SUPPORT / INFILL HOUSING
and
OPEN BUILDING

Papers on Principles and Practice

Volume 1 Principles, Methods and Studies

Volume 2 Support / Infill Projects and Commentary

Volume 3 Open Building Principles and Practice

edited by
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Volume 3

Open Building Principles and Practice

Introduction

These three volumes contain a selection of papers, articles and reports on the subject of Support / Infill housing and Open Building. They date from the early 1960's and include discussion of principles and methods, projects and products. Most of the projects shown and discussed are European. The volumes are:

Volume 1 Principles, Methods and Studies
Volume 2 Support / Infill Projects and Commentary
Volume 3 Open Building Principles and Practice

A separate document exists on Developments toward Open Building in Japan (Kendall, 1995). It discusses 24 built projects or planned developments and products in the period 1989 - 95 in Japan. Much work preceeded that period and is unfortunately not well documented in English.

The intent of the selection is to make available in one place a body of work to give those interested in further developments in practice a good grounding in what has been done to date. It does not intend to offer specific guidance in methods in the design of supports or infill systems. The book to study for the design of supports is Variations: The Systematic Design of Supports (Habaken) (MIT Press, 1976). No specific text exists to guide developers in the design and manufacturer of infill systems. However, the work of the OBOM group at TU Delft, while mostly in the Dutch language, provides useful background. Some is included in this collection.

Excluded from this collection is the extensive work on the subject of TISSUES. While Support / Infill concerns the level of buildings and their (mostly interior) infill or fit-out, TISSUES concern the larger context of the urban fabric: the form and space "rules" within which individual buildings can be realized by different parties while still offering a stable, coherent context.

No effort is made to present studies related to Tissues/Support/Infill in developing countries, of which there are many. These can be found most readily in the journal Open House International.

Further, in the sphere of professional education, few published articles exist and those that do are not presented here.

Volume 3
Open Building Principles and Practice

Contents

"OPEN BUILDING"- AN OVERALL STRATEGY FOR PARTICIPATION AS IN ACTION IN THE NETHERLANDS

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Paper for the Design Participation Conference at Eindhoven Technical University April 1985

Recently (November 1984) representative participants in the housing-procurement-process in The Netherlands have joined hands.
They founded the "Open Building"-foundation.
It's a unique initiative as they represent all walks of the process: users, politicians, authorities of all levels, financiers, investors, housing corporations, architects-designers-consultants, builders, manufacturers, installation firms of all sorts and researchers. So all participants involved in "design participation" as they are mentioned in the call for papers. You might say a real design-coalition-team to use one of the key-notions of this conference and perhaps even extending it a bit.

Their first aim is to apply systematically and on a broad scale the so-called "Open Building" concept as developed over the last fifteen years and as described in this paper.

A second aim is to develop further necessary tools in an interactive development process with the practical experience gained. To let this development-work happen as effectively as possible a co-ordinating tool for research and development in the field of Open Building the so-called Do-As-If-project is now under development. It is described at the end of this paper.

A third aim of the partnership is to develop in an interactive process with government and local authorities a new set of rules and procedures for the housing procurement process which will enable an effective application of the Open Building Concept.

An ambitious program certainly if you realize the scope of the Open Building concept and the vast restructuring-process it will mean. But it looks as if the pressure of circumstances will carry this initiative as I hope to make clear at the end of this paper.

"OPEN BUILDING": HOW I WILL DESCRIBE IT

What now is this so-called "Open Building". I will first describe its aims, than its tools, and than its expected effects on the roles of the participants. After this overall picture of Open Building I will say some things about the chosen strategy for implementation of the necessary changes and about the set-up of a co-ordinating tool for research and development, the already mentioned "Do-As-If-project". And finally I will discuss some items which I think make a development in the housing procurement process like Open Building almost inevitable under penalty of great frustration and inefficiency.

As the aim of this paper is to give an overall and coherent picture of the state of the art of Open Building including some background history, all meant as a base for discussion about all aspects involved, it will be clear that the descriptions of the different items have to be rather brief.

Before moving to the aims of Open Building just another remark. What "Open" stands for you will discover from the aims. But I want to make sure that you do understand that "Building" must be understood in a very broad connotation. It stands for the whole procurement-process. In Dutch this is possible so we say "Open Bouwen" but whether "Building" can be used in English as done here I am not quite sure. So any suggestion for a better name is welcome.

OPEN BUILDING: ITS AIMS

They have been described very condensed as:

"Open Building is aimed at giving all roles in the housing-procurement-process as much freedom as possible for independent and yet coherent decision-making within their expertise.

This independence concerns freedom and responsibility for making decisions about quality (what) and production (how) as well as freedom in timing of decisions (when)".

So Open Building is obviously aimed at opening up the process for participation on equal base for all the many participants involved nowadays. So far so good. But what does it take to reach that goal.

Almost everybody will agree that this freedom for independent decision-making has become very limited or one-sided. One-sided where a lot of power has been concentrated with one of the parties involved. This is clearly illustrated by the relation between the freedom in the individual user's decisionmaking versus the power of communal-

decisionmaking as represented by all sorts of regulations and procedures (fig. 7).

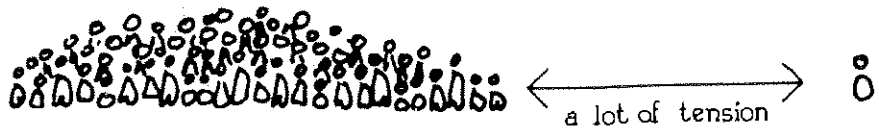


fig. 7 collectivity individual

Let us look a bit closer at the roots of this limitation of freedom. I will state 3 observations ("I see"), the combination of which is crusial to my opinion.

1. Permanent and rapid change on all fronts. In building this means constant change in the roles of participants, in plans, details, products, use of buildings etc.
   I will not dive into the causes of this phenomenon, they are many, specialization being not the least of them.

2. Diversity. This is closely linked to the first one, permanent and rapid change. While something new emerges former, often still new, solutions or trends have a tendency to stay with us. That makes our society very diverse with many different life-styles existing next to each other. In building it means we have now to cope with a great diversity in participants, demands, materials, techniques, etc. etc.

3. Complex interdependencies. Of course interdependence has always been there. And it has always turned out to be of a very complex nature if one really had to dive into it. But in a stable society with set ways of doing things and relatively slow change it does not surface as a problem. Time absorbs it. Only when things get on the move along a broad front and all the time the whole complex interdependece system does surface.

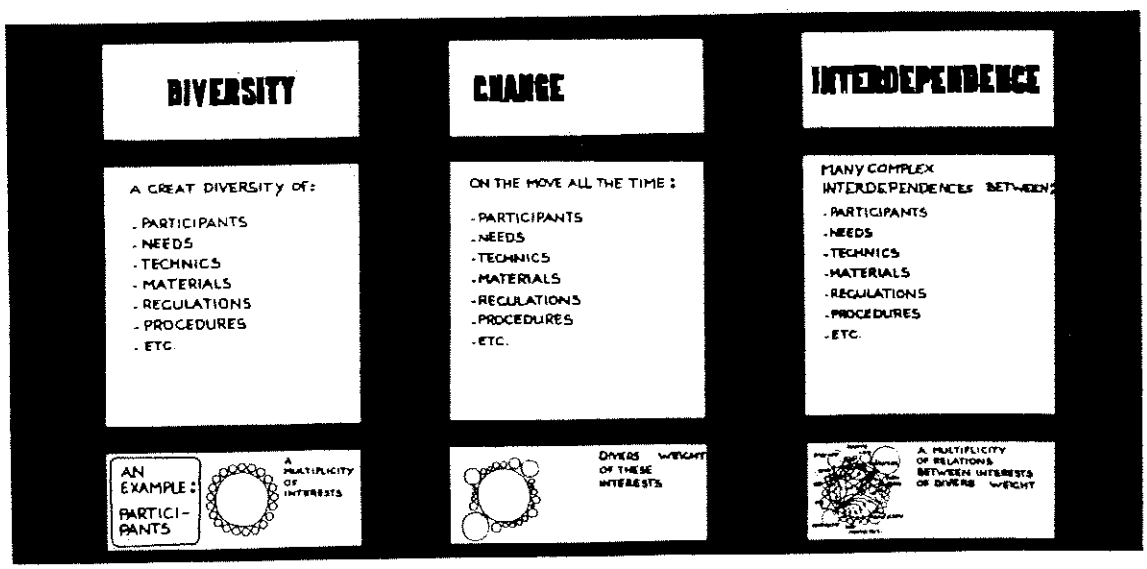


fig. 8

It is to my opinion the combination of these three caracteristics (see fig. 8)

- permanent and rapid change
- diversity
- complex interdependencies

that lies at the root of the lack of freedom for independent decision-making. If one changes one decision it turns out that a whole hoard of other decisions in which many other participants are involved has to be changed. Be it a decision about subsidies, lay-out, detailing, you name it. Which means you have constant conferences of a great number of participants and even then...

It seems quite clear that our ways of doing things are in many ways not able to cope with these charateristics. For instance thinking in terms of "the ideal solution" as still many architects (but not only architects) do is incapable of dealing with change and diversity. And if you think hard you may discover many more paradigms that are not adequat any longer. So it is no wonder that we cannot cope with things and that our built environment becomes very costly partly so because it often becomes non-fitting in a very short time. Also a lot of energy of participants is side-tracked and frustrated. Of course this not only goes for building. Every where is a lot of talk about "management of change" as one of the new notions seems to be.

My conclusion is that any new way of doing things has to be able to cope with all three of the characteristics.

To cope with permanent change and diversity it seems reasonable to go back to the carriers of this change and diversity: all the participants involved. To provide them with a freedom to act according to a great diversity of circumstances and to be able to make alert and quick changes at any moment. From the last characteristic, complex interdependencies, it will be clear that in order to reach this goal we will have to develop tools that enable us to deal with complex interdependencies. That means co-ordinating tools that offer a great range of freedom without losing coherence. Tools which enable real participation on an equal base for all parties involved.

In other words we are back at the aim of Open Building as stated at the beginning: "...to provide as much freedom for independent and yet coherent decision-making as possible. This independence concerns freedom for making decisions about quality (what) and production (how) as well as freedom in timing of decisions (when)." That is what "Open" stands for.
I can only invite you to look critically at the tools presented in the next part keeping in mind this goal and the 3 characteristics behind it.

OPEN BUILDING: ITS TOOLS

First as further background a little history. In The Netherlands we have been lucky enough to have Habraken (1) formulate already in the early sixties his support-infill Concept. Even as this theory has grown considerably in scope, his original ideas are still remarkably valid. The more so as the above mentioned characteristics of our society become more and more obvious and pressing.
Through this luck we have been able to develop gradually over this last 20 years a set of tools that seem appropriate. This has happened in and around SAR (Stichting Architekten Research, or, translated, Foundation for Architect's Research). SAR was founded in 1965. Its research-bureau's first director was Habraken and from 1973 onwards it was John Carp. SAR has had a remarkably stable budget over these 20 years. Half of it was provided by its participants, mainly architects and builders. Another half consisted of research commissions mostly government sponsored. All in all this budget has totalled over all those years to 10 million Dutch guilders.

Moreover over the last 10 years the SAR initiative has triggered diverse research work at different other research-establishments, university as well as private ones.
Also over the last 5-10 years in various government sponsored experimental projects now in use different results of this research work have been tried out and the experience has been channeled back to the research programs.

All this has greatly contributed to a wide-spread interest and to the initiative of founding the Open Building Foundation as an important step to a broad scale practical application.

Now what tools have been developed so far or are under development.
Just to give first the scope here follows a quick listing:

1. decision-levels
2. a new version of modular-co-ordination (M.C.)
3. performance specification rules

))) basic tools

4. a more elaborate set of rules derived from the new M.C.-rules for:
   a. building-nodes (details) b. all kinds of installations
5. a new set of rules for tendering
6. new financing concepts based on different life-cycles of parts of a building
7. a new set of rules for subsidizing housing
8. new procedural proposals for control and approval by authorities
9. computer-programs on the basis of these tools

As indicated the first 3 tools are at the very heart of Open Building. As you may conclude from their description they constitute the freedom of decision-making and the safeguard for coherence.

Let us have a closer look at each of them.

1. Decision-Levels: who decides about what (see fig. 9)
As can be seen from the picture it is a further elaboration of Habraken's original support and infill concept. In his concept as you may know the support is the communal and long-lasting part, the infill the individual and fast(er) changing part. Central to his concept was the re-introduction of the individual user into the (mass-) housing-procurement process.
The picture shows more decision-levels as they are called now. The tissue-level was introduced in 1973 with the study called SAR-73 (3). The house-allocation-level was added as here during the life-time of the support important decisions have to be made about the allocation and size of the different dwelling-units for which the support offers the potential. After this allocation-decisions each unit then can get its own lay-out according to the individuals need and this lay-out can also be changed with the change of the inhabitants and/or their needs.

A theoratical description of decision-levels might be: A decision-level is always related to a set of physical elements that constitutes on the one hand the context for variations on the next lower level and serves on the other hand to constitute variations on their own level on the basis of the next higher level (4).

I prefer to describe them by their potentials as there are:
- a structuring of the decision-making process very much related to territories and its related parties and that from highly communal to very individual as can be seen in the picture. Consequently if offers a possibility for structuring government rules and prodecures.
- a structuring of the life-cycle and its consequent costs and financing and of efficient renewal when demands are changing.
- a possibility for market-segmentation with in each segment clearly detectable products and its clients. In this context it is interesting to notice that the infill-segment for newly built houses and for the renewel of old houses have many things in common.
- specialization in production with the possibility of systematic product-development and less interference between highly individual products with great pluriformity

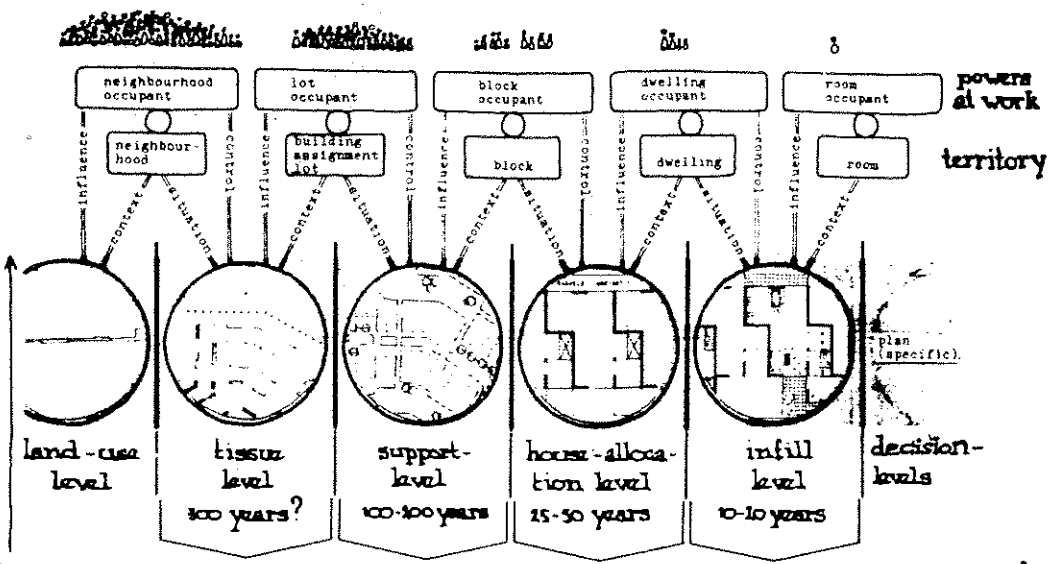


fig. 9

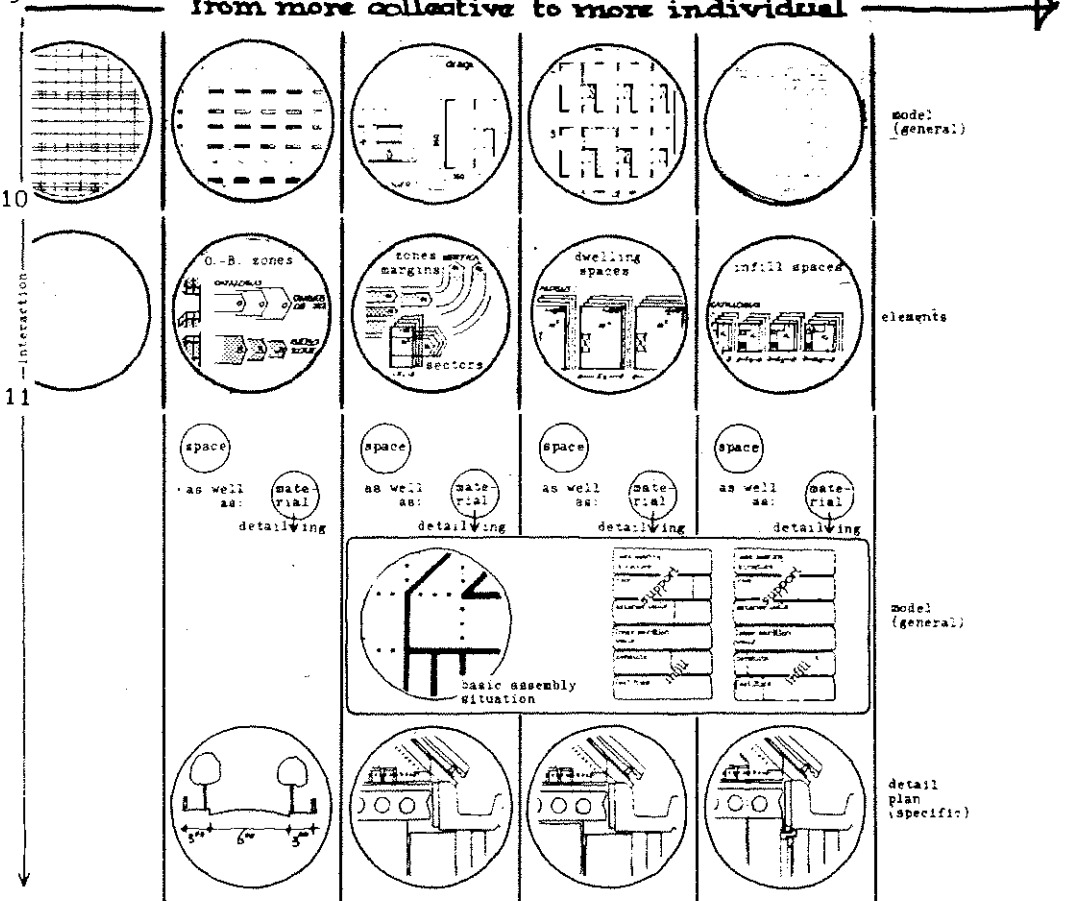


fig. 10

fig. 11

fig. 12

basis for an appropriate structuring of:

- decision-making
- governmental regulations
- design
- production
- markets
- management of housing estates
- financing

offering better possibilities for the development of:

- industrial production of components
- doing it yourself
- rehabilitation
- new specializations
- high incomes
- mass building
- rapidly changing needs

and more communal products with more things in common. On the other hand do-it-yourself production can more easily find its place according to diverse possibilities of users.

- a structuring of housing-management in which the users can take up their part again if they want to.
- the possibility to build up and constantly renew a common body of comparable models on each level (see fig. 10) and consequently to work more systematically from non-projectbound models to projectbound plans and vice versa. There are already quite a few studies on supports and tissues in this respect.
- to develop a thematic architecture where the longer-term parts form the theme and express themselves as such thus representing the communal part and where the shorter term infill constitutes the variations as an expression of individuals and through them of pluriformaty and change.

These are just examples, you might easily be able to think up a few more.

Around each level design-tools (5) have been developed of which the notions of "zones" and "margins" form an important part (see fig. 11). Especially margins constitute an important instrument for describing and assuring freedom of desicionmaking on the next-lower level and yet secure coherence.

It is fair to say that from the experience of working with levels it has become clear that a further theoratical built-up of usefull notions would be helpfull. Research in that direction certainly has got a new impulse from Habraken's latest book on the theory of levels "Transformations of the Site". Also the work done on the "Do-As-If"-project as described later already has given an impuls formulating questions from more practical nature.

2. Modular Co-ordination in a new version

This tool is meant to offer a co-ordinating tool in the field of position and dimension of both material and space.

If different parties must be able to decide independently about elements that in the end still must fit each other the necessity of this tool for Open Building may be clear (see fig. 12 and 13-6).

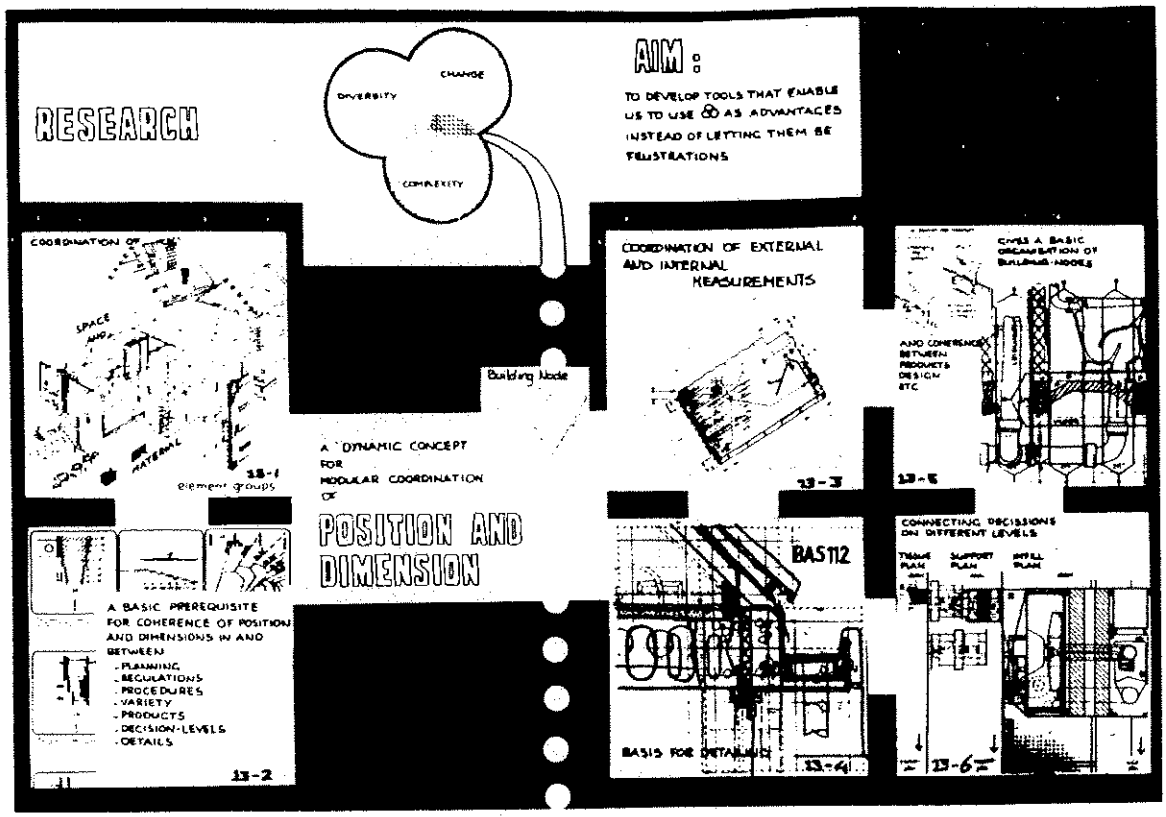


fig. 13

Another challenge this tool must fit is that the choice what set of elements belongs to a certain level should be kept an open choice. Sometimes the facade for instance may belong to the support-level while in another project or time part of it may belong to the individual choice of the user so those parts then will belong to the infill-level (see fig. 12).

Yet another challenge is that different solutions for a certain element should be interchangeable without causing a ripple-effect in the plan and/or in other elements, be it material elements or space. Only then freedom for independent decisionmaking can be assured to different participants.

It is the combination of these prerequisites and especially the ripple effect one that made it necessary to develop a new version of modular co-ordination. The old version of modular co-ordination is a typical add-on system of (modular) dimensions of elements which still can cause a lot of ripple effect.

This is the reason why this new version is built on co-ordination of position. And that dimensions are derived from that instead of the other way round.
Another difference is that all, and I repeat all, parts of the building are taken into account (see fig. 13-1 and 13-2). Looking at the state of the art in modular co-ordination internationally only one country comes close to this and that is Sweden. They have rules for almost all building-parts. But if you take a close look they contradict each other, in other words the building parts are not co-ordinated at all. My opinion on this is you either co-ordinate all parts, including space, or you do not co-ordinate.

And still another difference is that the rules are based on a very extensive and detailed study of the building-nodes (see fig. 13-4 and 13-5), being the place of potential conflict between the parts. Instead of starting from a very abstract way of looking at things as M.C. always has done. With the result that the difficulties in the nodes never really were taken serious.

A last difference to be mentioned is that the rules for dimensions deal as well with "external" dimensions of a product as with the co-ordination of "internal" dimensions: for instance position and dimensions of all kinds of openings in an element, reinforcement, ducts etc. (see fig. 13-3). Of course this has a close connection with what we learned from the study of building-nodes.

All this has resulted in an interrelated set of rules for all building-parts (see fig. 13-2). And also to a first related concept of detailing building nodes (see fig. 13-4). Moreover, it constitutes the possibility to leave the choice of technical solutions open. For this reason a difference has been formulated between a space-plan and a material-plan. The space-plan is what the user is interested in first of all and it can be the base for all official procedures and o.k.'s while it will be possible that producers, perhaps much later, offer a tender on the basis of the rules and of the performance specification. As this, because of the M.C.-rules, causes no changes in the space-plan there is no chance that again a whole round of procedural o.k.-ing should follow.

Much more could be said about this M.C.-concept, specially about other results of the very stimulating government-sponsored research that has been done over the last 5 years or so, but that would go far beyond the possibilities of this paper.
Concluding I would say this version of M.C. is very much process-oriented (open) (Toffler's 3rd wave) while up till now M.C. was very much thing-oriented (closed) (Toffler's 2nd wave). So according to Toffler's vision on our future the transition looks quite logical.

3. performance specification rules

This tool aims at complementing the freedom of desicion-making offered by the combination of decisionlevels and modular co-ordination, all together leading to a more open market where demand and offer can meet in a great diversity. Working with performance-specification gives more freedom in the tendering-system. It makes it possible to offer non-projectbound-developed solutions thus enabling high investment in the development of such solutions and products. On this tool quite a lot of development-work still has to be done.

As said the combination of these 3 tools is at the very heart of Open Building. Now follow the tools of a more detailed nature. They are also still more under development.

4. a more elaborate set of rules, partly derived from the new M.C.-rules, for:

a. building-nodes ("detailing") b. all kinds of installations

Both of them are very much aimed at being able to absorb changes locally without an unexpected ripple-effect to other plans and solutions in the project. For detailing it aims at being able to substitute part of the detail, for instance a floorsystem (see fig. 13-4), through another system without this causing a change in other parts of the same (or other) detail(s). Compatibility is a key notion here as well as changeability.

5. a new set of rules for tendering.

They will have to provide the procedural and legal possiblities, if one wants to, for using performance-specification for separate tendering on different parts of the project according to the decisionlevels.

6. new financing-concepts based on the different parties and products involved in different decisionlevels and on their different life-cycles (16). Some experiments are worked out at the moment.

7. a new set of rules for subsidizing housing

They have to cope with leaving freedom for change and pluriformity during the planning period as well as during the use on one hand and yet they have to constitute effective safeguards against misuse of subsidies. To ensure the last rules have become more and more detailed, to such an extend that what should be individual decisions have become (central) government decisions. Here again the decisionlevels offer new opportunities while also the division in space-plan and material plan as described under M.C. offers many procedural advantages.

8. new procedural proposals for central- and/or local governmental control and approval. Here again the dynamics of change have to be built in. In current procedures any (small) change tends to starting the procedure again for the whole project. Decisionlevels and the M.C. proposals for separate space- and material plans can structure this. What may even be more important on this governmental level Open Building does offer a possibility for a renewal of policy as may be clear by now.

9. computer-programs on the basis of these tools
It looks as if the structuring of the process and of parts of the process as offered by the different tools is very promissing for integrated computer-application. Some work has been done but it has only just started. Some computerprograms so far have been developed specially aimed at the participation-process giving for instance the possibility to offer immediately a price for a certain choice of infill. But work has only just started. At the end of this paper I will say a few more general things about the (im-)possibilities of the computer and its relation to Open Building.

These are the tools developed or under development at the moment. There will certainly still be many more necessary developments as experience increases. As you will see from the chosen implementation-strategy the organization is such that a constant open development process is foreseen and can be managed.

EFFECTS ON THE ROLES OF DIFFERENT PARTICIPANTS

As you may conclude from the wide scope of the tools these effects can be wide-spread and very profound. Whether they will be experienced as stimulating, given the existing frustrations, is a guess I leave to you.

Again I would like to start with a quick listing of the participants I want to consider:

1. the users
2. the component-manufacturers
3. the clients
4. the financiers
5. the architects/designers
6. the planners
7. the different consultants
8. the builders/subcontractors
9. the housing-management organizations
10. the authorities central and local

1. the users

As here the most important changes can emerge I start with him (or her).
The user will be provided with a much greater range of possibilities.
In common practice now the user is either buyer (owner) or tenant for the total house. He enters the process of decisionmaking mostly at the end by deciding (not) to buy or to rent. Sometimes by some kind of user-participation he can be involved earlier.
From what is said under tools it is quite clear that Open Building aims at giving him a possibility for individual decision-making and even defines a distinct area: the infill-level.
On all other levels he may have a possibility to take part in some kind of influence but at the infill-level decisions can be his responsibility if he chooses to.
This infill-level can cover a great part of the house including parts of the outer envelope or it can be a smaller part, perhaps only the kitchen or the bathroom.
Especially in this part he can choose to procure it by do-it-yourself activites or he can buy it and have it installed, perhaps in different parts and spread over a longer time-span.
This opens up in this market-segment a possibility for component-industries to trade directly or through super-markets etc. with consumers instead of having to go via the architect and/or the builder.
The kitchen-industry is a very good example of this development. I think even that this direct line from producers to client is an overlooked prerequisite for industrial production in building. Actually over the last ten years a lot more products have followed the kitchens. The only thing to be said is that many products, including the kitchens, are still based on traditional concepts as far as their integration with other products is concerned. In that respect I believe that Open Building will introduce a more fundamental approach with many innovative potentials in this field. A lot more could be said about the user but I will leave that to your imagination.

2. the component-manufacturers

From the above you will understand why I place this second and not the client or architect or builder.
This industry is provided with a set of tools that will enable it to develop products much more effectively as there is more certainty that they will fit into the projects and the levels aimed at. This non-projectbound product-development can thus carry a larger investment which will enable a different approach much more related to the durable goods market. It may be expected that a whole range of choice will be developed as now in the kitchen-industry including do-it-yourself products.
Another part of the market will be the support-sector. Here also the client will be much more clear so the product can be clearly defined. And the more you provide a

product with many potentials for the immediate design as well as for the period of use the more it can be used in many projects.

3. the clients

Obviously on the basis of Open Building there may be different clients: each level having its own clearly recognizable client.
Needless to say that the user of course also can be the client, be it for the whole house or for the infill-part while others are the client for the other levels.

4. the financiers

Again a greater range of choice in this case between possible financing-systems comes into being.
The support can be financed on a normal real-estate basis but with a longer period for depreciation period. Which is reality anyway even if it is not done on this basis at the moment.
Under housing-management another aspect of the financier's security will be discussed: the possibility to avoid a quick and unforeseen functional-economic depreciation because of the built-in potential to absorb changes in use and demand. This of course is also important for the client.

5. the architects/designers

Here again as with the component-industry the non-projectbound developmentwork can at last become profitable. It can range from systematically building up models in an interaction between different levels, as described under levels, to on-going systematic development of detailing as briefly described under modular co-ordination.
But even more important may be that changes during the design period can be managed much easier as a lot of the now usual ripple-effect has been eliminated. This goes for all levels as all these designs have an in-built possibility to absorb changes. And it also goes for the working-drawing fase through compatibility of components and details.
Of course there may be specialization on different levels be it tissue-, support- or infill-level, but often all three will be done as the knowledge of the interaction is important. Yet on the infill-level it may well be that the actual lay-out of design for the user may shift to interior-designers.
On the other hand systematic product-development may become a much more important part of the architect/designer's work be it on support or on infill-level.
But all in all the most difficult change for many architects may be to have to design for change.

