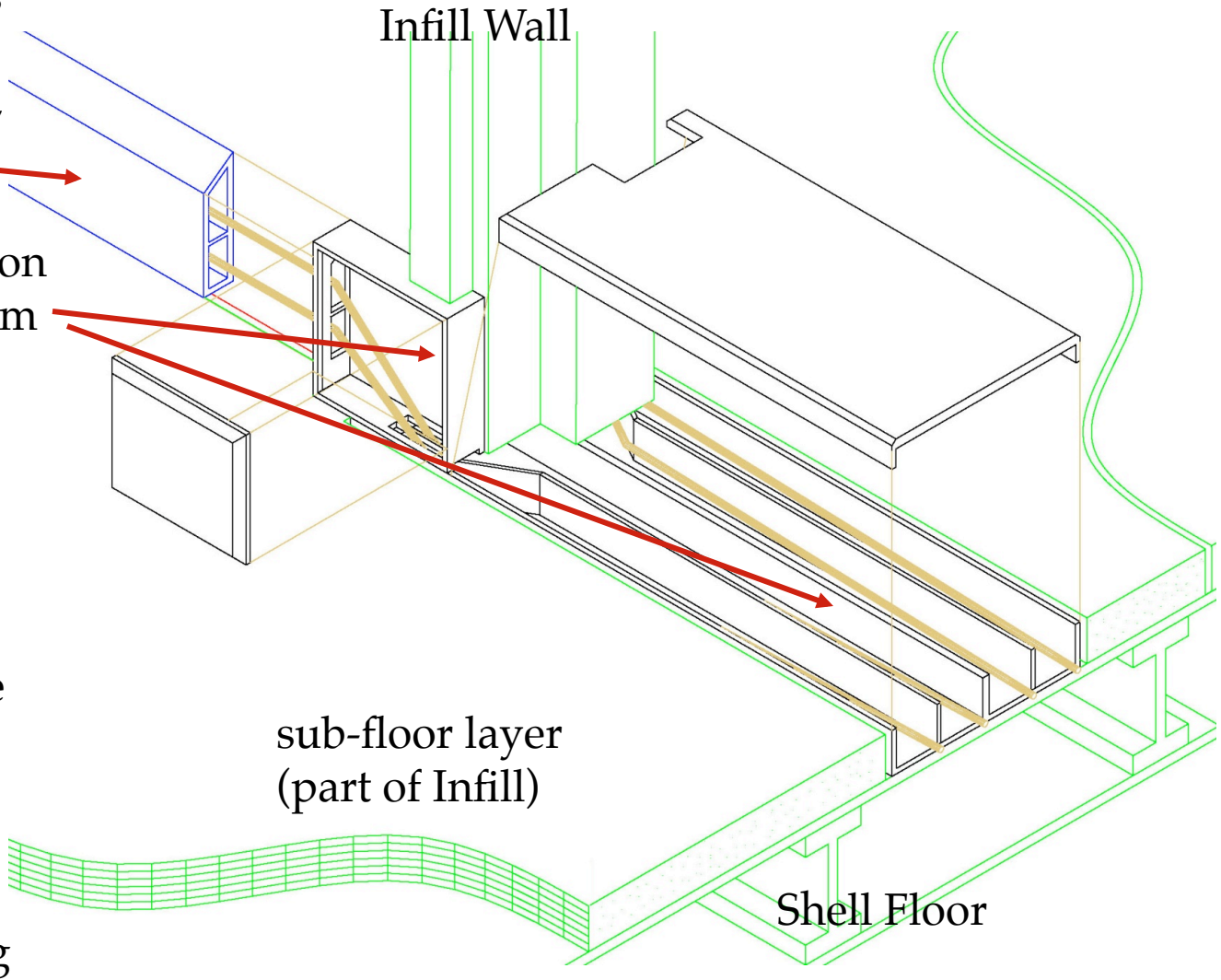
Section C-C

HOMEWORKS proposes using existing surface mounted cable raceways, such as this.

I have invented a transition box that routes cables from the surface-mounted raceway to a concealed raceway under the door.

Wall switches or other terminations in an Infill wall are connected inside the wall to the cabling in the surface-mounted raceway.

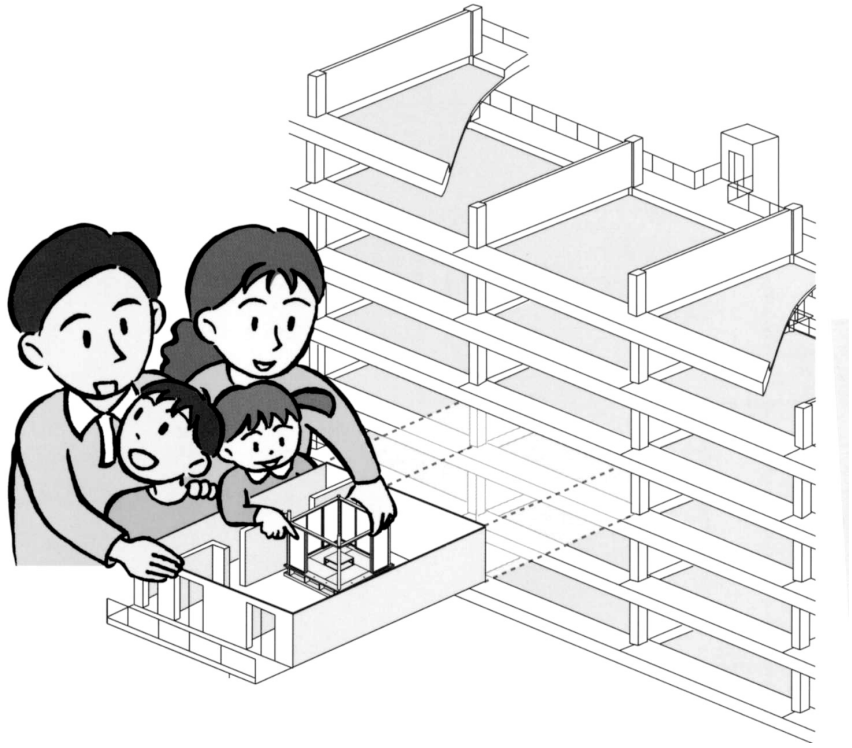
Remote control switching devices can also be used.



Those are the basic technical principles of HOMEWORKS.

The goal of HOMEWORKS is to provide a solution to the problem of filling in empty residential spaces quickly, per-dwelling.

The method can be applied in both new construction, in upgrading older residential buildings one-unit-at-a-time, or in converting non-residential buildings to housing.

