

SYSTEMS and VARIETY

**A systems approach to designing houses that
respond to user preferences**

Predictability and Change

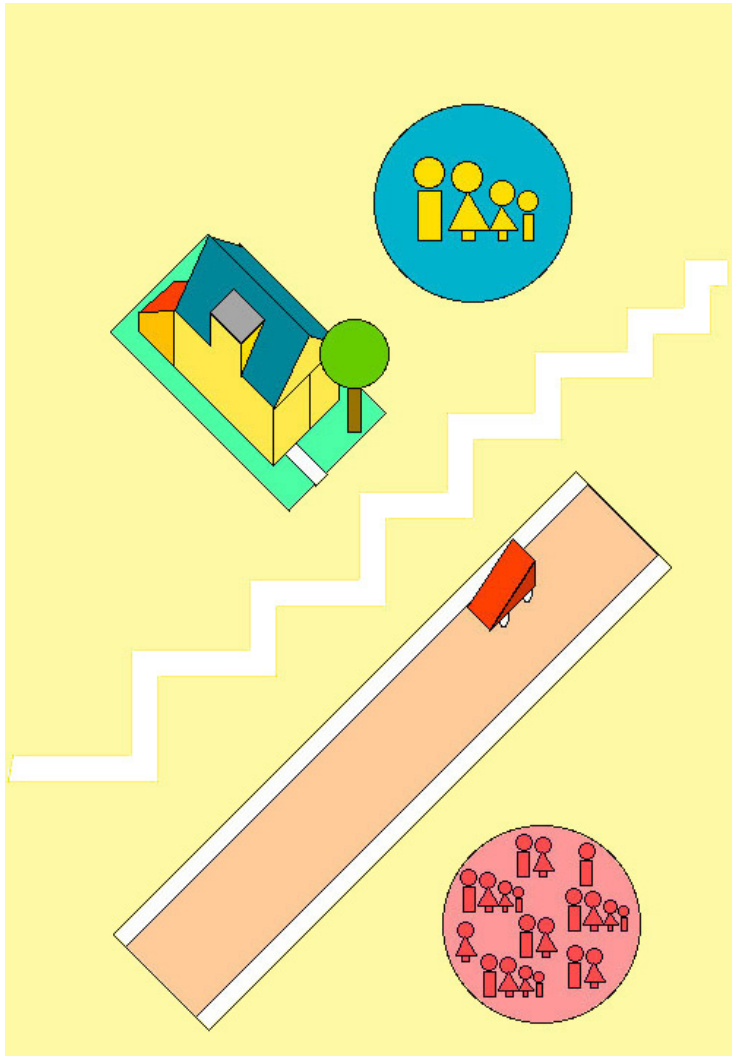
- Developers like predictability
- Banks like predictability
- Architects like predictability
- Contractors like predictability

But consumers like variety (just look around!) and like to change things to meet their preferences!



How can architects participate in balancing that predictability, variety and change?

Housing exists in two spheres



A private sphere
(where all kinds of
decisions are made)

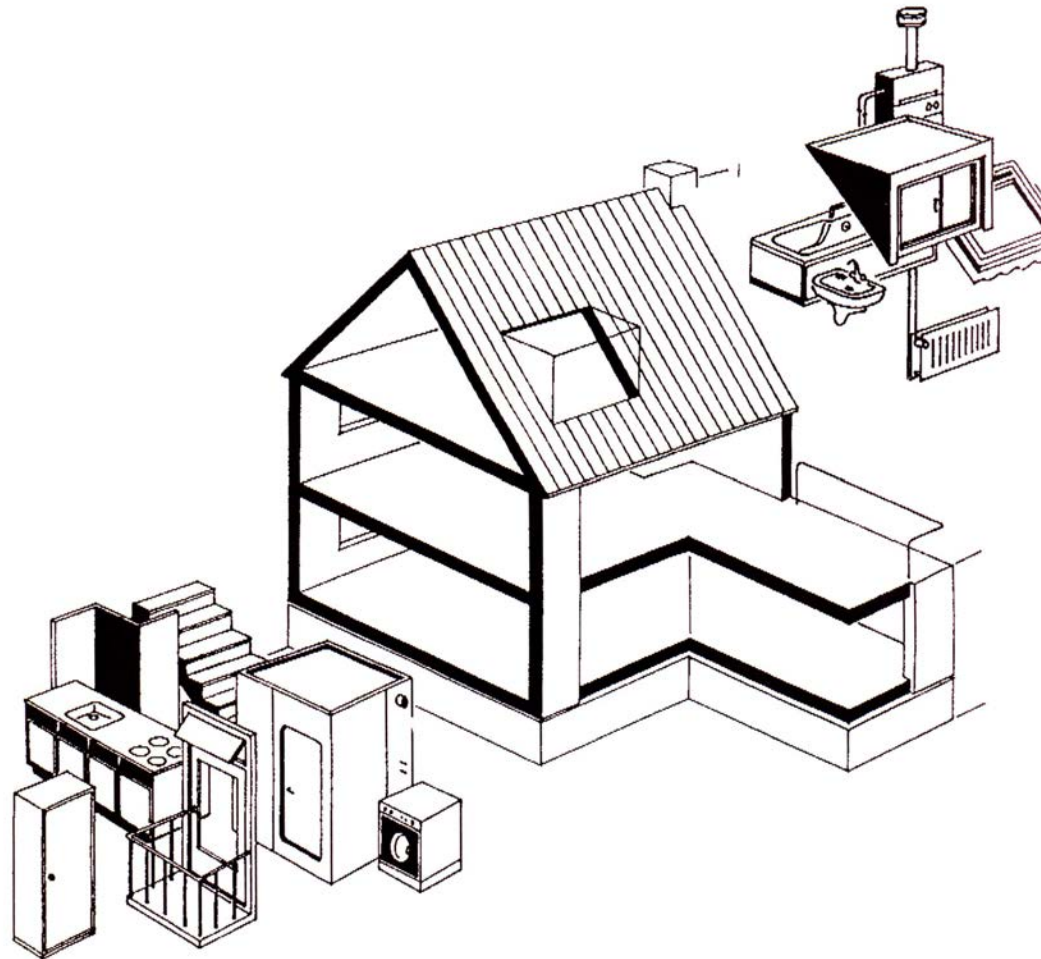
A public sphere
(where all sorts of
decisions are made)

(Thematic) variety is natural

PATTERNS, TYPES AND SYSTEMS ARE SHARED



Houses can also be seen as being made of “fixed” and “variable” parts



SOME PARTS LAST LONGER THAN OTHER PARTS...THE TWO MUST BE KEPT DISTINCT

Shell/Infill Study #1



Shell/Infill Study #1

The Separation of SHELL and INFILL

The Separation of SHELL and INFILL

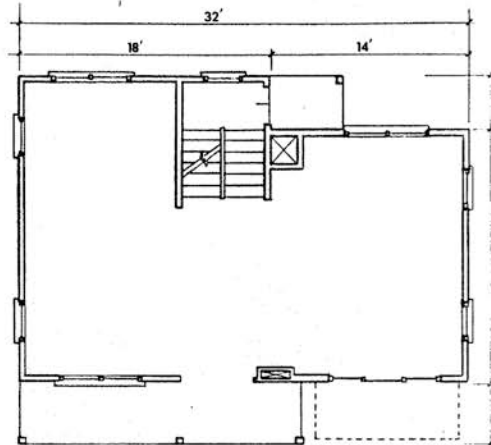
The strategy which we propose and which is studied in this report is the separation of the SHELL of a house from its INFILL. We propose this strategy as a way of managing more efficiently the variety that we now expect in houses.

In order to show what it means to make this separation in what we conventionally know as a kind of unibody artifact - a 2x4 house - we have taken an existing house in a development of 32 houses, in Boulder, Colorado, owned by one of the authors of the report. We are using it for convenience and because from a brief study of its plan, it seemed easily adaptable to the requirements of the study.

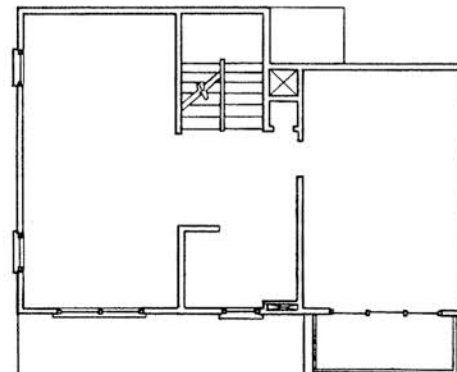
The SHELL is shown here, by illustrating the two principle floors of the four story house. The process of arriving at the SHELL is discussed in Appendix 2. The existing house from which we derived the SHELL is illustrated in Appendix 1.

This SHELL is capable of holding a number of different INFILL schemes, some of which are illustrated on the next two pages.

The SHELL, therefore, is a constant to a number of INFILL configurations. In general, we would say that a SHELL lasts longer, is more rooted to local conventions, climate, regulations and streetscape. The INFILL usually has a shorter life, is not so rooted in local trends, is independent by and large from the external environment, and is not so fully regulated by local code jurisdictions. The INFILL can, therefore, change while the SHELL remains constant. They can be understood as two separate but connected clusters of technical systems, which can be but need not be organized and controlled separately in their design, construction, use and change.



Ground Floor



Second Floor

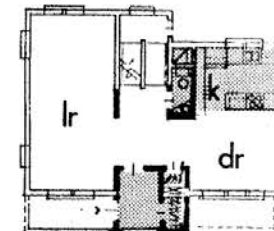
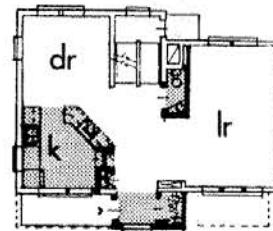
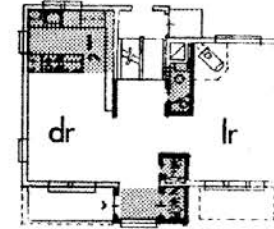
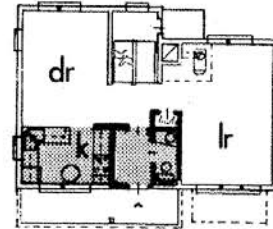
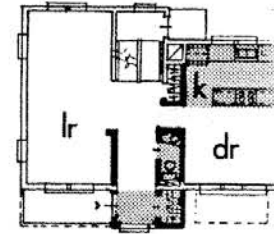
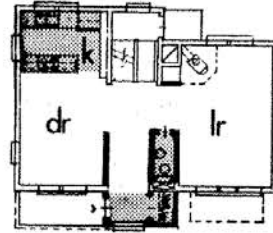
Shell/Infill Study #1

Ground Floor Plan Variants

Three spatial elements, or functional areas on the ground floor are 'unlocked'; they are the kitchen, the 1/2 bath/lav. and the entry foyer/front door. Because other functional elements are associated with these, they too shift position when the three main spatial elements are moved (closets, wing walls, and doors).

Given the SHELL, we have found that the kitchen can be placed in three different locations; the 1/2 bath can be in two different positions, and the foyer/entry can be positioned in at least 2 different ways. The six plans here illustrate some of the various combinations of these functional areas. Other plans are possible, as are other layouts (of cabinets, fixtures, and equipment) in these basic positional variants.

We have not positioned the kitchen in the south east corner, since we have the sliding patio doors (which could be French doors) there. Since we decided not to put exterior windows in INFILL, we decided not to make it easy to put the kitchen there, because it would have meant an awkward layout or reducing the size of the sliding patio doors. However, given the immediate adjacency of the SHELL chase beside the front door, someone could argue that the kitchen could be located where we have decided not to put it. The point is, again, that the six plans illustrated here are indications of capacity, but do not necessarily represent the full spectrum of possibilities of the SHELL. Other interpretations are possible.

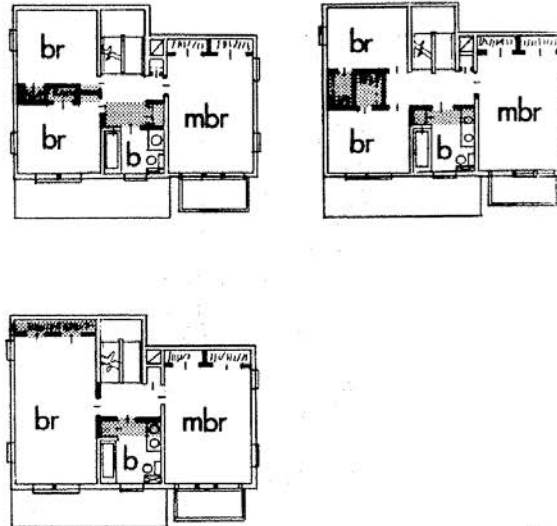


Shell/Infill Study #1

Second Floor Variants

On the second floor, we have fixed the position of the bathroom, while showing that it can be minimum size (as it was actually built) or can be larger (only possible because we moved the stair north 3' during our capacity study). Also, the big space on the west of the bath and stair can be one large room or two smaller ones. We show two ways to divide it. Other ways are possible, using 'system cabinets' available from Sweden, Italy and in the future possibly from the Japanese industry.