6. the planners

Here an important tool may be the possibility to work with margins.
Not that that in itself is new, but because of the focussing on change in the development of the tools it is built in much more systematically.
At least in The Netherlands the difference between longer term and much more communal decisions, as taken on tissue-level and of longer term and less communal decisions about actual buildings on the support-level has been blotted out. Town-planning has become an architect's business over the last 15 years. The tissue-design and the design of large groups of houses are done by one and the same designer, that is the architect. This has often the effect that new developments are just an addition of a very varied bunch of plans without any recognizable theme in these variations.
They are often more directed at sensational differences than expressing a common theme.
To the extent that we have even lost the ability to discuss the relation between town-planning and architecture.
I think decisionlevels with design tools like zones and margins can provide this possibility again even against odds like the tendency to be sensational.

7. the consultants

Instead of waiting for the design of the project and than reacting to it with each time again project-bound solutions, as is usual now for them, also the non-projectbound systematic development of solutions and products will be feasible. This goes very much for installations on the basis of the modular co-ordination rules. And even more so when the more elaborate rules are developed.

8. the builders/sub-contractors

Apart from the important possibility for non-projectbound development-work with high investment possibilities another possiblility stands out. It is the possibility for a systematic split between support-building teams and the infill-building teams. It is clear for some time already that these two require very different skills and organization. Mixing them as is usual practice now has many disadvantages.
Another feature may be the possibility that the infill-teams will be able to work in new buildings as well as in renewal projects of old buildings resulting in a bigger market with higher investment possibilities.
Whether specially the infill-part will be organized in separate businesses is open to the future. What might happen is that they combine skills as plumbing, electricity etc. Specially as more and more products originated in the do-it-yourself sphere now are used in professional installationwork.
Also the now already thriving businesses in the fields of kitchens, bathrooms, open-fire

places, windows etc. may all find a logical place instead of being fringe-activities.

9. the housing-management organizations

Here many new possibilities surface. To name a few:

- a very quick and alert reaction to changes in demand, be it in size of dwellings or in life-style and consequent lay-outs, without great costs as now is usual. This may be an important one with for instance the possibility that working at home comes into the picture very quickly now and will cause another change in demand as the many so-called "one-persons faculties" have done recently. Even use for different purposes than housing all together come into easy reach
- to leave the infill to the user as his own responsibility either by ownership or by having him rent it, all on his own specification
- the possibility to offer mixed possibilities of renting and ownership instead of only renting.
- to offer possibilities for a granny-flat when time comes as houses can easily be converted into smaller (or bigger) ones.

10. the authorities central and local

Their responsibility is to state policies concerning interests on all levels. As I pointed out they have had a tendency to move more and more into the individual level and prescribe things that should be left open.

This specially is the case when subsidies in any form are involved. A lot of so-called minimum standards have evolved for all sorts of things. A nice word for them is public-standards to protect the individual.

These minimum-standards over the last 20 years are by no means minimum any longer as no politician or expert wants to be accused of belittling the rights of people for the highest standard.

Minimum space-standards have now reached a level where adding them up gives a house that is hardly within reach of many people.

Let alone that people have freedom to decide to have a really minimum bathroom and a larger bedroom or vice versa. Or no bedroom at all. Or no kitchen. Or whatever their special circumstances require.

The seperation of support- and infill-level gives new possibilities. If public money is involved in financing the support the authorities can require that a support design complies to public-standards how high or low they may be. As can be seen in fig. 14

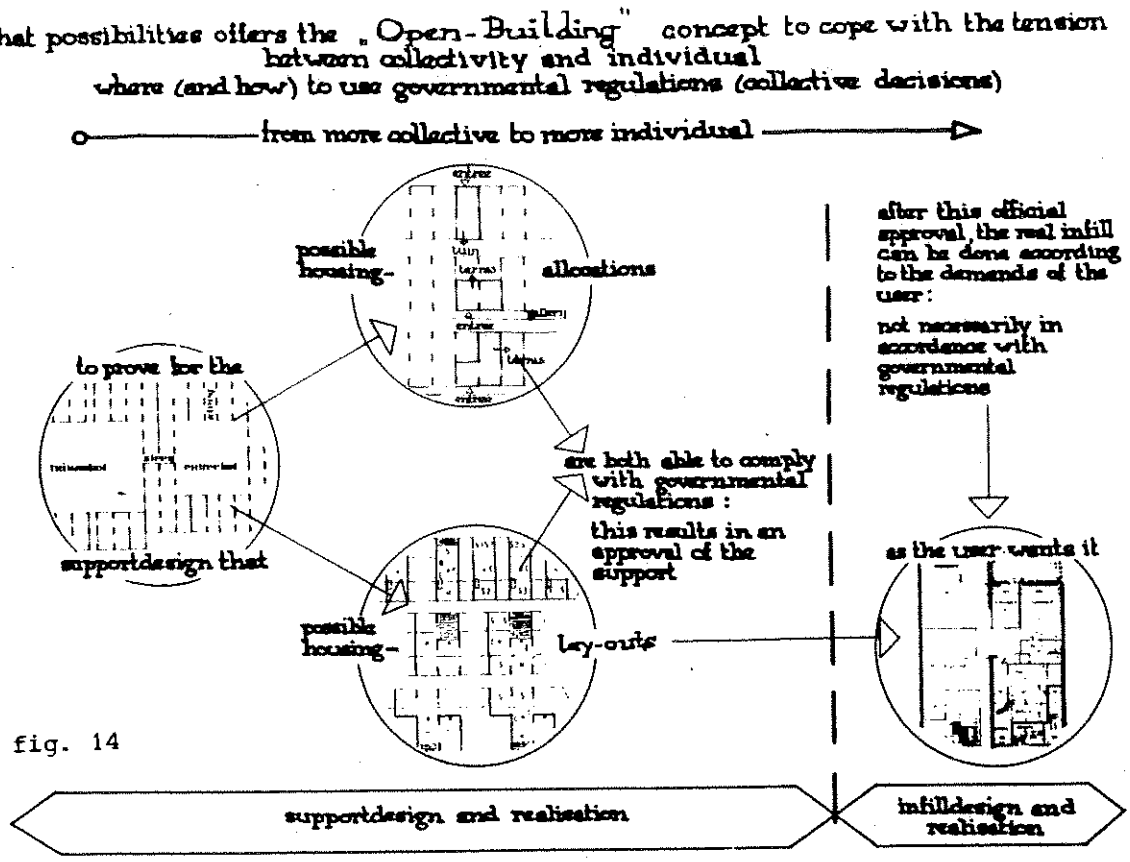


fig. 14

this means the designer has to prove that in a certain design of a support dwelling-units can be allocated that comply to standards set for such a unit. And the same goes for the lay-out possibilities of these possible dwelling units. But as also can be seen in this picture after the support has been o.k-ed and built, there begins a new stage where every user can do what fits him or her without having to comply to these space standard. So what really is communal is seperated from what is individual. And the same may be able for quite a few technical standards. A lot of frustrations both for authorities and individuals can be avoided. Of course this needs changed procedures but the basis is offered.

So far just a few changes that may occur in the roles of different participants. Many more can be anticipated but I will leave that again to your own imagination.

A concluding remark may be that Open Building offers the possibility that the role of each participant can be built out and intensified without the necessity to attack and diminish the basic roles of others. Open Building offers tools to manage diversity and let it grow in stead of trying to contain it.

A STRATEGY FOR WIDE SPREAD IMPLEMENTATION

Given the scope of the concept it is quite obvious that never one or even two or three of the participants in the procurement process will be able to push it through. Even the opposite: if for instance the architects would push it almost inevitably the builders (or others) will push back.

So we are very lucky that the interest and the involvement in the concept over the last five or so years has become so widespread that important people from all walks of the process could now join hands in the Open Building Foundatioin. Membership is after 3 months 110 with an average contribution of ƒ 5.000,- Dutch guilders. Just to give an idea of the spread, among these members are 25 architects-offices, 30 building-firms, 10 municipalities, 8 component-industries, 12 housing-corporations, and many others.

It might be interesting to know what strategy for the next 4 years has been adopted:

immediately

an immediate action for a growing number of further pilot-projects with special arrangements with the authorities where conflicts with existing rules appear. In conjunction with this the introduction of an "Open-Building-Project" and an "Open-Building-Product" certificate.

the next 1-1½ year intensive further development-work on different tools and products. To ensure an effective interaction with practice this is done through working-groups consisting of members involved in projects of different kinds. Some 10 working-groups have already started their work.

Their subjects are the further development of the tools mentioned already. Apart from that also a study of the existing stock of housing (some 5 million), the changes that must be anticipated in it and the role the Open Building concept can play is undertaken. While also a group works on product-development in the field of infill-components and installations.

This work is also aimed at building-up a wide spread force of professionals knowing the ins and outs of Open Building.

In order to keep in touch with a broader group of interested people every 2 months one or two working groups will present their results.

2nd and 3rd year

Thus also building up for a campaign in the 2nd en 3rd year directed at policy-makers on one hand and a broader public on the other hand. The laboratory premises situated at Delft and Eindhoven Technical Universities will be complemented with a public-oriented action centre situated where the public is.

3rd and 4th year

An intensive campaign to get going the necessary changes in regulations, procedures etc., building on the experience gained in the pilot-projects and the work done in the working-groups.

A DO AS-IF PROJECT.

The wide scope of the concept and consequently of the research- and development-work involves the danger that the necessary split up in many subjects leads to isolated developments. To avoid this a co-ordinating tool has been developed. A demonstration-model of it will be present at the DAP-conference.

The aim of it is actually three-fold:

1. to ensure interaction between the different subjects
2. to manage an intensive interaction between people from practice and their experience in pilot-projects on the one hand and researchers on the other hand.
3. to give students at the universities a tool to fit their thesis-work into the research- and developmentwork of Open Building

A very general description could be that it is a management-tool that offers the possibility for an open on-going developementprocess of Open Building where anybody can plug in with his or her specific bottle-neck or idea.
At the centre of this tool is a fictitious project situated in the old part of The Hague. This situation is chosen because it includes new built housing projects on a large scale as well as small infill-projects in existing blocs and renovation of existing houses.

On all decision-levels as mentioned designs can be made with many alternatives. They can be worked upon on 4 different scales: 1:1000, 1:200, 1:50, and 1:5. A special presentation-technique on presentation-boards for each schale has been developed to cope with alternatives in a such a way that in the discussions the consequences will be surfaced on all scales as clear as possible.

As it all is aimed at developing tools a special way of looking at things is introduced. On each scale the presentation boards are divided into four columns:

I See	I want	I can	I do
(observations)	(choice)	(tools)	(project)

As well known a man in practice has a strong tendency to jump from "I want" to "I do". Nothing is more exciting than being clever in having a quick solution for your special problem in your special circumstance.
But as Open Building is concerned with developing tools for communication and co-ordination in order to achieve freedom for different participants and not only for one, it is important to focuss on these tools, on what you want to achieve by them and why and what the effects are on project-level: that means in practice. So that is the reason for the introduction of these four distinct columns.
There is now some experimental experience in working with the Do-As-If-project and it turns out to be at least very stimulating for the participants. Whether it really also works as a management-tool for coping with very complex research has still to be proved.
It may be interesting to know that the Do-As-If-project is a research-commission from the Ministry of Economic Affairs on recommendation of the newly government founded body for Innovative Research Programs in Building. Their aim is to make it the core of one of their innovative programs that is focussed on the Open Building concept. This means special funding may be available specially if researchers and private enterprise take also responsibility for funding (50%-50% rule). The project is developed at the Department of Architecture of the Technical University of Delft under my responsibility. The researchers who develop it are Dirk Smets who has originally developed the concept, Ype Cuperus, Joop Kapteyns and Leen Hulsbos. Joop Kapteyns will be responsable for the management when it is operational.

So far this attempt to give an idea of the scope of "Open Building" in the title described as "an overall strategy for participation as in action in The Netherlands".
As for the notion "Design Coalition Team" as central in this conference, it may be clear by now that Open Building reaches out beyond design. And because of the independence created by mutually accepted rules there is even a questionmark behind the necessity for a coalition-team. At least where this term has come into being from the necessity to sit around the able all the time in order to cope with change, diversity and complex interdependencies.

Just to summarize, a fitting description of the Open Building concept I heard from prof. Bax who described it in terms he derived from the work of prof. Kwee, a phylosopher at Eindhoven Technical University.
Bax said it is a fascinating combination of "think-", "do-" and "make-" models or, to translate these words in more abstract terms, of conceptual-, procedural- and operational-models.

I do realize that a lot of what is said may be typically serving Dutch circumstances, But the ideas at the heart of Open Building may well fit the circumstances in other countries even if the more detailed tools and implementation-strategy may have to tackle other problems and consequently may have to be different.

WHAT LIES AHEAD

In the beginning of this paper I promised to discuss at the end "some items which I think make a development in the housing procurementprocess like Open Building almost inevitable under penalty of great frustration and inefficiency".
As you will have noticed I have mentioned in the course of this paper quite a few opinions on this subject already. So I can be rather brief now.
I did mention Toffler's "Third Wave" as I do believe that a lot of what he says about what lies ahead of us will come true in some form or the other. And in effect is already happening all around us. Look at the call for de-centralization, de-massification, de-synchronization, de-standardization, etc. Look at the development towards do-it-yourself and the pro-sumer often via the so-called unofficial or grey-economy. On which our economies all over the world seem to depend much more than any official will be willing to acknowledge.
I agree these are very general statements but if they come true we better prepare ourselves. And I do think ways of thinking like open Building do offer great opportunities to incorporate them.

Let me add two more reasons of decreasing generality.
The first is about the computer.
Some people say that the computer will from itself bring about the possibility to cope with all the problems arising and particularly those arising from permanent change, diversity and complex interdependencies. My opninion is that that is a very superficial way of thinking about the computer which denies the necessity of some sort of structuring. Of course it may well be that another concept of structuring than the Open Building one is possible in the light of the computer but I know of no one so far that includes all the possibilities offered by the Open Building concept. Diving into computers some time ago I was struck by the way they can strengthen each other. One more thing about the computer: I heard somebody say that there is a great danger that already outmoded ways of doing things are put in the computer. Thus giving the idea, as the performance will be 10-20-30 times quicker than we are used to, that the signs of non-fit after all do not have to be taken so seriously. And so sustaining the outmoded ways of doing things. I could not agree more.

The second is an even less general one. If you look close at the component-industry in building you are struck by the enormous growth in the number of ready-made components of all kinds. And they are of a nature that makes that many design-decisions are embodied in them. No architect can deny them any longer as still was possible 10-20 years ago. This development in itself might be enough to develop a way of thinking where non-projectbound development work can be done in a way that gives it a clearly structured place in each part of the process. Be it the design-, the production- or the distribution-, the financing- or the maintenance- and renewal-process.

And of course there must be a last concluding one. The demand for shelter all over the world is so enormous that no government can have the faintest hope to answer it if it does not provide the structure in which all available production-methods, old and new ones, can be combined with the enormous potentials of individuals. That is the challenge that lies ahead if you look world-wide.

1. N.J. Habraken, SUPPORTS, AN ALTERNATIVE FOR MASS HOUSING, the Architectural Press, London, English edition 1972 (Dutch edition 1961)

2. A. van Randen, NODES AND NOODLES, Open House, vol. 3, no.3, 1978, page 8-31

3. S.A.R.-report, SAR 73 the methodical formulation of agreements concerning the direct dwelling environment, SAR-buro, Eindhoven, 1975

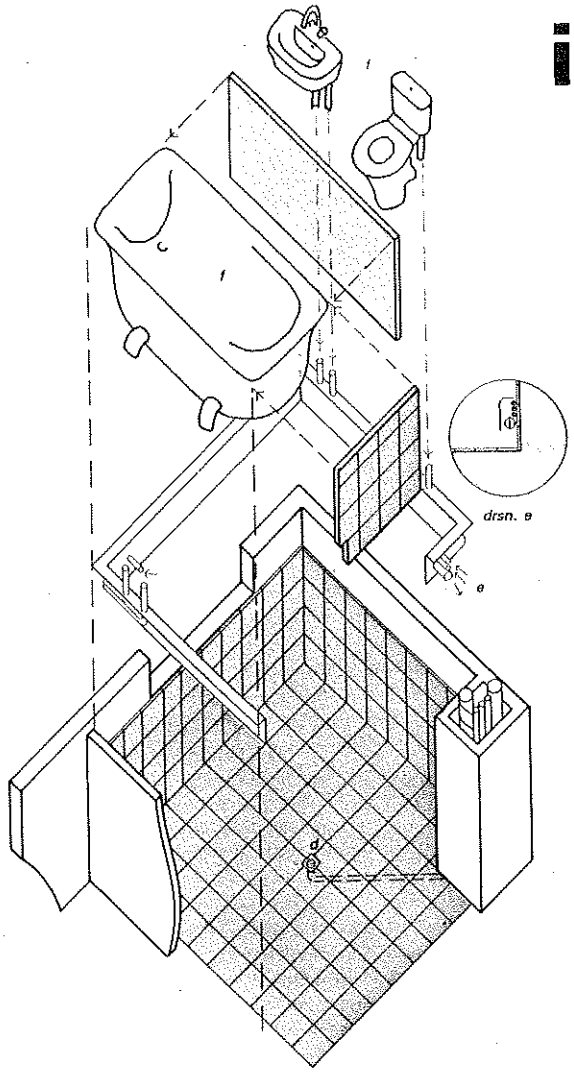
4. N.J. Habraken, TRANSFORMATIONS OF THE SITE, A water Press, limited edition 1982

5. SAR-LEVELS AND TOOLS, Open House, vol. 3, no.4, 1978 page 2-29

6. H. Tempelman Plat, COSTS AND RESPONSIBILITIES OF TENANTS AND HOUSING AUTHORITIES, Proceedings Third International Symposium on Building Economics, Volume V, 1984, page 83-93, National Research Council Canada.

Philip Broos

Open Building: anticipating the individual's needs



In the last few decades people have become increasingly aware of their rights. Through all sorts of bodies and organizations they are trying to get a greater say. More or less in pace with this development there is a marked tendency towards individualization, recognizable in virtually everything: a greater variety in motorcars, watches, fridges, hi-fi equipment, television sets, spirits, exotic fruit and vegetables, magazines, and TV networks. Something to suit all tastes. Moreover, more and more people setting up a home for themselves, with things that have been carefully selected.

One sector where individualization is lacking is council housing. Here the occupant has little choice and certainly no say. Thousands of individuals, with as many different ideas about living, are accommodated in identical flats. Even the place of the socket for connecting with the radio and television aerials and the height of the kitchen draining-board are the same everywhere. It is the housing corporation and/or the architect and the building regulations that have hitherto decided what an individual's 'nest' was to look like.

The 'Opan Building' method, which is being developed by the OBOM working group of Faculty of Architecture of Delft University of Technology enables future occupants to decide as easily about the installation of the major structurel elements as about the colour of the wallpaper. At no extra cost!

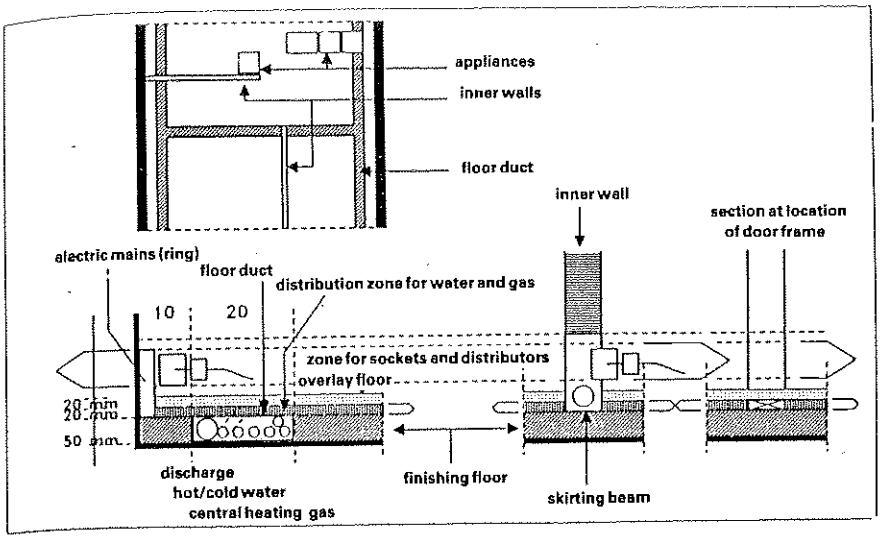
Owing to the flexibility of Open Building the housing shortage is going to be alleviated. That is why the method has aroused interest even in Peking, Nanking, Hong Kong, Singapore, Indonesie and Australia.

House owners are constantly making changes. Don't tell me that the occupants of a rented house would not like to do the same", says prof.ir. A. van Randen, professor of building methodology in the Faculty of Architecture and responsible for the OBOM working group, OBOM being the Dutch abbreviation of Open Building Research Model. His own home, two labourer's houses overlooking Lake Hillegersberg in Rotterdam, skilfully converted into one, testifies to the former part of his statement. An inquiry conducted by ir. Frans Boekhorst in Rotterdam has shown that occupants in the lowest income bracket are the ones that make most changes/improvements to their homes, which confirms that tenants, too, want to change the interior.

"That's where you can see how people really want to live: they are the kind of people who follow their own ideas, regardless of all sorts of rules. It's these very rules which are fatal to an individual's zest for life. In the past forty years the Government has been wielding a lot of power in house building through legislation and its policy on subsidies. What this has meant, in fact, is that the Government has determined the colour of the tiles in your bathroom and the size of your doorknob", says the professor. "All of these, are things the occupant should be deciding about, for he is the one who will be living in the house. I am quite well aware of the fact that absolute freedom for the architect may involve a great lack of freedom for the occupant."

Accordingly, the basic idea of Open Building (OB) is to create conditions under which the infill of a home can be adapted to the occupant's wishes at all times. When houses are newly built, the first occupants are asked to express their personal preferences, as close to the completion date as possible. And that applies to any home, whether rented or bought.

Giving the flexibility of Open Building it should be possible to become more responsive to the needs of the housing market. Situations such as those prevailing in Singapore and Hong Kong, where ten-year-old apartment buildings are being demolished because they have become sub-standard, will then belong to the past.



Raised floor with hollow skirting

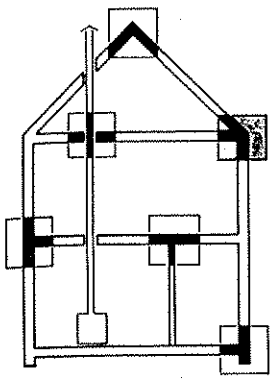
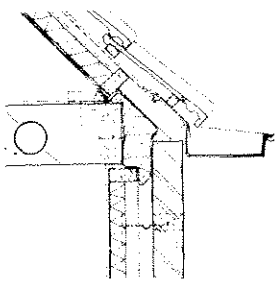


Diagram of building nodes in house



Detailed view of building node

1958

The theory of Open Building was developed some thirty years ago, in 1958, by prof.ir. J. Habraken, who is now Dean of the Faculty of Architecture of the prestigious Massachusetts Institute of Technology (MIT). In those days Habraken was a student of architecture at the Delft University of Technology. It took three years before his book 'Supports, an alternative to mass building' was published in 1961. It describes how houses or flats can be built on a massive scale without recourse to mass building.

Van Randen, who was a fellow student of Habraken's at the time, became involved in the ideas about Open Building at quite an early stage. Together they still form the international consultancy of Architectural Systems Cambridge USA/Rotterdam NL.

"Habraken's view was that an essential part is missing when you exclude people from the process of building a house. Because you are then building a home for people in general, not for the occupants," says Van Randen. "In fact he had already come up with a solution before the problem arose. Mass house building was still unknown in 1958 in Holland.'

In 1965 Habraken asserted the proposition that: 'Efficiency is attained not through repetition, but through diversity.' Efficiency is achieved by allowing the occupants to decide in advance about the layout of the place. Normally, after the house is finished, considerable alterations (and hence expenditure) would be involved to achieve the same goal. "Nowadays the term market-oriented building is used: diversity to match that of the customers. This is in fact what Habraken put forward back in 1958", says prof. Van Randen.

An important element in Habraken's theory of Open Building is the distinction between collective and individual decision-making: a say in the collective part and the right to decide for one's own part.

The Foundation for Architectural Research (Dutch abbreviation SAR), set up in 1964 by 25 architectural firms, has further developed the theory underlying Open Building in the past 24 years, initially under the direction of Habraken. To translate that theory into practice, five years ago the Delft Faculty of Architecture set up the OBOM working group. The working group, comprising architects and industrial designers, was co-sponsored by the Innovative Research Programme for Building Construction of the Ministry of Economic Affairs.

OB in practice

Mr and Mrs Jansen, for instance, rent a floor area of eighty square metres. It is a 'normal' rented flat and consequently, by signing the rental agreement, they undertake not to make any constructional changes. Until their departure the couple will have a living room of five by ten metres and two small bedrooms, both of two by three metres. Even though in the meantime Mr and Mrs Jansen acquire a family of three, the layout of the flat will remain the same, with all the discomfort this involves.

Another example: Mr and Mrs Pietersen-De Hoog also rent a floor area of eighty square metres, but in a block constructed according to the Open Building method. A month before completion of the block the couple is asked to make known their wishes with respect to the interior. Since both the husband and the wife have just completed a period of training, they have not got much money. So they take out a mortgage on the interior. Since they both like big open spaces, they planned only a small bedroom with a door opening into a small bathroom, all with movable walls. Thus the mortgage can be limited to fifteen thousand guilders. Three years later Mrs Pietersen decides to go to evening classes in management techniques. This means that in addition to her domestic work, she will have to study a lot. So a study is installed. A year later Pietersen also starts evening classes, so a second study is added. Five years later the first of the three children is born. Since

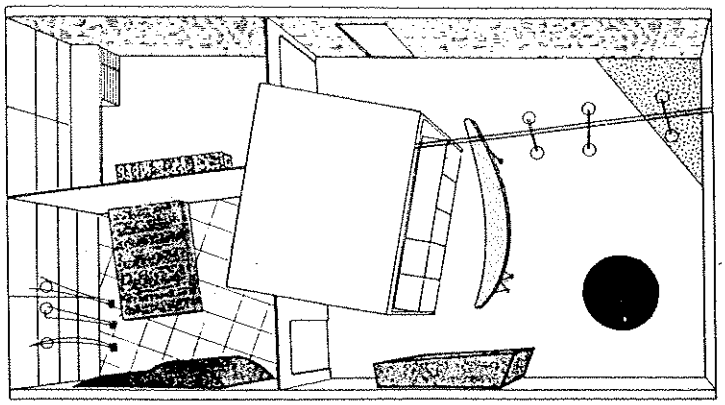
Mrs Pietersen is no longer in urgent need of a study, its walls are removed and the space is added to the living room. Somewhere else in the flat a baby room is planned, with a wash basin and baby shower. When the second and the third child are born and while they are growing up, additional rooms have to be provided. The family prefers not to give up the large central living room, and moving to a bigger place does not appeal to them either. They are quite attached to their present abode. So Mr and Mrs Pietersen start bargaining with the lady next door, who has lost her husband the previous year. Now that her son has left home, she no longer needs so much space. Because of the cost of heating and maintaining of the flat she is quite prepared to let the Pietersen family have part of it.

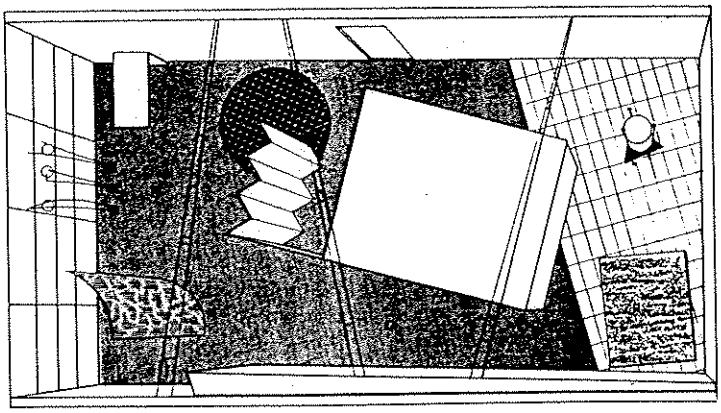
Another mortgage is acquires on the infill and the rearrangement can be undertaken. This involved removing part of the wall between the two flats, in the concrete of which reinforcement has been deliberately omitted. A new transverse wall is built in the neighbour's flat, which thus becomes smaller but cheaper.

Fixed and variable

Clearly, both the family and the widow benefitted here from the possibilities of meeting personal wishes which Open Building offers. The OBOM working group has developed a model which makes a distinction between fixed and variable: broadly speaking, between support and infill. It is not only material objects that are fixed or variable; the distinction also applies to forms of

Raised floor with piping underneath. Office block De Stieldrager, Ridderkerk





Various layouts of housing unit with mobile wet area. In The Hague district of Mariahoeve eighty of such units are now under construction

ownership, having a say in things, decision making and financing. With rented flats, for instance, this means that there are two owners, and this has an effect on the power to take decisions. The housing corporation owns the support (the framework of the block) and the occupant is the owner of the infill. The model also indicates the moment at which occupants should be consulted. Thus, a maximum is specified in order that only a minimum need be laid down! Another distinction made by the OB model is that between collective and individual decision-making.

Collective decisions concern:
- long-term projects (several generations and the planning of the district/area),
- the support (the immovable property),
- the owner (housing corporation),
- static/fixed (consultation about the infrastructure of the district).

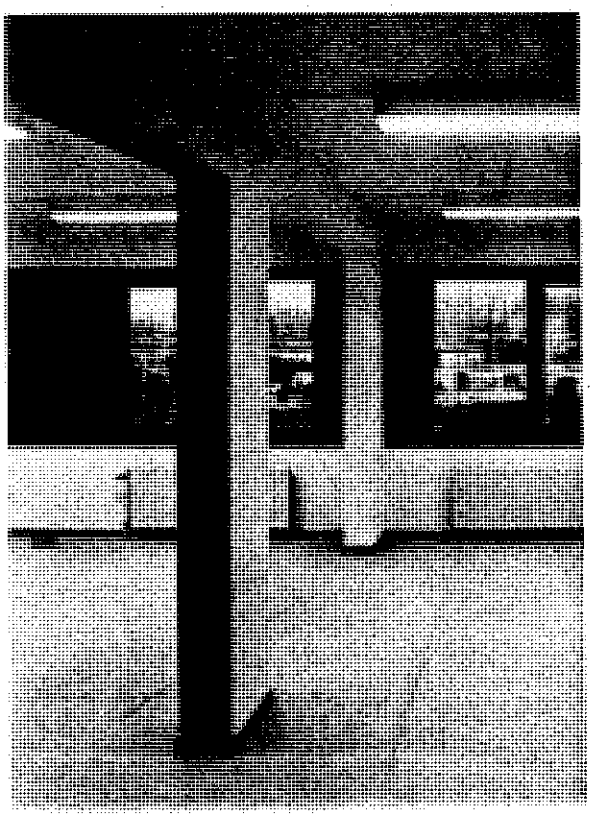
Individual decisions concern:
- short-term matters (a generation or less),
- movables (the infill: bathroom, kitchen),
- the occupant,
- flexible/variable.