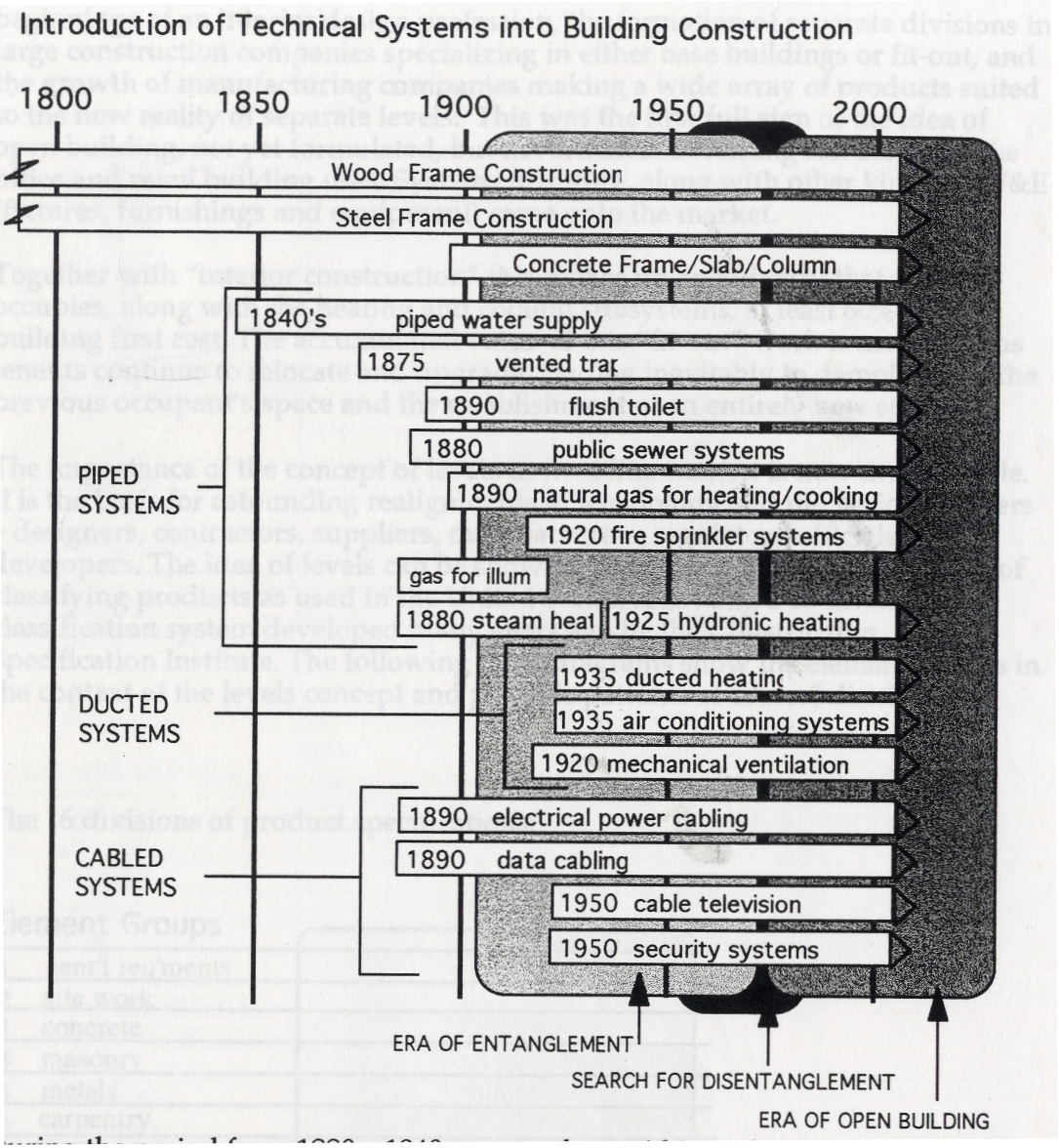


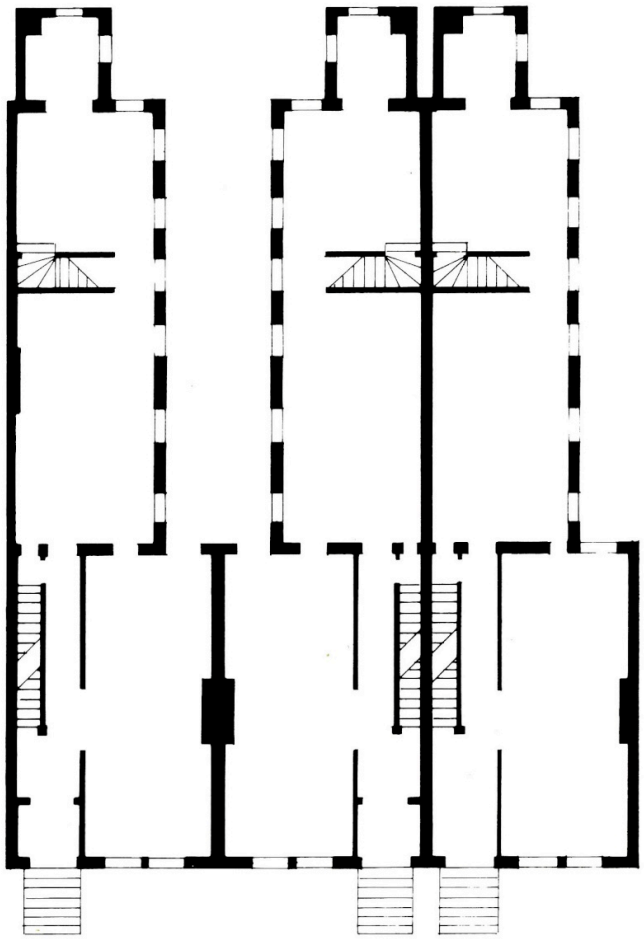
A Brief History of the Entangled American House

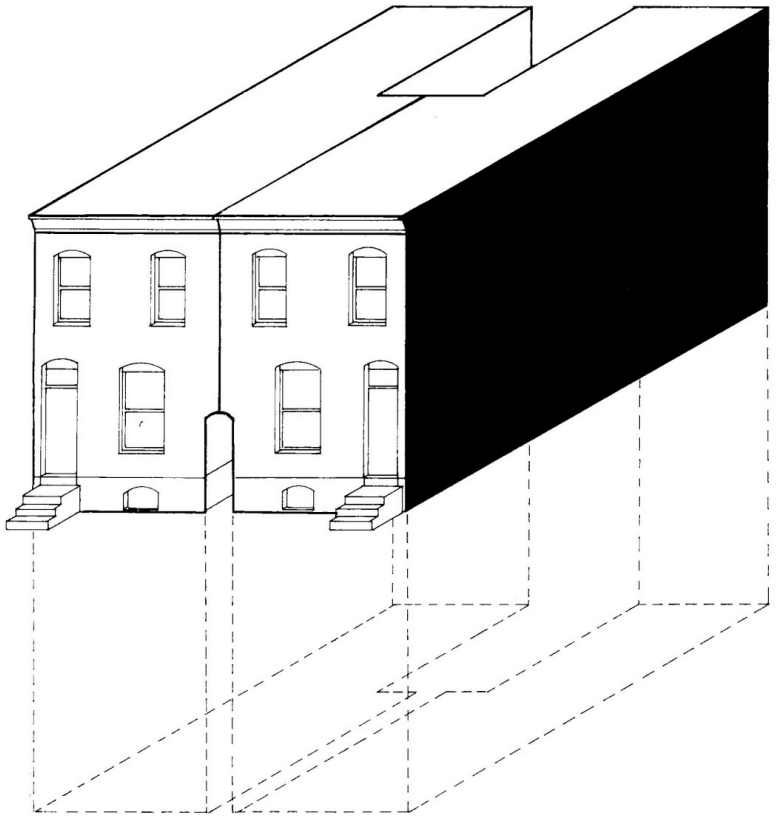
The history of housing technology in the U.S. indicates in part why a movement toward open building is difficult and slow.

The technical problem is that the "entrails" of houses (pipes, wires and ducts) have become necessities only in the past 50-75 years.

They were woven into buildings, becoming "entangled" with other technical systems like structure and walls.







This is a row-house built in the 1700's in the US.

It uses masonry bearing walls and floors of wooden joists. Kitchens and bathrooms were attached to the back of the houses.

Rooms are not labeled. Most rooms were multifunctional.