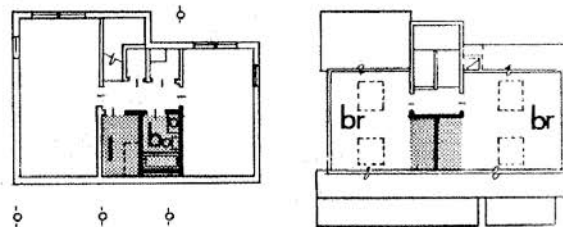
Making the bathroom larger allows a double lavatory, and a space which could be used as a shower or as a storage space.



Basement and Attic Plans

We studied variants in the attic and basement, but since we do not focus on these floors in the later study of the technical systems, we are only illustrating one plan on each floor. Other plans are possible given the SHELL.

In the basement, the furnace room is at the foot of the stairs and partly tucked under it. It is positioned under the large vertical chase which goes up to the roof, and carries main flues, stack vents and some piping and wiring. The full bath that we show is fixed in position because of the W.C. flange is buried in the concrete floor. The other



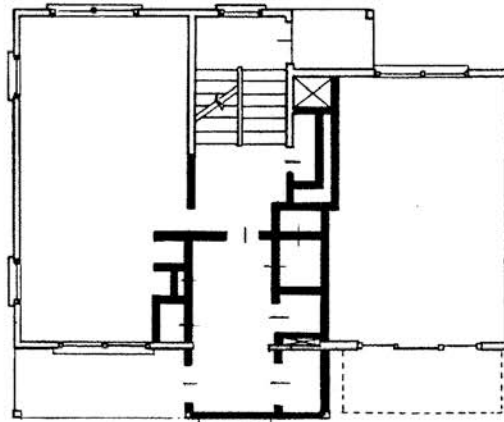
Shell/Infill Study #1

INFILL Variants / Composite Drawing

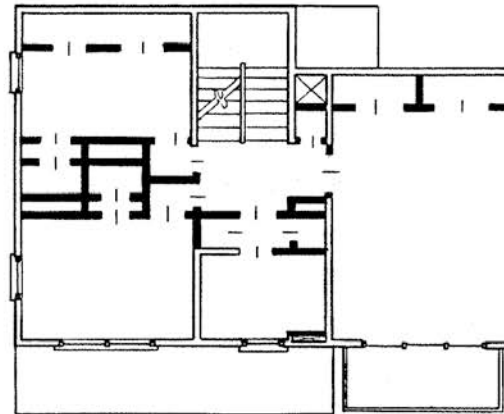
The two accompanying drawings show the SHELL with all the INFILL space plan variants illustrated on the previous pages, superimposed.

This helps to visualize the distinction between SHELL and INFILL. It also helps in seeing the aggregated consequences of the INFILL in the SHELL. This is of concern, since we need to provide framing, blocking and other technical elements in the SHELL to facilitate the interface connections of SHELL and INFILL systems.

These interfaces will be discussed in later sections. In brief, these connections will occur in all the systems: partitions; DWV; water supply; heating system; electric, data, and communications systems; equipment, fixtures and cabinet systems; and finish systems.



Ground Floor



Second Floor

Shell/Infill Study #1

The SHELL / The SHELL Systems

The Shell

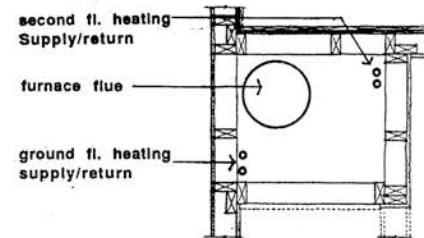
The drawings that appear here represent the design of a SHELL which is fixed in a great many aspects, but which leaves open a number of alternatives in the distribution of functional spaces, such as bathrooms, kitchen, living and dining and bedrooms. The SHELL is a completed phase of construction, but it does not yet make a dwelling. Decisions must still be made about where to place the various functional areas of the house within the SHELL, and further detailed decisions about equipment and finishes must still be made.

This does not mean that we have not thought about those INFILL decisions. In fact, we have thought about them in detail. But we have decided to prepare a SHELL design that can accommodate a certain number of alternatives in those remaining decisions. That is to say, we have made a design of a SHELL, in such a way that it has the capacity to 'hold' several 'lower level' alternatives, some of which must be selected to make the house livable.

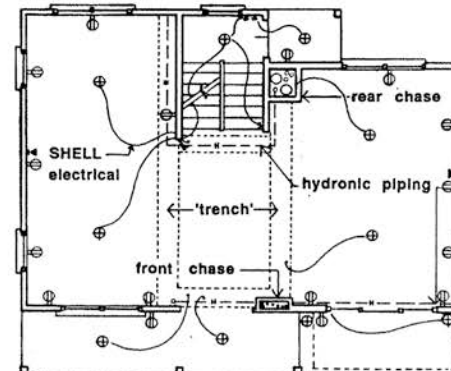
We have designed a SHELL which in most respects is fixed on the exterior, with the exception of the area immediately around the front door. There are many decisions about the shell that we do not go into, because they do not directly effect the interface with subsequent infill decisions that we are interested in focusing on in this study, although they should be examined.

For example, we do not discuss color, exterior material, window type, balcony railing design, decks, gutter type, roofing material, among a number of other normal decisions involved in a full SHELL design. Nor do we specify how the SHELL should be built; should it be panelized, site built, or brought to the site in modular units, and so on. We also do not discuss alternative wall sections and methods of building the walls. These and many other decisions in the domain of the SHELL are matters of importance, but not to this study. They constitute alternatives in constructing the SHELL, and while they do impact the decisions on INFILL directly, they are not covered in this report.

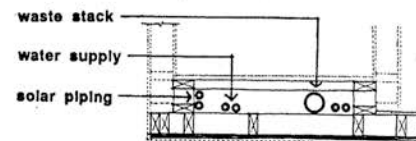
What we have fixed in the SHELL can be understood most directly by saying that the



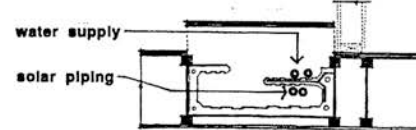
Rear Chase



Ground Floor/SHELL Systems



Front Chase



'Trench'

Shell/Infill Study #1

SHELL has the interior drywall up and ready for painting on all walls and ceilings, including the basement ceiling; we have allocated three alternative positions of the kitchen on the main floor (it cannot go upstairs in this SHELL), we have given the main floor 1/2 bath two alternative positions, and we have studied a number of the many partition locations that are possible in relation to these functional alternatives. The entry 'expression' is not fixed; that is, the area around the front door - the front window, the foyer size, the door type and its position, and so on, are put in the INFILL. However, the front porch roof and floor deck are SHELL.

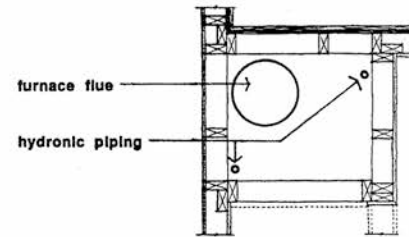
The entire exterior of the house, with the exception of the area just described at the front door, is SHELL. The landscaping, including sidewalks, planting, and sod we also consider to be SHELL, although this can certainly be moved to the INFILL category.

Upstairs, the bathroom position is fixed, but it is possible to choose the size within a 3ft margin. The number of bedrooms can also vary on the second floor, from 2 to 3. Two vertical plumbing and wiring and ventilation chases are provided, as well as some horizontal openings ('trenches') in the subfloor on the first, second and third floors.

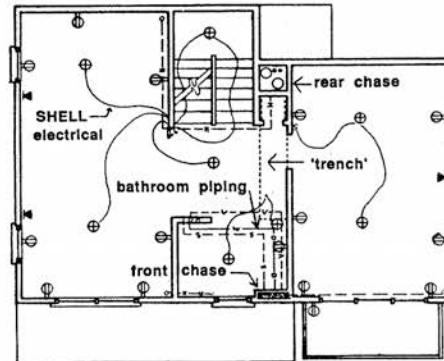
The various distribution systems are split between SHELL and INFILL.

We need to be explicit about this idea of 'fixing' some aspects of the design, a process which then gives us certain constraints on the next decisions that need to be made. This process takes place at several 'levels'. For example, as we noticed earlier in outlining the context of variety in a development, on the same building site, it is possible to place different houses; in the same house SHELL, it is possible to place several INFILL packages (i.e. different floor plans and equipment layouts); in the same functional area (e.g. kitchen) it is possible to have several layouts; in the same kitchen layout, it is possible to have several kitchen cabinet designs; in the same cabinet type, it is possible to have alternative hardware; and so on.

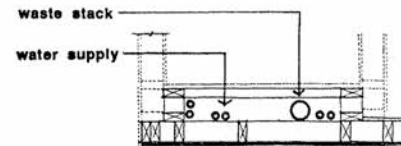
We should also point out that fixing the design of the SHELL does not mean that the SHELL cannot be varied by the initiative of



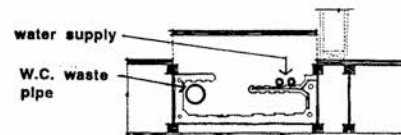
Rear Chase



Second Floor/SHELL Systems



Front Chase



'Trench'

Shell/Infill Study #1

INFILL scheme is selected, certain SHELL elements will be altered before construction begins to suit that INFILL selection. This is fine. It is standard customizing practice within some set of standard constraints that the particular developer works with.

The point is that when we make this or any 'customizing move', we may want to know the consequences in terms of the efficiency of the construction operation, on a multi-house project. We would also like to know something about the long-term consequences of customizing decisions of all kinds, on the capacity of the house to adapt to changing conditions of ownership and technology.

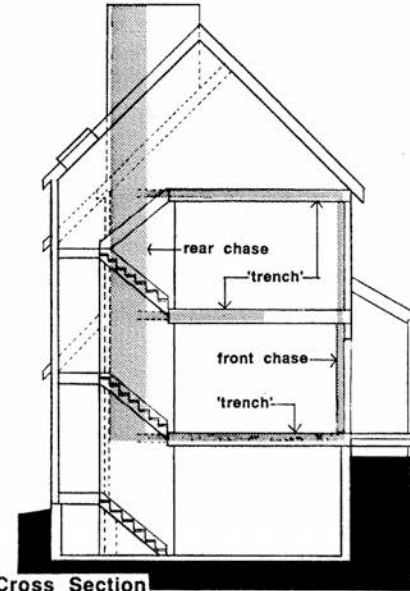
Windows

We made a very careful study of the implications of putting all first floor windows, or even some of them, into INFILL. This seemed to be desirable in certain respects, but not others. For example, it was a good idea to link kitchen location with window width and sill height selection. Given our intention to give the shell capacity for three alternative kitchen positions (we had originally aimed for four), and recognizing the sill height problem, we wanted to leave the window decision tied to the decision about kitchen location, thus putting at minimum the ground floor windows in INFILL.

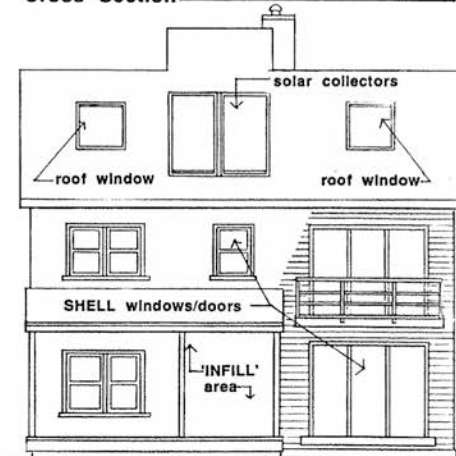
On the other hand, we wanted to 'button up' the house as much as possible (for security, humidity control for sheetrocking, etc), by putting all windows in SHELL. In the end, we did put all windows except at the front door, into SHELL.

Second floor, basement, and attic roof windows could be all SHELL, with no conflict, given the relatively small INFILL decisions on those floors.

In general, for the exercise, we wanted to push the SHELL decisions as far as possible, without locking up all INFILL decisions (in other words, without reducing INFILL to zero).