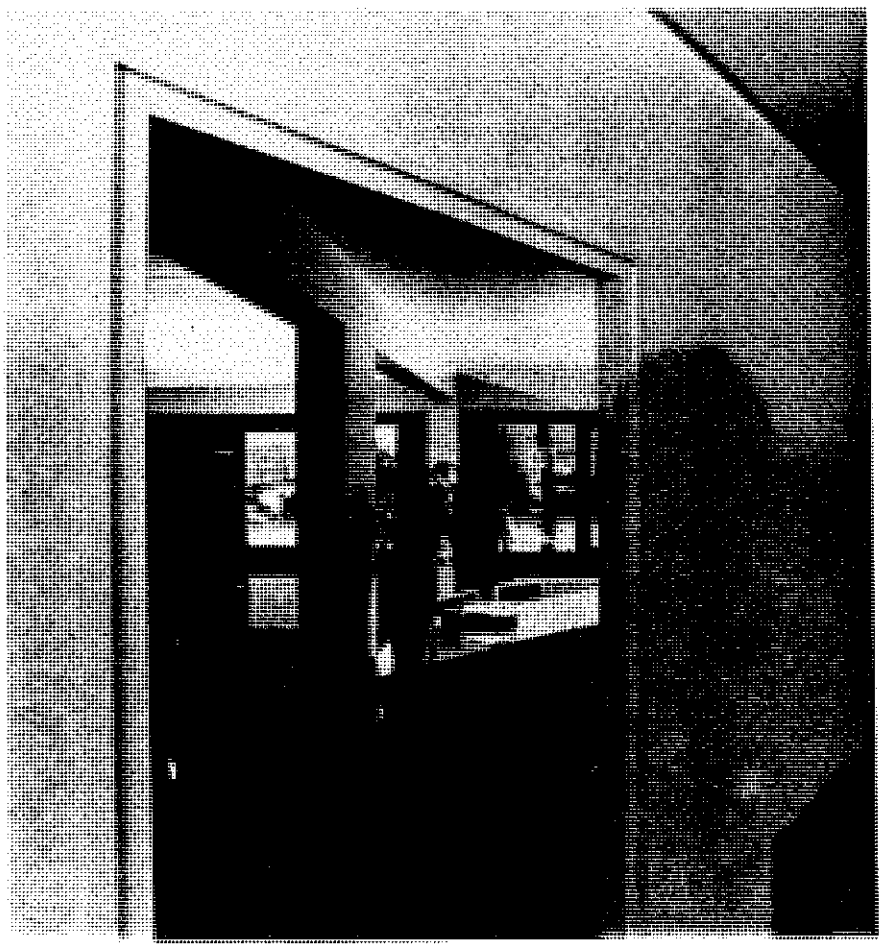
The less collective the decision, the shorter the period over which it extends. The effect of land-use decisions may extend over some three hundred years in the case of a district and over one hundred or two hundred years for an area, whereas for the building itself the period is twenty-five to fifty years. The impact of individual decisions concerning the infill is restricted to ten or twenty years, before the kitchen, or the kitchen cabinet doors, are replaced.

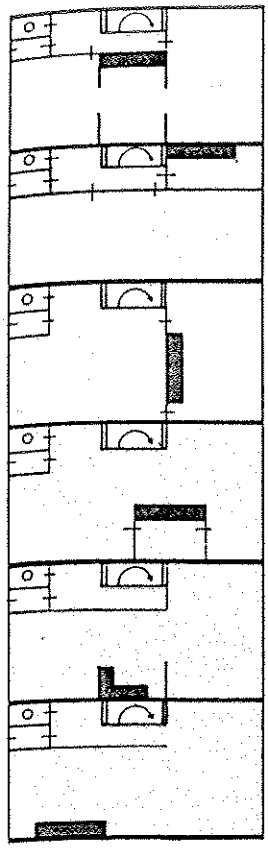
Tools

One of the objects or tasks of the OBOM working group is to design 'tools', to put the theory and the Open Building model into practice. Conventional design work is based on custom, legislation, manufacturing practises and technique. But Open Building, is an entirely new, original method of thinking and building. Some 'tools' developed by the working group are non-technical in nature, such as

Two rooms in office block De Stieldrager, Ridderkerk. The right-hand photograph shows a diagonal wall which the tenant had installed.







First step towards freedom in layout: within certain dimensional restrictions the kitchen can be installed at various locations.

novel forms of tender (based on performance requirements), new forms of financing (separate mortgages for support and infill), and new forms of subsidy (for example, for the support only).
Here a distinction is made between what has already been laid down and what can still be changed. The latter part includes not only the flat's infill, but also the layout of the block of flats. Thus, today the housing corporation may need two- or three-room units, but in a few years' time it may be compelled to change them into four- and five-room flats to meet the demands of the housing market.
Parts of projects are farmed out to other universities: At the State University of Limburg in Maastricht lawyers are studying the legal aspects of movable and immovable property. It is conceivable, when a house is sold, for the question to arise as to whether, under the Open Building regime, the kitchen is part of the movables or the immovables. At the Erasmus University in Rotterdam the relation between cost and quality in Open Building is being examined. The Research Institute for Policy Sciences and Technology at Delft University is developing new forms of financing.

Practical 'tools' which the OBOM feels are needed and the development of which is being initiated, often concerns arranging such relationships. A good example is the approach to the problem of the electrical wiring, which is bound up with all the subsystems. The conduits are nearly always concealed in the walls, so that all the subsystems are interconnected. This means that the locations of the wall sockets have to be decided at an early stage of the building operations, whereas the idea underlying Open Building is to do this at the latest possible moment. In the OBOM working group the problem is being handled by an architect and an industrial designer. Recommendations are being developed for independent wiring systems that can be easily modified.
Other examples of such developments are:

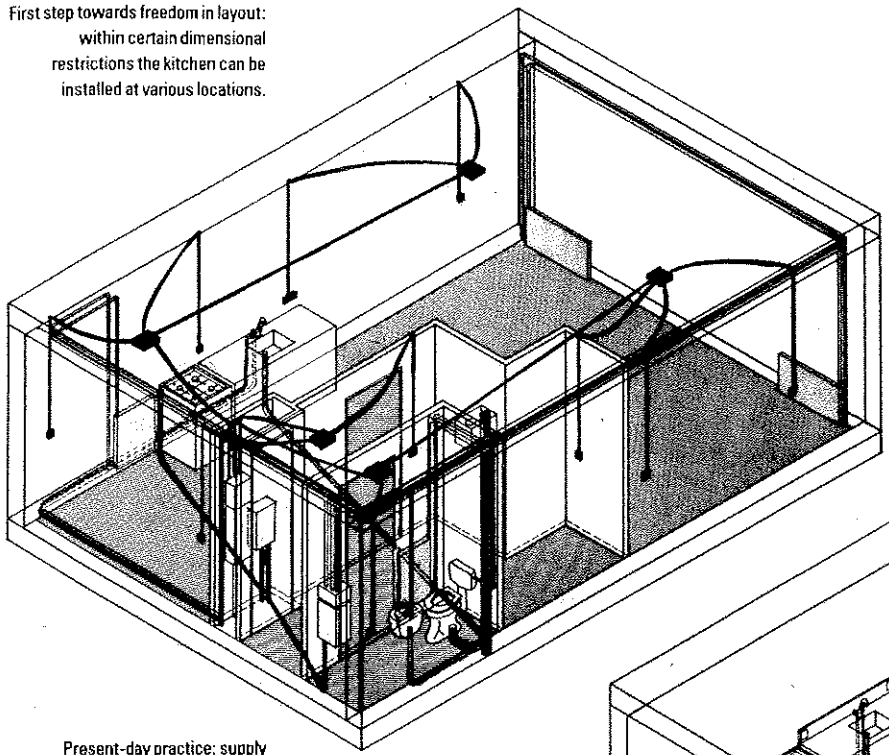
- Modern supply meters, making the meter cupboard superfluous.
- Inner walls that can be moved without demolishing.
- Computer programs based on the other 'tools' and
- flexible gas and water piping with handy couplings, no longer forming an obstacle to any changes in the layout of the flat or house.

Transfer of knowledge

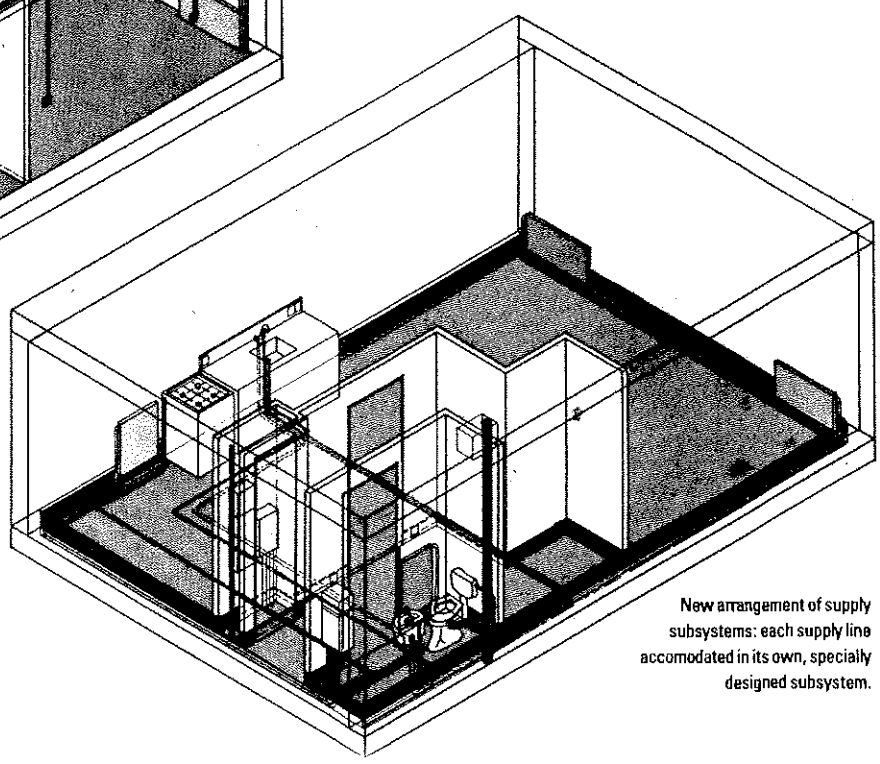
The OBOM working group not only plays a vital part in identifying problems and proposing solutions, its tasks also include the dissemination of knowledge and experience gained with Open Building. The OBOM group does this jointly with the Open Building Foundation, a organisation with representatives from the world of architects, contractors, housing corporations, municipalities, manufacturers, subcontractors, etc. Their aim is to promote the large-scale application of Open Building. The Foundation and OBOM have together formed study groups, each with a well-defined practical problem as its item to study; examples being: forms of financing, forms of open management, legal problems and wiring and piping.

Components industry

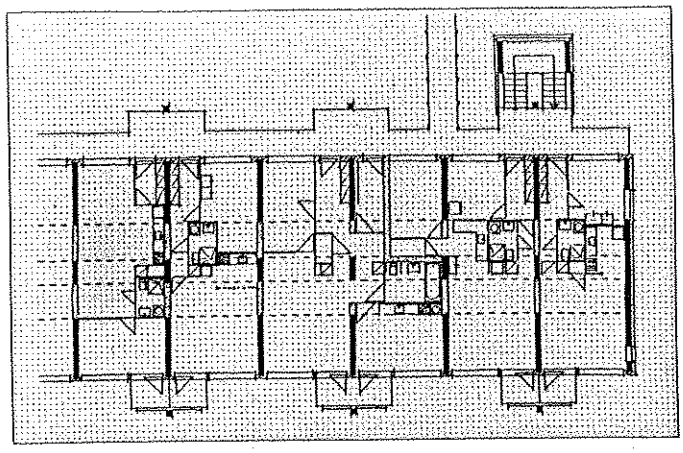
The idea underlying the design of 'tools' is standardization with a view to variation. "Our philosophy", says Van Randen, "is that it's not the solutions that need to be standardized, but the situations, so that in a standard situation you can still think up a variety of solutions. Variety, after all, is the hallmark of our time, isn't it?"
Since more and more products are being supplied ready-made by third parties, more people are becoming involved. This is why the working group has published a book entitled 'Plans and Details using Modular Co-ordination'. The book contains dozens of drawings of building nodes, i.e. places where different parts of a structure or material meet. An example of a building node is the interface where a wall, floor and roof meet. If the manufacturers of equipment, contractors and architects can be persuaded to adopt the standards



Present-day practice: supply systems interwoven with several other systems.



New arrangement of supply subsystems: each supply line accomodated in its own, specially designed subsystem.



Example of support where units can be repartitioned. In some units the non-reinforced parts of the load-bearing wall have been removed.

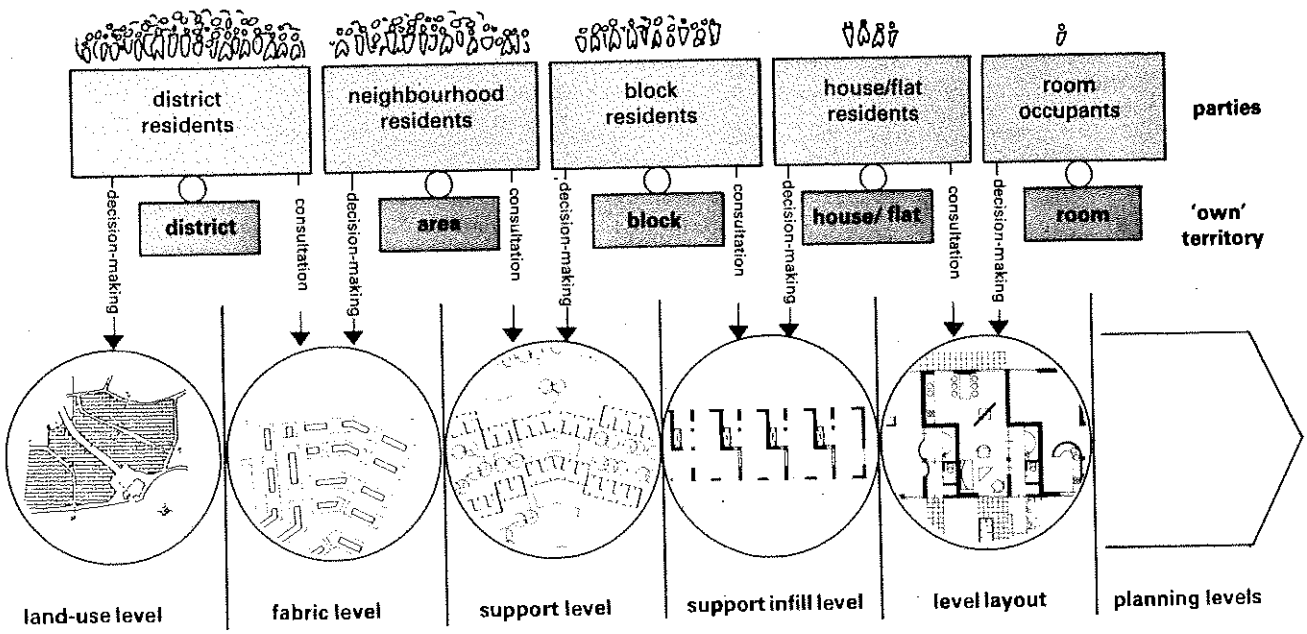
recommended in the book, it will be easier to plan the infill. The occupant will then get a much wider choice of products, because they will all fit in. Dishwashers of make X will then have their connections in the same place as those of manufacturer Y. Height and width will also be the same. Manufacturers are certain to benefit from these efforts, for they in fact will increase their sales potential. "The components industry has so far shown little consideration for residents", says prof. Van Randen. "They just delivered the goods to contractors and that was it. But things are now changing. More and more manufacturers are now developing products themselves and selling them direct to the end user. Just look at the kitchen industry. A kitchen from the Dutch manufacturer Bruynzeel used to be standard in every flat, but now you find a kitchen showroom on every street corner."

The future

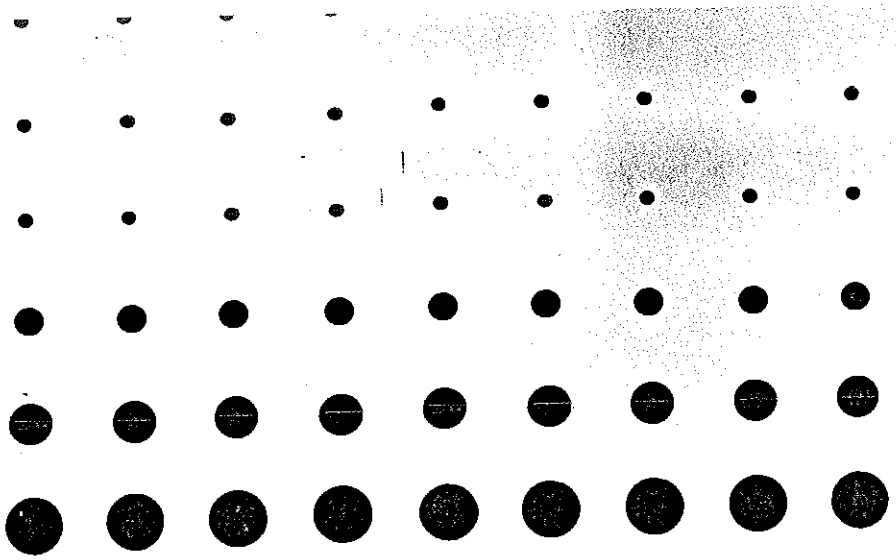
In the Netherlands a great many Open Building projects have been realized in recent years. Some thousand's of flats and houses are involved. "People who have decided the layout of their own homes are very enthusiastic", says Van Randen. "Yet I have a confession to make. There are still quite a few hurdles with respect to subsidies and other regulations. In fact, they sometimes make Open Building virtually impossible, because they are based on a completely different mode of operation. It is assumed that things will remain the way they were for ever. But in the field of legislation we have now at least made one step forward: in the preamble to the proposed new building regulations they have now included as a major objective 'to allow freedom in choosing the layout of houses and flats'."

Over the years Open Building has been stirring up increasing interest abroad. The OBOM working group has been in touch for some time now with housing authorities in Peking, Shanghai, Nanking, Hong Kong, Jakarta and Singapore on Open Building projects. Prof. Van Randen has already paid some visits to the People's Republic of China, Hong Kong, Singapore and Indonesia. In all those countries there is a considerable housing shortage. Having learned form the Hong Kong situation, where ten-year-old apartment buildings have been demolished because the apartments were found to be too small, the Chinese are mainly interested in the flexibility of the system. It will allow them to build supports/frameworks now, which are then turned into apartments of thirty square meters. Then, when the time comes, the apartments can be reconverted into larger ones, according to the needs at the time.
Some projects have already been planned with the cities of Peking, Nanking and Shanghai. The funding is now being discussed with the Dutch government.
Interest from abroad is, however, not restricted to Third World countries. The OBOM working group recently had the pleasure of receiving Steve Kendall, director of research at the Faculty of Architecture of the Catholic University of Washington. Dr Kendall is planning to set up an Open Building Institute along the lines of the OBOM.

Decision-making levels in open building



For further information about Open Building, please contact prof.ir. A. van Randen, telephone (0)15 – 78 54 00



OBOM

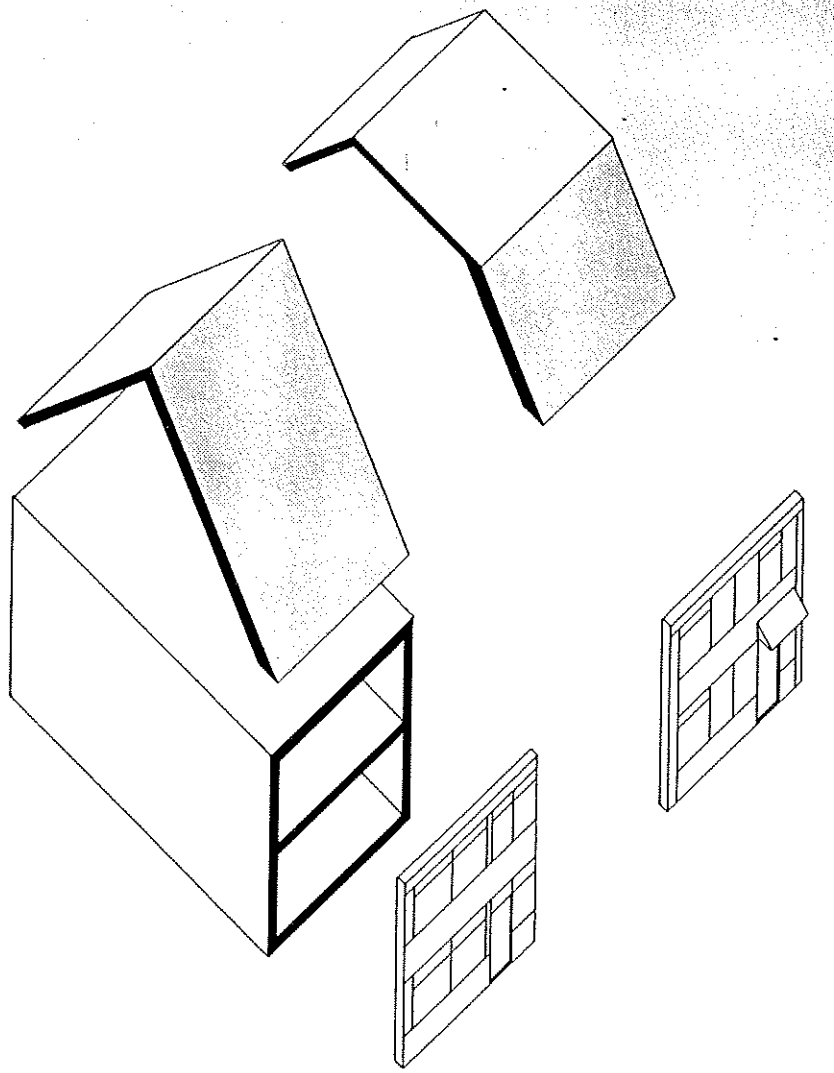
Open Bouwen Ontwikkelings Model

Aanbevelingen voor Open Bouwen

Recommendations for O.B.

Inleiding

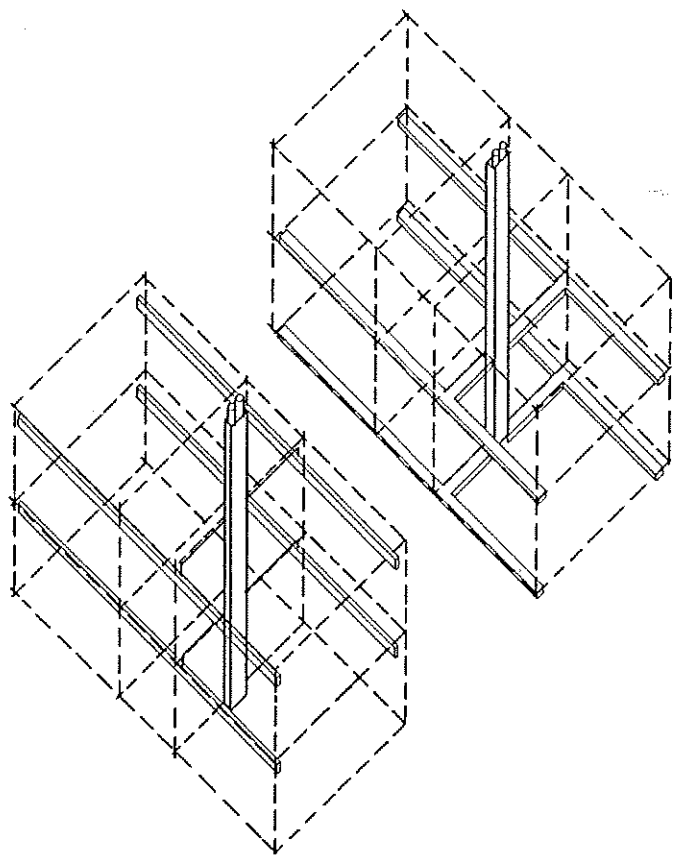
In dit boekje worden de drie aanbevolingen uitgewerkt, waarmee het boekje "5 Fasen in het proces van Open Bouwen" besluit. Dit heeft geleid tot een aantal suggesties hoe Open Bouwen nú mogelijk is, met bestaande middelen en met de huidige regelgeving.



Vast en Variabel.
Onderscheid tussen "vast" (links) en "variabel", rechts.

Vast zou kunnen zijn:
- *dragende wanden*
- *vloeren*
- *gevels*
- *dak*
- *meterkast*
- *leidingkoker*
- *mantelbuizen*
- *sparingen*

Dit zijn alle duurzame elementen met een repetitie-effect.



De werkgroep OBOM (Open Bouwen Ontwikkelings Model) van de Technische Universiteit Delft bracht aan de hand van vier praktijksituaties de huidige stand van zaken in kaart.

Dat leidde tot een aantal aanbevelingen en adviezen die het bouwproces zo open mogelijk maken. Die mate van openheid kan verschillen van project tot project. En het is de opdrachtgever die daarover beslist.

Het onderzoek van de werkgroep geeft in totaal vijf openingen (of stappen) naar Open Bouwen. Die hebben te maken met het ontwerp, de uitvoering en het beheer. De opdrachtgever kiest welke stappen hij wil zetten, hoe groot de invloed van de bewoner zal zijn, in welke mate de drager straks verkavelbaar zal blijken. Zo komt u tot de meest ideale combinatie van vaste en variabele elementen.

1. Kiezen tussen vast en variabel

De eerste aanbeveling van de werkgroep en essentieel voor de toepassing van Open Bouwen is het onderscheid tussen "vast" en "variabel", tussen drager en inbouw.

Bij voorkeur zouden de volgende elementen variabel moeten zijn:
- Binnenwanden die de indeling van de woning bepalen.
- De plaats en de afmetingen van keukens en natte cellen.
- De uitrusting van de woning, zoals het keukenblok, de natte cel en wastafels.
- De afwerking van wanden en vloeren.
- De leidingen die (vanuit vaste punten in de drager) de genoemde elementen verbinden met de hoofdaansluitingen.

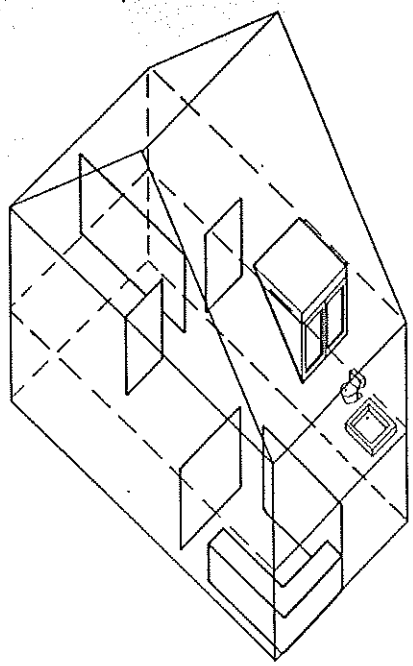
Door de keuze voor veranderbaar moeten twee zaken in de toekomst altijd gerealiseerd kunnen worden:

a. Het woonprogramma binnen de woonruimte moet aangepast kunnen worden. Daarbij valt te denken aan bij voorbeeld:
   - meer of minder (slaap)kamers,
   - een grotere of kleinere badkamer,
   - een grotere of kleinere keuken,
   - een open of gesloten keuken.

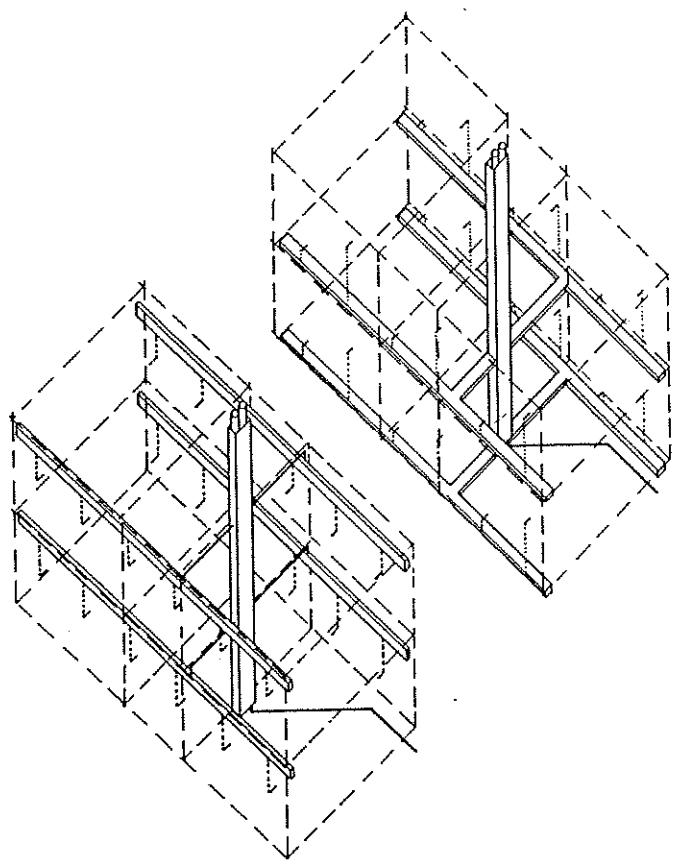
Dit geeft de bewoner de mogelijkheid om zijn woning in de toekomst aan te passen, als woonwensen of de huishoudensituatie daartoe aanleiding geven.
Dit geldt zowel voor bewoners van huur- als koopwoningen! De eigenaar krijgt de mogelijkheid om de woningindeling later zodanig te wijzigen, dat de woning weer bij de tijd is of beter verhuurbaar wordt.
Dit geldt bij voorbeeld bij leegstand en bij een veranderde woningmarkt-situatie.

b. Uitbreiding, vermindering of aanpassing van woonattributen moet mogelijk blijven, zoals:
   - het keukenblok,
   - de sanitaire elementen,
   - vloer- en wandafwerkingen.

De afwerking van een woning, sanitaire attributen en de keuken-uitrusting zijn modegevoelig en sterk onderhevig aan persoonlijke smaak. Ook slijten en verouderen ze sneller dan het vaste deel van de woning, de drager.
Als inbouw-elementen kunnen worden veranderd zonder al te rigoreuze aanpak (of zelfs sloop) van de drager, dan is al veel bereikt.
Zonder al te veel kosten kan dan in de toekomst de woning worden aangepast aan de smaak van nieuwe bewoners of de dan heersende mode.



Variabel zou kunnen zijn:
- binnenwanden
- dakkapellen
- woonattributen
- sanitaire elementen
Deze elementen zijn onderhevig aan mode, smaak, slijtage en gezinssituaties.

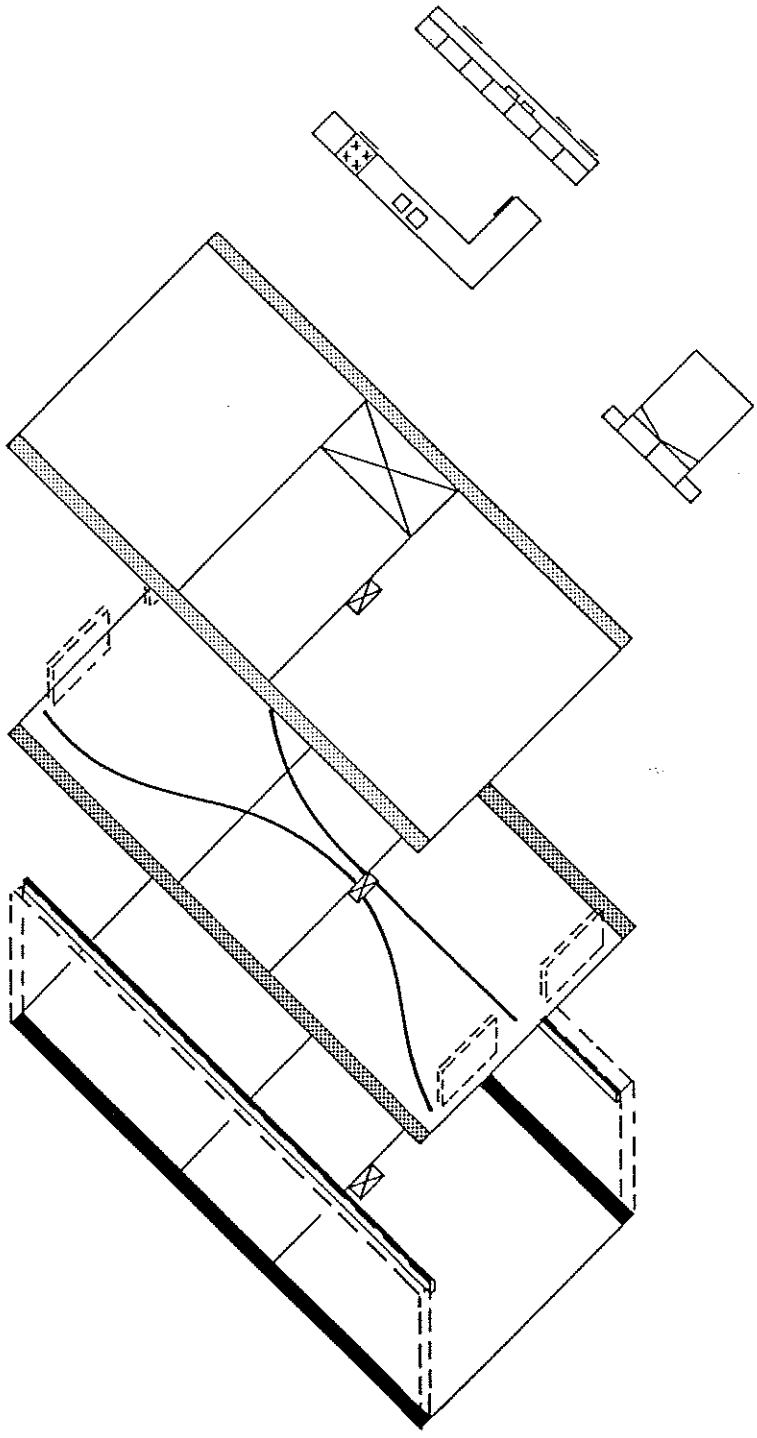


2. Gelijkvormigheid in de drager (het vaste deel)

De tweede aanbeveling van de werkgroep is om het vaste deel, de drager, zoveel mogelijk gelijkvormig te houden.