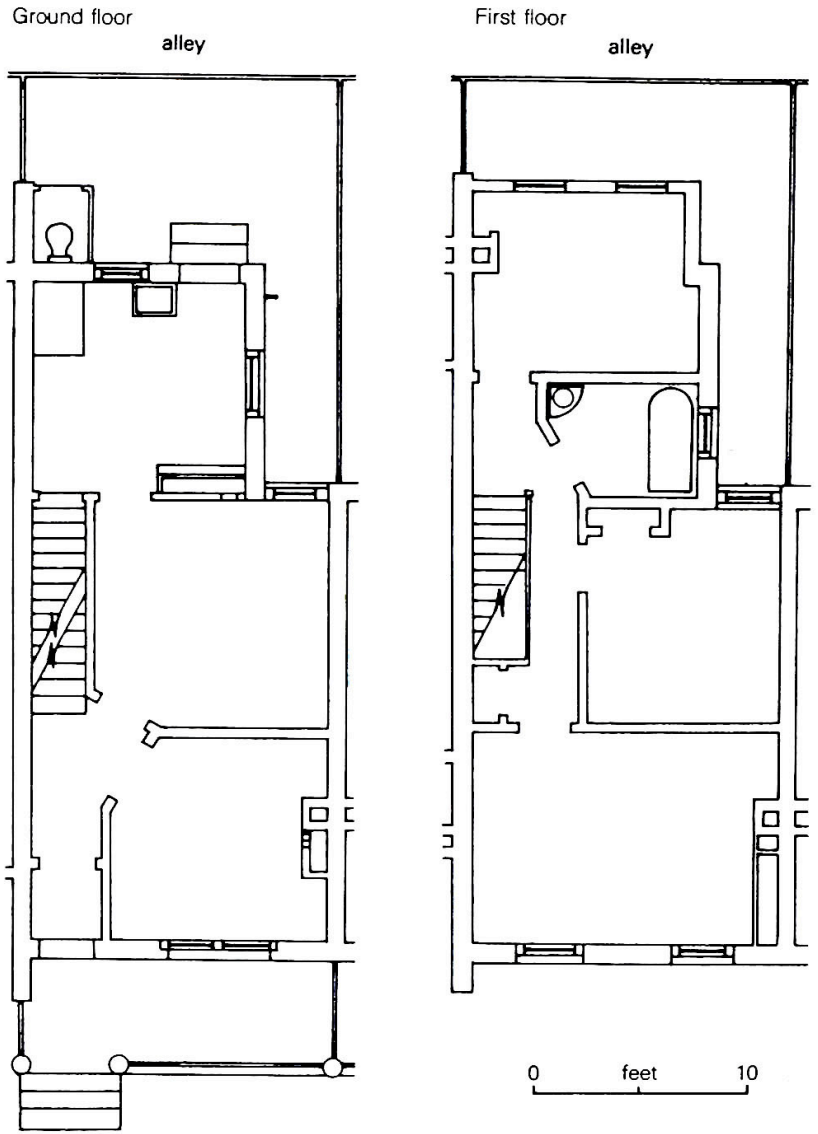
This is the plan of a townhouse built at the end of the 19th century.

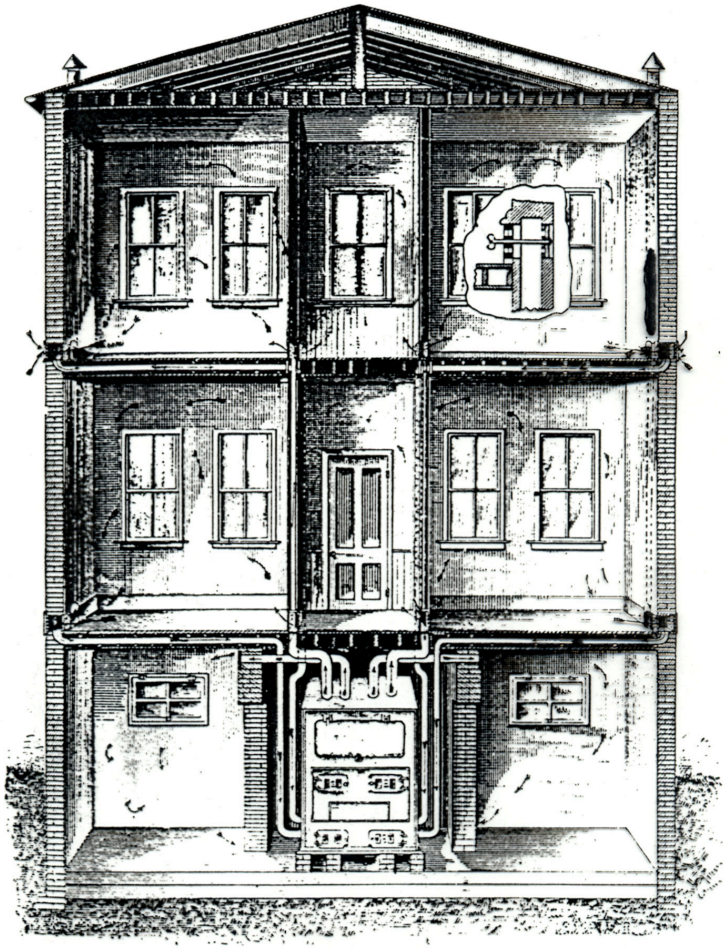
A toilet is located outside the house, reached from the back yard.

A bathroom is on the second floor.

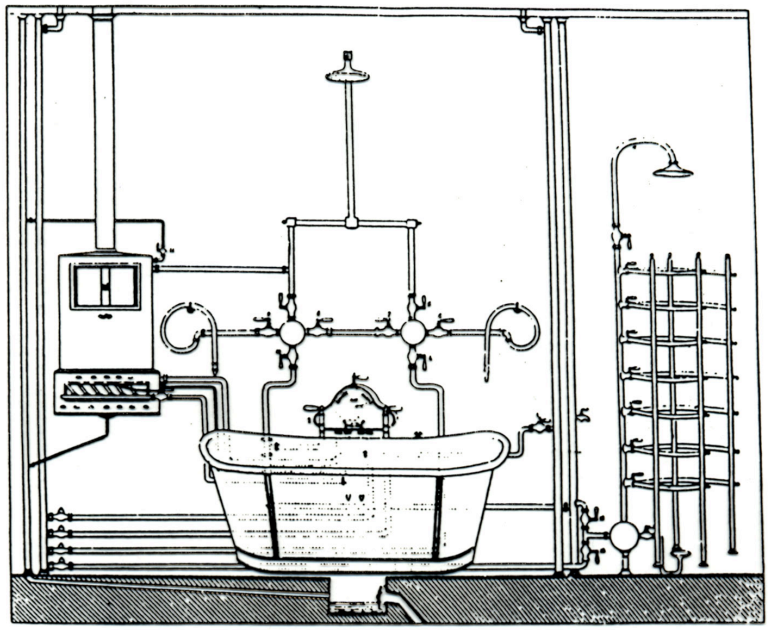
This was already an improvement from what was normal only 50 years before, when a pit latrine was located away from the house, and a well located outside of the house was the only source of water for bathing and cooking.