Cross Section



South Elevation

Shell/Infill Study #2

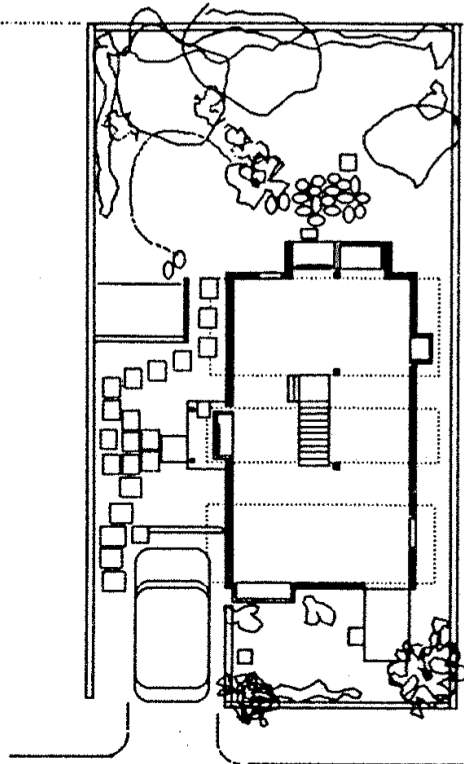
SHELL INFILL HOUSE

A STUDY ON THE
APPLICATION
OF THE
OPEN
SYSTEMS
APPROACH
IN
HOUSING DESIGN
SUBMITTED TO
MY
COLLEAGUES
AND FRIENDS
IN
JAPAN
MAY/JUNE
1987
N. JOHN
HABRAKEN.



SHELL
INFILL
HOUSE

Shell/Infill Study #2



THIS PARTICULAR DESIGN IS ONLY TO DEMONSTRATE THE METHOD OF WORKING. A SIMILAR DEMONSTRATION COULD BE GIVEN WITH ANY OTHER TYPE OF DWELLING. THE DESIGN DOES NOT PROPOSE ANY STANDARD OR ANY PARTICULAR WAY OF LIVING. ALL DESIGN DECISIONS WERE ONLY MADE FOR THE SAKE OF DEMONSTRATION.

THIS IS THE GROUND FLOOR PLAN OF A HOUSE SHELL. IN THE SHELL MANY DIFFERENT FLOOR PLANS CAN BE MADE. THE DESIGN OF THE HOUSE IS DONE ON THE BASIS OF THE OPEN SYSTEMS METHOD. THIS METHOD SEES THE HOUSE AS COMPOSED OF MANY SUBSYSTEMS THAT RELATE TO ONE ANOTHER IN A HIERARCHICAL WAY. THIS MEANS THAT WE RANK THE SUBSYSTEMS IN SUCH A WAY THAT EACH CAN ONLY BE DEPLOYED AFTER THE SYSTEMS HIGHER IN THE ORDER HAVE BEEN DEPLOYED FIRST. EACH SUBSYSTEM IN TURN MAKES THE CONTEXT FOR THE NEXT SUBSYSTEM TO BE DEPLOYED. IN THE FOLLOWING PAGES THIS WAY OF WORKING IS ILLUSTRATED.



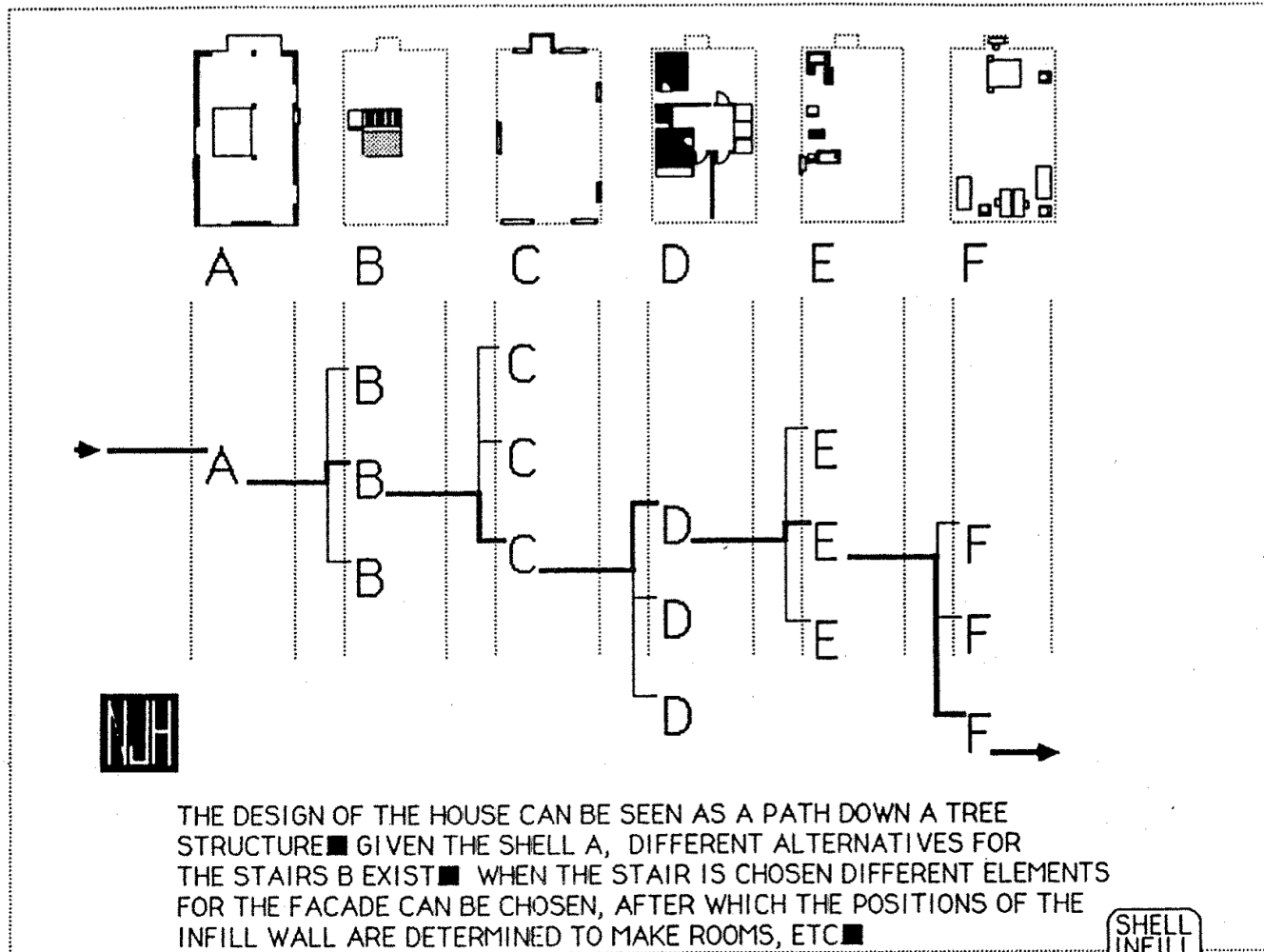
SHELL
INFILL
HOUSE

Shell/Infill Study #2



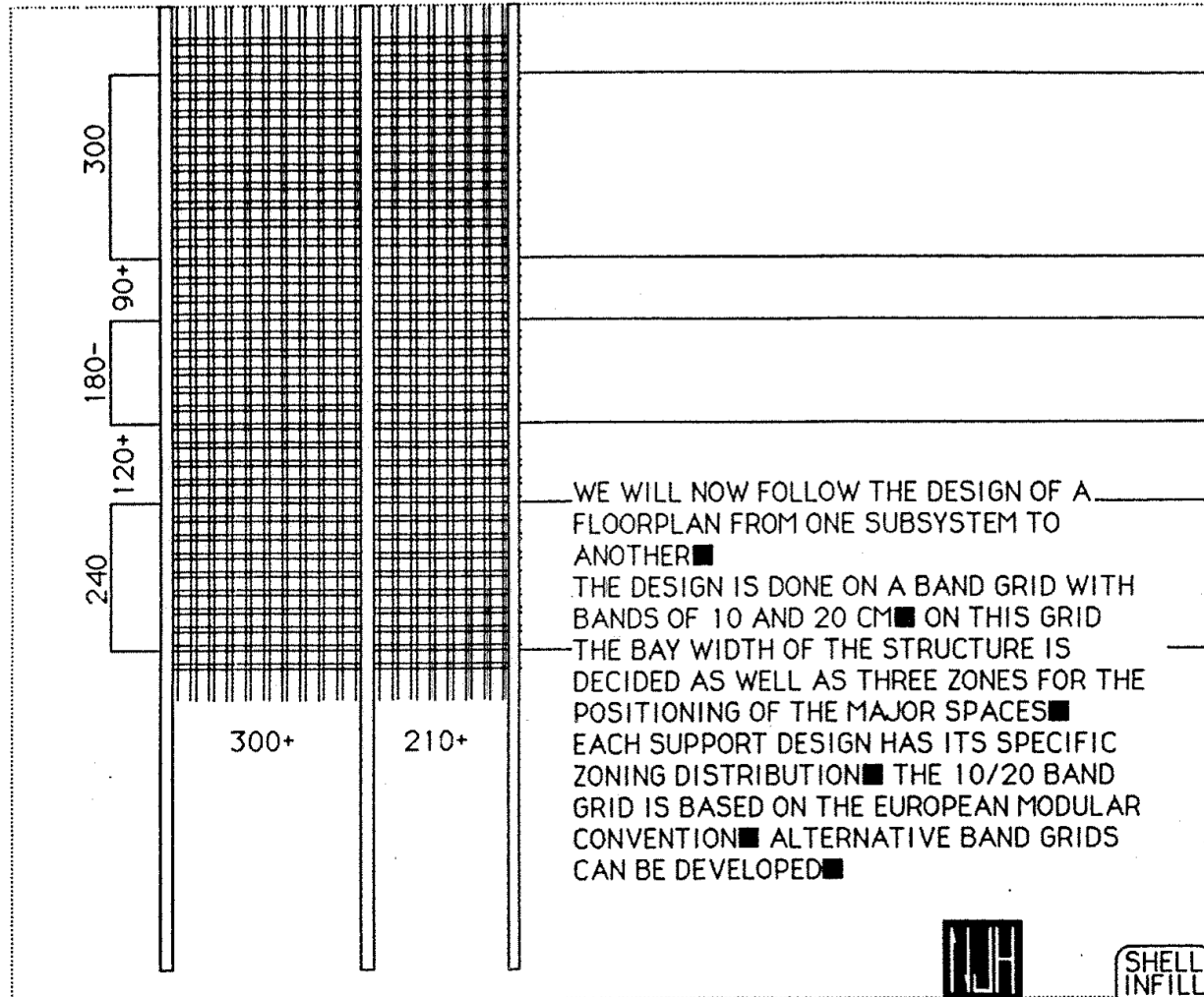
OVERVIEW OF THE MAJOR SUBSYSTEMS THAT MAKE THE HOUSE DESIGN ■
A. THE SHELL OF THE HOUSE ■ B. THE STAIRS ■ C. THE WINDOWS AND
OTHER FACADE ELEMENTS ■ D. THE INFILL WALL SYSTEM ■ E. THE KITCHEN
AND BATHROOM EQUIPMENT ■ F. THE FURNITURE ■ THE RESOURCE SYSTEMS
LIKE PLUMBING AND ELECTRICITY ARE NOT SHOWN HERE, THEY MAKE A
SEPARATE ORGANISATION DISCUSSED LATER ■

Shell/Infill Study #2



THE DESIGN OF THE HOUSE CAN BE SEEN AS A PATH DOWN A TREE STRUCTURE ■ GIVEN THE SHELL A, DIFFERENT ALTERNATIVES FOR THE STAIRS B EXIST ■ WHEN THE STAIR IS CHOSEN DIFFERENT ELEMENTS FOR THE FACADE CAN BE CHOSEN, AFTER WHICH THE POSITIONS OF THE INFILL WALL ARE DETERMINED TO MAKE ROOMS, ETC ■