Door de drager op te bouwen uit gelijkvormige elementen, kan worden geprofiteerd van het repetitie-effect. Dit hoeft niet te betekenen dat alle wooneenheden gelijk worden. Immers, met het aanbrengen van de inbouw-pakketten wordt tegelijk de diversiteit aangebracht. Het betekent wel dat er geld bespaard wordt daar waar de kosten gemaakt worden. Namelijk in het meest kapitaalintensieve, duurzame deel van het gebouw dat niet aan verandering onderhevig is. Daarbij kan worden gedacht aan de bouwmuren, vloeren, gevels en daken. Maar ook aan vaste delen van de leidingen, de installaties en overige voorzieningen.

Deze aanbeveling gaat weliswaar over de drager, maar er hoort nog iets bij. Drager en inbouw vullen elkaar aan. Samen vormen ze de wooneenheden. Dit kan alleen goed gaan als er in de drager voorzieningen opgenomen zijn, waar de inbouw op kan aansluiten in allerlei varianten.

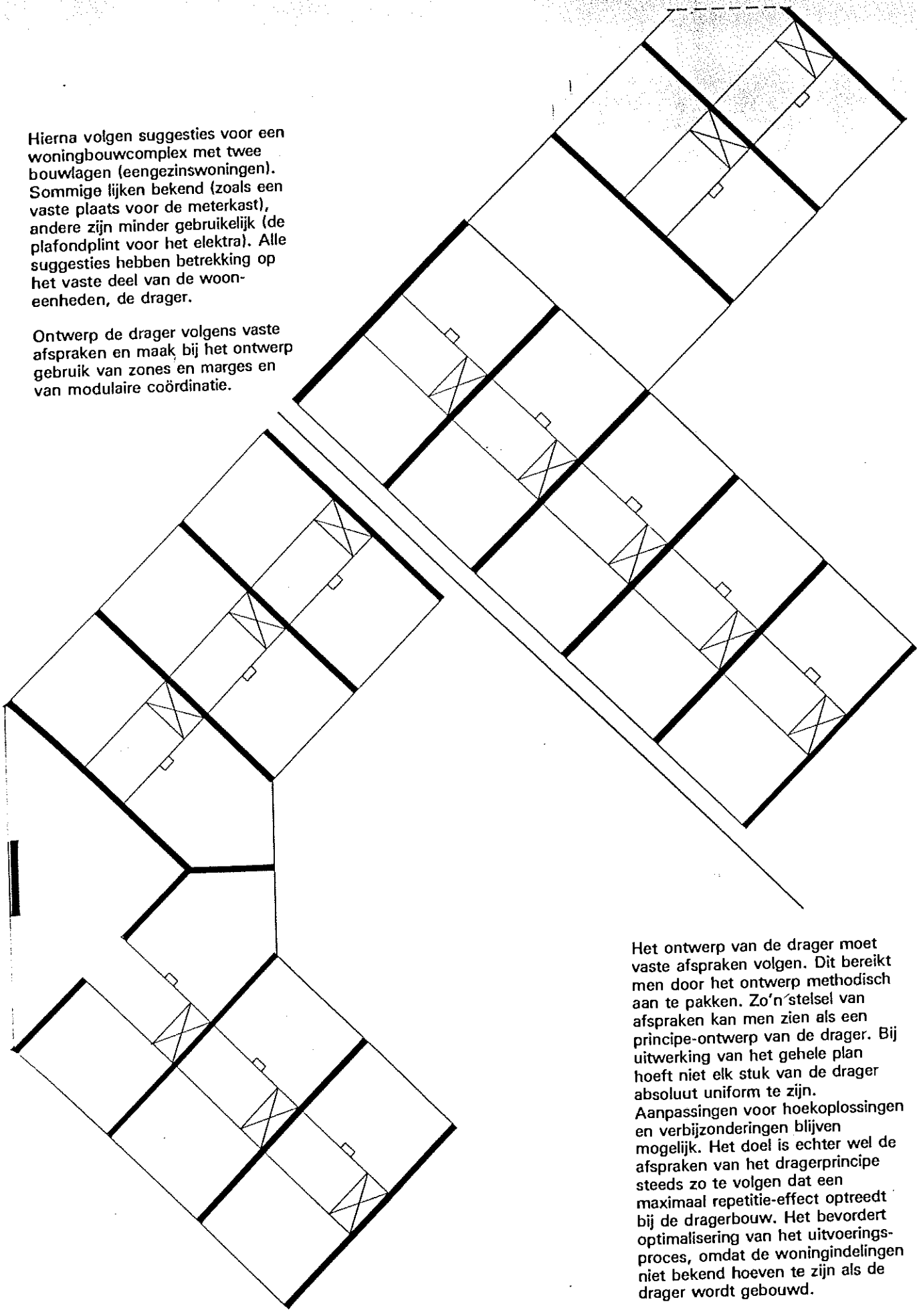


Volg bij het ontwerp principe-afspraken, links:
- De drager wordt op methodische wijze ontworpen
- .Modulaire coördinatie (NEN 6000) kan zorgen voor een zinvolle beperking van plaats en maat van materiaal.

rechts:
De drager kan vele vormen krijgen, maar is zoveel mogelijk opgebouwd uit gelijkvormige elementen.

Hierna volgen suggesties voor een woningbouwcomplex met twee bouwlagen (eengezinswoningen). Sommige lijken bekend (zoals een vaste plaats voor de meterkast), andere zijn minder gebruikelijk (de plafondplint voor het elektra). Alle suggesties hebben betrekking op het vaste deel van de woon-eenheden, de drager.

Ontwerp de drager volgens vaste afspraken en maak bij het ontwerp gebruik van zones en marges en van modulaire coördinatie.



Het ontwerp van de drager moet vaste afspraken volgen. Dit bereikt men door het ontwerp methodisch aan te pakken. Zo'n stelsel van afspraken kan men zien als een principe-ontwerp van de drager. Bij uitwerking van het gehele plan hoeft niet elk stuk van de drager absoluut uniform te zijn. Aanpassingen voor hoekoplossingen en verbijzonderingen blijven mogelijk. Het doel is echter wel de afspraken van het dragerprincipe steeds zo te volgen dat een maximaal repetitie-effect optreedt bij de dragerbouw. Het bevordert optimalisering van het uitvoerings-proces, omdat de woningindelingen niet bekend hoeven te zijn als de drager wordt gebouwd.

Drageronderdelen

Letters in de illustraties verwijzen naar de tekst.

Nu volgen aanbevelingen met betrekking tot de verschillende drageronderdelen. Deze komen het best tot hun recht als ze worden toegepast in samenhang met elkaar.
Om hierin orde te scheppen kan gebruik gemaakt worden van bestaande ontwerpsystemen, waarbij zones en marges worden onderscheiden om de drager-"afspraken" vast te leggen. Deze afspraken hebben gevolgen voor de plaats en de maat van materialen. NEN 6000, Modulaire Coördinatie voor Gebouwen, geeft hiervoor richtlijnen.

Aanbeveling: Neem in de drager voorzieningen op met het doel dat de later toe te voegen inbouw maximaal veranderbaar is (en blijft). Hier volgen enkele suggesties voor de drager:

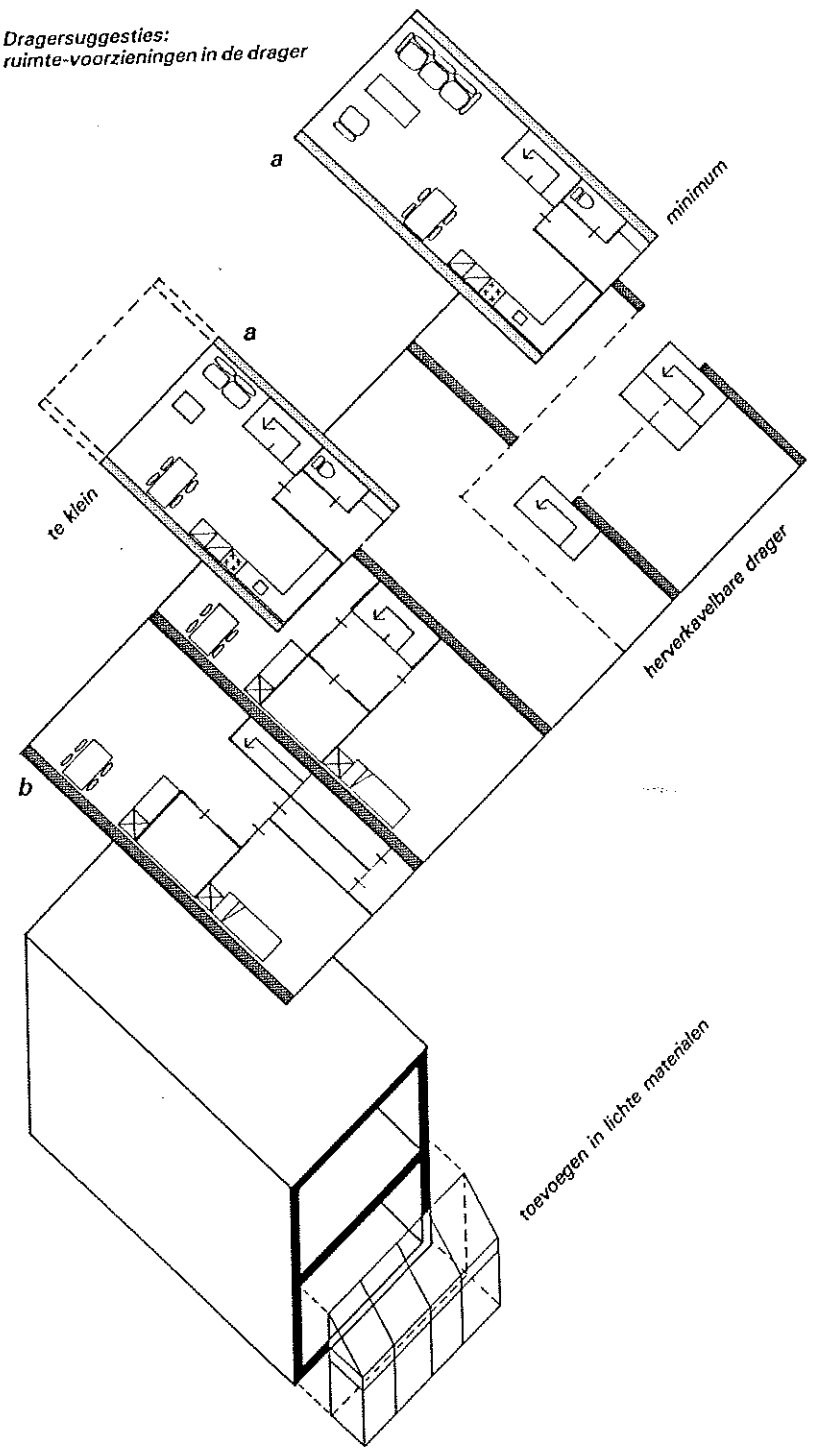
a. *De hoofdmaten van de drager bepalen de ruimtelijke mogelijkheden van de inbouw. Geef daarom de drager nooit de maten van een minimale woning, maar op zo'n minst de maten van een gemiddelde woning.*

Als de dragermaat kleiner is dan de gemiddeld gewenste wooneenheid dan moeten voor veel bewoners (met "gemiddelde" wensen) aanpassingen worden gemaakt. Dat kost geld. Het einde van het liedje is dan een project met woon-eenheden van gemiddelde grootte en met enkele minimale woningen. Voor hetzelfde geld zou de drager iets groter kunnen worden gemaakt. Aanpassingen van een "krappe" drager tot gemiddelde wooneenheden zouden dan niet nodig zijn.
Er is nog een voordeel. Naarmate de hoofdmaten van de drager royaler zijn, nemen de mogelijkheden voor de plattegronden toe. Zo kan veel gemakkelijker worden voldaan aan de gevarieerde wensen van de bewoners.

b. *Woningdifferentiatie is te realiseren binnen een drager. Dit moet bij voorkeur gebeuren door een of meer (drager)-eenheden te koppelen. Dit kan door het maken of uitsparen van openingen in de dragende muren.*

Dezelfde techniek kan worden toegepast in de toekomst, wanneer het complex toe is aan renovatie en/of herverkaveling. Woning-differentiatie is ook mogelijk door het naar buiten plaatsen van gevels. Maar dit heeft een belangrijk nadeel: ze worden nooit teruggezet. Dit betekent dat de differentiatie bij de bouw wordt vastgelegd en dat herverkaveling in de toekomst niet meer voor de hand ligt.

Dragersuggesties: ruimte-voorzieningen in de drager



c. *Geef de meterkast een vaste plaats in de drager.*

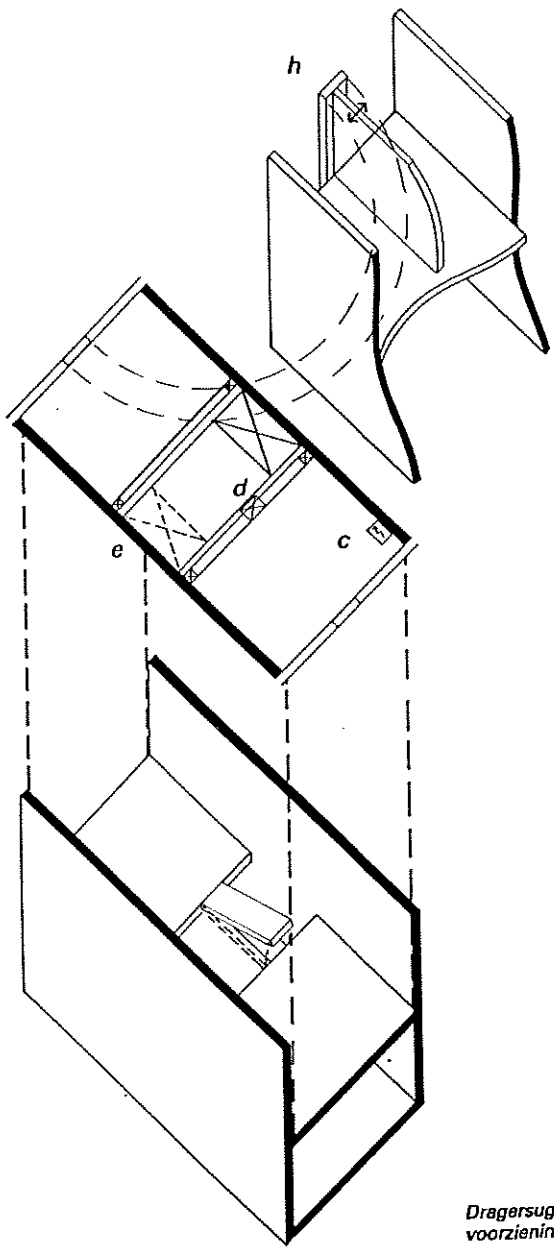
De meterkast is naast de leidingkoker een centraal punt in de woninginstallatie, door de meet-, schakel- en verdeelinstallatie die ze herbergt. Bovendien is de meterkast van het energiebedrijf en hoort als voorziening tot de drager. Bij het streven de drager zo gelijkvormig mogelijk te houden spreekt het haast vanzelf de meterkast een vaste plaats te geven. Vooral omdat daardoor het hoofdleidingsysteem van de drager gelijk kan blijven.

d. *Maak de leidingkoker tot een deel van de drager.*

Bij twee (of meer) bouwlagen is er altijd sprake van verticaal leidingentransport. Daarvoor is een leidingkoker gebruikelijk. Die zit vol met techniek en behoort niet tot het domein van de bewoner. Maak daarom de leidingkoker tot deel van de drager. Deze leidingkoker kan dan worden gebruikt voor de distributie van dragerleidingen, zoals elektra, riolering, ventilatie en centrale verwarming. Soms is een tweede (kleinere) leidingkoker gewenst. De leidingkoker moet gemakkelijk toegankelijk zijn om bij de leidingen te kunnen voor onderhoud en veranderingen. De badkamer moet aan de leidingkoker grenzen vanwege de toiletafvoer. Als de leidingkoker niet aan de meterkast grenst, moet er verbinding gemaakt worden met behulp van mantelbuizen, ook in verband met onderhoud en eventuele veranderingen.

e. *Bied de mogelijkheid van een alternatief trapgat.*

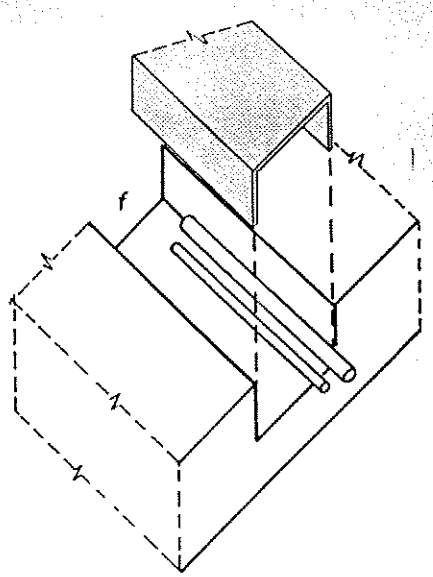
In de verdiepingsvloer van de drager kan een trapstrook worden opengehouden, die de mogelijkheid biedt tot het plaatsen van de trap in meer posities. Waar dat niet nodig is kan het gat met bij voorbeeld houten delen worden gesloten. Dit is eenvoudig aan te brengen en gemakkelijk te wijzigen. De constructieruimte kan tegelijk worden gebruikt voor het verslepen van leidingen.



Dragersuggesties: voorzieningen in de drager.

f. *Breng in de dekvloer vloergoten aan.*

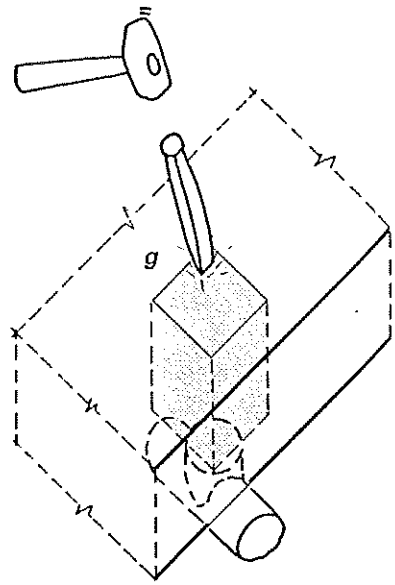
Deze vloergoten kunnen worden gebruikt om leidingen van en naar de leidingkoker horizontaal te verdelen.



Dragersuggesties:
vloergoten in de dekvloer.

g. *Neem zachte blokken op in de dragervloeren.*

Deze zachte blokken (gasbeton bij voorbeeld) bieden de mogelijkheid om later leidingen door de vloer te voeren. Hiermee kan bij het leidingentracee nu reeds rekening gehouden worden. Zo zou onder een zacht blok de afvoerleiding reeds voorbereid kunnen zijn met een T-stuk, waarop dan gemakkelijk aangesloten kan worden.

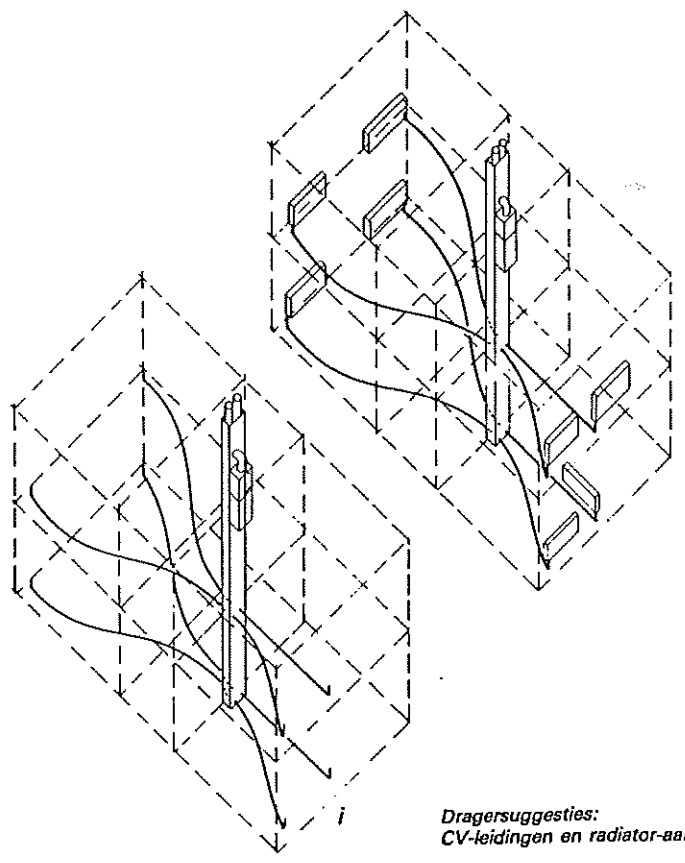


Dragersuggesties:
zachte blokken in de vloer.

h. *Maak penanten in de gevel op die plaatsen waar aansluitingen van binnenwanden verwacht kunnen worden.* *(zie pag. 7)*

i. *Horizontale cv-leidingen moeten in de afwerkvloer opgenomen kunnen worden.*

Ook bij de verwarmingsinstallatie kan er onderscheid gemaakt worden tussen een drager-deel en een inbouw-deel. Voor de verticale distributie kan de leidingkoker worden gebruikt (is immers ook drager).
De horizontale cv-leidingen zouden in de afwerkvloer opgenomen kunnen worden. (Let wel: alleen het onveranderbare, dus het dragerdeell)
Hierdoor worden straks veel kruisingsproblemen voorkomen bij het aanbrengen van de binnenwanden.
Aan de gevel moeten net zoveel aansluitpunten voor radiatoren zitten als er ruimten aan de gevel gemaakt kunnen worden.



Dragersuggesties:
CV-leidingen en radiator-aansluitpunten.

j. *Leg een patroon aan van in de dragerwanden en -vloeren opgenomen systeem van loze leidingen.*

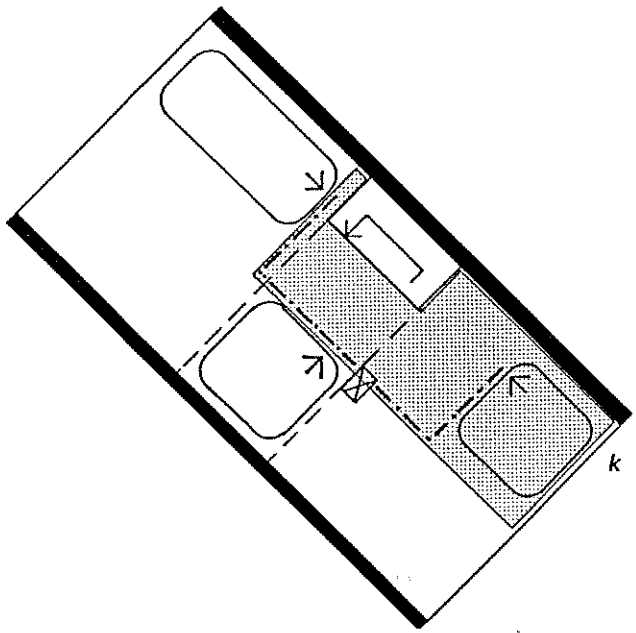
Plafondplinten worden via deze loze leidingen gevoed vanuit de leidingkoker. Eventueel noodzakelijke elektraleidingen in binnenwanden die evenwijdig aan de gevel staan, kunnen via de plafondplinten worden gevoed.
In de bouwmuren zitten zakeinden die ook worden gevoed vanuit de plafondplint.

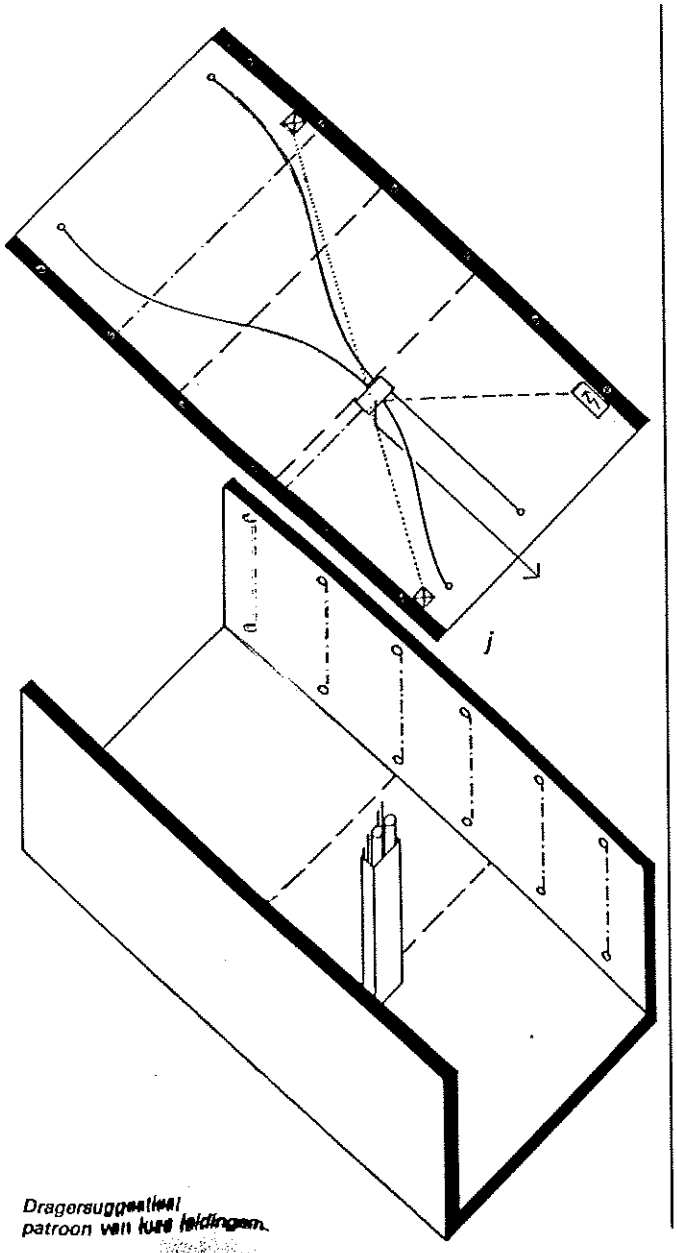
Volgens dit voorstel is het dragerdeel van de elektraleidingen vrij groot. Hiermee wordt de in het oog springende wildgroei van opbouwleidingen voorkomen.

k. *Maak een verlaagd plafond in de entreeruimte en/of de ruimte voor de trap.*

In het voorafgaande zijn diverse maatregelen voorgesteld om de leidingen zowel verticaal als horizontaal te verdelen. Soms kan een verlaagd plafond uitkomst bieden voor met name het verslepen van de badkamerafvoer naar de leidingkoker.

Dragersuggesties: verlaagd plafond.





Dragersuggestief patroon van loze leidingen.

3. Geef prioriteit aan veranderbaarheid

De derde aanbeveling van de werkgroep betreft de inbouw: geef voor de inbouw prioriteit aan het "variabel" zijn. Gebruik ten behoeve van de inbouw materialen en technieken die veranderbaarheid maximaal garanderen.

Maak bij het ontwerp gebruik van zones en marges en modulaire coördinatie.

De inbouw moet ontworpen worden volgens dezelfde ontwerpsystematiek die gebruikt is bij het ontwikkelen van de drager. Dit vereenvoudigt de afstemming van de inbouw op de drager. Het betekent dat ook voor het ontwerpen van de inbouw het gebruik van zones en marges wordt geadviseerd. Voor afspraken over plaats en maat kan NEN 6000, Modulaire Coördinatie voor Gebouwen, worden toegepast.

Hierna volgt een korte opsomming van materialen en technieken die beschikbaar zijn of die op korte termijn ontwikkeld kunnen worden.

a. *Binnenwandensysteem en drager-elektra.*
Het binnenwandsysteem moet bij voorkeur leidingloos worden gehouden.

Binnenwandsystemen hebben als regel weinig inwendige ruimte voor het opnemen van leidingen (elektra, water, afvoer). Bij voorkeur moeten ze dan ook leidingloos gehouden worden. Dit betekent wel dat er met name voor het elektrasysteem wat uitgebreidere voorzieningen moeten worden opgenomen in de drager. Bij de aanbevelingen voor de drager is een voorstel gedaan voor het elektrasysteem. Hierbij is het mogelijk de binnenwanden van elektra te voorzien vanaf de plafondplint. Bij demontage van de binnenwand vervalt het aansluitpunt op de plafondplint. Bij verplaatsen van een binnenwand kan er een nieuwe aansluiting worden gemaakt op de plafondplint. Dit betekent dus dat de plafondplint doorloopt op de bouwmuren, achter de aansluitingen met de binnenwanden.

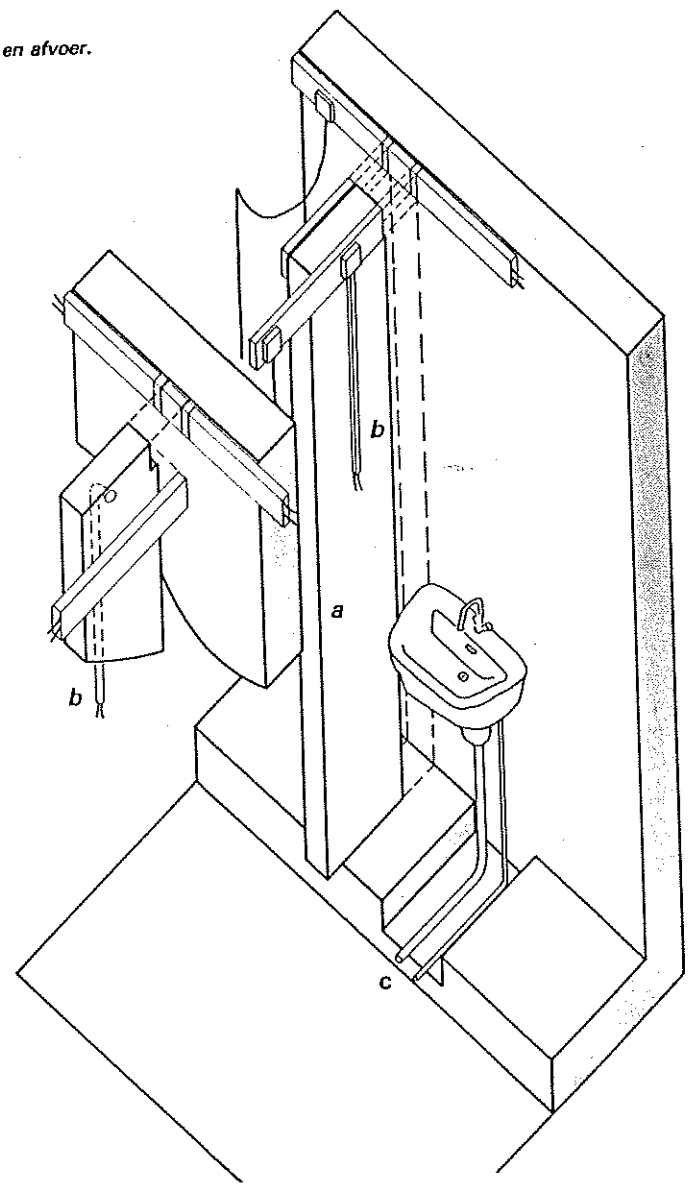
b. *Binnenwandsysteem en inbouwelektra, opgebouwd of ingebouwd.*
De bij de drager behorende elektra plafondplint kan ook boven langs de binnenwanden lopen.