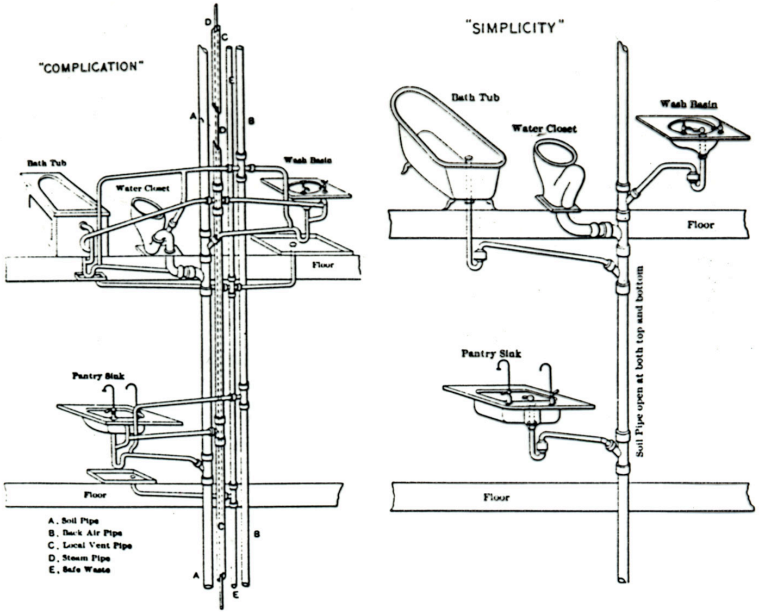
But this was also the birth of the era of "**entanglement**". Pipes entered the house to serve sanitary systems.





From Elliott, Technics and Architecture, MIT Press, 1992

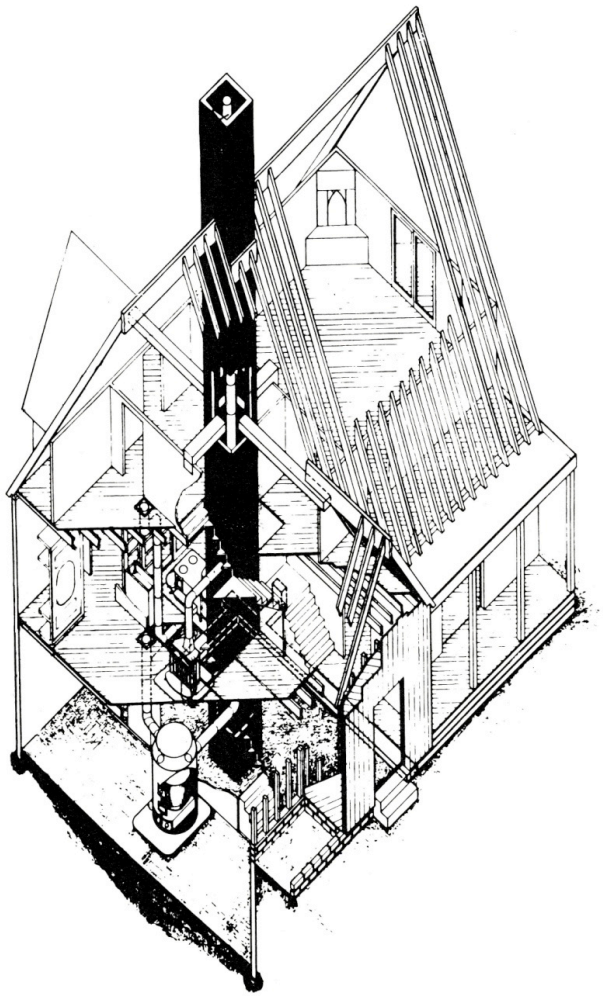


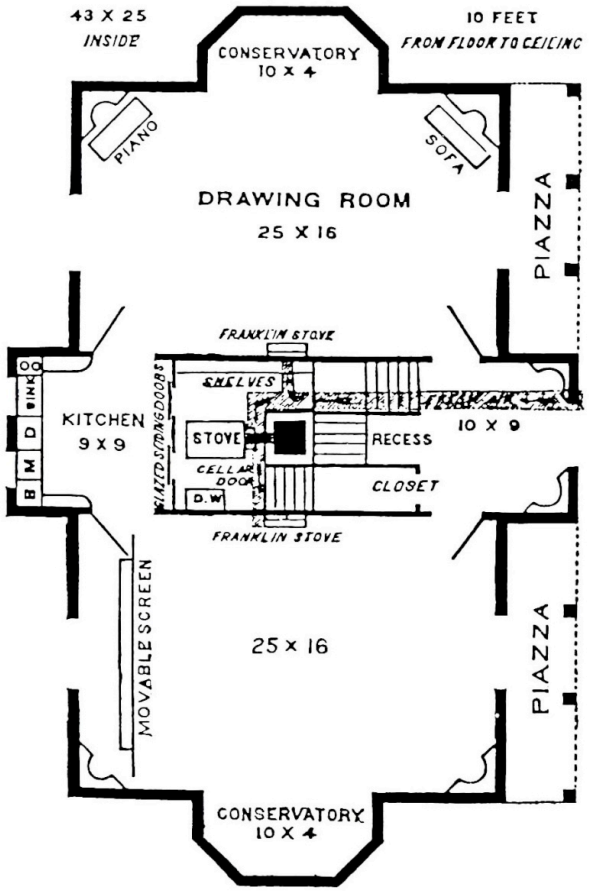


From Elliott, Technics and Architecture, MIT Press, 1992

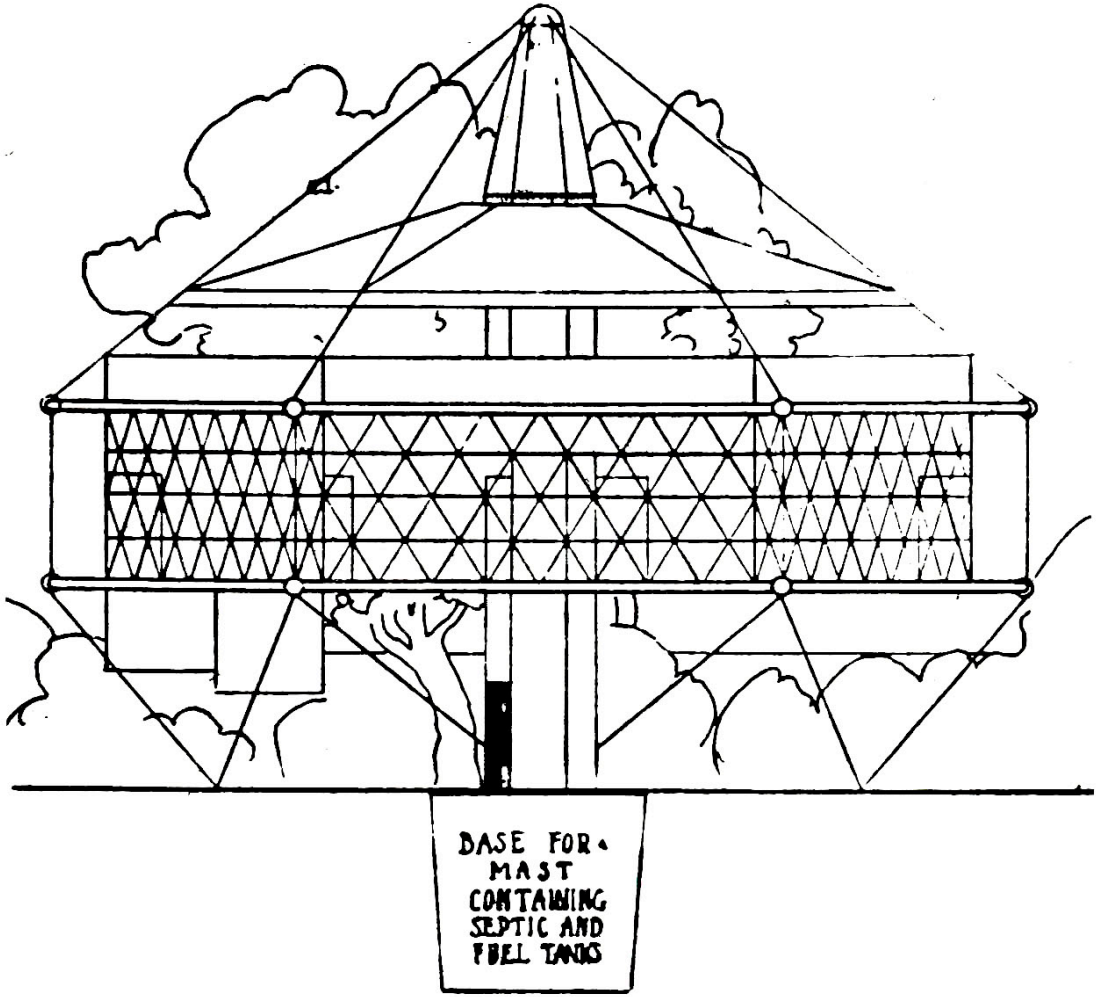
These two images show exactly the entanglement I speak of.