Shell/Infill Study #2

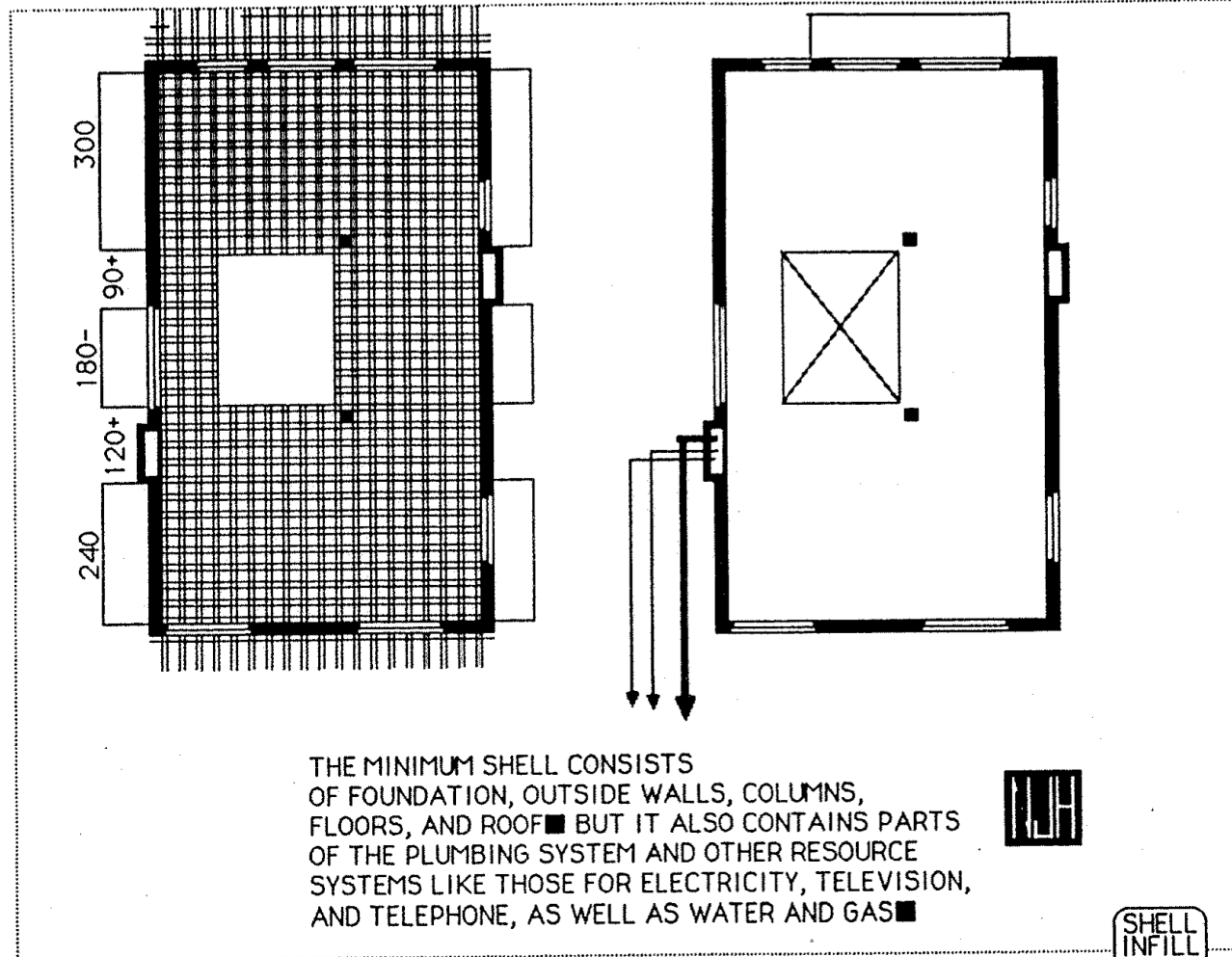


WE WILL NOW FOLLOW THE DESIGN OF A FLOORPLAN FROM ONE SUBSYSTEM TO ANOTHER ■
THE DESIGN IS DONE ON A BAND GRID WITH BANDS OF 10 AND 20 CM ■ ON THIS GRID THE BAY WIDTH OF THE STRUCTURE IS DECIDED AS WELL AS THREE ZONES FOR THE POSITIONING OF THE MAJOR SPACES ■
EACH SUPPORT DESIGN HAS ITS SPECIFIC ZONING DISTRIBUTION ■ THE 10/20 BAND GRID IS BASED ON THE EUROPEAN MODULAR CONVENTION ■ ALTERNATIVE BAND GRIDS CAN BE DEVELOPED ■



SHELL
INFILL
HOUSE

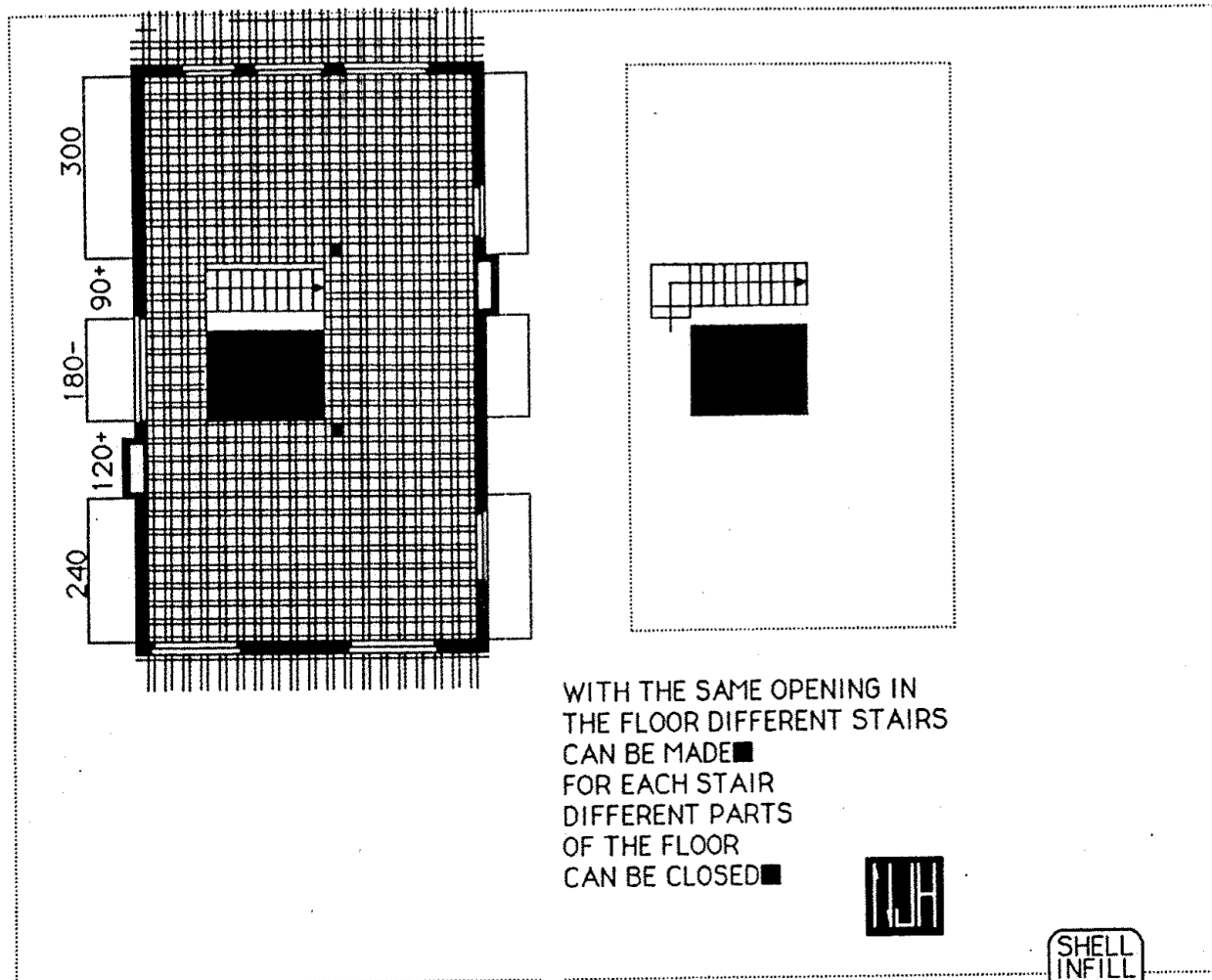
Shell/Infill Study #2



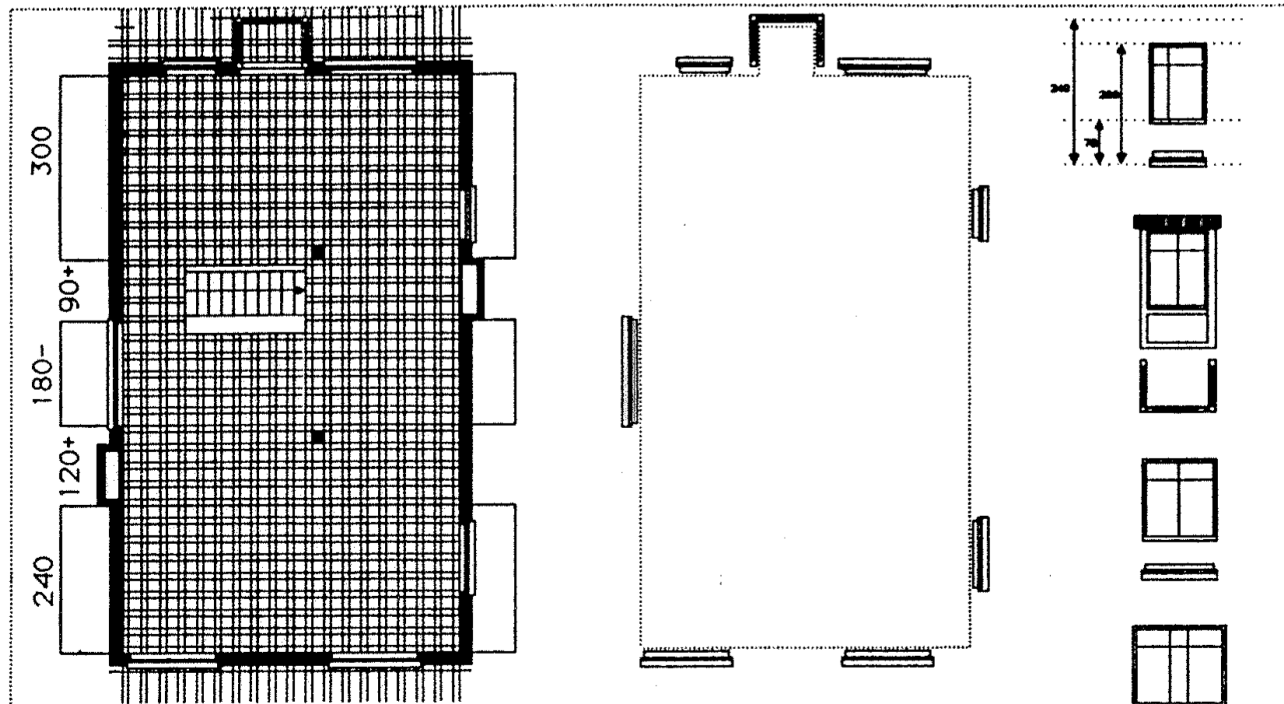
THE MINIMUM SHELL CONSISTS OF FOUNDATION, OUTSIDE WALLS, COLUMNS, FLOORS, AND ROOF ■ BUT IT ALSO CONTAINS PARTS OF THE PLUMBING SYSTEM AND OTHER RESOURCE SYSTEMS LIKE THOSE FOR ELECTRICITY, TELEVISION, AND TELEPHONE, AS WELL AS WATER AND GAS ■



Shell/Infill Study #2



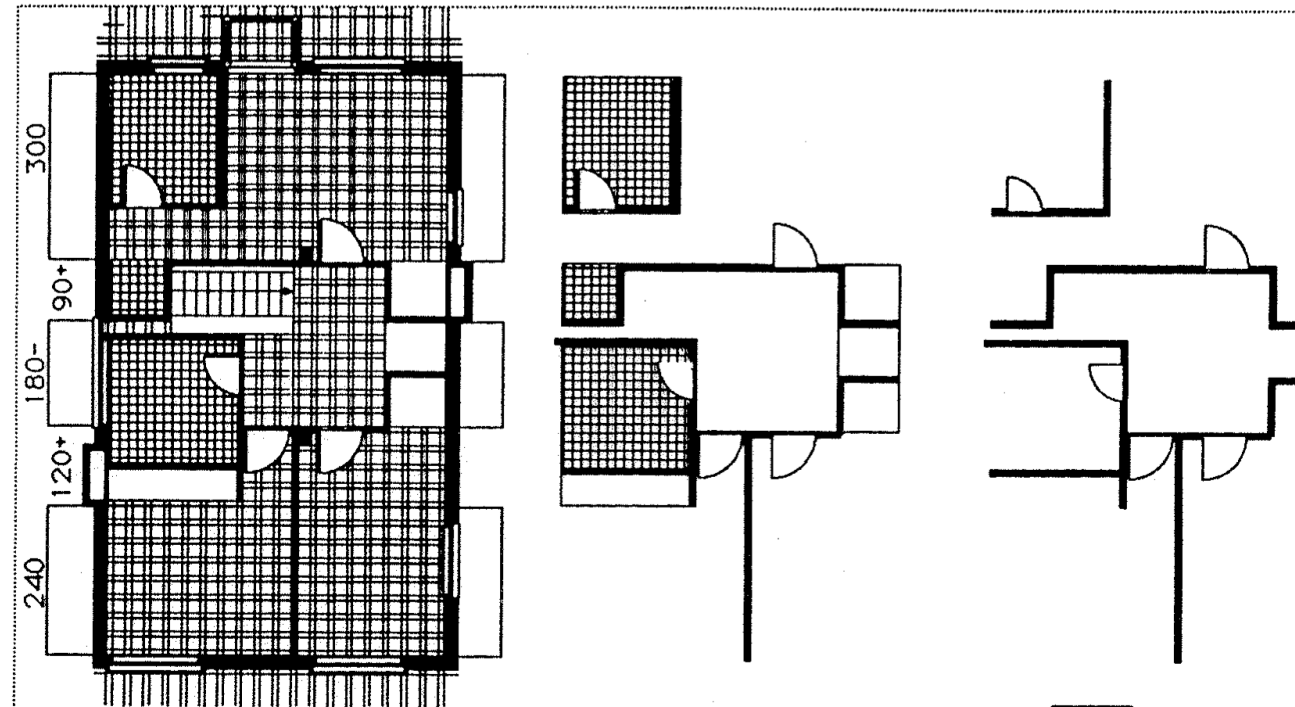
Shell/Infill Study #2



THE WINDOWS, DOORS AND OTHER FACADE ELEMENTS ARE BROUGHT IN ■ WHILE THE OPENINGS IN THE SUPPORT STRUCTURE ARE FIXED ■ THE WINDOWS CAN BE DETACHABLE AND BECOME PART OF THE INFILL SYSTEM TO BE CHOSEN WHEN THE FLOORPLAN IS KNOWN ■ THE ALTERNATIVE IS TO DETERMINE THE WINDOWS BEFORE THE FLOOR PLAN ■ AN INTERMEDIATE SOLUTION ALLOWS FOR PARTIAL CHANGE OF WINDOW PANELS OR MULLIONS WITHIN A FIXED WINDOW FRAME ■