Opgebouwd: op de plafondplint kunnen trekschakelaars worden gemonteerd. Lichtpunten aan het plafond kunnen met een losse draad vanuit de trekschakelaar worden gevoed. Ook gewone schakelaars zijn mogelijk. Die worden, evenals wandcontactdozen gevoed met een opbouw zakeind. Ingebouwd: net als in de dragerbouwmuren kunnen ook in de binnenwanden loze leidingen voor zakeinden worden opgenomen. Deze zakeinden kunnen wandcontactdozen en schakelaars voeden. Dit systeem kan in de toekomst gemakkelijk worden uitgebreid met op afstand te bedienen schakelaars op de plafondplint.

c. *Binnenwandensysteem, waterleiding en afvoer.*

In de drager-afwerkvloer kan een leidinggoot worden opgenomen (dit is een van de drageraanbevelingen). In die goot kunnen de waterleiding en een dunne afvoerleiding worden gelegd. Hierop kunnen met opbouwleidingen slaapkamerwastafels worden aangesloten. Uiteraard moeten de plaats van de binnenwanden en van de vloergoten op elkaar zijn afgestemd.

Inbouwsuggesties: elektra, waterleiding en afvoer.



d. *Neem een schrobputje op in de drager-vloer.*

Als er een schrobputje gemaakt wordt in de badkamer moet het in de normale afwerkvloer worden opgenomen en is daarmee dus onderdeel van de drager. Bij vergroten of verkleinen van de badkamer blijft het putje bruikbaar. Wenst men meer positie-mogelijkheden van de badkamer in de drager, dan moet voor elke positie een sparing worden opgenomen in de dragervloer voor het schrobputje en een mantelbuis.

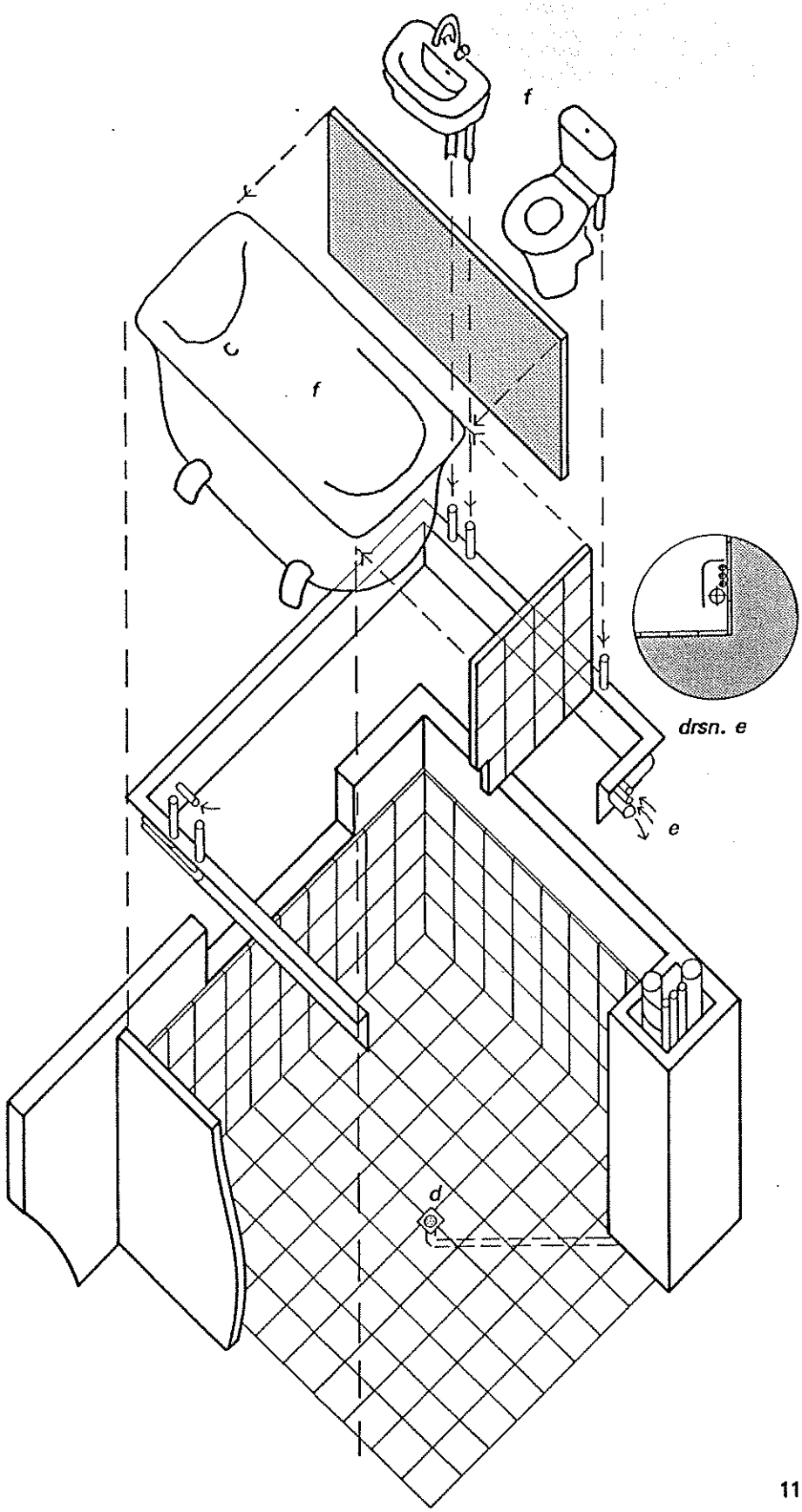
e. *Maak een "sanitaire" plint.*

Het opnemen van leidingen (water, afvoer, gas) in binnenwanden is moeilijk of onmogelijk, maar wordt in ieder geval ontraden. Vervanging of verandering zorgt voor problemen. Daarom wordt voorgesteld om in sanitaire ruimten zoals de badkamer leidingen opgebouwd aan te brengen. Deze leidingen worden gegroepeerd tot een pakket. Dit pakket loopt boven de vloer van de badkamer langs twee of drie wanden en wordt als geheel afgedekt met een spat-scherm.
De waterdichte afwerking van de wanden en de vloer loopt door achter en onder het leidingen-pakket. Alle elementen worden op deze sanitaire plint aangesloten.

f. *Zorg voor zelfstandige plaatsing van de sanitaire elementen.*

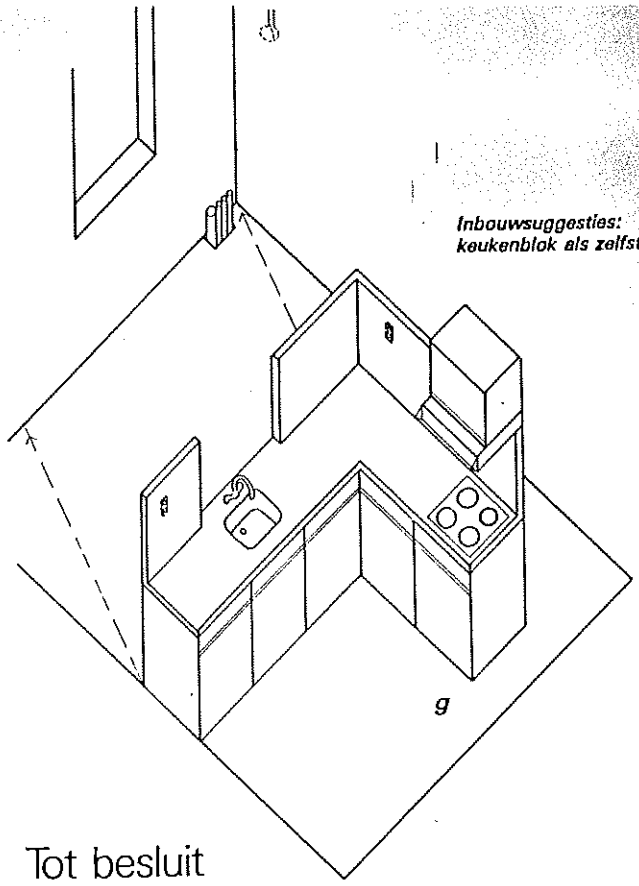
Om later sanitaire elementen gemakkelijk te kunnen vervangen moeten ze zelfstandig worden geplaatst. Dus zonder dat ze worden ingetegeld of ingeplakt in de waterdichte wand of de vloer-afwerking van de badkamer.
Bij voorbeeld: Het tegelwerk loopt door onder of achter het bad of de douchebak. Als men de ruimte onder het bad of de douchebak wil wegwerken, kan dat met zelfstandig afgewerkte of betegelde schotten.
Omdat alle elementen op de plint worden aangesloten kan de badkamer worden betegeld los van die elementen en later naar wens opnieuw worden ingedeeld. De vloer van de badkamer hoeft hiervoor niet te worden verhoogd.

Inbouwsuggesties: sanitaire plint.



g. *Maak van het keukenblok een zelfstandig element en zet het los voor de wand.*

Voorgesteld wordt van het keukenblok een zelfstandig element te maken en het zover van de wand te plaatsen dat de leidingen erachter langs kunnen worden gesleept.
De tegelafwerking van de keuken met het spatscherm achter het aanrecht moeten onderdeel zijn van het aanrechtelement. Zo blijven schone dragerwanden over (zonder sloopschade) bij het verplaatsen of vervangen van het keukenblok.



Inbouwsuggesties:
keukenblok als zelfstandig element.

Tot besluit

Het kenmerk van de aanbevelingen in deze publikatie is dat ze te realiseren zijn met materialen en bouwmethoden die nu al beschikbaar zijn. Dat betekent dat Open Bouwen niet iets is voor de toekomst, maar nu al heel goed in de praktijk te brengen is.
De ideeën achter de aanbevelingen zijn uiteraard ook toepasselijk op andere beschikbare materialen en methoden. Dat geldt nu, maar zeker ook in de toekomst.
Ongetwijfeld zal dat leiden tot nieuwe en andere praktische voorbeelden. Zodra die zich voordoen, zal de werkgroep OBOM u daarvan op de hoogte houden.

OBOM

Open Bouwen Ontwikkelings Model

Voor meer informatie:

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Technische Universiteit Delft

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Open Building.... and OBOM

People's ideas change faster than buildings. It would prove very helpful to all parties in the building process when buildings could be changed and adapted without demolition and high costs. How can we include the possibility for adaptation and change in buildings (and in the building process)? The OBOM is working on this question; this leaflet tells you more about it.

.....for every one

All parties in the building process have an interest in a good adaptability of buildings.
Some examples.

Occupants want a house to measure. No high expenses to move to an other (more suitable) accomodation.
No loss of expenses spent on the house but a home that suits their wishes and budget concerning the use and finishing touch.
Very often this will require more initiative from the occupants than they are used to now.

Proprietors see the number of removals declining.
Occupants do not wish to move, because they have got attached to "their" house. Adaptable houses are popular: the number of unoccupied houses is kept down to a minimum.

Builders can build fast and efficiently owing to a good planning of the fixed part of the house. This fixed part offers all connections to the variable part. This variable part is chosen by the occupants. After that the built-in components can be installed and the house can be finished according to the occupants' wishes.

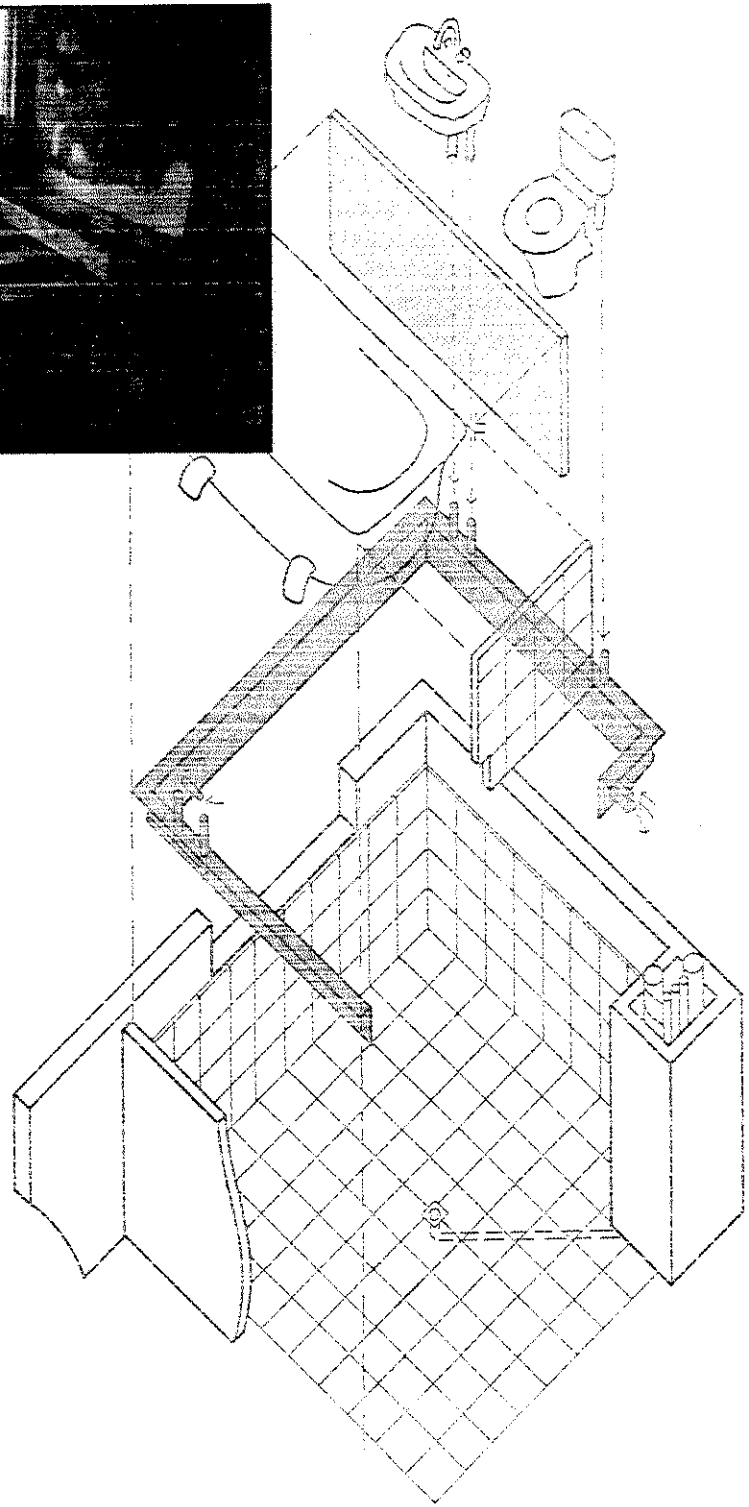
Designers can make alterations till an advanced stage of the designing process without changing the complete design (thanks to a good planning).

.....requires practical research

The practical examples show that Open Building is possible at this moment. But available products, methods and existing regulations often act prohibitively.
In turn it appears that the large variety of mains (gas, water, electricity, telephone, aerial antenna system, central heating, sewerage, ventilation) and the regulations concerned determine the building process. The OBOM is working on this problem and has been making sugestions to arrange the mains in the houses in a different way. Per variety a distinction is made between the fixed and the variable part of the installation. This requires a new arrangement ("unlinking") of the mains in the houses. This is not always posible without adapting the existing regulations. For this research the work of undergraduates is used.

.....for various building processes

With Open Building most experience was gained from the building of new houses at the end of the seventies.
The principle of Open Building: "Make changing possible by unlinking fixed and variable parts" has a much larger field of application. It is practicable where problems of adaptation and attuning arise. This applies for example for the building of public utilities and also for rehabilitation of post-war housing.



.....for export

Building is determined by climate, local traditions and possibilities. Dutch solutions are not necessarily applicable elsewhere. Open Building distinguishes solutions tied to place and time and identifiable considerations.
In accordance with the culture of a country - and based on the Open Building way of thinking - specific solutions can be developed suitable for its own building and housing traditions.
Therefore the OBOM made contacts in o.a. Australia, China, Hongkong, Japan, Singapore and Indonesia.

.....is already happening

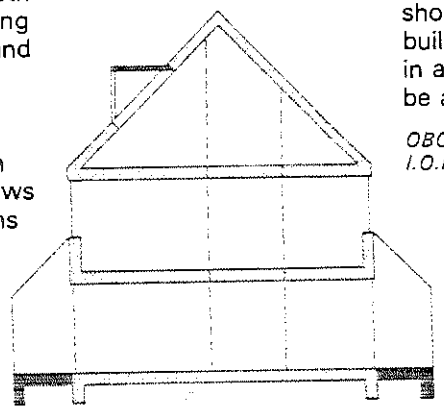
Open Building prides itself on a 25 years' tradition.
During that period one has been building in a more or less "open way". Sometimes very emphatically as a "support-infill" project, but more often without that name.
Open building offers the possibility to build to measure and to introduce simple changes in a later stage; one time by technical solutions, an other time by the influence of the occupants but both times being dependent on financing schemes that make adaptations and changes possible.

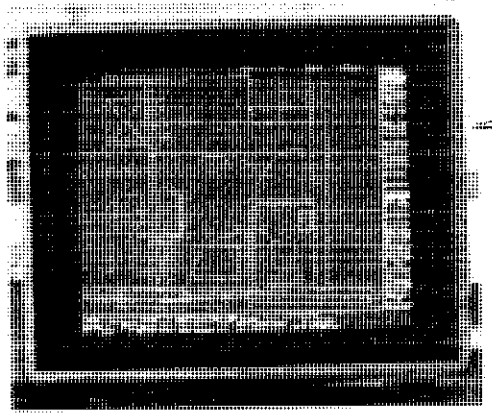
The OBOM investigates practical examples of "more or less" Open Building and reports them. It shows that within the existing regulations and the present financial possibilities progress can be made to the aim of Open Building.

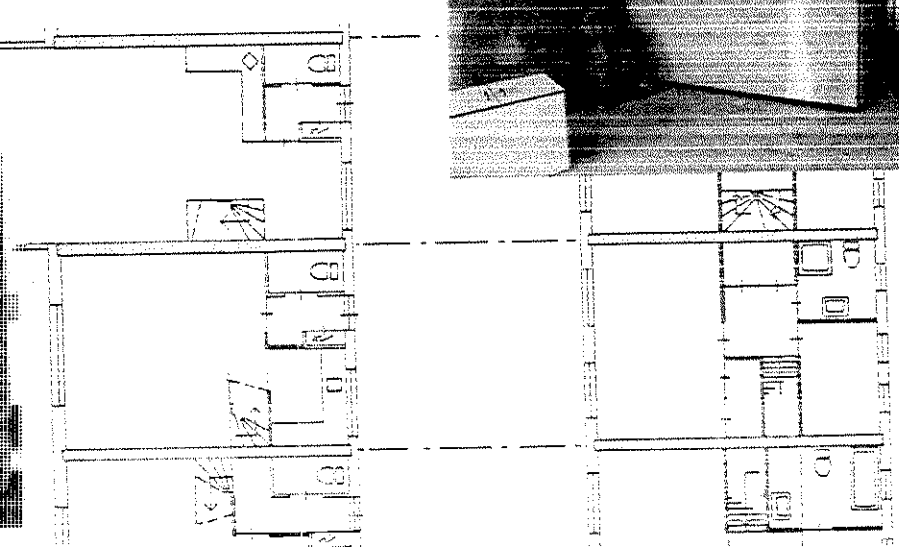
.....requires fundamental research

In the last decade the University of Technology Delft has contributed a great deal to three standards in the field of modular co-ordination in building. (NEN 2880, NEN 2883, NEN 6000).
This work was executed by the "Van Randen Group", the forerunner of the "OBOM Group".
In co-operation with TNO/IBBC of the University of Technology Eindhoven this research is now being continued. This research should simplify the development of building products without knowing in advance how and where they will be applied.

OBOM came about thanks to, among others, I.O.P.-Bouw.





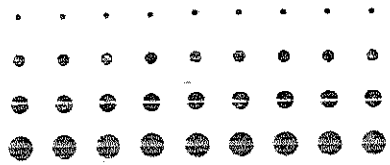


.....requires new means

Building is too expensive and too definite to try something new impetuously.
Therefore a testing environment is needed where products and ideas can be tried before being realised.
"Pretending" by computer before really executing.

There are not only problems of adaptation in building constructions but also between computers of for example architects, advisers and building contractors.
Appointments necessary for Open Building can also be helpful in exchanging data between various computer systems.
OBOM is experimenting herewith in practice.

For more information:



OBOM

Open Bouwen Ontwikkelings Model

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CONSUMER ORIENTED DESIGN, BUILDING & MANAGEMENT: Policy Plan of the Open Building Foundation

1 INTRODUCTION

1.1 Aims of the Open Building Foundation

The Foundation's main aim is to encourage a consumer-oriented design, building and management of the built environment by distinguishing three territorial levels that can be indicated with the terms Infill, Support and Tissue level. On each of these levels the extent of participation and responsibilities can be determined for:

- the individual consumer (Infill level);
- institutes such as housing corporations, being responsible for initiating and managing the exploitations of buildings (Support level); and
- municipal authorities (Tissue level).

These aims are set because the Foundation strongly believes this approach to lead to:

- consumers actively participating in creating and adapting their environment, resulting in an increased awareness and feeling of responsibility for their housing and working environment;
- an improved co-ordination of the parties involved in designing, building and management of the built environment;
- a higher appreciation of the built environment and housing conditions, resulting in an increased living satisfaction and therefore a lower tenant turnover;
- a better integration of function on the Infill, Support as well as the Tissue level, resulting in a more attractive built environment;
- a decrease of costs related to the change of the built environment;
- a decreased demolition rate of durable building parts and therefore a reduction of capital destruction;
- improved conditions for manufacturing and recycling building products; and
- a better response to a wide range of social developments related to issues like multi-racial societies, cottage industries, ageing populations, mobility, environmental problems, renovations, etc.

The Foundation intends to reach the above described aims by provided a platform for participants in the building industry, teaching and research who either appreciate the consumer oriented approach or want to obtain access to the available knowledge in this field.

The Foundation aims:

to stimulate

- by executing an efficient public relations strategy;
- by stimulating the realisation of experimental Open Building projects;
- by describing research projects;
- by initiating teaching programmes; and
- by organising design competitions.

to co-ordinate

- by establishing contacts between participants in the building industry, teaching and research;
- by establishing collaborations within the fields mentioned; and
- by maintaining a data bank containing information regarding names, addresses and subjects of people in the building industry, teaching and research involved in Open Building.

to debate

- by organising manifestations (meetings, symposia, congresses) presenting and open minderly discussing the result's of Open Building projects of the building industry, teaching and research.

1.2 What does Open Building stand for?

Primarily Open Building is a concept to give direction to ideas concerning living and working and the way people can participate. It is based on the concept of levels, from which each of the responsibilities of the parties concerned are determined and in this way providing better conditions to collaborate.

Open Building is also a concept which continuously evaluates questions regarding the coherence between design, building and use of the built environment.

However, Open Building means more. Over the past decade an extensive 'body of knowledge' based on this concept was formed, allowing real consumer oriented design, building and management.

Important parts of this body of knowledge to be mentioned are:

- a detailed and coherent framework of definitions based on the distinction of Infill, Support and Tissue level. They provide the potential for the built environment in good harmony with the parties concerned, environments that can be adapted to the changing needs of its users;
- practical methods to design Tissue, Support and Infill plans (for example SAR 73 and SAR 65);
- a large number of publications dealing with a great variety of subjects regarding Open Building. The quarterly journal Open House International covers Open Building projects of all kinds, in all places;
- computer software to support the design, construction and management of Open Building projects;
- courses on different teaching levels; and
- individuals and institutes having specialised knowledge and always willing to pass on this information.

2 PRACTICE

The Foundation knows that the best way to stimulate Open Building is the direct way towards the building practice. Therefore the Open Building Foundation wants to address itself to all parties playing a role in the process of design, building and management:

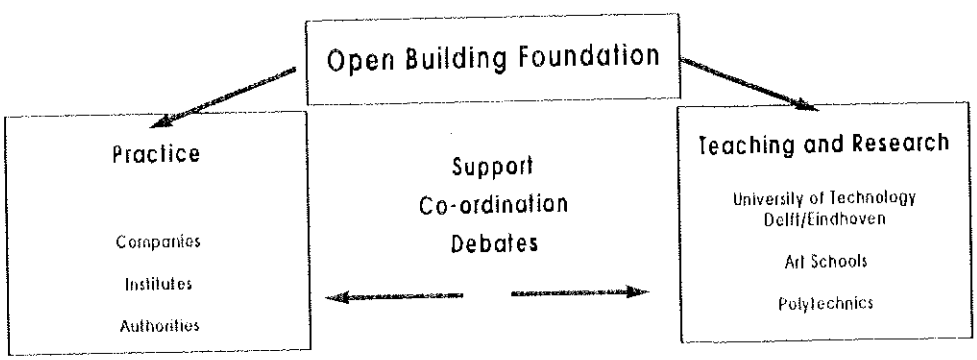
- consumers and consumer organisations;
- clients;
- financiers and developers;
- designers and consultants;
- builders and manufacturers of building products;
- managers; and
- governmental authorities and political parties.

The Foundation knows that in order to adopt the Open Building concept, all the parties concerned have to learn to adapt in reaction to new developments that results from a more consumer oriented approach in residential as well as in industrial building. For all parties mentioned the major problems will be indicated, to forming the Foundation's target and being subjected to the Foundation's support in solving these problems.

2.1 The consumer

The consumer, tenant or owner may not always realise the advantages and possibilities for his living as well as his working environment, that is offered by an Open Building approach - an approach that implies that the consumer becomes the client of the Infill dealers.

The Foundation aims to inform about the possibilities to adapt the living and working environment to contemporary and especially to tomorrow's consumers' needs by the distinction of a separate Infill level and, if necessary, by contracting the architect or housing consultant). It is therefore necessary to explain the advantages of a long term strategy of the housing process.



Not all consumers can be addressed individually, thus the Foundation will not limit itself to inform individuals but will also get in contact with relevant consumer organisations. In addition, it will consider setting up Open Building workshops at universities, art schools and at polytechnics.

2.2 The Client

The Open Building concept implies a client on every level. This includes a distinction between an Infill client, a Support client and a Tissue client.

A consumer oriented approach will only be established if the client of a building (many times not being the user) asks for it. This is usually not the case, because most of the clients are not aware of the advantages offered by an adaptable environment. They have little idea how to set up a list of demands that anticipates future changes. There is also the over-emphasised interest in short term costs, feeding the widespread belief that flexible and adaptable building is more expensive.

In addition it should be stated clearly that one client can be the commissioner of the Support part of the building, whereas one or more users can be client/commissioner for the design and construction of the Infill plans.

The Foundation will work on these problems by informing clients on all levels about the advantages of the Open Building concept. It will also stimulate the development of tools to improve the description of the list of demands and tools needed to evaluate plans on the capacities and on their long term costs.

2.3 The investor and developer

To this group the economical advantages of Open Building should become clear because Open Building projects will have a higher expectancy in terms of future lettability and saleability.

As mentioned in the case of the client, the developer will also need cost calculation programmes to be developed, to give him a clearer insight in the profits of Open Buildings. The Foundation aims to support developments in the field of period cost calculations and their results being promoted under investors and developers.

It will be clear that the Open Building concept assumes further reflections on new ways of financing separately the Infill, Support and Tissue plans.

2.4 The designers and their consultants

In the design process the architecture systems (load bearing, structure, finishings, technical installations, furnishings) and town planning systems should be given shape in such a way that adaptations easily can be made at affordable costs. This requires an integral approach of design problems on the Infill, Support and Tissue levels.

For the architects this situation integrates the ability to demonstrate the actual and future capacity of building by drawing (fixed) structures and (variables) layouts for rooms, dwellings, departments, buildings and building lots.

In addition the architect or an independent housing consultant must be able to advise users in designing Infill plans.

In consultation with the consulting engineers, solutions on the Infill, Support as well as on the Tissue level will have to be found, to determine the fixed structure on the one hand and to cater for the desired variety on a lower level on the other hand.

Not all the designers can be expected to have the skill to distinguish structure from variation. Therefore the Foundation's aims of stimulating the development and promotion of tools (design methods, computing techniques) that allow for 'thinking in structures and options'. This can be achieved by introducing Open Building design and teaching programmes at universities, aimed at Infill, Support and Tissue designers.

Open Building not only will have to focus on architects, but on town planners as well, especially if it concerns questions regarding the user - environment relationship. In this context further attention to town fabric issues should be given.

2.5 The manufacturers

In the field of manufacturing a distinction between Infill, Support and Tissue products and manufacturers needs to be established. The Foundation aims to support Open Building initiatives in this field by maintaining and stimulating good contacts with its representatives and Foundation members.

This includes:

- initiating experimental projects;
- supporting research, resulting in practical solutions;
- initiating contacts between representatives of the building industry and those of research and

teaching institutes;

- supporting the user of modular co-ordination on the infill, Support and Tissue level;
- analysing built Open Building projects; and
- publishing the results through public media, conferences and teaching.

2.6 The management

Open Building consumer oriented and adaptable projects and environments, realised along the lines of Open Building, create new problems for the management of these estates. Therefore it makes sense to introduce a distinction between the management and administration of the separate Infill, Support and Tissue levels. The Foundation wants to support and publish the development, aimed at the management of Support-Infill projects. The development of automated management systems to keep a consumer oriented administration for housing corporations and facility managers must be given a high priority.

2.7 The government and political parties

By maintaining contact between governmental institutions on the national as well as on the local level the Foundation aims to generate new ways to support Open Building. In this context it can be considered to publish guidelines for municipalities and their council members to develop zoning and building plans. Special attention needs to be given to the design and management of the environment.

In order to achieve the aims mentioned above, the legislation of rules and codes needs to be modified. The distinction of separate levels of decision making, being Infill, Support and Tissue level should be used as a structuring element.

3 TEACHING AND RESEARCH

The Foundation aims towards teaching and research institutes to obtain optimal support for their practice directed activities. It will therefore set up a unique teaching and research plan in collaboration with the OBOM Open Building Research Group (University of Technology, Delft) and GOM Group Design Methods (University of Technology, Eindhoven).

3.1 Teaching

In consultation with the universities mentioned, the Foundation aims to realise an Open Building curriculum on the bachelors as well as on the master degree level.

Based on lectures, classes and design projects to be developed for the universities, teaching packages (modules) can be made for polytechnics, art schools and post graduate courses. In addition, the possibilities for the universities in Delft and Eindhoven to establish a special Chair in Open Building will be investigated.