The “2x4” way of building came into being in the US in the 1830’s, supported by the efficient mass-production of nails (fasteners) and thin sticks of lumber. Low-skilled workers could now build houses.

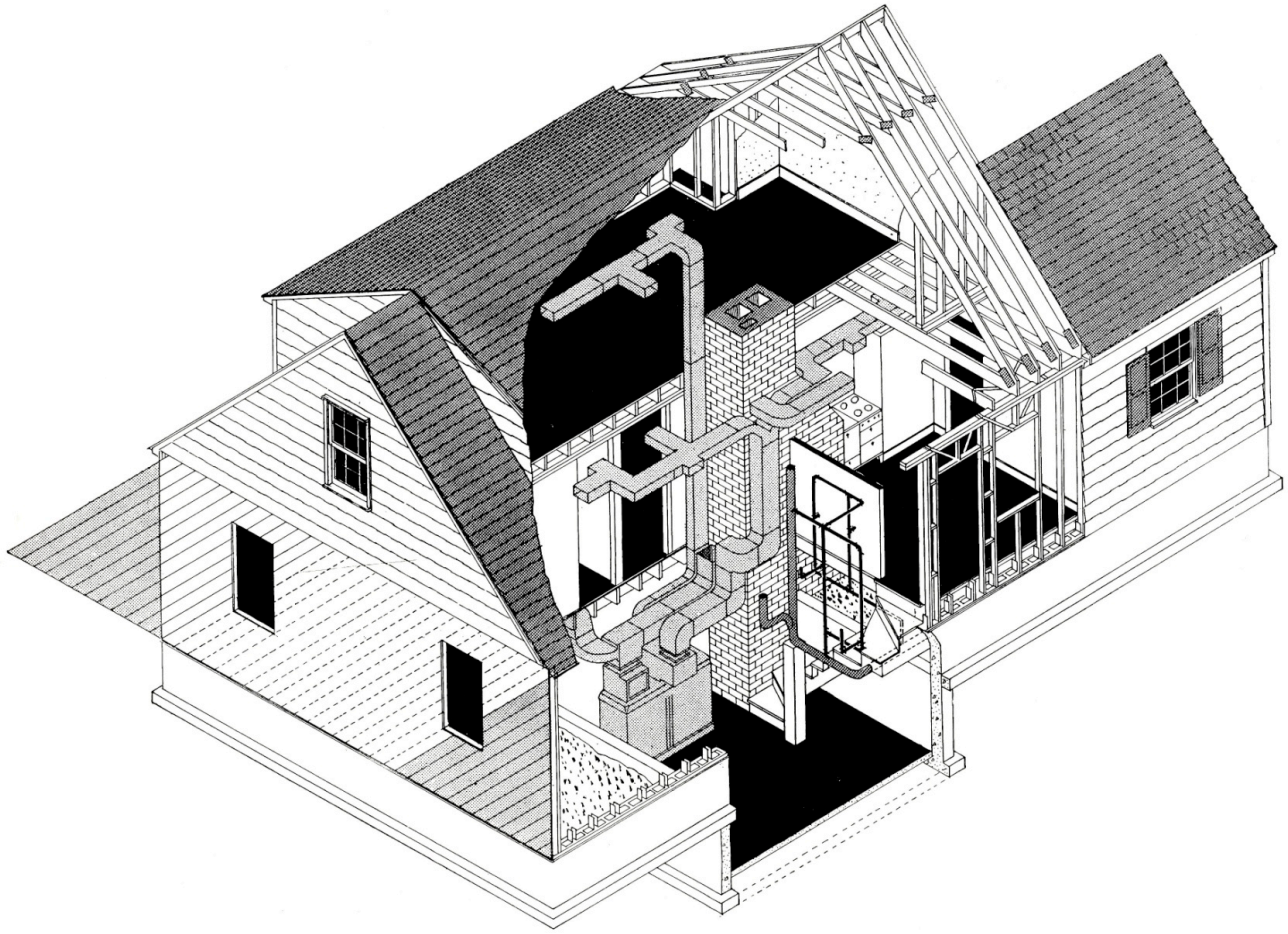




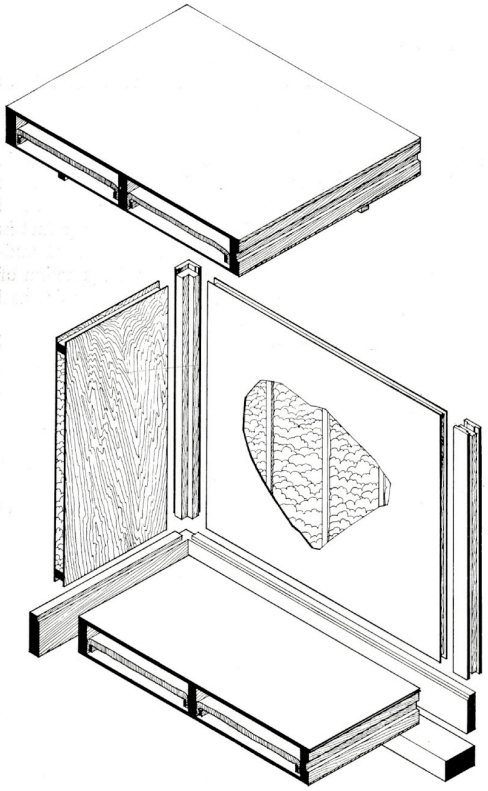
Functionalism led to assigning specific uses to specific spaces. This coincided with the introduction of “wet” spaces into the house (here a kitchen is shown) and the introduction of “central heating”. This was a proposal for an AMERICAN WOMAN’S HOUSE in 1869.