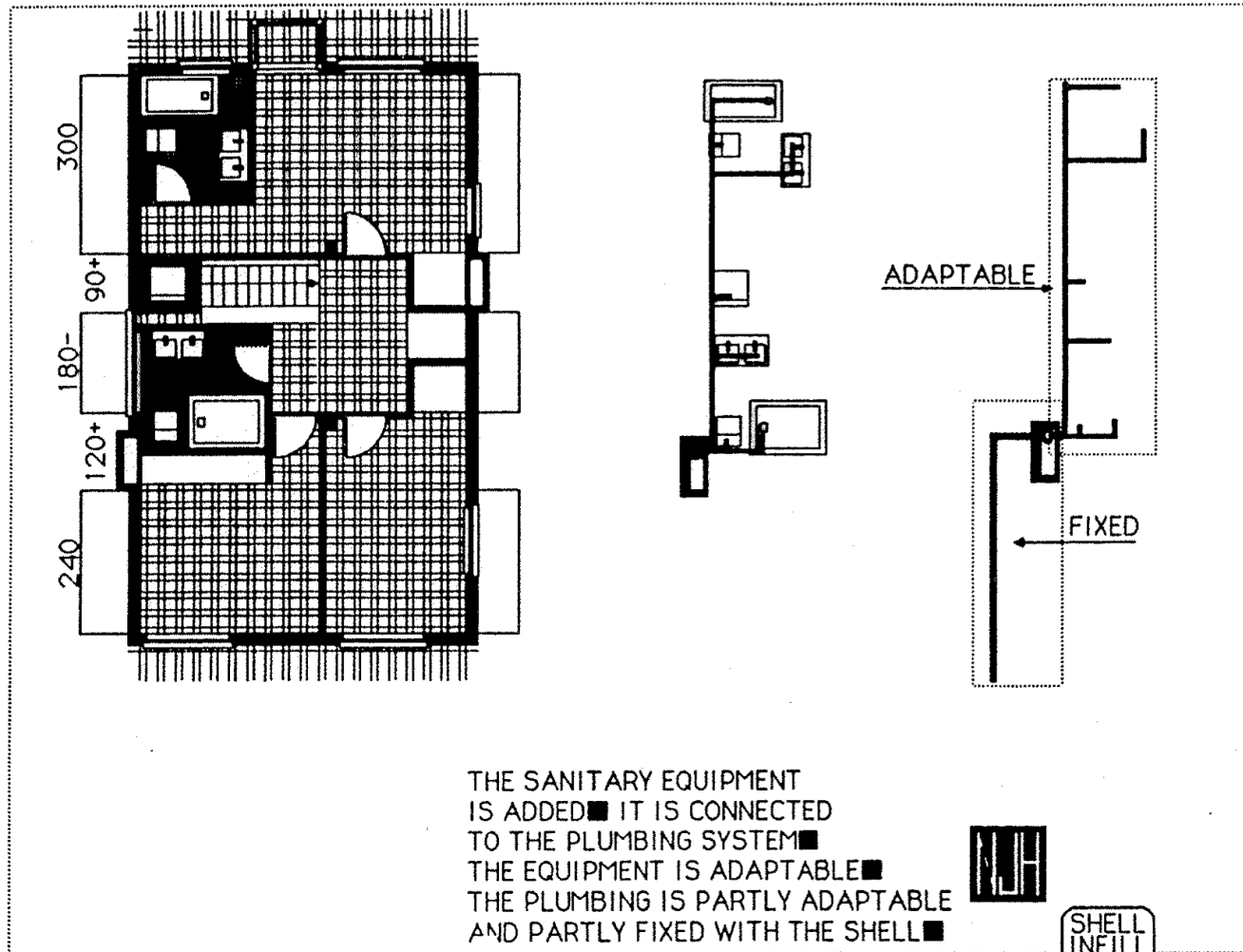
Shell/Infill Study #2



THE SYSTEM OF INFILL WALLS ■ TO THIS SYSTEM ARE ADDED THE FLOOR FINISHES LIKE THE TILES IN THE BATHROOMS ■ ALSO, CUPBOARDS AND OTHER STORAGE SPACES ARE ADDED AS A SEPARATE SYSTEM ■ IN THIS EXAMPLE THE WINDOWS ARE ALREADY PLACED. MODIFICATIONS OF SOME WINDOWPANELS MAY BE NEEDED TO ADJUST TO THE INFILL, LIKE IN THE WINDOW SERVING BOTH BATHROOM AND STAIRWELL ■

SHELL
INFILL
HOUSE
8

Shell/Infill Study #2

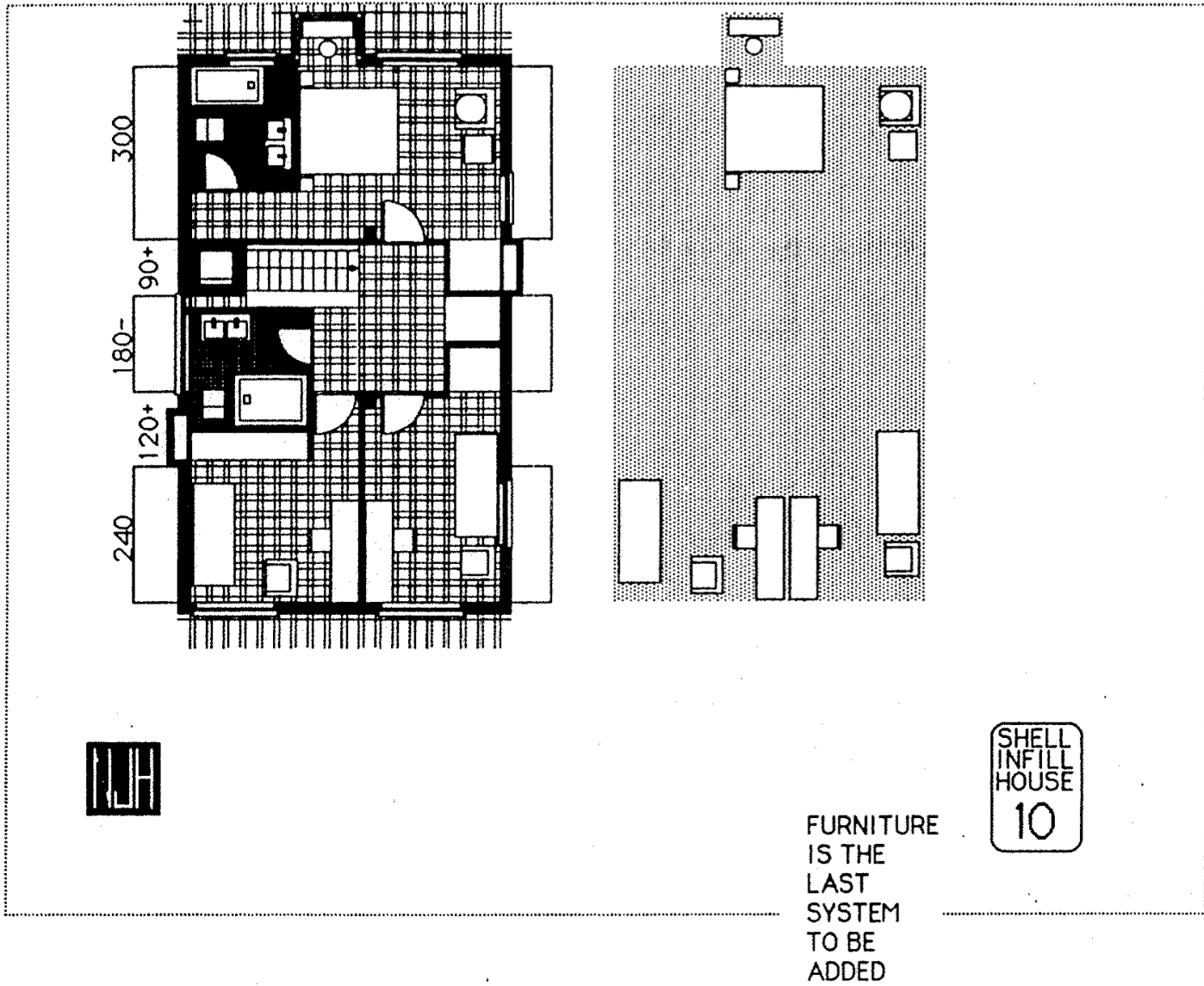


THE SANITARY EQUIPMENT IS ADDED ■ IT IS CONNECTED TO THE PLUMBING SYSTEM ■ THE EQUIPMENT IS ADAPTABLE ■ THE PLUMBING IS PARTLY ADAPTABLE AND PARTLY FIXED WITH THE SHELL ■