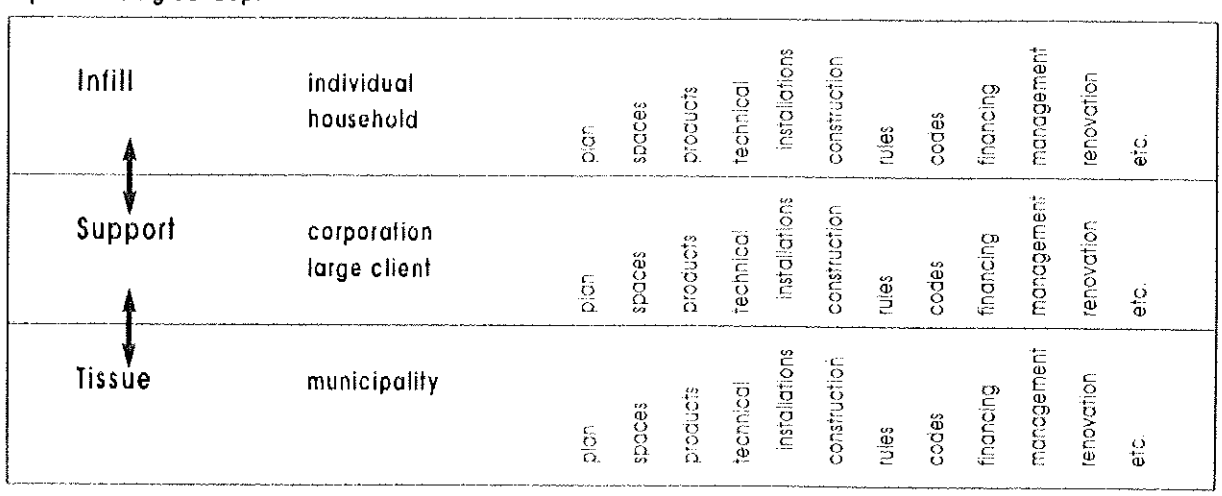
3.2 Research

The Foundation believes that many developments in the building practice need support by means of research. It will therefore use its influence to require, carry out and publish research projects. Close ties will be maintained with the universities of Delft and Eindhoven and with other research institutes involved in Open Building research.

These initiatives will cover all means of funding:

- research funded by universities;
- research projects within the masters degree curriculum; and
- contract research.

Open Building concept



The research results should become available for all parties concerned to form a potential point for new research projects.

4 Priorities of the policy

In the preceding part of this policy plan a general idea is given of the areas the Foundation is aiming towards. Within the framework it is necessary to define a limited number of priorities for the activities in the years to come.

The six priority areas:

- co-ordination and general policy;
- attention to the user and the client;
- internationalisation;
- product and project development;
- teaching and development; and
- public relations.

4.1 Co-ordination and general policy

The executive committee of the Open Building Foundation finds itself at the beginning of a new phase for Open Building. The achievements of an enthusiastic group of people, having promoted the ideas of Open Building over the past 25 years, have resulted in widespread adoption of these ideas by many individuals and institutes involved in shaping our housing and working environment. There are many indications that the Open Building ideas are still growing in the daily practice of building and that these ideas are chosen as a starting point for designing, building and managing the built environment.

It is the committee's task to be a co-ordinating body for all activities developed by individuals and institutes both on a national as well as on international scale.

Summary policy plan Open Building Foundation

	Co-ordination and general policy *Jan Remmerswaal*	**Attention to user and client** *Karina Benraad / Cora de Ruyler*	**Internationalisation** *Ype Cuperus*	**Product and project development** *Gerard Nieuwenhuijzen*	**Teaching and Research** *Jan Thijs Boekholt*
	databank for members, projects and publications members' meeting day, 1 per year small symposia writing, phoning and visiting members insight in subsidies and finance structures, contacts with financiers presentation on RAI'92 building exhibition	contacts with consumer organisations contributions to exhibitions and manifestations organising design contests	international workshops, 1 per year international congress, 1 per 2 years excursions	experimental projects outdoor exhibition RAI '94 product development	development of: - teaching programmes on the bachelors degree - teaching programmes on the masters degree - teaching programmes shortened polytechnics training - post graduate training structuring Open Building research programme
Public relations *Gonneke van de Kimmenade*	lists of members, projects and publications newsletter reports of symposia, workshops and congresses	leaflets aimed at various target groups announcement and publication of design contests	newsletter Open House International reports of symposia, workshops and congresses	Publications on the design and evaluation of experimental projects Open Building product catalogue	textbooks research reports research plan

4.2 Attention to the user and the client

It is self evident that Open Building starts to a great extent with questions being asked by users and clients. Nevertheless, these groups have partly been informed about Open Building solutions for their problems. It is the committee's intention to pay extra attention to informing these target groups.

4.3 Internationalisation

The Foundation is convinced that the Open Building knowledge and experience generated and accumulated in the Netherlands is quite unique. Thus this 'body of knowledge' can serve as a high-tech export product.

By sharing this knowledge some markets to aim for in the first instance could be:

- the European Economic Community (EEC);
- Eastern European countries;
- newly industrialised countries (Mid and Southeast Asia); and
- developing countries (Asia, Africa and Latin America).

4.4 Product and project development

The advantages of an Open Building approach are most convincingly shown in real building systems and in projects. A distinction can be made between realising Tissue and Support projects and the development of Support and Infill systems. Stimulation in the field of product and project development as mentioned above will be one of the Foundation's priorities.

4.5 Teaching and development

The Foundation believes that questions being generating by an effective Open Building information campaign should be answered thoroughly. It therefore aims for a high accessibility of available knowledge for all parties concerned by means of adequate teaching modules.

In additional it is believed to be useful to make a plan which indicates a structure for Open Building research.

4.6 Public relations

The above mentioned priorities demand a public relations policy that aims to advocate the advantages and profits of the Open Building approach to all parties concerned with using, designing, building and managing the housing and working environment. Consequently drawing up and executing an adequate public relations plan will create one of the priorities of the policy. This plan includes the five above mentioned priorities of the policy, being the co-ordination, the attention to the users and clients, the internationalisation, product and project development and teaching and research.

CONCLUSION

The Foundation's policy described in the six priorities as mentioned above, will be indicative of the activities to be undertaken by the committee of the Open Building Foundation in the years to come. The proposed activities resulting from the policy plan are summarised in matrix form.

Open Building Foundation
Stevinweg 1
2628 CN Delft
The Netherlands

Consumentgericht bouwen: baas over en achter de eigen voordeur

PROF. IR. A. VAN RANDEN

Consumer oriented building:
in full control of and behind one's frontdoor

Consumentgericht Bouwen, de individuele bewoner centraal, is iets vanzelfsprekenders denkbaar?
U, als bewoner, kiest gewoon hoe U Uw huis ingedeeld en uitgerust wilt hebben en in welke prijsklasse. Net zo als U de keuze van Uw Hifi-installatie of Uw auto of Uw vakantie bepaalt. En niet alleen U kunt zelf kiezen, maar ook Uw buurman, sterker nog alle bewoners van Uw straat of flatgebouw. Eén ding is zeker, er zullen geen twee woningen qua indeling en uitrusting hetzelfde zijn. Net zo min als er in Uw straat twee gelijke Hifi installaties of twee gelijke auto's of twee gelijke vakantie-arrangementen zijn. Alleen, de variatie in de woningen zal nòg meer punten omvatten dan bij de genoemde zaken het geval is, tenminste áls U Uw zin krijgt.

Consumentgericht bouwen betekent leveren wat de individuele klant wil, dus leveren in grote verscheidenheid. Consumentgericht bouwen betekent ook leveren op het afgesproken tijdstip, voor de afgesproken prijs en met de nodige garanties. Consumentgericht bouwen vereist daarnaast een bouwproces dat gestuurd wordt door de individuele klant: honderd woningen betekent in principe honderd projecten van één woning. Dat is een omwenteling in een bedrijfstak die zich in de afgelopen jaren helemaal heeft gericht op de zogenaamde seriematige woningbouw, het zo veel mogelijk herhalen van dezelfde woning.

Consumer oriented building, the individual occupant being the focus of attention, what could be more natural? As an occupant you simply choose the way your house is laid out and equipped, and in what price bracket, just like you select your Hifi, your car or your vacation. You are not the only one to make this choice, but your neighbour also, in fact every occupant of your street or flat. One thing is certain, there will be no indentical houses qua layout and equipment, just as Hifi-sets, cars or holiday-arrangments differ within one street. However there will be more deviation points between the houses than the above mentioned things, at least if you are afforded your own choice.

To build consumer oriented means to fulfil the wishes of the individual occupant, thus to supply in great variety. Consumer oriented building also means to supply at the agreed time, for the agreed price and with the requisite guarantees. Apart from that consumer oriented building requires a building process controlled by the individual client: a hundred houses basically means a hundred different projects of a single house. This is a revolution in a branch of industry concentrating on the so-called mass-production of buildings during the last few years, the endless repetition of the same house.

is er nu ontwikkeld aan de Faculteit der Bouwkunde en in het bijzonder
et OBOM, de Open Bouwen onderzoek groep, om dit mogelijk te
en. Daarover wil ik het in dit afscheidscollege graag hebben.
migen onder U zullen op z'n minst verschillende elementen uit het
og bij eerdere gelegenheden gehoord hebben. Maar er zijn ook nog
wat onder U voor wie alles nieuw is en zij hebben er recht op een
pleet verhaal te krijgen. Het leek me daarom gerechtvaardigd, en
elijk ook boeiend, om al die elementen bij deze gelegenheid van
gblik en vooruitzien nog eens in een kort en bondig betoog te vatten. Zo
it helderheid.

echter een belangrijke beperking: de nadruk zal liggen op de bouw-
nische en bouwmethodische aspecten van het consumentgericht
wen omdat dat de onderwerpen van mijn leerstoel waren. En ook
lat deze vertaalslag van theorie naar practische toepasbaarheid mij na
het hart ligt. Deze beperking is ook aanvaardbaar omdat in de hieraan
rafgaande voordrachten prof. Habraken de architectonisch-methodi-
e, prof. Crouwel de culturele aspecten, de Heer Zegers nieuwe ontwikke-
en in de uitrusting van de woning en mijn opvolger prof. Brouwer de
luctontwikkelings aspecten al aan de orde gesteld hebben.
zal duidelijk zijn dat er daarnaast nog beheerstechnische en financie-

at has been developed at the faculty of architecture and in particular by
OM, the 'Open Building' research team, to make this possible? This will be
item of this farewell lecture. Some of you may have heard a few elements of
speech before, at comparible occasions, but for others all of this is new and
y have the right to hear the complete story. It seems therefore justified, and
efully fascinating too, to recapitulate on this occasion of reviewing and
king ahead, all these elements into a brief and concise argument, so increa-
g clarity.

wever there is an important restriction: the main points of this lecture are the
ects of architectural technology and construction methodology of consumer
nted building, because these were the subjects of my chair. In addition the
ctical application of a theory is very dear to me. This restriction may also be
eptible because the preceding lectures questioned many of these aspects:
f.Habraken gave a lecture on the architectonic, methodical aspect,
f.Crouwel spoke about the cultural aspects, dr.Zegers brought up the new
velopment in home equipment and my successor Prof.Brouwer raised the
ect of product development.

rings-aspecten een belangrijke rol spelen, maar U zult mij hopelijk vergeven dat ik die deze keer laat liggen.

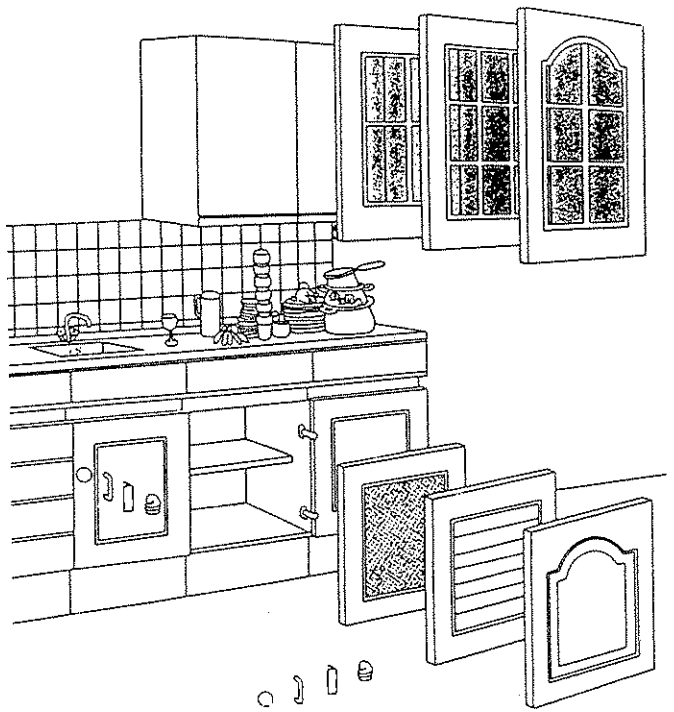
Wat is er nu ontwikkeld om het consumentgericht bouwen en daarmee het produceren in grote verscheidenheid in de woningbouw mogelijk te maken? Eerst voor de volledigheid in het kort nog even een stukje theorie. Daarbij gaat het om de begrippen 'vast'en 'variabel', 'niveau' en 'weefsel'-'drager'-'inbouw'

Vast en Variabel
Door het OBOM is een aantal jaren terug in een IOP onderzoek het 'vast en variabel' principe geformuleerd [1]. Dit kwam voort uit een observatie van de manier waarop de keukenindustrie tot een zeer efficiënte productie van een grote verscheidenheid gekomen is. U kent dat wel: van een bepaalde fabrikant zijn de kastjes standaard. U kunt daarbij dan uit een grote verscheidenheid deurtjes kiezen van een bepaalde vormgeving of, zo U wilt, van een bepaalde Life-Style. Daarna kunt U bij Uw gekozen deurtje weer een handgreepje kiezen uit het assortiment dat bij dat deurtje past. (afb. 1)
Het kastje is dus 'vast', de deurtjes zijn 'variabel'. Als U om U heen kijkt kunt U vele voorbeelden ontdekken die gebaseerd zijn op het 'vast en variabel' principe. De werkwijze is dus niet nieuw, maar wij hebben het een naam

It will be understood that in addition to these aspects of finance and housing management play an important role, and I hope you will forgive me for omitting those this time.

Which development made consumer oriented building possible and by that producing in great variety in residential construction? First, for the sake of completeness, a synopsis of the theory about the notions 'fixed and variable', 'level' and 'tissue-support-infill'.

Fixed and Variable
A few years ago the 'fixed and variable' principle had been formulated in a I.O.P. research by OBOM.[1] This evolved from the observation of the way the kitchen industry came to a very efficient production of great variety. We are all acquainted with the standard cupboards of a certain manufacturer. You can choose from a large variety of doors with a certain design or, if you like, with a certain Life-Style. Along with this chosen door you can single out a handle of an assortment which matches the door.
Thus the cupboard is 'fixed' and the doors are 'variable'. Looking around, you



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gegeven. En daarmee kan het deel worden van het collectieve weten. Maar het gaat verder. Zoals U zag kunt U, nadat U Uw deurtje gekozen heeft, bij dat deurtje weer kiezen uit en aantal greepjes. Dus na Uw keuze is het deurtje kennelijk 'vast' geworden en zijn de greepjes 'variabel'. Er is dus sprake van verschillende niveaus van 'vast en variabel'.

Niveaus

Daarmee zijn we dan gekomen bij een tweede instrument om verscheidenheid beheersbaar te maken: het door Habraken geïntroduceerde 'niveaubegrip' [2]. In zijn definitie van niveau is een element (b.v. het keukenkastje) van een hoger niveau indien:

a: een verandering op het daaronder liggende niveau geen verandering teweeg brengt op het hogere niveau.

b: een verandering op het hogere niveau een verandering op het lagere niveau teweeg brengt.

Dus bij het keukenvoorbeeld: het deurtje is van een lager niveau dan het kastje want een andere keuze van het keukendeurtje heeft geen verandering van het kastje ten gevolge. Maar verandering van het kastje brengt wel een verandering van het deurtje teweeg.

will find many things based on this 'fixed and variable' principle. This method of working is not original, however we gave it a name and therefore it may become part of the common knowledge. But there is more. As you have seen, it is possible to select handles after you have chosen a certain door; after your choice, the door has become fixed and the handles variable. In short, there are different levels of fixed and variable.

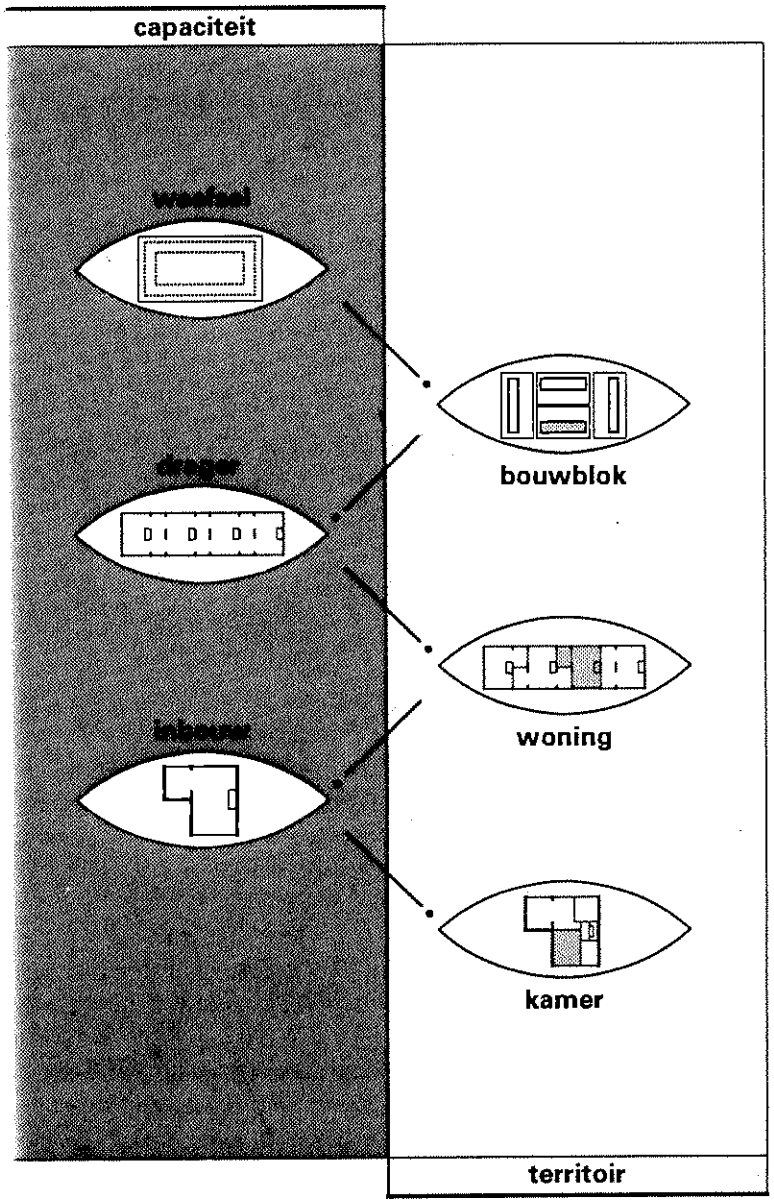
Levels

The notion 'level' introduced by Habraken [2] is the second instrument to bring variety under control. According to his definition, an element (for instance a kitchen cupboard) is of a higher level if:

a. a change on the underlying level effects no alteration on the higher level.

b. a change on the higher level effects an alteration on the lower level.

The kitchen example: the door is of a lower level than the cupboard because choosing another door does not alter the choice of the cupboard, while another cupboard does bring a change of door.



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Besluitvormingsniveaus Weefsel-Drager-Inbouw

Dit brengt ons bij het derde instrument, de vertaling van de vorige twee principes in de besluitvormingsniveaus weefsel-drager en inbouw, eveneens geïntroduceerd door Habraken [3] en destijds verder uitgewerkt door de Stichting Architecten Research [4]. Begrippen die intussen een zekere volwassenheid bereikt hebben en waarop wij vruchtbaar voort hebben kunnen bouwen.

Wij hebben daar nog twee tussenniveaus aan toegevoegd (zie afb. 2). Het zijn z.g. verkavelingsniveaus waarop in feite territoir, en dus zeggenschap, wordt toebedeeld. Dit is het best te illustreren aan het woning-verkavelings tussenniveau. Een drager is in principe op verschillende manieren verkavelbaar door het maken van verschillende combinaties van dragerruimten. Er kunnen kleine of grote woningen in vele combinaties in worden gerealiseerd. Dit kan ook gebeuren nadat de drager al gerealiseerd is, nu en ook later.

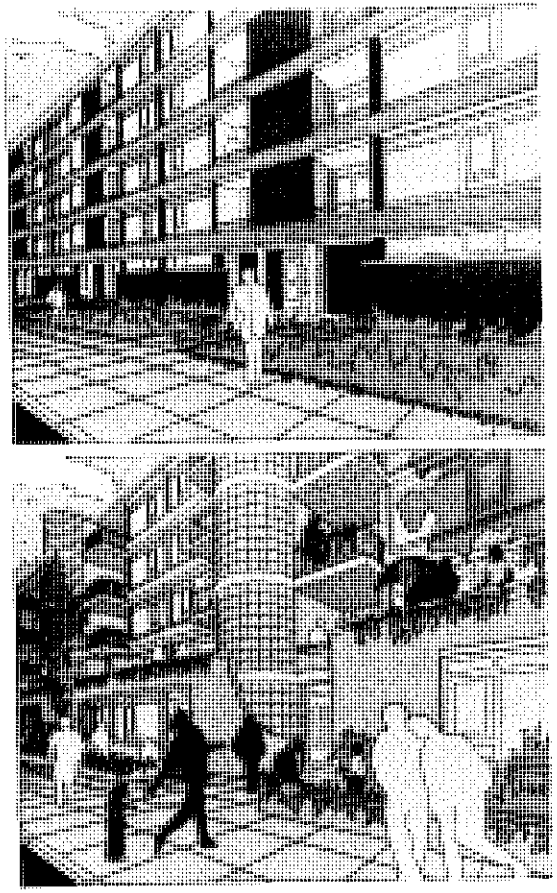
Hiermee is ook een belangrijk ontwerp methodisch kenmerk blootgelegd: het ontwerpen van een drager is niet het ontwerpen van woningen die daarna gecombineerd worden tot een gebouw, zoals dat nu gebeurt. Het ontwerpen van een drager is het ontwerpen van potenties. De SAR heeft daar destijds ontwerp methoden voor ontwikkeld. Het gaat om de potentie om op het woningverkavelings-(tussen)niveau bepaalde woninggrootte-

Decision-making levels tissue-support-infill

The third instrument is a translation of the two preceding principles into the decision-making levels 'tissue, support and infill', also introduced by Habraken [3] and worked out by the Stichting Architecten Research.[4] These notions have reached a certain maturity upon which we can rely.

We have added two interlevels (see fig. 2), the so-called allotment levels upon which territory, and therefore authority is allocated. This can be best illustrated by the dwelling allotment interlevel. A support can be allocated in several ways by making different combinations of support rooms. Houses of various size can be realized in many different combinations. It can also be done after the support is realized, now as well as later on.

With this an important methodical design feature comes to light; the designing of a support does not mean the designing of houses which then will be combined to make a building, as happens nowadays, to design a support is to design capacity. At the time the SAR developed a design method for it, involving a potency to realize variations in dwelling size on the dwelling allotment level. Subsequently, it is possible within the variants of dwelling size, to realize on the following level, which is the infill, a series of variants for the infill. It is obvious



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varianten te realiseren. Om vervolgens op het daaropvolgende niveau, dat van de inbouw, binnen een bepaalde woninggrootte-variant een serie varianten te kunnen realiseren voor de inbouw. Het zal duidelijk zijn dat de keuze uit die varianten pas in een later stadium hoeft te gebeuren en dat die keuze ook weer gewijzigd kan worden. Immers, een verandering op inbouwniveau veroorzaakt geen wijzigingen op het woningverkavelings-niveau. Op deze wijze is een besluitvorming in lagen mogelijk, waarbij op ieder niveau een zelfstandig eindproduct wordt afgeleverd. Dit eindproduct schept de voorwaarden voor de keuze varianten op het volgende lagere niveau maar wordt niet meer beinvloed door wat op dat volgende lagere niveau wordt gerealiseerd.

Tot zover een stukje theorie als achtergrond voor een practische uitwerking.

Scheiding Drager - Inbouw
Ik wil nu mijn betoog toespitsen op een rigoureuze scheiding van drager en inbouw als een belangrijk hulpmiddel om consumentgericht te bouwen. Want daar ging het immers om.

De *drager,* een product dat gebonden is aan de grond. Bovendien heeft de drager een publieke kant omdat het als gebouw beeldbepalend is (afb. 3).

that the selection of variants can happen afterwards and that the choice also can be changed, after all, a change on the Infill level causes no alternation on the dwelling allotment level. This way a layered decision-making is possible at which an independent final product is handed over on each level. This final product creates the conditions for the selection variants on the following lower level, but is not influenced anymore by what is realized on this lower level.

So far a little theory as background information for the practical working out.

The separation of support and infill
I want to concentrate my lecture on the rigorous separation of support and infill as an important aid to build consumer oriented, for this is what we are concerned with.

The *support* is a product bound to land. Moreover it has a public aspect because as a building it determines the image of the public space (see fig. 3). A support for apartments also has to fulfil a few collective functions: entrances, stair wells, main supply and return ducts etc. For all these reasons a support is subject to

:en drager voor meergezinswoningen moet ook nog een aantal gemeen-
.chappelijke functies vervullen: toegangen, trappenhuizen, hoofd aan- en
fvoerleidingen etc. Om al die redenen is een drager onderhevig aan
ublieke en politieke besluitvorming en moet hij voldoen aan allerlei
oorschriften. Het product is bovendien voor een deel van het maakproces
ltijd bouwplaats gebonden en dus bij het maken onderhevig aan weer en
vind. Wat betreft de markt, afnemers zijn vaak institutionele opdrachtge-
ers als beleggers, woningbouwverenigingen, projectontwikkelaars e.d. De
waliteit van een drager wordt sterk bepaald door de plek waar hij staat en
oor de publieke en collectieve functies die hij moet vervullen. Dit natuurlijk
aast de potenties die hij biedt op het niveau van de woningverkaveling en
e inbouw. De drager is een af product en wordt in principe glas en water-
icht opgeleverd. Maar het is mogelijk dat de drager zo ontworpen en
itgevoerd is dat bepaalde zaken zoals een voordeurpartij of een erker of
en dakkapel later nog door de specifieke bewoner kunnen worden geko-
en. Waarmee deze elementen dan tot het volgende lagere niveau behoren,
amelijk het woningverkavelings niveau. In dat geval zal ook de architec-
ur de kenmerken van vast en variabel vertonen. Het variabele deel kan
an individueel ingevuld worden binnen de randvoorwaarden van het
chtectonisch ontwerp van de drager. Dit is een nog onontgonnen aanpak
oor architecten en industrie. Intussen wordt er op het OBOM gewerkt aan

iblic and political decision-making and also has to answer to many regula-
ons. Moreover for a part of the construction process the product is bound to the
ilding site and therefore affected by wind and weather. As for the market, the
stomers are often corporate clients such as investors, housing corporations,
operty developers etc. The quality of the support is determined by its place
d the public and collective function it has to fulfil. Apart from this, of course,
e support offers capacities on the dwelling allotment level and infill. The
pport is a finished product and will be handed over roofed and glazed (like
y other building). It is possible to design and execute the support in such a
y that certain elements as the frontdoor, the bay window or dormer can be
osen by the specific occupant afterwards. Then these elements belong to a
wer level, namely the dwelling allotment level. In such case the architecture
all display the features fixed and variable. The variable part can be filled in
dividually within the prior limited conditions of the architectural design of the
pport. This is still virgin territory for architects as well as for industry.
eanwhile OBOM is working on a few experiments in this field.

e *infill* is a product which is completely subject to the choice of the individual

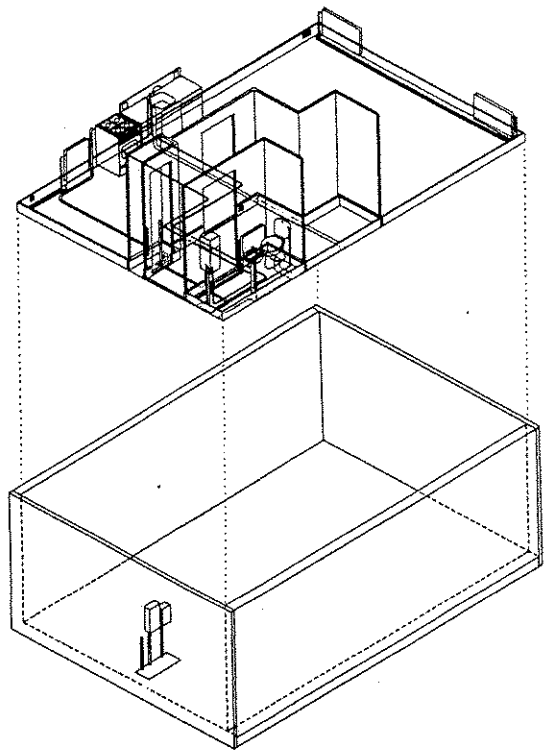
een aantal experimenten op dit gebied.

Dan de *inbouw*, een product dat helemaal in de keuzesfeer van de individuele consument kan liggen, letterlijk dicht op zijn huid [5]. Het omvat allereerst de ruimtelijke indeling van een woning en de voor die indeling noodzakelijke elementen zoals niet dragende binnenwanden, kozijnen, deuren e.d. Daarnaast omvat het de uitrusting, zoals keuken, sanitair en andere toestellen en, last but not least, alle installaties of op zijn minst dat deel van de installaties dat bepaald wordt door de indelings- en uitrustingskeuzes van de individuele bewoner. De inbouw als product is in dit beeld helemaal gericht op de consumentenmarkt. Bovendien is het een product dat zijn toepassing zowel vindt in nieuwbouw als in renovatie. Veranderingen aan een woning zullen zich het meest afspelen in de inbouw-sfeer. De inbouw als product vereist een consument-gestuurd productie- en marketing-proces, dit in tegenstelling tot de drager.

Door zo'n scheiding ontstaan in feite twee markten, met ieder hun duidelijk te definiëren product en afnemers (zie afb. 4) en omdat dat zo is, ontstaat ook de mogelijkheid dat er gescheiden drager- en inbouw- producenten ontstaan.
Drager en inbouw, twee verzelfstandigde producten die ieder hun eigen

consumer [5]. First of all it includes the spatial layout of the house and its neccessary elements such as inner partition walls, frames, doors etc. It also includes equipment for example found in the kitchen, sanitary fittings and other appliances and, last but not least, every installation or at least this part of the installation determined by the layout and equipment choice of the individual occupant. From that perspective the infill as a product is completely oriented on the consumers market. Moreover it is a product which can be used in New construction as well as in renovation.

For the most part the alterations of a house will take place on the infill level. In contrast to the support, the infill as a product requires a consumer controlled production and marketing process. Actually this seperation effects two markets, each having their own clearly defined products and buyers (see fig. 4). As a result of this there can be separated producers for support and infill.
Support and infill, two independent products, each having their own marketing and production requirements; the support controlled by the public and collective domestic aspects and the infill completely oriented on the great variety of wishes of the individual occupant.



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marketing- en productie-eisen hebben. De drager meer gestuurd door de publieke sfeer en de collectieve aspecten van het wonen. De inbouw geheel gericht op de grote verscheidenheid aan wensen van de individuele bewoner.

Een helder beeld maar kan die scheiding nu zo maar? Wat is er nodig om dit mogelijk te maken. Daarmee heeft het OBOM zich de afgelopen jaren bezig gehouden.

Installaties

Bij mijn inaugurele rede [6] vertoonde ik een prent waarop zichtbaar gemaakt was hoezeer installatie-leidingen verweven zijn met bouwkundige elementen als vloeren en wanden, waarin ze zijn ingestort of ingehakt (zie afb. 5). Ik heb toen betoogd dat o.a. hierdoor het z.g. spaghetti effect optreedt, onvoorspelbare afhankelijkheden tussen vele partijen die allemaal betrokken zijn bij ontwerp en uitvoering van al deze onderdelen. Hierdoor is in de sfeer van de techniek een enorm coördinatiecircus ontstaan. En is er bovendien een kwaliteits-beheersingsprobleem van niet geringe omvang.

Waarom zijn installaties nu zo belangrijk in relatie tot consumentgericht bouwen?