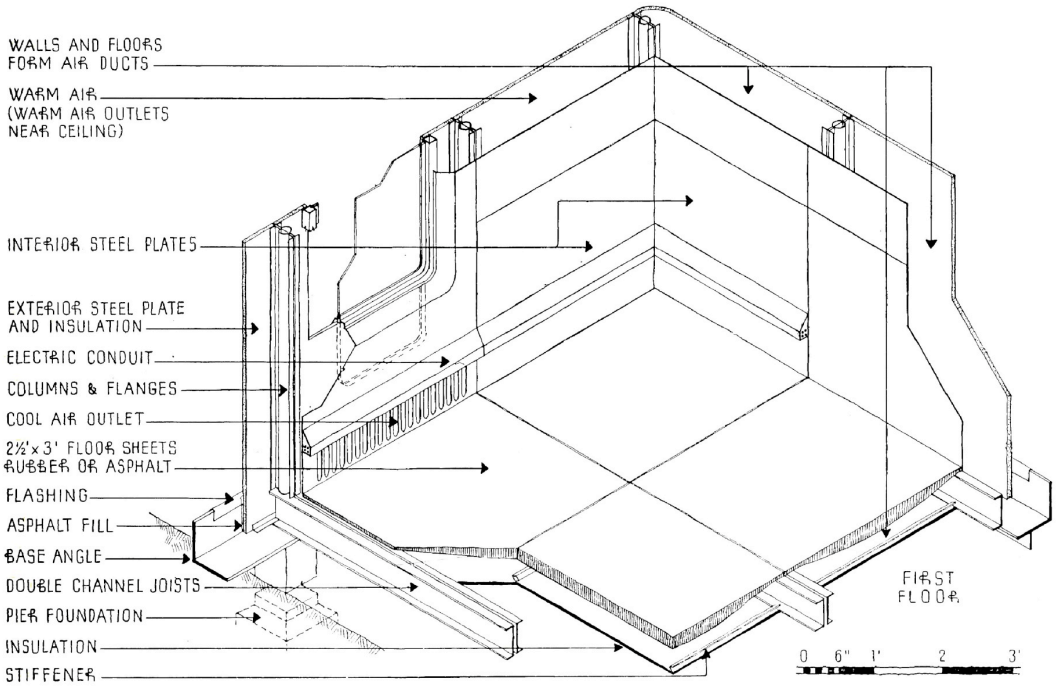


In the early 20th century, Buckminster Fuller proposed a similar central utility core in his proposal the Dymaxion House.



During the years 1929-39, experimentation focused on “integrating” new mechanical systems into houses. This house- published in 1937 - had modular design, standardized plans, new production “flow patterns”, and new construction practices proposed to deliver savings in cost and time.





During this period, many new construction methods were proposed. Almost none successfully entered the market. Those that did include consideration of mechanical systems "integrated" them into the new ways of building, making them tightly coupled or interdependent.

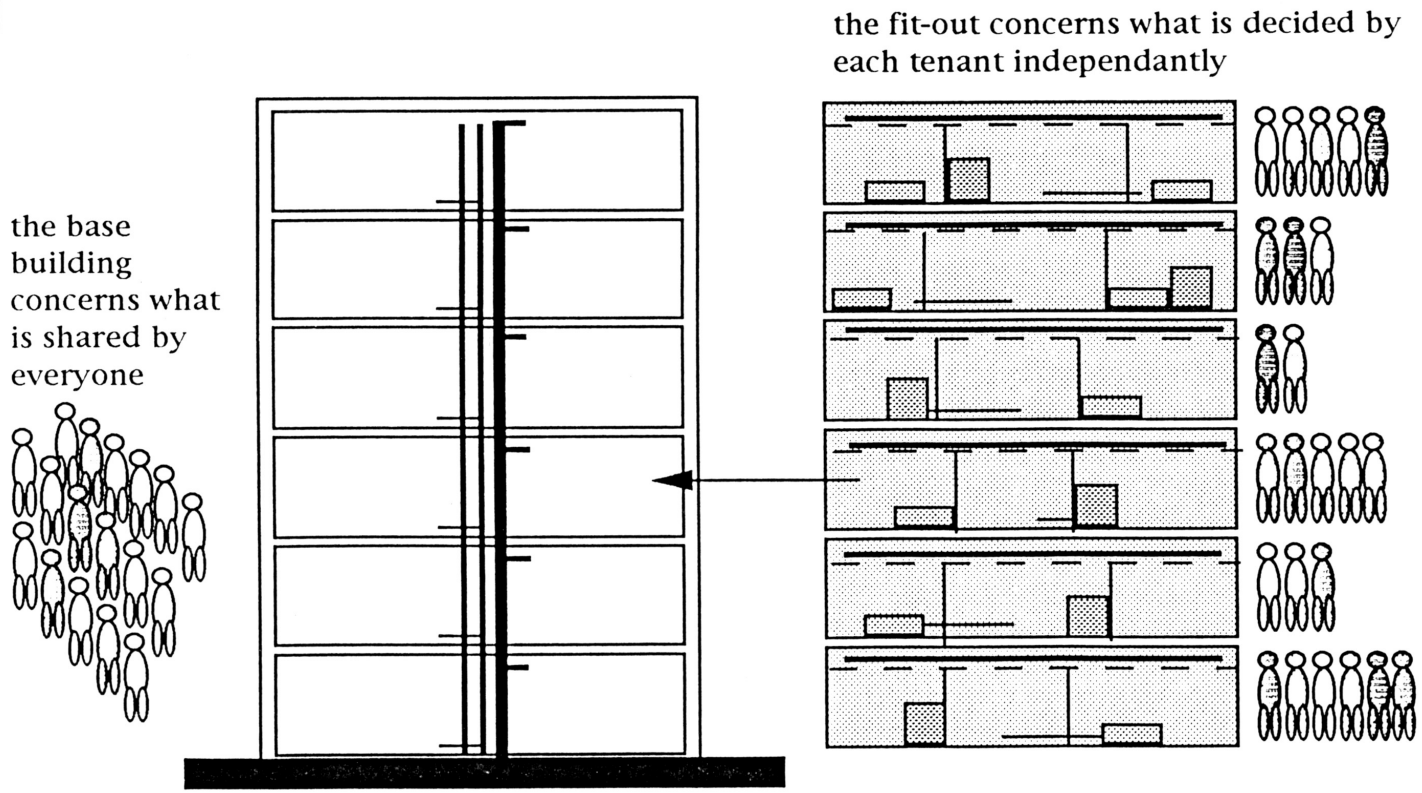
Changes to the way of building would require changes to the mechanical systems, and vice-a-versa.

This is the state of "**entanglement**" we now face. The cavities in 2x4 walls and floors have been filled with pipes, wires and ducts as they have been introduced over the past 75 years.

The disorganization evident here results initially in poor quality, waste, and technical and organizational conflict, and makes later alterations difficult, costly and even dangerous.