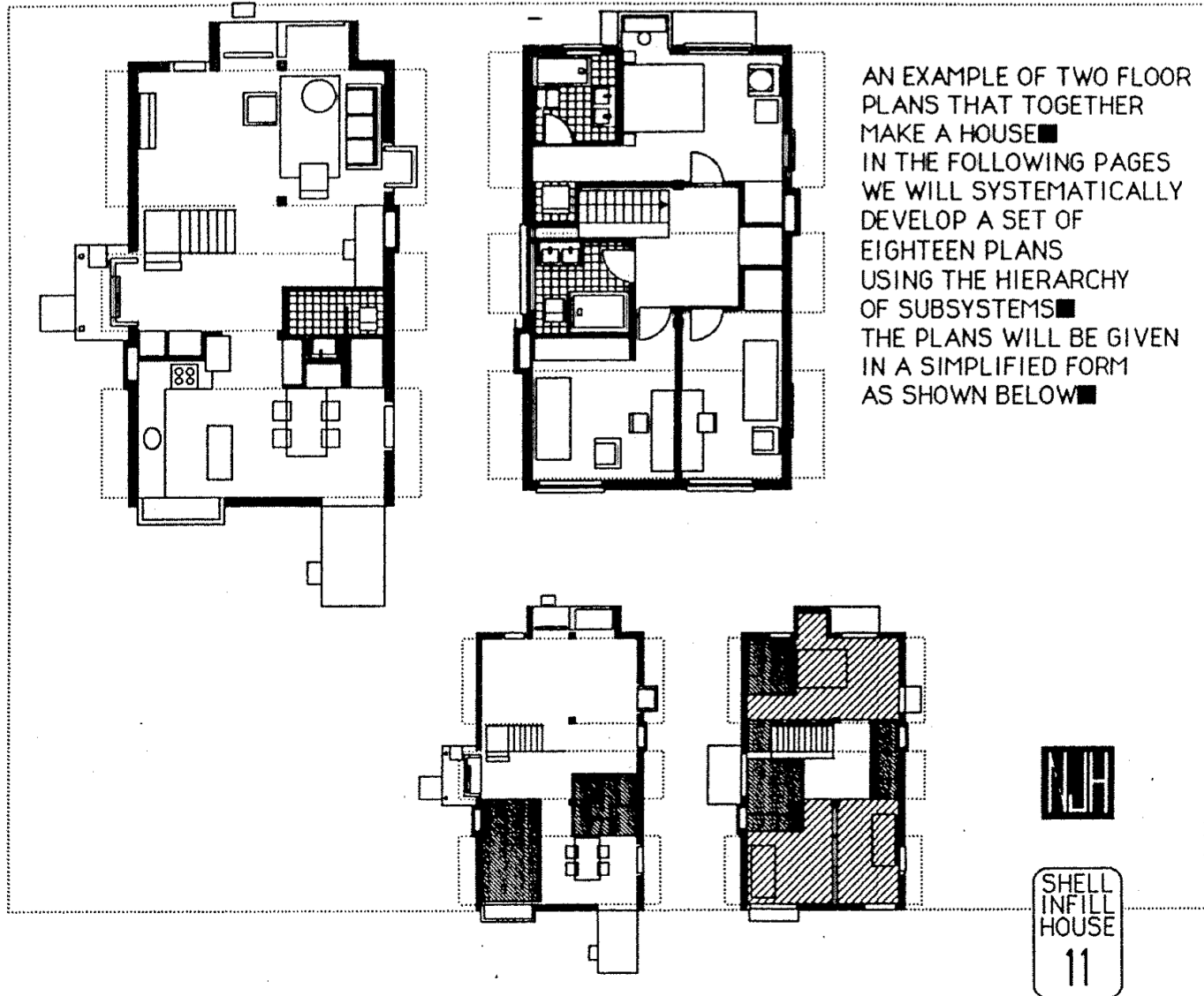


SHELL INFILL HOUSE
9

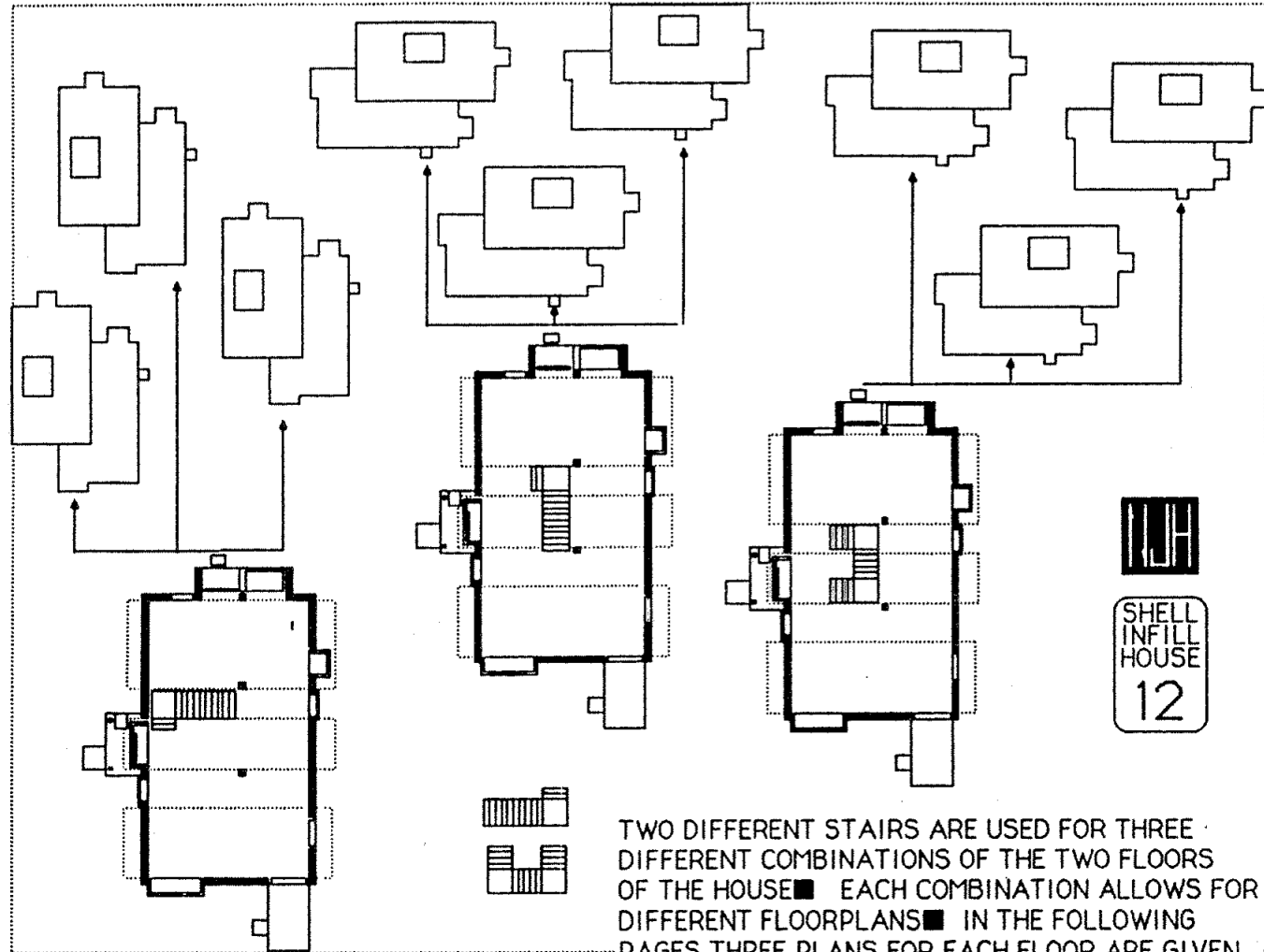
Shell/Infill Study #2



Shell/Infill Study #2

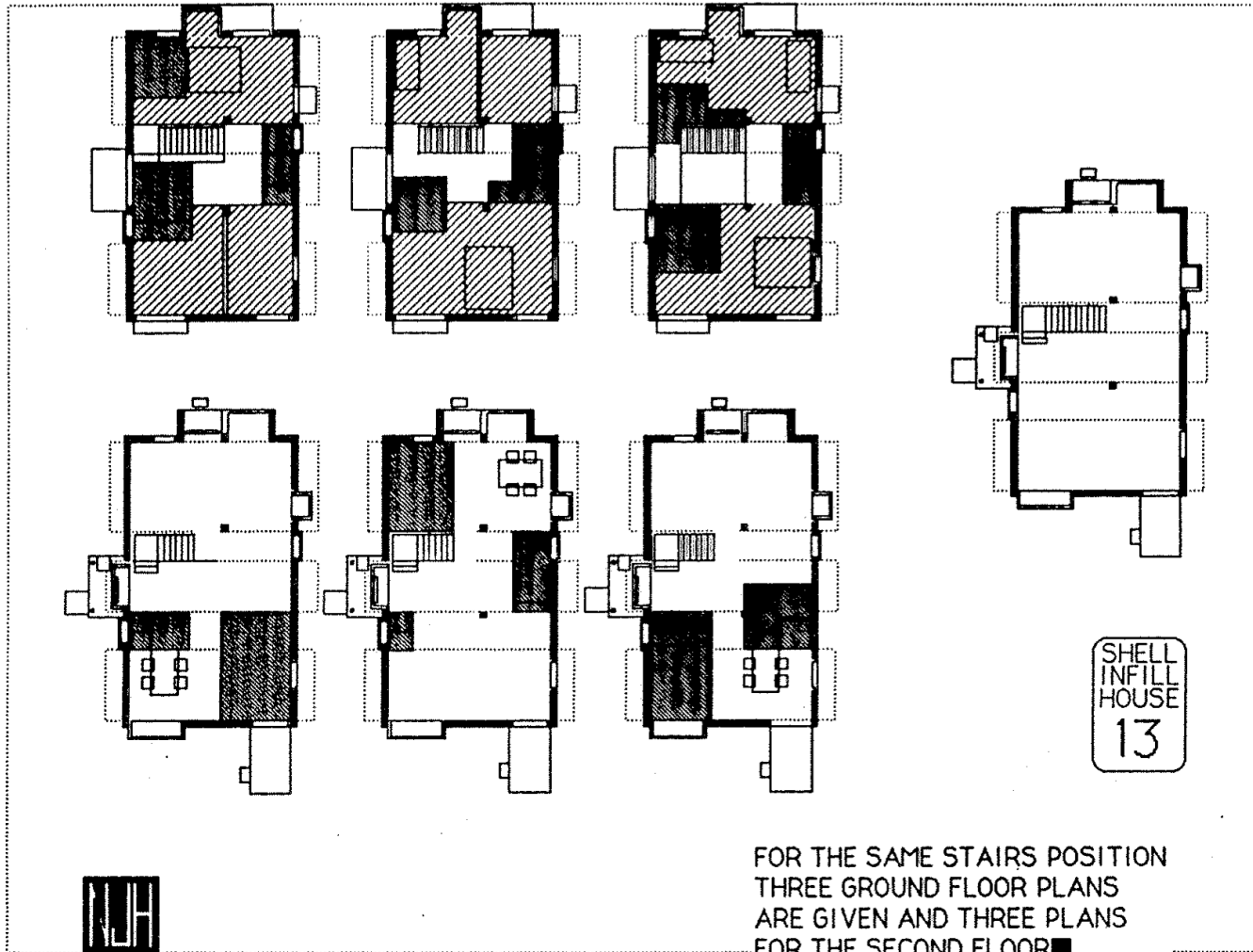


Shell/Infill Study #2



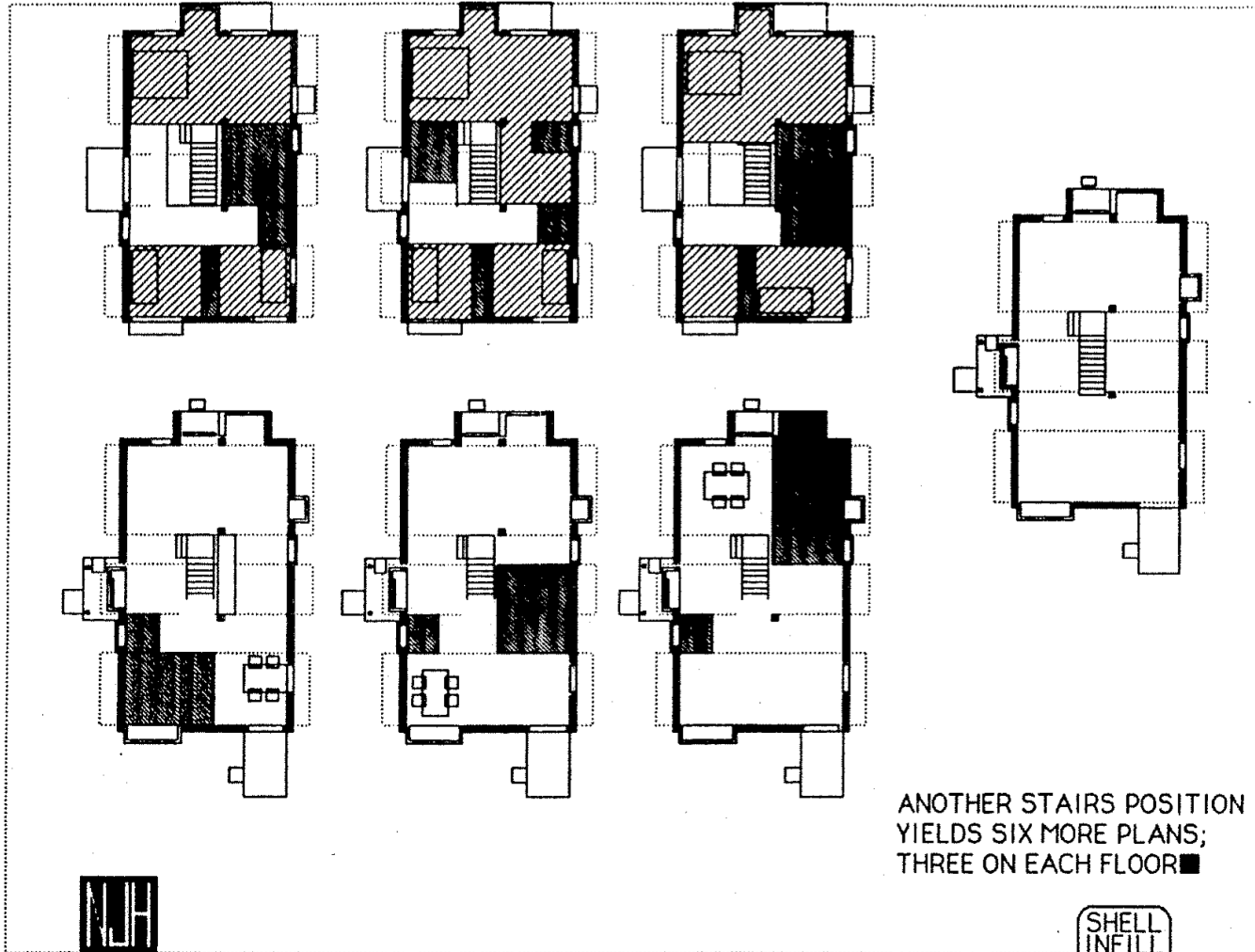
TWO DIFFERENT STAIRS ARE USED FOR THREE DIFFERENT COMBINATIONS OF THE TWO FLOORS OF THE HOUSE ■ EACH COMBINATION ALLOWS FOR DIFFERENT FLOORPLANS ■ IN THE FOLLOWING PAGES THREE PLANS FOR EACH FLOOR ARE GIVEN FOR EACH COMBINATION, A TOTAL OF EIGHTEEN FLOORPLANS YIELDING TWENTYSEVEN POSSIBLE COMBINATIONS ■