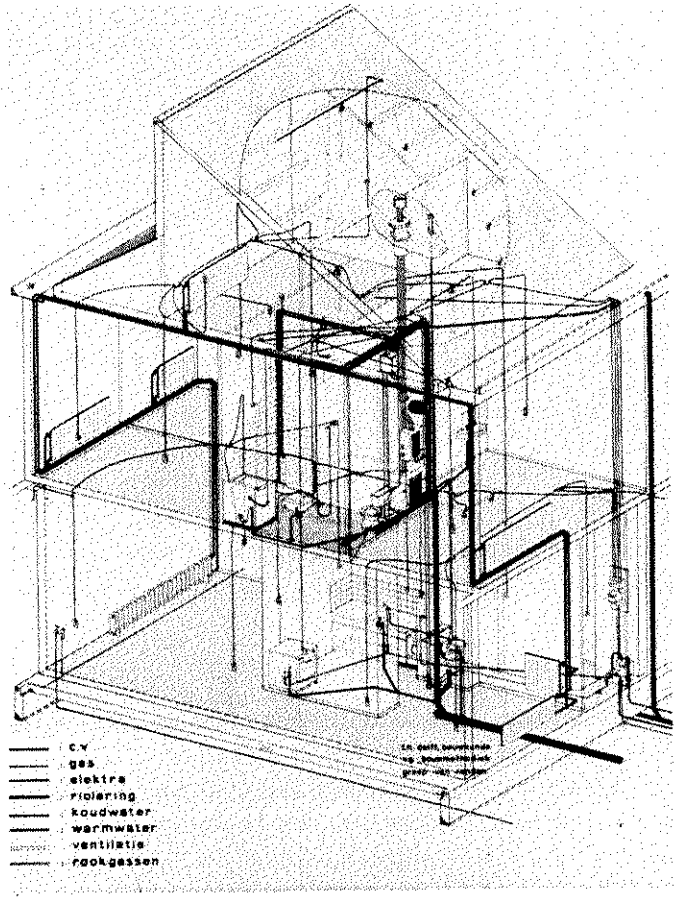
This is a clear image, but is such a seperation possible? What exactly is neccessary to make it possible. OBOM has been working on this issue for several years now.

Installations

In my inaugural lecture [6] I showed a picture demonstrating how much ducts belonging to the installation are interrelated with constructional elements such as floors and walls in which they are casted or hacked (see fig. 5). At that time I argued that this causes e.g. the 'Spaghetti effect' meaning unpredictable dependencies among the many parties that are invloved with the design and the execution of these parts. This is why an enormous co-ordination circus arose in the field of technology along with a serious quality-control problem.

Why are the installations in relation to consumer oriented building so important?

Ducts belonging to the installation are ending or beginning where certain appliances have to be operated; the sink, the washing machine, the bath, the television etc. This means that the location of the wall sockets have to be



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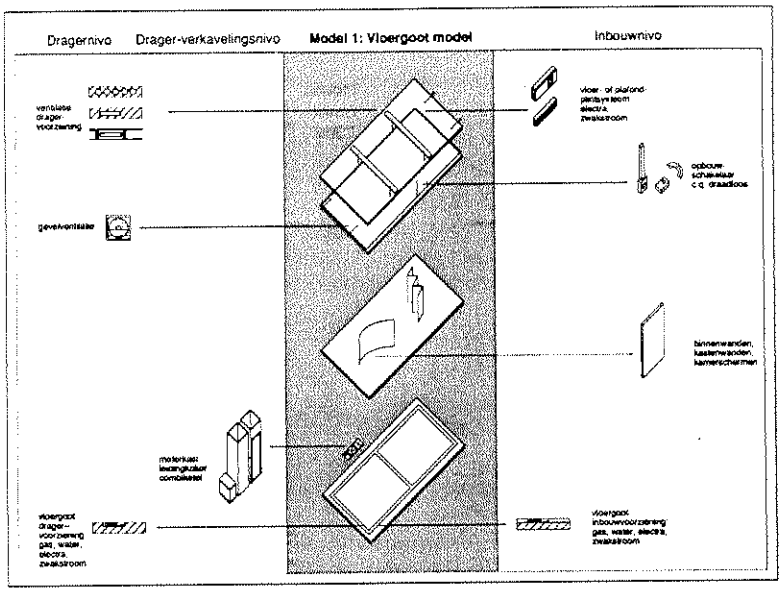
Installatieleidingen eindigen of beginnen waar bepaalde toestellen bediend moeten worden: een gootsteen, een wasmachine, een bad, een televisietoestel etc. etc. Wanneer deze leidingen b.v. ingestort moeten worden, moet dus al in een zeer vroeg stadium van het ontwerp bekend zijn waar de bewoner straks zo'n toestel neer wil zetten. Omdat de toekomstige bewoner meestal nog niet bekend is, beslissen deskundigen voor hem waar de keuken moet komen, waar de badkamer en waar de TV straks zal staan. En vervolgens wordt deze plek in beton vastgegoten.

De conclusie ligt voor de hand: breng al deze installaties en hun leidingen pas later aan, namelijk als de bewoner heeft kunnen kiezen. En doe het dan liefst zo dat ze later nog aangepast kunnen worden als omstandigheden dit vereisen. Kortom maak flexibele installaties in plaats van versteende. Dit is van groot belang om twee redenen.
Ten eerste: toestellen zijn meer en meer heel persoonlijke verlengstukken van ons leven geworden en zij zijn daarmee aan dezelfde veranderingen onderhevig die in ons leven een rol spelen.
Ten tweede: er komen steeds nieuwe mogelijkheden bij, die later toegevoegd moeten kunnen worden. Denkt U maar aan de Home Bus Systems waar de Heer Zegers over heeft gesproken.
Dit alles maakt dat installaties en hun leidingen onderhevig zijn aan een

decided at an early stage of the building operations. Because the occupant is usually unknown, the expert determines the placing of the kitchen and the bathroom, and even decides where the television will be standing. Then these places are embeded in concrete.

The conclusion speaks for itself: the installation ducts are to be installed only after the occupant has made his choice, preferably in a way they can be adapted to different circumstances. To put it briefly, to make variable installations instead of fixed ones. This is very important for two reasons. Firstly the appliances have increasingly become personal continuations of our lives and are therefore subject to the same changes. Secondly, new possiblities are coming up all the time which should be added to like the Home Bus Systems of which dr.Zegers has spoken. Thus the installation and ducts are subject to a dynamic process, they have become part of life's dynamics (although this will be more applicable for one installation then for another). Nowadays, almost every wish of an occupant is connected, one way or the other, with one or two pipe-ends.



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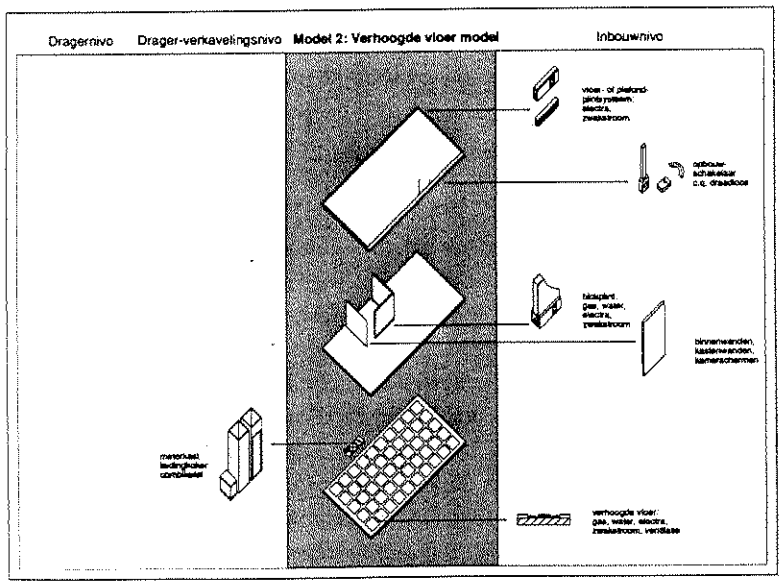

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dynamisch proces, zij zijn deel geworden van de dynamiek van het leven (al zal dat natuurlijk voor de ene installatiesoort meer gelden dan voor de andere). Bijna iedere wens van een bewoner is tegenwoordig op één of andere manier verbonden met één of meer leidinguiteinden.

Leidingdragende systemen

Hoe maak je het nu mogelijk dat installaties pas later aangebracht worden? In de afgelopen jaren zijn in het OBOM modellen ontwikkeld, waarin verkend wordt welke mogelijkheden er zijn. Van die modellen is ook onderzocht wat de uitvoerbaarheid is, zowel technisch als economisch. Wij hebben daarbij het begrip leidingdragend systeem ingevoerd. Dit zijn systemen waarin leidingen op een overzichtelijke en gemakkelijke manier kunnen worden aangebracht, en die het mogelijk maken dat ze, bij het ene model meer dan bij het andere, ieder gewenst punt in een woning kunnen bedienen, nu en later. U kunt daarbij denken aan leidinggoten in een betonvloer, aan een later toegevoegde verhoogde holle vloer, aan speciale leidingwanden, aan een verlaagd plafond, en aan combinaties daarvan. In de afbeeldingen 6 en 7 zijn twee voorbeelden gegeven, van een leidinggoot en van een verhoogde vloer. Zij komen voor in het IOP-rapport *Leidingsystematiek in relatie tot flexibiliteit* [7]. De modellen zijn zo weergegeven dat zichtbaar is welke voorzieningen op het niveau van de drager

Duct-carrying systems

How to apply installations afterwards? The last few years models has been developed by OBOM exploring the possiblities and workability, technical as well as economical. Concerning this we have introduced the notion 'duct-carrying systems'. These systems, in which ducts can be applied in an orderly and easy way, depending on the model, enable the operation of every desired point of the house, now and in the future. For instance the channels for ducts in a concrete floor, a raised hollow floor which is added later, special walls acting as shafts for ducts, a lowered ceiling and combinations of these. Fig. 6 and fig. 7 give two examples: a channel for ducts and a raised floor. They are also mentioned in the IOP-report *Systematics for ducts and Flexibility*.[7] The models are reproduced in a way it is perceptible whether the facilities should be applied on the support level or the on infill level. Thus an important part of the duct-carrying systems of the channel model, namely the channel, already has to be installed within the support, unlike the raised floor model, which can be selected and applied only within the infill phase. This is not without significance if you want a similar model to be applicable in renovation, where the support is already installed. In most cases, it will be impossible to install a channel at that stage.

ngebracht moeten worden en welke tot het inbouwniveau behoren. Zo ɔet bij het gootmodel een belangrijk deel van het leidingdragende steem, namelijk de goot, al in de drager worden gemaakt. Dit in tegen-elling tot het verhoogde vloermodel, dat pas in de inbouwfase gekozen eft te worden. Dit is weer van belang als je ervoor kiest dat een dergelijk ɔdel ook toepasbaar moet zijn in de renovatie. Daar is de drager een geven waarin het vaak niet meer mogelijk zal zijn bijvoorbeeld een goot n te brengen.

euwe installatietechnieken

ɔ grond van deze modellen is vervolgens nagegaan welke bezwaren de bruikelijke technieken en voorschriften met zich meebrengen. Bij alle ɔdellen bleek dat leidingdiameters en afmetingen van bepaalde voorzie-ngen zoals stopcontacten (te) zware eisen stelden aan het benodigde imtebeslag van de intermediaire systemen. Installatie vloeren moeten te ɔg worden en wanden te dik. Hieruit is een speurtocht gevolgd naar de ɔgelijkheid om met kleinere leidingdiameters te werken. Voor de riolering eft dit geleid tot een serie proeven samen met het Laboratorium voor romingsleer van de TU-Delft, die wijzen in de richting dat kleine diame-rs minstens zo effectief zijn als de nu voorgeschreven grotere diameters. proeven worden voortgezet, waarbij ook onderzocht wordt of aan een dergelijke installatie bijzondere voorwaarden gesteld moeten worden en zo ja welke. Een dergelijk onderzoek is nu ook gestart voor de mechanische ventilatie-voorzieningen. Op grond van deze verkenningen bestaat er goede hoop dat er oplossingen ontwikkeld kunnen worden die de modellen qua ruimtebeslag uitvoerbaar maken.

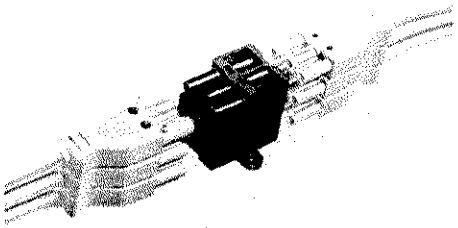
Om in deze modellen op effectieve wijze installatie leidingen in vele verschillende configuraties, al naar de keuze van de consument, aan te kunnen brengen worden er ook eisen gesteld aan de installatietechnieken en materialen. Er loopt nu bij OBOM een project waarbij een studie gemaakt wordt van 'steek in' technieken voor het aanbrengen van leidingen. Een voorbeeld is het Wieland electra verdeelblokje, in feite een soort insteek-centraaldoos. (zie afb. 8). Een ander uitdagend voorbeeld is de Gardena water steek-in verbinding (zie afb. 9) zoals die tot nu toe alleen in tuingereedschap wordt toegepast. In beide voorbeelden kunnen leidingen in de fabriek voorzien worden van (contra-)stekkers die op het werk alleen maar ingestoken hoeven te worden om de noodzakelijke verbindingen te vormen. De insteek-verbindingen zijn zo gemaaktdat deze alleen maar foutloos tot stand gebracht kunnen worden. Op deze wijze is de uiteindelijke kwaliteit van de installatie niet meer afhankelijk van arbeid op de bouwplaats maar zit de kwaliteit van de verbinding ingebakken in een in de

ew installation techniques

bsequently on the basis of these models it has been verified which disadvan-ges are involved in the usual techniques and requirements. All models show at the diameters of ducts and the dimensions of certain facilities such as ckets take too much of the allotted space of the duct-carrying systems. cause the installation floor has to be high and the wall thick, research for ssiblities of working with smaller diameters for ducts has started. For the werage a series of tests were done at the Laboratory of Hydrodynamics at elft University of Technology showing that smaller diameters can be as fective as the prescribed larger ones. These tests will continue and be exami-d if similar installation requires special conditions, and if so, which condi-ns. Now a similar investigation has started for the mechanical ventilation-cilities. On the basis of these explorations there is hope for a solution in the velopments of models of a more practicle size.

o apply the installation ducts in different configurations in an effective way, cording to the choice of the occupant, demands will be placed on the installa-n techniques and materials. At this moment OBOM is making a study of the lug-in' techniques of the installation of ducts, such as the Wieland distributor, which is in fact a sort of plug-in central distributor (see fig. 8). Another defiant example is the Gardena water plug-in connection (see fig. 9) used only for gardening tools up till now. In both examples ducts can be completed in the factory with a coupling socket, which only has to be plugged-in during the installation to make the neccessary connections. The plug-in connections are especially manufactured to make only problem free connections.
This way the final quality of the installation is no longer dependent on the construction workers, for it is located within a product made and controlled by a factory. Because the complex connections have to be faultless and moreover because it is very difficult to detect faults in these installations, it is of great importance in my opinion to take this plug-in installation method as a basic assumption for the Home Bus Systems which are developing now.

Apart from the making of installations there is also the installation and connection of all sorts of appliances, like a washbasin, a bath, an oven, a radiator e.g. The installation of these appliances should also be simplified. ESPRIT is a certain infill development which introduced the notion 'plug-in products' as is described in *Designing flexible housing demands* [8], a beautifully edited



8

9

fabriek vervaardigd en gecontroleerd product. Bij de nu in ontwikkeling zijnde Home Bus systemen is het m.i. van het grootste belang dat vanaf het begin deze steek-in installatiemethode als uitgangspunt genomen wordt. Dit ook omdat het gaat om het maken van ingewikkelde verbindingen waarbij het maken van fouten onmogelijk moet zijn. Dit ook omdat het opsporen van fouten bij dit soort installaties heel moeilijk is.

Behalve het aanbrengen van de installaties is er ook nog het installeren en aansluiten van allerlei toestellen. Denkt U aan een wastafel, een bad, een oven, een radiator etc. Ook daarvoor geldt dat het installeren vereenvoudigd moet worden. In het kader van een bepaalde inbouw ontwikkeling, Esprit genaamd, is de term 'Stekkerklare producten' gelanceerd, zoals beschreven in het prachtig uitgevoerde boek *Vormgeven aan flexibele woonwensen* [8]. Het OBOM is nauw betrokken bij de ontwikkeling van nieuwe methoden en technieken om dit mogelijk te maken. [9]

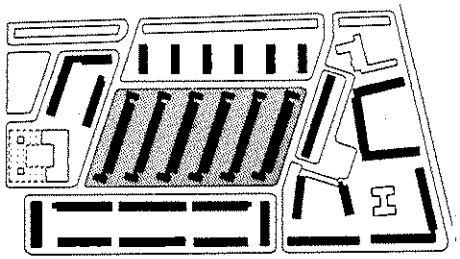
Het is de combinatie van de eerder genoemde leidingdragende systemen en de hierboven beschreven nieuwe installatietechnieken die nieuwe mogelijkheden biedt. Deze combinatie maakt het mogelijk dat alle leidingen en installatiedelen waarvan het beloop beïnvloed wordt door de keuze van de individuele bewoner, deel worden van het inbouwniveau. Een drager

edition. To realise this OBOM is closely involved in the development of new methods and techniques. [9]

The combination of the afore mentioned duct-carrying systems and the above described new installation techniques provide new opportunities. With this combination all ducts and installation parts, subject to the occupants choice, will become part of the infill level, so the support only contains the main supply and return ducts. (see fig. 4)
Meanwhile in practice three systems are developing: the ESPRIT system, the inter-level system and the Matura system. Recently these systems have been described in detail by the working group 2000 and the SEV.

Renovation
The introduction of seperation of the levels tissue, support and infill requires a new approach at the coming renovation of the postwar districts, as is described in the OBOM report *Open Building District Renovation*.[10] In this report it is suggested to give each level an individual approach (see fig. 10)
For the environment of a district this method implicates, on the tissue level, that

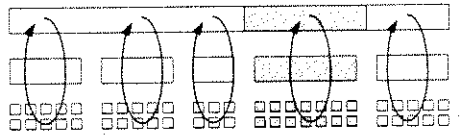
Traditioneel:
verticaal
planproces



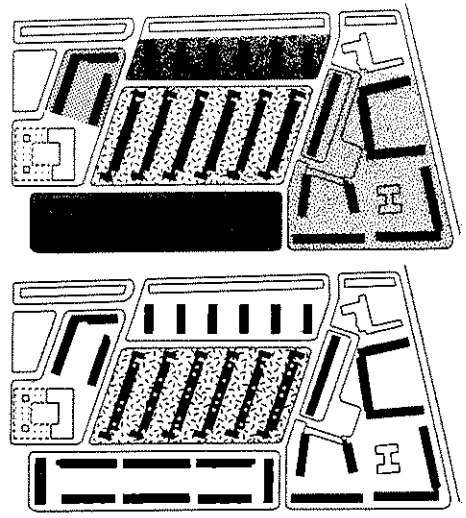
weefsel:

drager:

inbouw:



Horizontaal
planproces



weefsel:

drager:

inbouw:

bevat in dat beeld alleen de hoofd aan-en afvoeren (zie afb. 4) Intussen zijn er in de praktijk een drietal systemen in ontwikkeling: het Esprit systeem, het Interlevel systeem en het Matura systeem. Zij zijn onlangs in een studie van de Werkgroep 2000 en de SEV uitvoerig beschreven.

Renovatie

Invoering van het niveau -onderscheid weefsel- drager en inbouw levert ook bij de komende renovatie van de naoorlogse wijken een nieuwe aanpak op. In het OBOM rapport *Open Bouwen Buurtvernieuwing*[10] wordt dit duidelijk gemaakt. Voorgesteld wordt ieder niveau zijn eigen aanpak te geven. (afb. 10)
Op weefselniveau betekent dit een aanpak waarbij voor de woonomgeving in een wijk de oorspronkelijk separaat tot stand gekomen complexen nu gezamenlijk worden aangepakt en niet ieder complex op zich. Het is een uitgelezen kans om bij de vernieuwing de samenhang in een wijk te versterken. Het is het niveau waar (deel)-gemeente en complexeigenaren elkaar nodig hebben en elkaar kunnen versterken. Overigens zou het weefselniveau, in feite het niveau waarop het ontwerp van de buurt en daarmee vooral de buitenruimten gestalte krijgt, veel meer aandacht verdienen maar in dit bestek ontbreekt daarvoor de ruimte. Bij het OBOM lopen intussen een aantal studies op dit niveau.

the blocks, which were established independently from each other, are to be dealt with simultaneously.
This will be the ultimate chance to confirm by means of renovation the coherence within the district. At this level the local council and the proprieters of the blocks are interdependent and are able to strengthen one another. The tissue level on which the design of the district and the outdoor area are taking shape deserves particular notice however, a more detailed definition is outside this scope. OBOM is presently researching this particular level.

The block owners are responsible for the support level. Here the renovation of public elements takes place such as new entrances, new elevators, insulation of the facade, new shafts, in fact all the activities which can be done without intruding upon the occupant's private property.
Finally in each house the infill level is handled seperately. By means of an infill package it will be possible to renovate the infill individually at the moment a house becomes available, or whenever the occupant wishes it to occur. It is even possible to meet the wishes and possiblities of the individual occupant to a large extent. Anyway, it is no longer neccessary to come to an agreement with all the

et dragerniveau is duidelijk de verantwoordelijkheid van de complexeige-
aren. Hier vindt renovatie plaats van die zaken die gemeenschappelijk zijn,
v. nieuwe entree's, nieuwe liften, gevel-isolatie, nieuwe leidingkokers e.d.
principe kunnen deze werkzaamheden verricht worden zonder door te
ingen in de privé sfeer van de bewoners.
et inbouwniveau tenslotte wordt per afzonderlijke woning behandeld:
novatie per mutatie. Door toepassing van een inbouwpakket zal het
ogelijk zijn de inbouw van woningen individueel te renoveren op het
oment dat een woning vrij komt of als de bewoner het zelf wil. Daarbij is
et zelfs mogelijk in verregaande mate tegemoet te komen aan wensen en
ogelijkheden van die individuele bewoner. Het is dus niet meer nodig tot
vereenstemming te komen met de gezamenlijke bewoners van een blok of
oject, iets wat er meestal toe leidt dat niemand krijgt wat hij zou willen:
een krijgt teveel, de ander te weinig.

ouwbesluit
aarmee zijn we aangeland bij voorschriften en (bouw)vergunningen. Hier
aat een omwenteling voor de deur met de invoering van het Bouwbesluit
oor de woningbouw. Voor wie het niet weet, centraal thema is vrije
deelbaarheid van woningen. De tot nu toe bestaande voorschriften over
antal en maten van kamers etc. komen te vervallen. Daar is destijds hevig

cupants of a housing-block resulting mostly in a situation where nobody gets
hat he or she wants; too much or too little.

uilding Order
e shall now discuss the regulations and building permits. With the introduc-
n of the new Building Order for residential construction forthcoming changes
n be expected. For those who do not know, the central theme is the free choice
dwelling layout. The until now existing regulations concerning the number of
oms and their sizes are to expire. Against this a serious protest arose at the
ne because control of spatial utility would then be thrown overboard. Within
e framework of this discussion OBOM developed three proposals in coopera-
n with Stichting Open Bouwen which are still of current interest. They make
ear how the division Support-Infill takes a structural effect on the allocation of
sponsibilities. It seems worth while to review these proposals within the scope
this account on consumer oriented building.

esting the dwelling quality
ie first proposal concerned the continuation of floor surface standards, but

verzet tegen gerezen omdat daarmee de controle over de ruimtelijke bruikbaarheid over boord gezet zou worden. In het kader van die discussie heeft het OBOM destijds, in samenwerking met de Stichting Open Bouwen, een drietal voorstellen ontwikkeld die nog steeds actueel zijn. Zij maken duidelijk hoe invoering van de scheiding drager - inbouw structurerend kan werken op het toebedelen van verantwoordelijkheden. Het lijkt me de moeite waard die voorstellen in het kader van dit betoog over consument-gericht bouwen opnieuw naar voren te brengen.

Toetsing woonkwaliteit
Het eerste voorstel was om de oppervlakte-normen niet te laten vallen, maar om die alleen van toepassing te laten zijn op de toetsing van de kwaliteit van het ontwerp van de drager. Bij de aanvraag voor een bouwvergunning voor een verkavelbare drager zouden een aantal woninggrootte-varianten moeten worden ingediend. Van iedere woninggrootte-variant zou vervolgens een aantal inbouwvarianten moeten worden overlegd. Deze varianten kunnen dan getest worden aan de oppervlakte-normen. Daarmee kan dus de potentiële ruimtelijke gebruikskwaliteit van de drager worden verzekerd. Dat is van groot belang omdat dragers potentieel een lange levensduur hebben. Vervolgens kan de drager op dragerniveau gebouwd worden. Bij het realiseren van het inbouwniveau echter is de gebruiker

only to apply to the testing of the quality of the support's design. In the application for a building permit for a support which allows for subdivision a number of variations in dwelling size should be put down. Subsequently for each variation in dwelling size a number of infill variants should be submitted, afterwards these variants can be tested by the floor surface standards. Thus the potential quality of spatial utility can be ensured, which is very important considering the potential long-life of supports. Next, a support can be built on support level. However, when it comes to realizing the infill level, the occupant is entirely free to layout his own house. He has a choice: to live according to government standards or to his own personal preferences. Influence of the government is maintained when it concerns the more collective and long-life support level, but should not affect the quality of the layout on the individual infill level.

Divided building permit
The second proposal with regard to the Building Order concerned setting up conditions for a divided building permit: for the support which allows for subdivision, the support subdivision and the infill. The intention of this is to

eheel vrij om zijn eigen indeling te maken. Een bewoner kàn dus kiezen
n te wonen overeenkomstig de overheidsnormen, maar kan ook zeer
ersoonlijke voorkeuren volgen. Op het meer collectieve en lang meegaan-
dragerniveau dus wel, op het individuele inbouwniveau geen overheids-
vloed op de kwaliteit van de indeling.

escheiden bouwvergunning
et tweede voorstel met betrekking tot het Bouwbesluit was om de voor-
aarden te scheppen voor een gescheiden bouwvergunning voor de
erkavelbare drager, de drager-verkaveling en de inbouw. De bedoeling
ervan is het structureel mogelijk te maken dat de drageraanvraag geheel
gehandeld kan worden zonder dat nog bekend hoeft te zijn welke woning-
ootten uiteindelijk gerealiseerd zullen worden. Er kan daardoor zeer alert
ereageerd worden bij het indelen van de drager in woningen. Dit is van
lang omdat de planvoorbereiding van een drager vaak lang duurt door
jvoorbeeld de gebondenheid aan politieke besluitvorming. Bovendien is
een gedetailleerd woningbehoefteonderzoek nodig waarvan de uitkom-
en bij realisatie vaak alweer achterhaald zijn. De gescheiden bouw-
ergunning voor de inbouw spreekt voor zich, omdat het voor iedere
oning mogelijk moet zijn dat de uiteindelijke bewoner eigen keuzen kan
aken. Misschien omdat niet alle woningen op hetzelfde tijdstip verkocht

of verhuurd worden.

Om deze gescheiden bouwvergunning mogelijk te maken zijn de voorschrif-
ten van het bouwbesluit toebedeeld naar de drie niveaus. (fig. 11)
De drageraanvraag kan, behalve op de voor de drager geldende voorschrif-
ten, voor de volgende twee niveaus eventueel ook getoetst worden aan de
oppervlaktenormen voor woninggrootte en inbouw-indelingen zoals
hierboven voorgesteld onder 'Toetsing woonkwaliteit'.
De tweede fase van de bouwvergunning beslaat de definitieve keuze van de
te realiseren woninggrootten in de reeds gebouwde drager. Dit is uiteraard
alleen van toepassing indien de drager verkavelbaar is en slaat ook op
latere wijzigingen. Deze fase kan worden overgeslagen als de drager niet
verkavelbaar is.
De derde fase van de bouwvergunning betreft de inbouw en wordt voor
iedere woning individueel aangevraagd.

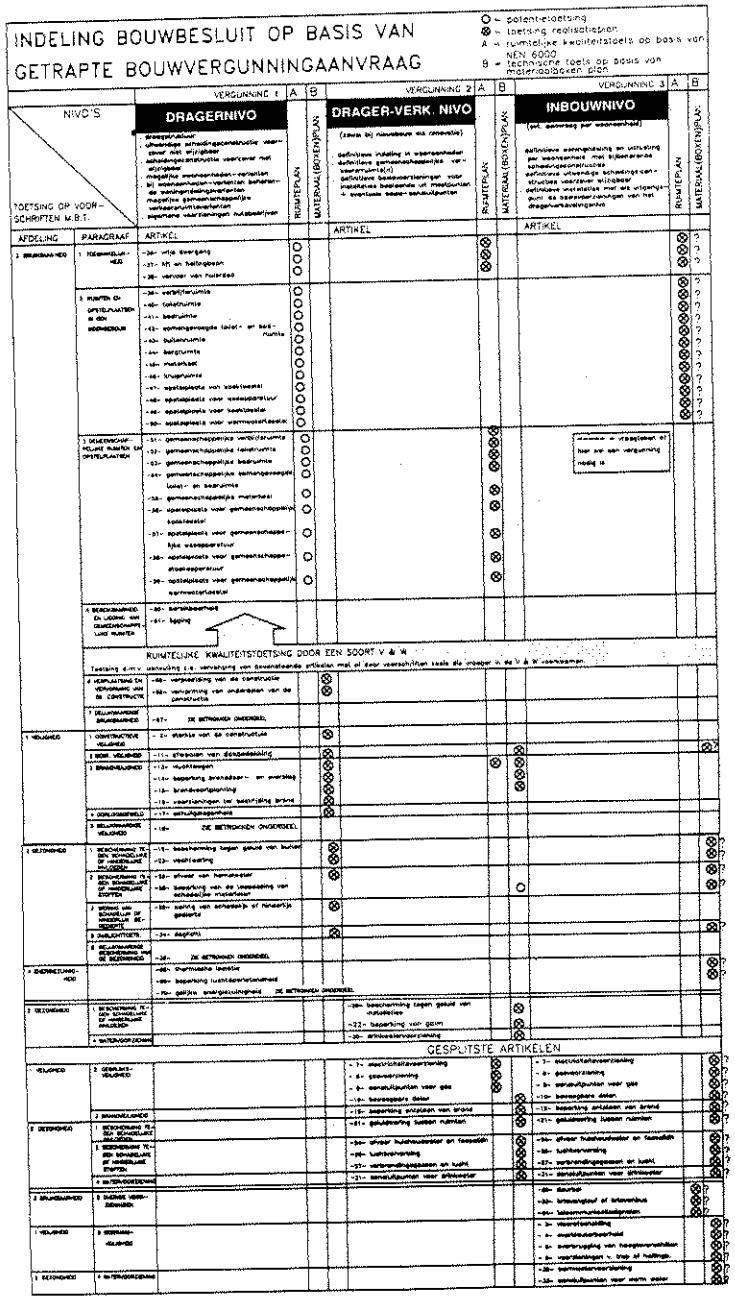
Door de invoering van deze drie fasen van de bouwvergunning kan de
discussie over hoe veel invloed de overheid moet hebben heel helder
gevoerd worden. Tijdens een discussie met een aantal directeuren van
bouw- en woningtoezicht over het voorstel bleek b.v. dat men unaniem
grote twijfel kreeg over de voorschriften die op het inbouwniveau bleken te

ake it structurally possible to deal with the support application completely,
ithout it being known which house size variants will be realized in the end. By
is we can respond with alertness to the market for the division of supports into
uses. This is important since the plan preparation of a support takes a long
ne because of e.g. the restriction to political decision-making. Moreover, it
n't necessary to submit a research to housing demands, the outcome of which
often outdated by the time of realization. A divided building permit for the
fill speaks for itself because the eventual occupant of every house should be
lowed to make their personal choices, and perhaps also because not every
use is sold or rented at the same time.

o facilitate this divided building permit the regulations of the Building Order
e appointed to the three levels: (fig. 11)
ne support application can be tested by support's statutory regulations, but also
r the next two levels by the floor surface standards for dwelling units and infill
youts as mentioned above under 'Testing the dwelling quality'.
ne second phase of the building permit takes up the final choice of the actual
use size in the already built support. Of course this only applies to the support

which allows for subdivision and also refers to future alterations. This phase can
be missed out when it concerns a support which doesn't allow for subdivision.
The third phase of the building permit concerns the infill and is applied for for
each house individually.