Open Building: A model of a new Infill Industry

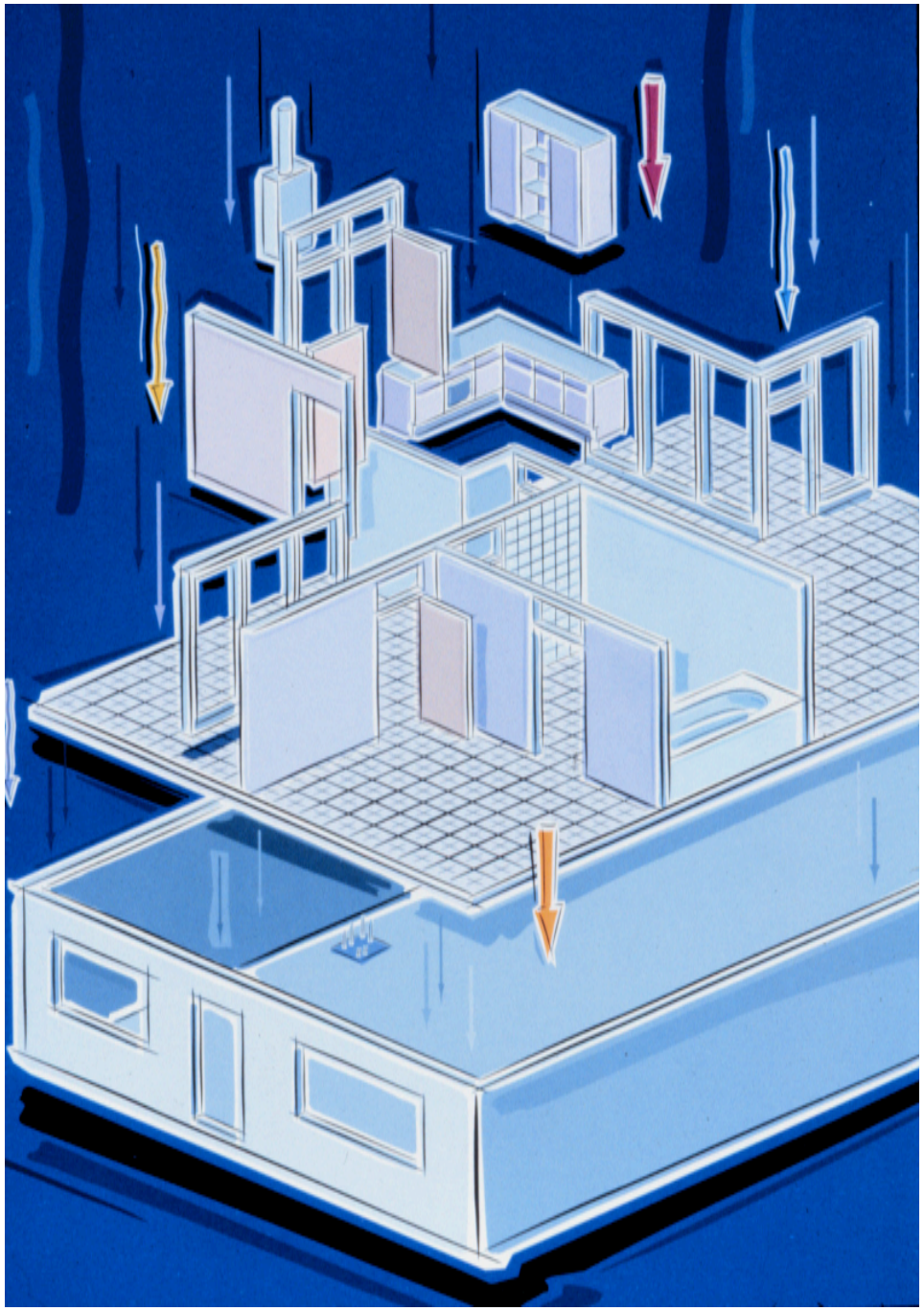
Architecture • Open Building

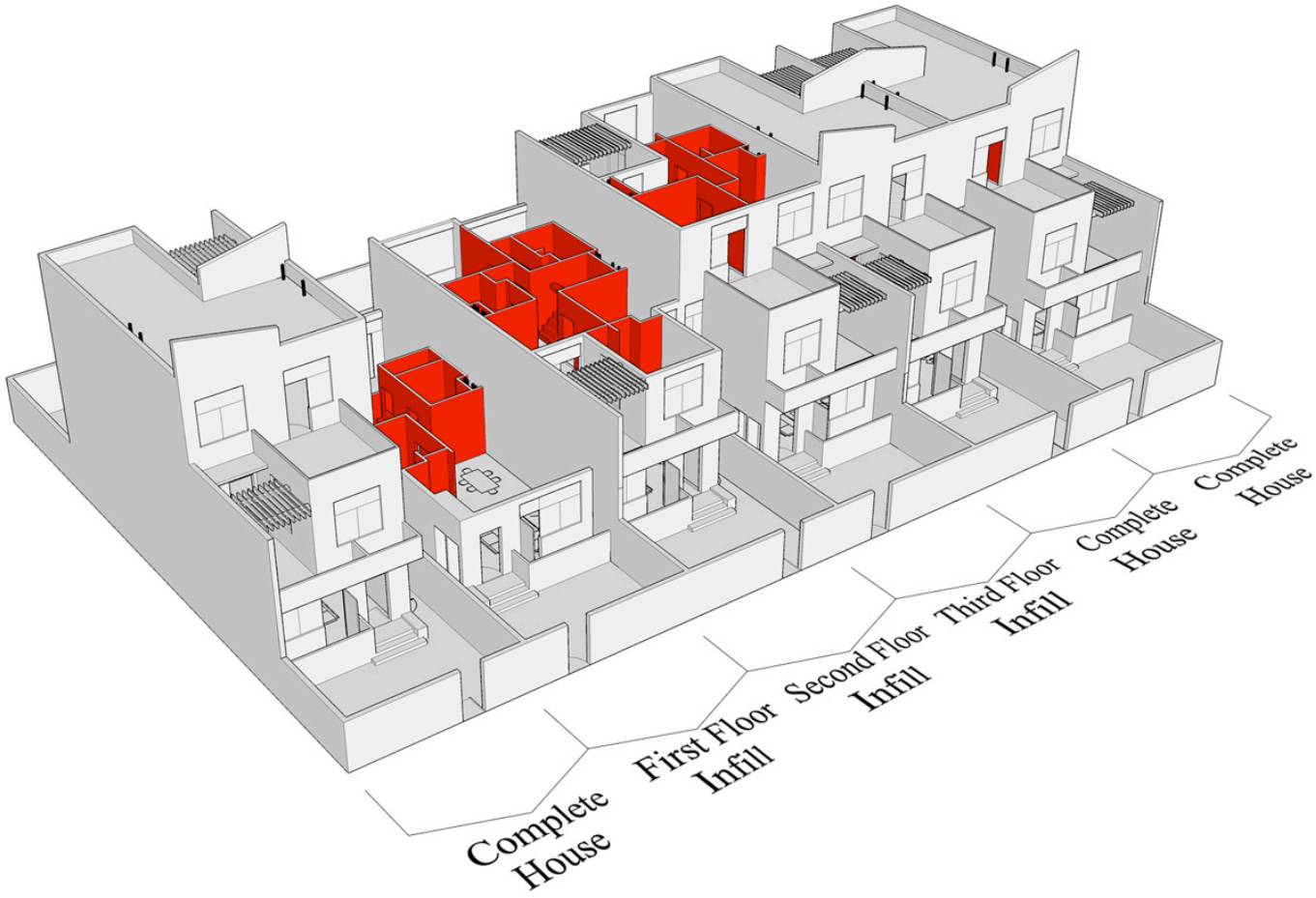


This diagram shows the separation of the whole building into BASE BUILDING and FIT-OUT. This is a technical distinction as well as a separation of responsibilities.