Shell/Infill Study #2



FOR THE SAME STAIRS POSITION
THREE GROUND FLOOR PLANS
ARE GIVEN AND THREE PLANS
FOR THE SECOND FLOOR ■
EACH FIRST FLOOR PLAN CAN BE
COMBINED WITH EACH SECOND
FLOOR PLAN ■

Shell/Infill Study #2

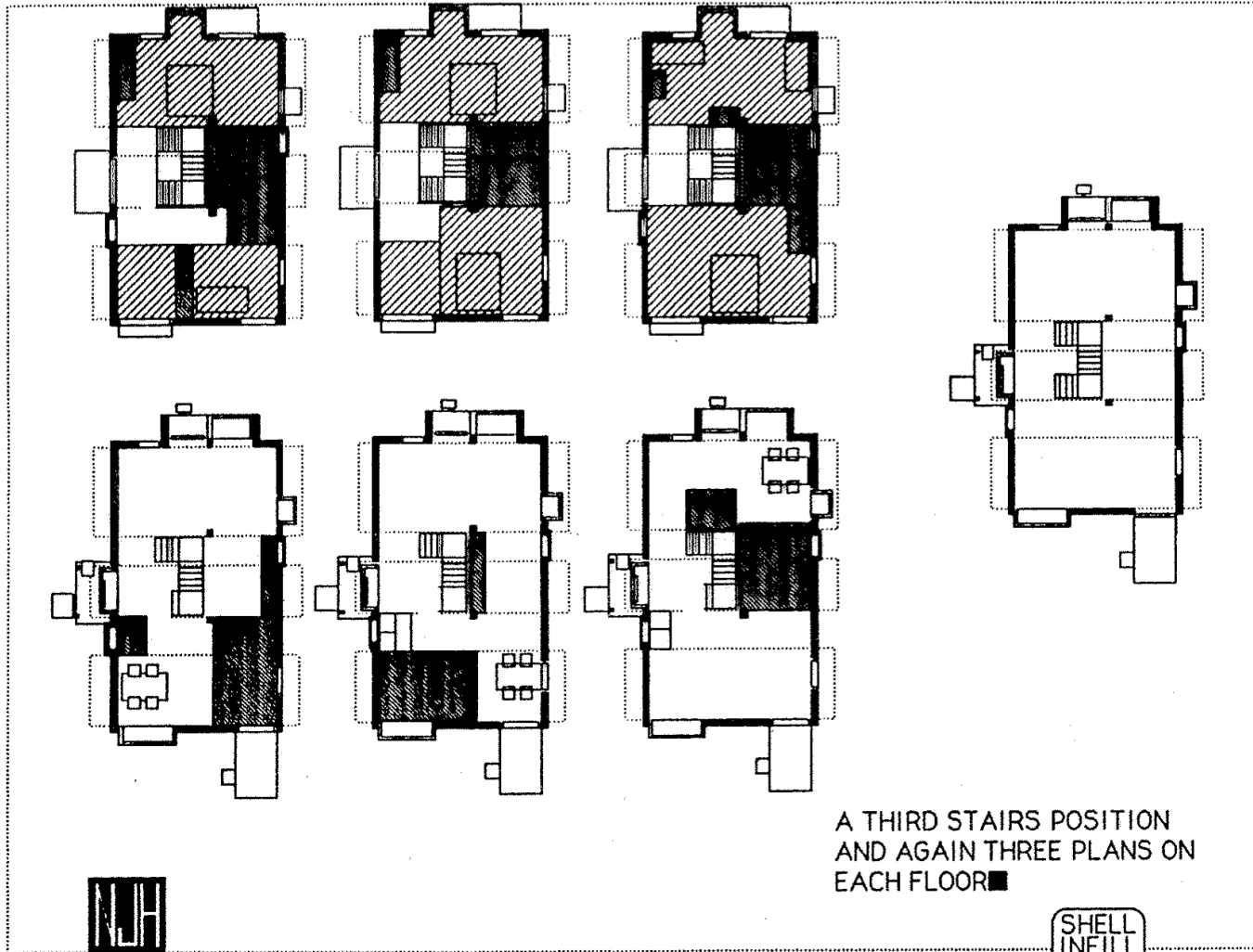


ANOTHER STAIRS POSITION
YIELDS SIX MORE PLANS;
THREE ON EACH FLOOR ■



SHELL
INFILL
HOUSE
14

Shell/Infill Study #2



A THIRD STAIRS POSITION
AND AGAIN THREE PLANS ON
EACH FLOOR ■



SHELL
INFILL
HOUSE
15

Shell/Infill Study #2



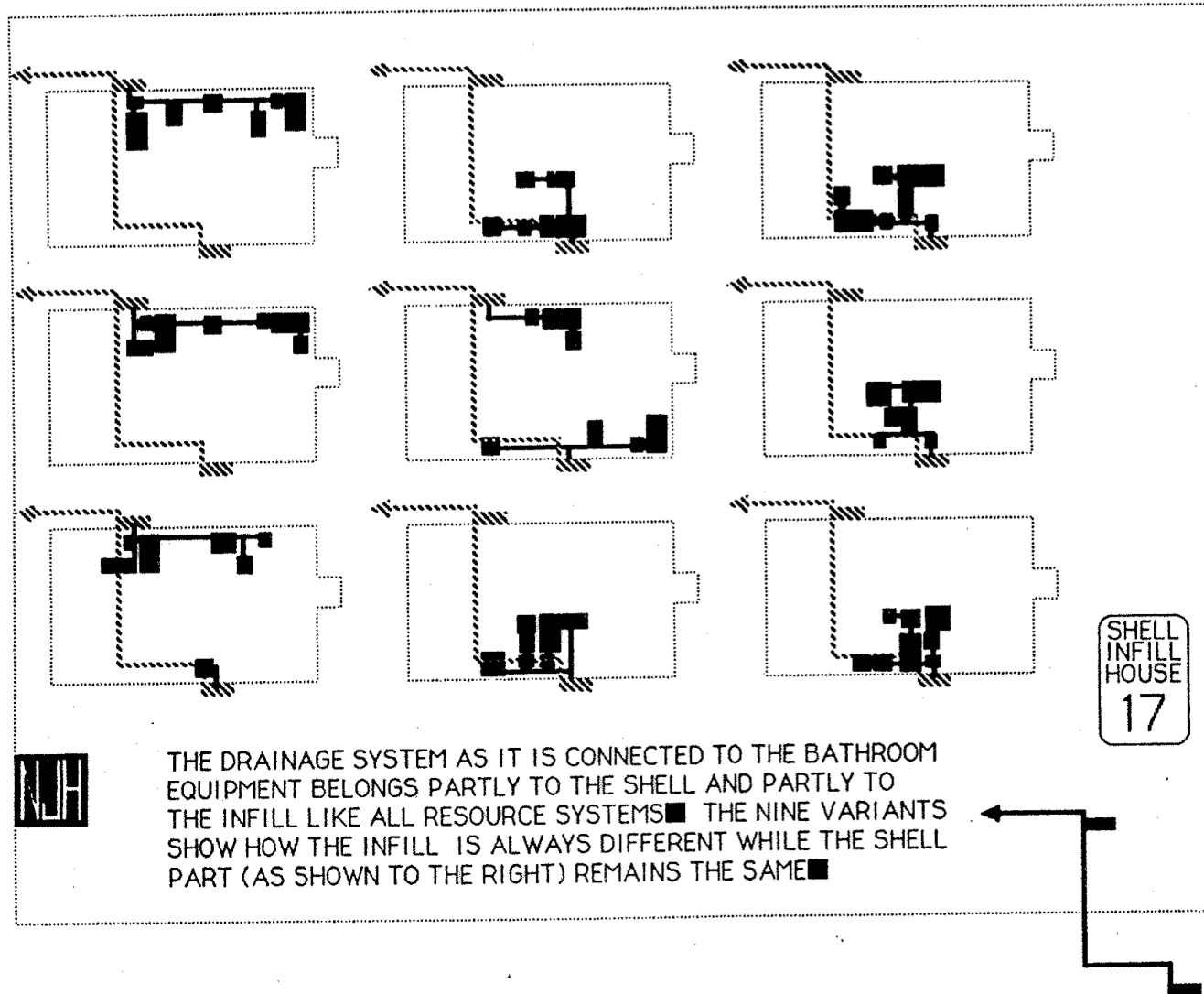
BATHROOM AND KITCHEN EQUIPMENT CAN BE ARRANGED IN DIFFERENT WAYS ONCE THE ROOMS HAVE BEEN LAYD OUT ■
HERE ARE THREE SECOND FLOOR PLANS CORRESPONDING TO THE THREE STAIRS POSITIONS GIVEN EARLIER ■
EACH PLAN HAS TWO ALTERNATIVE ARRANGEMENTS FOR THE BATHROOM EQUIPMENT ■