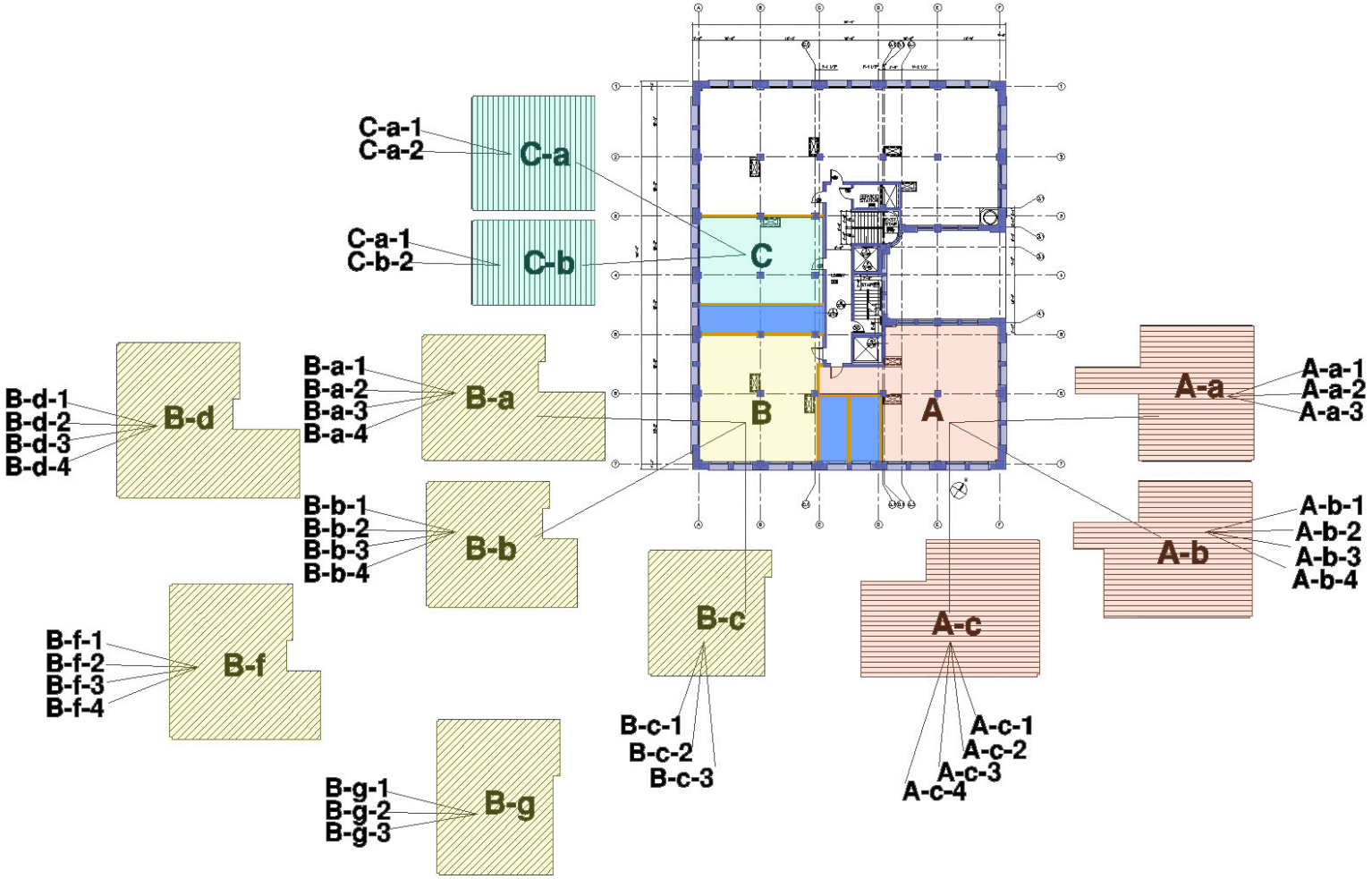
A base building is architecture.

The INFILL is the part of the whole building related to the individual dwelling unit, matching the basic social unit of society.





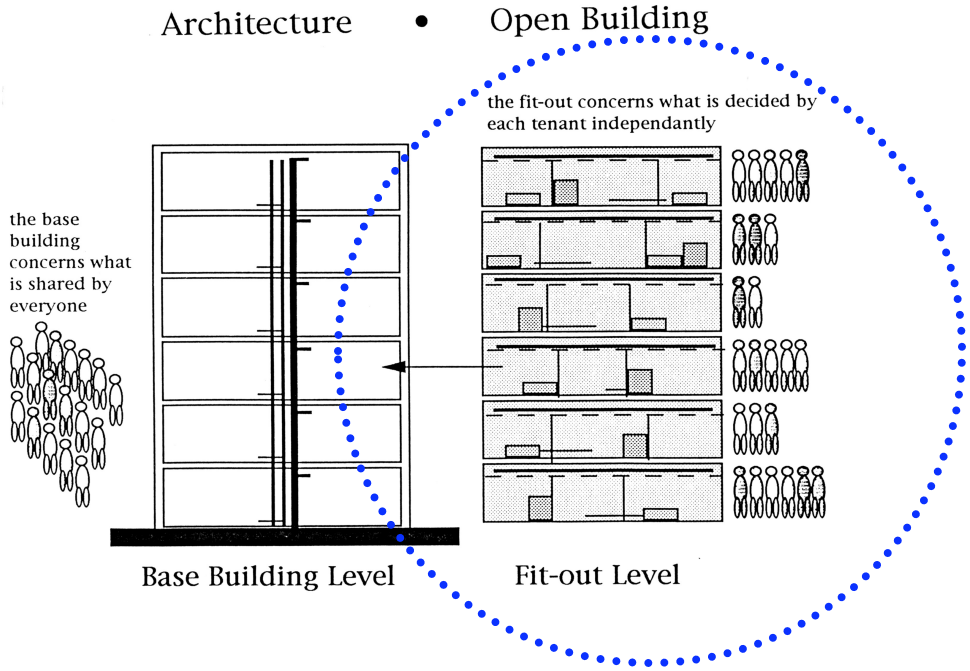
This is what the distinction looks like in a townhouse development.



This is a diagram of the CAPACITY of a given floor of a multi-floor building. For any unit size, a number of floor plans are possible.

This gives DECISION FLEXIBILITY to the developer, since each floor can be different with no technical problem.

A New Residential Infill Industry



We know how to build base buildings;

Architects, engineers, contractors, bankers and regulators know what to do;

Infill is familiar in office buildings and shopping centers;

NOW WE NEED NEW COMPANIES IN AN INFILL INDUSTRY FOR HOUSING.

The following slides show how such a company would work.

HOMEWORKS for Townhouses

A fabrication facility where all the parts for each customized infill package - from many suppliers - are prepared for delivery.

Loading the first of a series of containers with all parts needed for the first phase of the infill installation. IT support is critical.

Delivering and unloading the container in front of the empty Shell it will be installed in over the coming two weeks.

Unloading a container into the Shell.

A multi-skilled team of workers installs the Infill step-by-step before handing over the keys to the new occupant with a users' manual. Waste materials are loaded into the container for delivery back to the fabrication center for recycling or reuse.

The finished dwelling unit several weeks later, with furnishings brought in by the new occupant.

HOMEWORKS for Multifamily buildings

The fabrication facility where all the parts for each customized infill package - from many suppliers - are prepared for delivery.

Loading the first of a series of containers with all parts needed for the first phase of the infill installation.

Delivering and unloading the container at the building where an empty Shell space awaits the Infill installation over the coming two weeks.

Lifting the container to the window for unloading.

Preparing to unload the container into the empty Shell space after securing it to the building.

Alternatively, INFILL can be brought into the dwelling this way, as is now done for large furniture, in Taiwan and Korea.

A multi-skilled team of workers installs the Infill step-by-step before handing over the keys to the new occupant with a users' manual. Waste materials are loaded into the container for delivery back to the fabrication center for recycling or reuse.

The finished dwelling unit, two weeks later. Furniture is brought in by the new family.

Ultimately, open building can help restore the individual household to the housing process.

This is important for social well being, maintains the "small-scale" in residential environment, and helps make more sustainable neighborhoods.

With this realignment of forces, industry can organize to meet the demand of the individual household, like it has done in other consumer-oriented sectors such as consumer electronics, automobiles and IKEA-like furniture companies.

We have much work to do!

So, let us get to work without delay!

This is a new challenge to architecture and architects. Can we meet this challenge with Imagination, energy and humility?