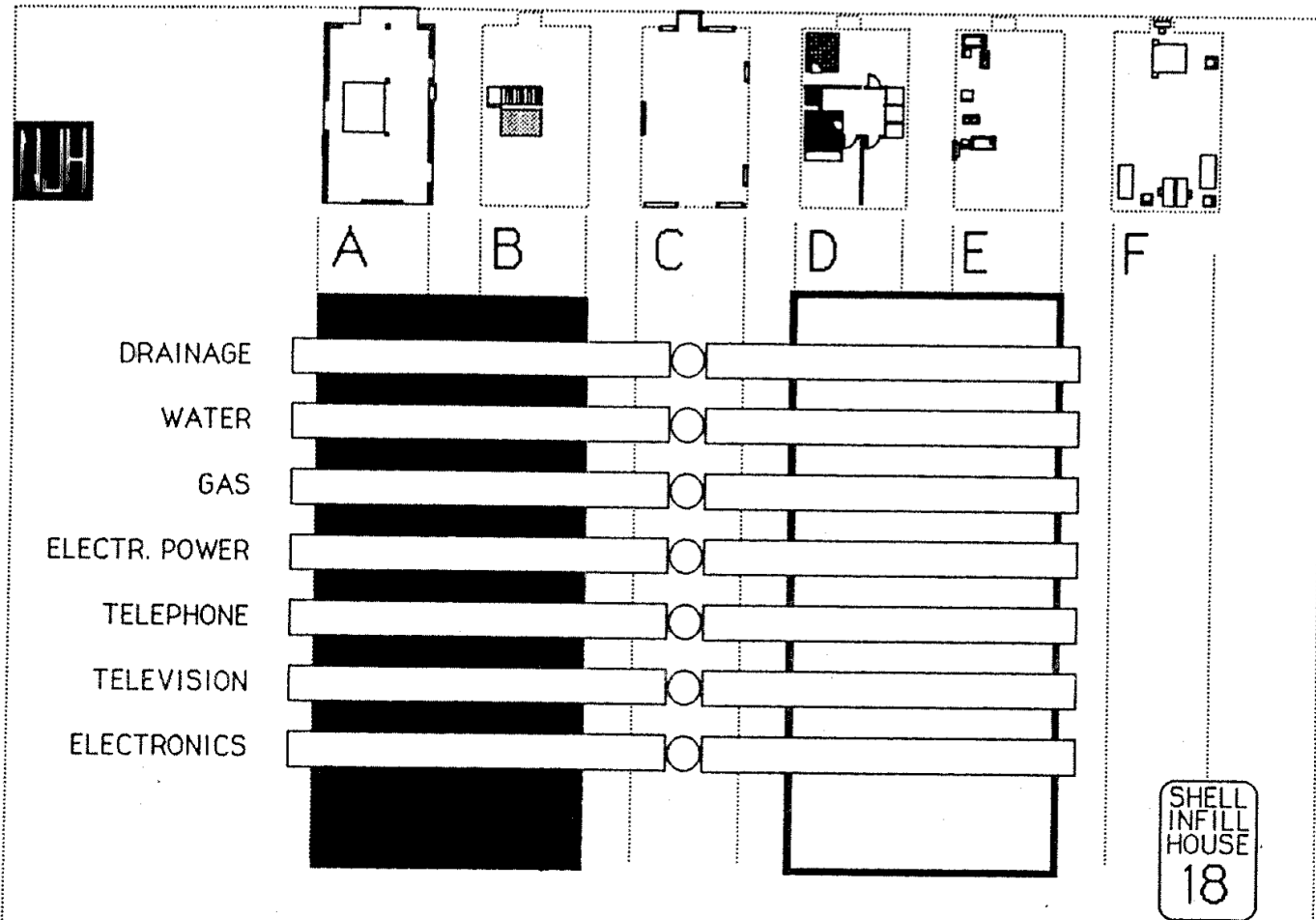
SHELL
INFILL
HOUSE

16

Shell/Infill Study #2

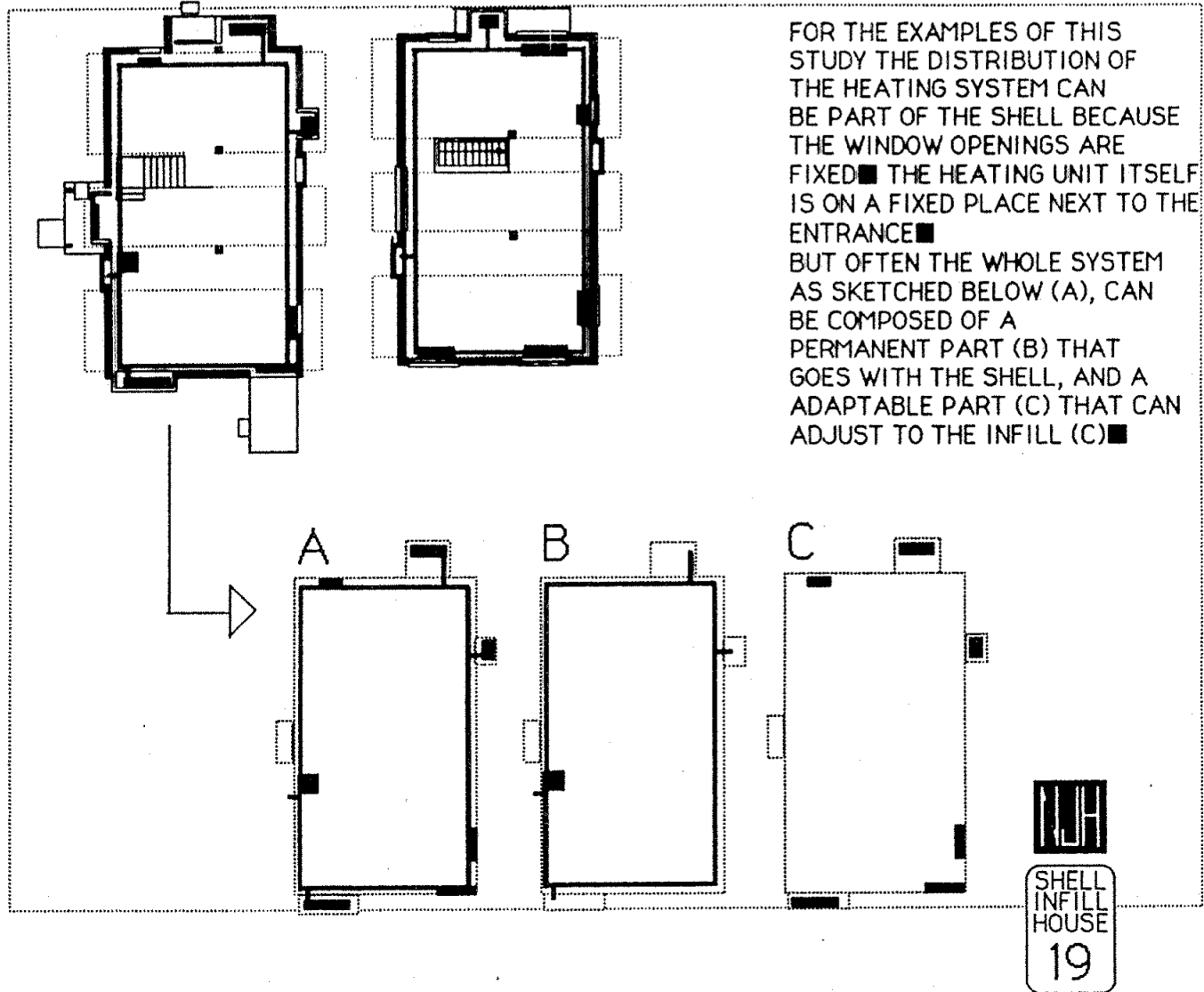


Shell/Infill Study #2

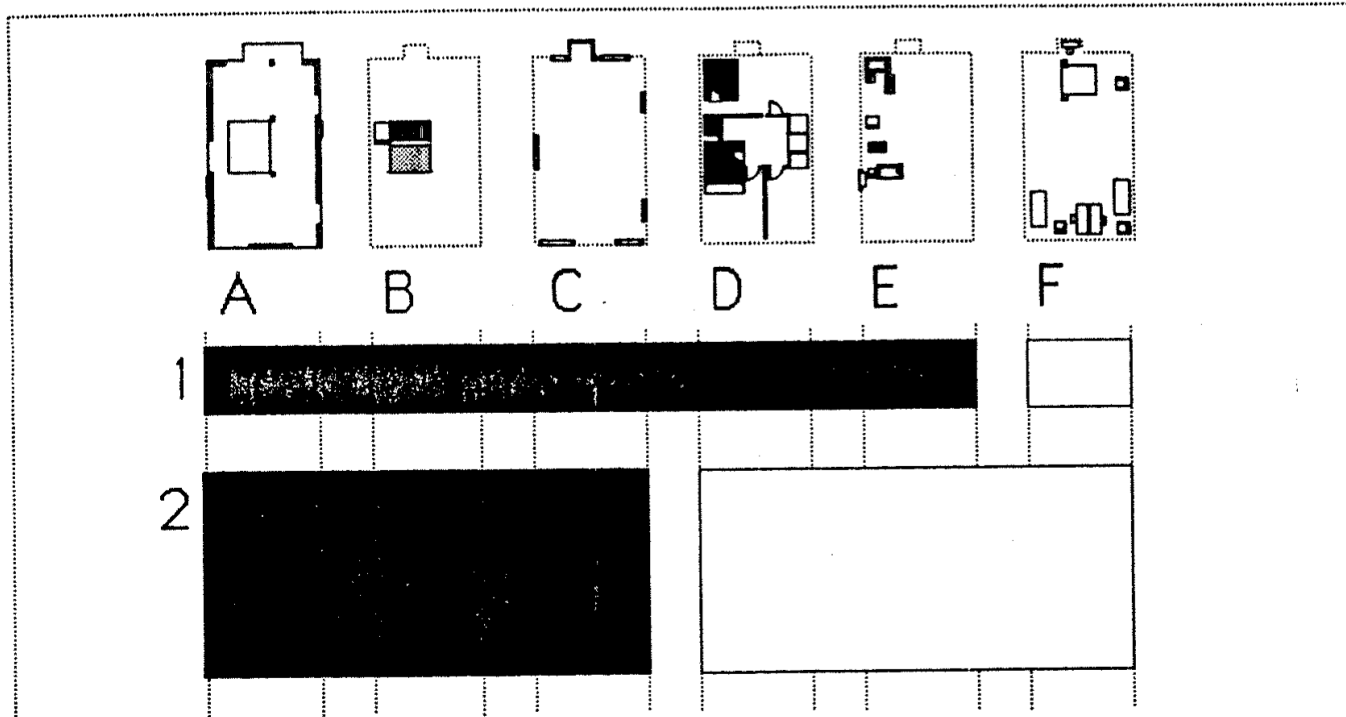


PUTTING ASIDE THE FACADE ELEMENTS AND THE FURNITURE WE CAN DISTINGUISH TWO COMPOSITE SYSTEMS: THE HOUSE SHELL INCLUDING THE STAIRS, AND THE INFILL WALLS INCLUDING SURFACE FINISHES AND STORAGE ■ EACH RESOURCE SYSTEM HAS A PERMANENT PART CONNECTED TO THE SHELL AND A ADAPTABLE PART CONNECTED TO THE INFILL ■

Shell/Infill Study #2



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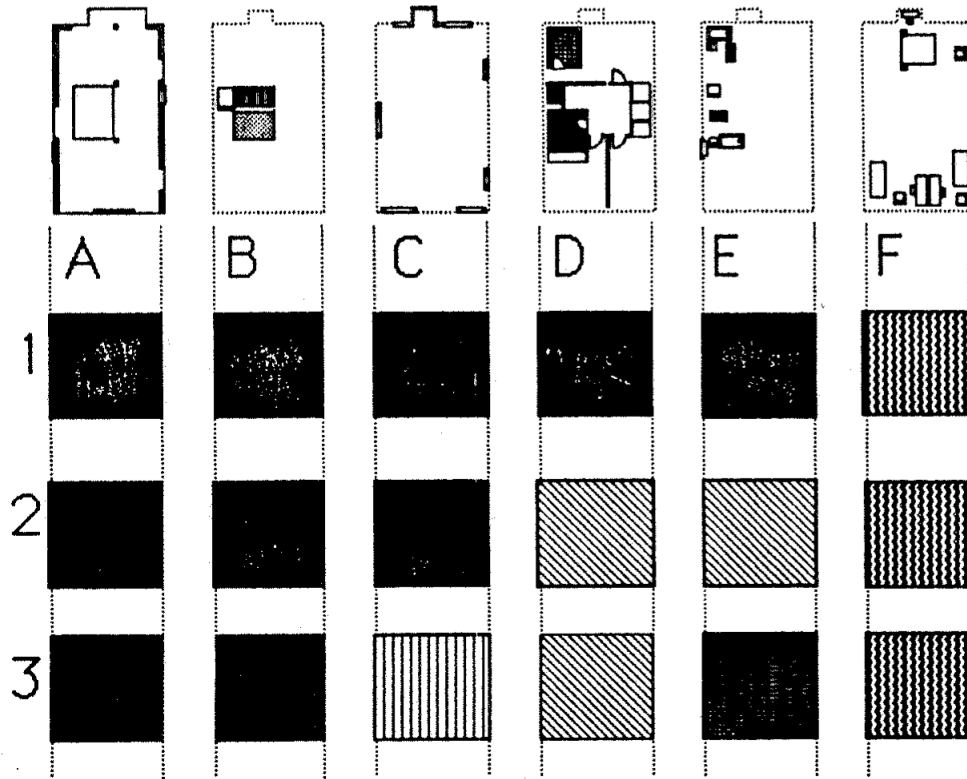


THE SUBSYSTEMS WE HAVE DISCUSSED SO FAR MAKE FOR A VARIETY OF PLANS THAT CAN BE PRODUCED AND DESIGNED EFFICIENTLY ■ BUT THIS SYSTEMATIC WAY OF WORKING ALSO MAKES FUTURE ADAPTATION TO USER PREFERENCES EASIER TO ACHIEVE ■

IN TODAY'S TECHNOLOGY IT IS ONLY THE FURNITURE THAT IS EASILY ADAPTABLE TO USER NEEDS ■ ALL OTHER SUBSYSTEMS, ONCE INSTALLED, ARE DIFFICULT TO CHANGE OR TO SEPARATE. (1) ■ THE SHELL-INFILL APPROACH SEEKS TO MAKE THE SUBSYSTEMS D AND E MUCH MORE ADAPTABLE INCLUDING THE RESOURCE SYSTEMS THAT ARE CONNECTED TO IT ■ THIS INFILL CAN BE DISTINGUISHED FROM THE SYSTEMS A, B, AND C THAT MAKE THE MORE PERMANENT SHELL (2) ■



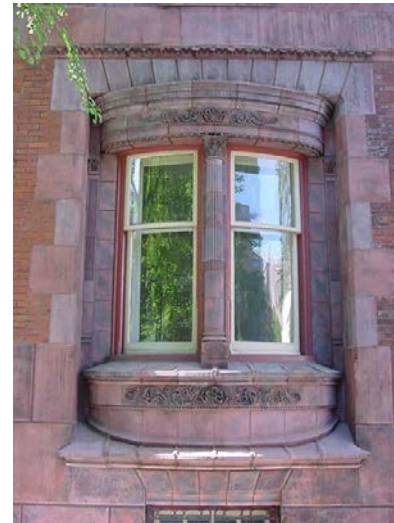
Shell/Infill Study #2



THE SUBSYSTEMS THAT MAKE ONE HOUSE CAN BE PRODUCED BY DIFFERENT COMPANIES ■ DIAGRAM 1 GIVES THE NORMAL SITUATION WHERE ONE COMPANY OFFERS THE WHOLE HOUSE TO THE CUSTOMER EXCEPT FOR THE FURNITURE ■ NO.2 SUGGESTS HOW THE BUYER CAN FIND A SHELL WITH ONE COMPANY AND A INFILL SYSTEM WITH ANOTHER ■ CASE NO.3 GIVES A SITUATION WHERE A LOCAL BUILDER PUTS TOGETHER A HOUSE WITH PRODUCTS FROM DIFFERENT COMPANIES ■



Control of variety is an architectural skill to be learned and enjoyed!



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