By the introduction of a building permit in three phases, it is possible to discuss
perspicuously the amount of governmental influence. During a discussion about
the proposal with several managing directors of the building and housing
inspection department it appeared they all began to doubt the regulations for the
infill level. They had never realized so explicitly that on this level they were
intensly interfering in private matters. This discussion appears to be very
necessary. As you may know, demands in the Building Order are now made via
standard papers, the discussion about these demands is completely consigned to
the experts, the consumer is omitted although he is the one who must pay.
Facilities with a shared function, like support walls, are subject to a public
collective decision process. But imagine these experts deciding that inside walls
in a house, your private property, must have extra sound insulation. You are not
given the choice whether to get a cheap or a more expensive wall. It is obvious



slaan. Men had zich nooit zo expliciet gerealiseerd dat men daarmee een intensieve bemoeienis had met wat in feite sterk in de privé sfeer ligt. Deze discussie lijkt hard nodig. Zoals U misschien weet worden eisen in het Bouwbesluit nu gesteld via normbladen. Daarmee is de discussie over die eisen geheel in handen gelegd van deskundigen, de consument staat geheel buiten spel maar moet wel betalen. Nu is dat voor voorzieningen die een gemeenschappelijke functie hebben, zoals draagmuren, onderhevig aan openbare collectieve besluitvorming. Maar wat te denken van het feit dat deze deskundigen nu bijvoorbeeld hebben beslist dat binnenwanden in een woning, Uw privé terrein dus, aan zwaardere geluidseisen moeten voldoen. U mag dus niet meer kiezen tussen een goedkoop wandje of een duurdere wand. Het is duidelijk dat we grote moeite hebben de betuttelende wijze van werken achter ons te laten, terwijl dat nu juist de bedoeling is van het nieuwe Bouwbesluit. Dat deskundigen de neiging hebben steeds zwaardere eisen te stellen is begrijpelijk, dus consument en politici let op Uw zaak.

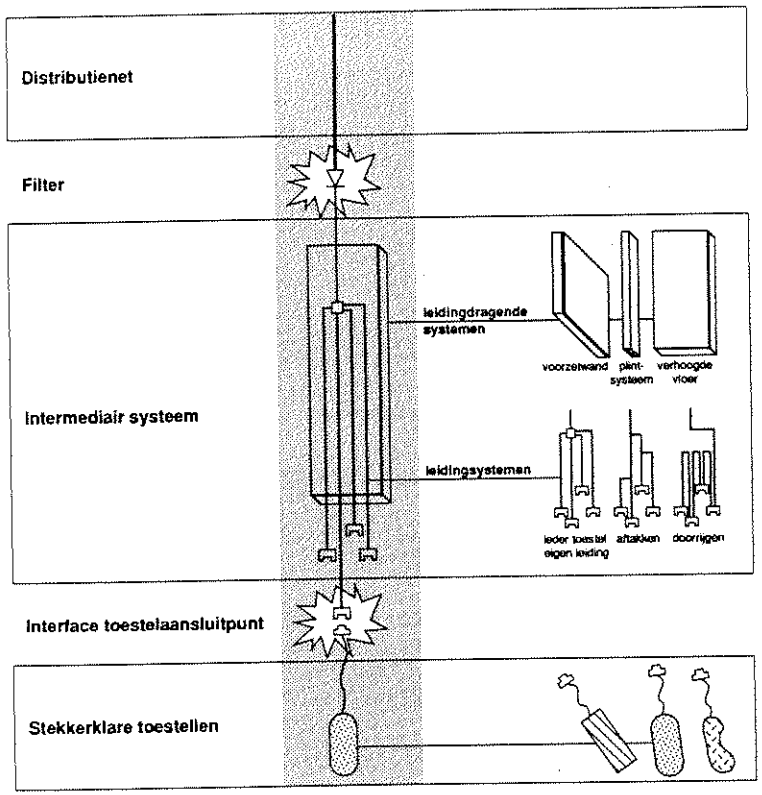
Tenslotte nog ten overvloede: ieder die in één keer alle drie bouwvergunningen wil aanvragen kan dat nog altijd doen, ook na een eventuele invoering van de gescheiden bouwvergunning, de gang van zaken is dan dezelfde als nu.

that we find it hard to part with the patronizing method of working, whereas this is exactly the intention of the new Building Order. It is hardly surprising that experts tend to make higher demands, so consumer and politician beware!

Finally, perhaps unnecessarily: It is still possible to apply for all three building permits at once, even after the possible introduction of a divided building permit the procedure will still be the same.

Utility companies

Now the third proposal for the Building Order. This considers the influence of Utility companies. The Building Order states that the conditions of the Utility companies for connection should be fulfilled. Up until now the interference of utility companies goes as far as the tail ends of the installation ducts: taps, sockets, etc. It is precisely laid down how many sockets, for instance, there should be in a living room. This already presupposes the existence of a living room, so the utility company doesn't confine itself to the collective part but also takes up responsibility for the part which is your private property.



12

Nutsbedrijven

Nu het derde voorstel voor het Bouwbesluit. Dit heeft betrekking op de invloed van de nutsbedrijven. Het Bouwbesluit vermeldt dat voldaan moet worden aan de aansluitvoorwaarden van de nutsbedrijven.
Tot nu toe strekken de bemoeienissen van de nutsbedrijven zich uit tot en met de uiteinden van de installatie leidingen: kranen, stopcontacten etc. Er is bijvoorbeeld nauwkeurig voorgeschreven hoeveel stopcontacten in een woonkamer moeten zitten. Dit vooronderstelt dus al een woonkamer. Het nutsbedrijf beperkt zich dus niet tot het collectieve deel maar neemt ook verantwoordelijkheid voor het deel dat in de privé sfeer van de woning ligt.

Bij het OBOM is nu een model ontwikkeld waarbij het inbouwdeel van de installaties geheel tot de eigen verantwoordelijkheid behoort van de bewoner. Een voorwaarde daarvoor is wel dat die bewoner via 'zijn' installatie geen schade kan berokkenen aan de collectieve infrastructuur van de nutsbedrijven en, via die collectieve infrastructuur, aan mede-afnemers van die nutsbedrijven. Bij de telefoon is dat intussen geregeld door een kastje in de meterkast, aangebracht door de PTT, waar vandaan U sinds kort alles zelf mag doen. Mits U voldoet aan een tweede voorwaarde, n.l. dat U een goedgekeurd telefoontoestel gebruikt. Om dit te bewerkstelligen mogen alleen goedgekeurde toestellen verhandeld worden.

At OBOM a model is developed in which the infill part of the installations is the ocuupant's own responsibility. However it is stipulated that the occupant cannot cause any damage via 'his' installation to the collective infrastructure of the utility companies and, via this collective infrastructure to fellow customers of these utility companies. In the case of the telephone, this is taken care of by a box in the meter cupboard, fitted by the PTT, after which you can do everything yourself, providing you comply with the second condition: using an approved telephone. Therefore only approved telephones may be sold.

OBOM is exploring the possibilities of using such a model (see fig. 12) for water, electricity and gas also. In principle the utility companies could install a 'filter'. For water this could be a one-way valve, for example, which prevents possible polluted water from the infill installation to stream into the collective network. Picturing this the construction of an infill installation would be entirely the occupant's responsibility, the utility company doesn't need to prescribe anymore how many sockets or tapping points there should be or how your installation should look like. From the utility companies' point of view a logical condition would be the obligation of installations being installed by systems

OM onderzoekt de mogelijkheid om een dergelijk model (zie afb. 12) ook
›r water, electra en gas te hanteren. In principe zou het nutsbedrijf een
er' aan kunnen brengen. Voor water zou dat b.v. een terugslagklep
›nen zijn, die maakt dat eventueel vervuild water van de inbouwinstalla-
niet in het collectieve net kan stromen. De aanleg van de inbouw-
tallatie zou in dit beeld geheel de verantwoordelijkheid van de bewoner
›nen worden., zodat het nutsbedrijf niet meer hoeft voor te schrijven hoe
›l stopcontacten U moet maken of hoe veel tappunten en hoe Uw
tallatie er uit moet zien. Een logische voorwaarde van de kant van de
sbedrijven zou kunnen zijn dat installaties moeten zijn aangelegd d.m.v.
temen die een systeemkeur hebben, naar analogie van het goedgekeur-
telefoontoestel. Bovendien is het denkbaar dat bijvoorbeeld voor gas
› goedgekeurde electronische beveiliging, zoals nu in ontwikkeling in het
ier van Home Bus systemen, deel van de voorwaarden zou zijn.
t is, eventueel als overgang, natuurlijk mogelijk om de oude en de
uwe wijze van werken naast elkaar te laten bestaan. De nieuwe wijze van
rken is dan alleen voor inbouwinstallaties die een systeemkeur hebben.

lenende potentie van niveaus
ze drie voorstellen met betrekking tot het bouwbesluit illustreren de
lenende potentie van de invoering van besluitvormingsniveaus. Een

ordening die ook een bijdrage kan leveren aan een heldere politieke discussie over verantwoordelijkheden, deregulering en mondigheid van de burger in relatie tot volkshuisvesting.
En dan tenslotte, voor ik een voorbeeld laat zien van een practische uitwerking van deze gedachten in een concreet inbouwpakket, nog iets over de potenties van deze visie voor de bouwnijverheid.

Vernieuwingsmogelijkheden voor de bouwnijverheid
In het begin heb ik al aangeduid dat drager en inbouw qua markt en besluitvorming verschillende producten zijn. De drager grondgebonden, beeldbepalend voor de omgeving, vaak gebonden aan collectieve functies en door dit alles in sterke mate onderhevig aan publieke besluitvorming. De inbouw niet grondgebonden en in z'n functies geheel gericht op de individuele consument. Bovendien het meest onderhevig aan veranderingen in gewoonten, smaak etc. Daarnaast is er een duidelijk verschil in beslissers en dus, heel belangrijk, een verschil in markt. De drager zal over het algemeen een institutionele opdrachtgever als client hebben, een woningbouwvereniging, een belegger, een projectontwikkelaar. De beslissingen over de inbouw daarentegen zullen liggen bij de consument, de directe gebruiker. Het product zit dicht op zijn huid en vertoont alle kenmerken en potenties van een consumenten-product. Hier is het misschien toch

›ing a system hallmark, by analogy with the approved telephone. Furthermore
› quite conceivable that as for gas, for example, part of the conditions would
›n approved electronic safety device, which is now being developed within
scope of Home Bus systems.
a transitional stage it is of course possible to have the old and new method of
rking co-existing with each other. The new method of working can be
›lied to installations of the infill with a system hallmark only.

e organizing capacity of levels
›se three proposals with regard to the Building Order illustrate the organizing
›acity of the introduction of levels of decision-making, which can contribute
› clearer political discussion about responsibilities, deregulation and maturity
the citizen in relation to public housing.
›ally, before showing you an example of the practical elaboration of these
›ughts, by means of a concrete infill package, here's something more about
potentials of this outlook for the building industry.

›ovatory possibilities for the building industry
lready indicated at the outset that support and infill are different products qua

market and decision-making. The support being land-bound, determining the image of the environment, tied to collective functions and because of all this strongly liable to public decision-making. In turn the infill is not land-bound and is entirely orientated towards the individual consumer. Furthermore the infill is the most affected by change of habit, taste, etc. What's more, the decision-makers differ from each other and therefore, most important, there is a difference in market. In general the support will have an institutional client as customer, for instance a housing corporation, an investor, a property developer. On the other hand the decisions about the infill will be taken by the consumer, the immediate user. The product is very dear to him and shows all the characteristics and potentials of a consumer product. Although earlier I said I would not mention this due to lack of time, it is here perhaps appropriate to draw attention to the studies on the financing of the infill, as they are recently made.

I also showed it to be possible to make the two products totally independent of each other, without there arising coordination problems. When installations, as far as they belong to the house itself, are completely transfered to the infill, responsibilities could be clearly defined.

zijn plaats, ondanks mijn opmerking in het begin dat ik daar wegens
gebrek niet op in zou gaan, te wijzen op studies over de financiering van
inbouw, zoals die de laatste tijd zijn gedaan.
eb ook laten zien dat het mogelijk is die twee producten geheel onafhan-
ijk van elkaar te maken, zonder dat er coördinatieproblemen hoeven op
reden. Als installaties, voorzover behorend bij de woning zelf, geheel
rden overgeheveld naar de inbouw kunnen de verantwoordelijkheden
delijk afgebakend worden.

t lijkt daarom voor de hand te liggen om nu serieus te gaan denken aan
e gespecialiseerde productie-organisaties, met ieder een eigen marktbe-
dering.

ger-producenten die niet langer gehinderd worden door de zeer indivi-
le wensen van de uiteindelijke gebruiker. Wensen die ingepast moeten
rden in publieke en institutionele besluitvorming en in een productiewij-
die zich daar slecht toe leent. Immers, drager-producenten bieden dan
product dat zo is ontworpen, dat het als kwaliteit biedt, dat in de
ouwfase tegemoet gekomen kan worden aan de individuele wensen van
toekomstige bewoner. Een belangrijke concurrerende factor is dan de
te van vrijheid die het eigen drager-product biedt op basis van het

refore it seems obvious to me to think seriously about two specializing
duct organizations, both with their own market approach.

port manufacturers who are no longer impeded by the very individual
hes of the eventual user, wishes that must be fitted in public and institutional
ision-making and in a method of production which is ill suited for it. After
support manufacturers will then release a product designed in a way it can
r the quality of meeting individual demands of the prospective occupant in
phase of infill. An important competing element will then be the extent of
dom the support product offers on the base of the design. Practically seen,
manufacturers of supports are liberated from the tyranny of installations.
allations which also develop themselves in a way they fit less and less in this
phase of building. Moreover an intelligent support system will offer a
ice of designs, perhaps by separating the support construction and the outer
l, then the same support construction will allow for a variety of outer walls.
s may lead to specialized suppliers of support construction and outer walls,
h with a finished product and the means for specialized product develop-
t. What's involved is the subject of research at OBOM, now also and

ontwerp. Heel practisch gezien: de producenten van dragers zijn bevrijd van de tirannie van de installaties. Installaties die zich bovendien zo ontwikkelen dat ze steeds minder thuis horen in deze ruwe fase van de bouw. Een intelligent dragersysteem zal bovendien qua vormgeving keuze bieden. Misschien wel door draagconstructie en gevel in principe te scheiden. Dan kunnen bij eenzelfde draagconstructie-systeem meerdere gevels toegepast worden. Dat zou weer kunnen leiden tot gespecialiseerde (toe)leveranciers voor draagconstructie en gevels met ieder een af product, en ieder de mogelijkheid tot gespecialiseerde productontwikkeling. Wat daar aan vast zit is onderwerp van onderzoek bij het OBOM, nu ook en zelfs in het bijzonder, voor de utiliteitsbouw.

Daarnaast inbouwproducenten die geheel consumentgericht zijn. Die op basis van een uitgekiend systeem geïndividualiseerde inbouw met geïndividualiseerde geavanceerde installaties kunnen leveren. Hun verkoop en productie-organisatie moet consumentgestuurd zijn.

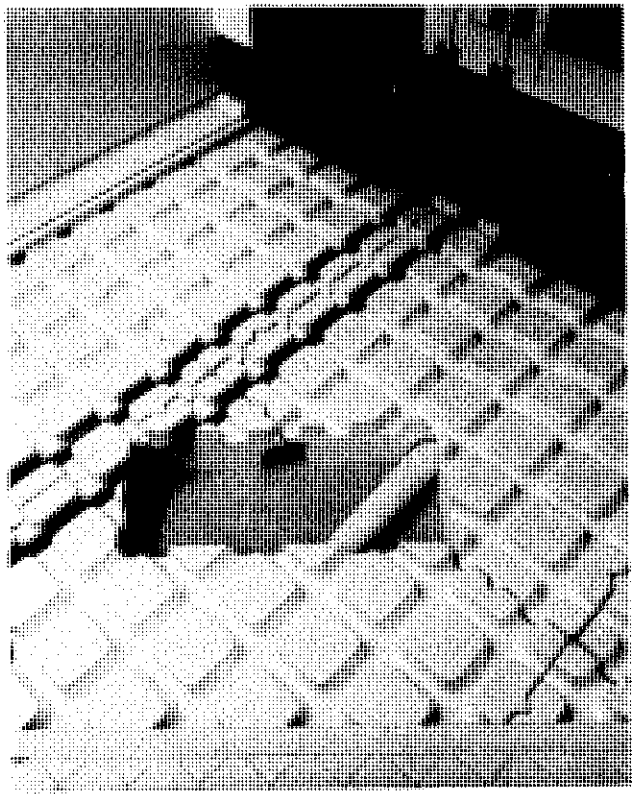
Tenslotte, enkele jaren geleden introduceerde ik het zgn. Sony-Neckermann-Toyota effect, namen die staan voor branches die per jaar meer omzetten dan de woningbouw. Wil de bouw weer een stuk van dit besteedbaar inkomen terugveroveren dan zal dat alleen kunnen als de consument

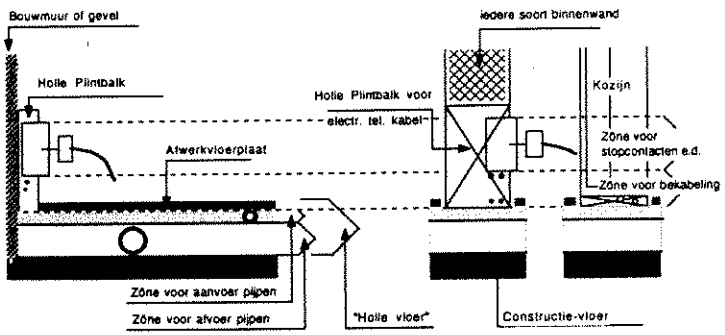
particularly for offices, schools, hospitals, etc.

Next to this there will be infill manufacturers that are entirely consumer oriented, that, on the base of a planned system, can offer a personalized infill with personalized advanced installations. Their sales and production organization must be consumer-controlled.

Finally, several years ago I introduced the so-called Sony-Neckermann-Toyota effect, names that signify branches that turn over more per year than the residential construction. If the building industry wants to recapture a part of this disposable income, the consumer should be able to choose from a large variety. The kitchen branch proved this to be possible.

That this isn't just a vision of the future I will illustrate by showing you an infill product in the development of which Habraken and myself are closely involved. It is the Matura Infill system, which I mentioned before as one of the three systems in the making.
This sytem is based on the fact that all installations belong to the infill, except



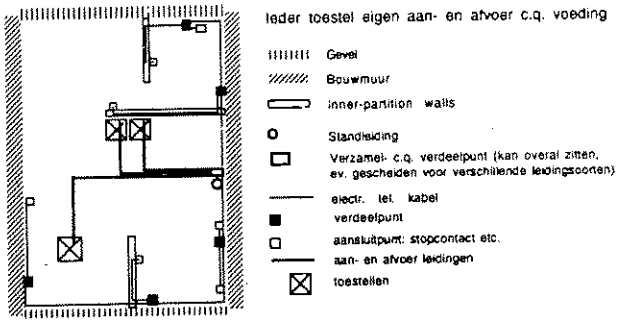


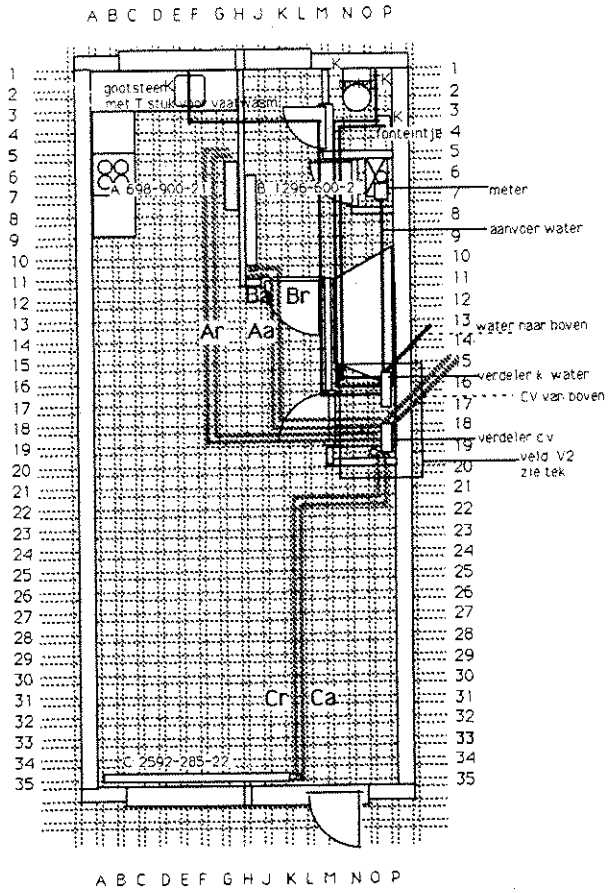
13

zelf kan kiezen uit een ruim aantal mogelijkheden. Dat het mogelijk is heeft de keukenbranche bewezen.

Dat dit geen toekomstmuziek hoeft te zijn wil ik U tenslotte graag illustreren aan de hand van een inbouwproduct bij de ontwikkeling waarvan Habraken en ik nauw betrokken zijn. Het is het Matura inbouwsysteem, wat ik al eerder noemde als één van de drie systemen die in ontwikkeling zijn.
De basis van dit systeem is dat alle installaties deel zijn van de inbouw behalve de hoofd aan- en afvoeren. Een tweede belangrijk uitgangspunt is geweest dat het inbouwsysteem geschikt moest zijn voor de inbouw-renovatie van de naoorlogse woningen.
Allereerst is er een zonering ontwikkeld van boven elkaar liggende zones voor verschillende soorten leidingen. Deze zonering maakt cruciale kruisingen van leidingen mogelijk (afb. 13). Dit is op zijn beurt weer nodig om een vrije distributie van leidingen mogelijk te maken. Dit door ons ontwikkelde zoneringsvoorstel is destijds, op verzoek van het IOP, neergelegd in een rapport *De ordening van het inbouwpakket*. Het is de eerste aanzet geweest voor het algemeen gerichte leidingonderzoek van het OBOM waar ik eerder over sprak.
Verder is een uitgangspunt geweest dat ieder toestel eigen aan- en afvoerleidingen heeft van of naar een verdeler bij het betrokken hoofdaansluit-

for the main supply and return ducts. A second important point of departure was the suitability of infill systems for infill renovation of postwar houses.
First of all a zoning is developed, consisting of zones for different ducts laying above each other (fig. 13). This zoning enables the crucial intersection of ducts, which in turn is necessary to make free distribution of ducts possible. This proposal of zoning we developed was at the time written down, at the request of the IOP, in a report *De ordening van het inbouwpakket* (Ordering the Infill package). It has been the driving force for the more general orientated research of ducts by OBOM which I mentioned before.
Another point of departure was the idea that every appliance has its own supply and return duct to or from a distributor at the relevant main source interface (fig. 14). These main source interfaces can be positioned anywhere in the support, concentration in a shaft isn't necessary. This is especially important in renovation, and will also simplify the design of supports.
On the base of vertical zoning an intermediary system is developed, which consists of a so-called Matrix tile with floor boards, a hollow base profile under the non load-bearing inner partition walls or against a load-bearing wall, and vertical shafts. The matrix tile has lower and upper grooves in which ducts can

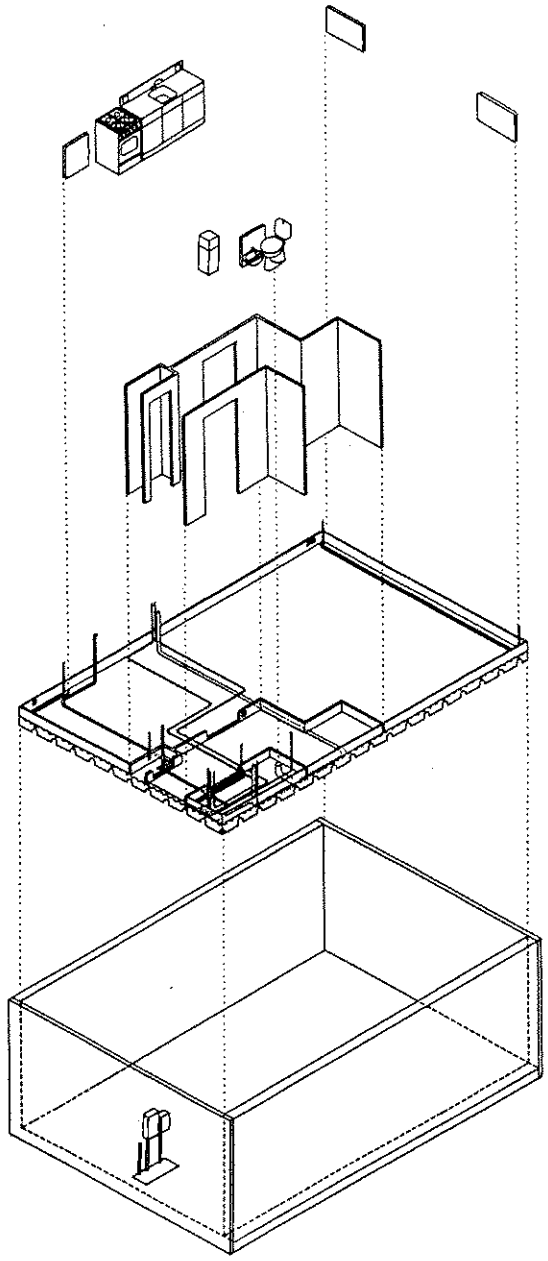




punt (afb. 14). Deze hoofdaansluitpunten kunnen in principe overal in de drager zitten. Concentratie in een leidingkoker is niet nodig. Dat is vooral belangrijk voor renovatie, maar kan ook het ontwerp van dragers vereenvoudigen.
Op basis van de verticale zonering is een leidingdragend systeem ontwikkeld. Het bestaat uit een z.g. Matrixtegel met dekvloer, een holle plintbalk onder de niet dragende binnenwanden of tegen een bouwmuur en verticale leidingelementen. De matrixtegel heeft onder- en bovengroeven waarin leidingen kunnen worden gelegd. In de holle plintbalk worden de electra en de diverse informatiedragende kabels en aansluitpunten ondergebracht. In de verticale leidingelementen tenslotte kunnen leidingen omhoog gebracht worden en aansluitpunten een plaats vinden. De matrixtegels en de holle plintbalk zijn na installatie het 'vaste' deel waarin de leidingen en de aansluitpunten het 'variabele' deel vormen. De leidingen kunnen in principe ieder punt bereiken. Dit maakt een vrije keuze van indeling en uitrusting mogelijk. Het is in feite georganiseerde vrijheid van keuze.

Dit leidingdragende systeem met z'n installaties vormt de basis van het Matura systeem en wordt het 'ondersysteem' genoemd. Dit ondersysteem kan vervolgens gecombineerd worden met ieder op de markt zijnd subsysteem zoals binnenwanden, deurkozijnen en deuren, keukens, sanitair etc.

be laid. Electricity and various information carrying cables and interfaces are placed in the hollow base profile. Finally, in the vertical shafts, ducts can be brought upwards and interfaces can be positioned. After installation the matrix tile and the hollow base profile become the 'fixed' part in which ducts and interfaces form the 'variable' part. In principle, the ducts can reach any point, which enables a free choice of layout and equipment; in other words it is an organized freedom of choice.
This duct carrying system with its installations form the base of the Matura system and is called the 'lower system'. This lower system can be subsequently combined with any subsystem available on the market, such as innerwalls, door frames, doors, kitchens, bathroom facilities, etc. No special demands are made on these products. What's more, in principle they are free of ducts. These elements are called the 'upper system'. The possible free choice of the upper system allows for a wide range of choice for the consumer. The developed coordination system as presented by the lower system is applied in a very consistent way. This organization enabled the development of a relatively simple computer programme by which the customer's choice of infill can quickly be fed into the computer. The programme will then automatically determine the



Aan deze producten worden geen bijzondere eisen gesteld. Bovendien zijn ze in principe leidingvrij. Deze elementen worden het 'bovensysteem' genoemd. De vrije keuzemogelijkheid voor het bovensysteem geeft een grote keuzevrijheid aan de consument.
Het ontwikkelde coördinatiesysteem als vertegenwoordigd door het ondersysteem is heel consistent toegepast. Deze ordening maakte het mogelijk een betrekkelijk eenvoudig computerprogramma te ontwikkelen waarmee de keuzes van de inbouw-cliënt heel snel in de computer gebracht kunnen worden. Het programma bepaalt dan automatisch afmetingen en aantallen van alle elementen en produceert ook alle noodzakelijke tekeningen, bestellijsten, paklijsten, maakorders om onderdelen op maat te maken, eventueel instructies voor productiemachines etc.

Alle elementen van het onder- en bovensysteem voor een specifiek huis worden in een distributiecentrum klaar gemaakt. Daarna gaan ze in een container in omgekeerde volgorde van montage in het huis. Een gecertificeerd montage team van drie mensen monteert vervolgens de gehele inbouw inclusief de afwerkingen in het huis. Uiteindelijk wordt er op gemikt dat binnen 3 á 4 weken na opdracht de sleutel, het gebruikershandboek en de garantie aan de bewoner overhandigd kunnen worden.

sizes and amounts of all the elements and also produces drawings, order lists, packing lists, production orders to make certain parts to size, and possibly instructions for production machinery, etc.

Every element of the lower and upper system of a specific dwelling is manufactured in a distribution centre, after which they are packed in a container in reverse order of assembly. A certified assembly team of three then assembles the entire infill on site, including the finishes. In the end it is the intent to supply the key, the user's manual and the guarantee to the occcupant within three or four weeks from ordering.

In short, the advantages of this system are:
- total disconnection of support and infill
- no special demands on the support, thus suitable for renovation also
- support free of ducts creates new opportunities for support systems
- free distribution of ducts and therefore free choice of layout and placement of appliances per house
- a wide range of choice of upper system

voordelen van het systeem zijn kort samengevat:
algehele ontkoppeling van drager en inbouw,
geen bijzondere eisen aan de drager, dus ook geschikt voor renovatie,
drager leidingvrij, geeft nieuwe mogelijkheden voor dragersystemen,
vrije distributie van leidingen en dus vrije keus plattegrondindeling en toestelplaatsing per woning,
grote keuzevrijheid bovensysteem,
computergestuurd ontwerpen,
computergestuurde logistiek,
eenvoudige en effectieve kwaliteitscontrole per woning door:
- klaarmaken elementen in distributiecentrum,
- verpakking in container met éénmalige handling op het werk
- montage door klein gecertificeerd montageteam,
verzekerde garantie mogelijk op basis van kwaliteitscontrole,
gebruikershandboek per woning op basis van computergestuurd ontwerp,
de inbouw is een geïndividualiseerd product geworden als een moderne auto voor de prijs van een auto.

kosten, zult U vragen, die zijn niet hoger dan die van de huidige werkze.

computer-controlled design.
computer-controlled logistics
simple and effective quality control per house by:
- manufacturing of elements in a distribution centre
- packing of a container ready to hand
- assembly by a small certified assembly team
insured guarantee possible based on quality control
user's manual per house based on a computer-controlled design
the infill has become a personalized product, like a modern car for the price of a car

e costs, you may ask, are not higher than those of the present production thod.

s possible, that much is proved by a series of trial dwellings in the private perty sector, the sector of rented houses and in the renovation. The system is w being made ready for introduction to the market. Although I am officially irering you will understand that my work in this field is by no means finished.

Het kàn, zoveel is nu wel bewezen aan de hand van een serie proefwoningen in koop- en sociale huursector en in de renovatie. Het systeem wordt nu klaargemaakt voor introductie op de markt.
U zult begrijpen dat dit werken aan een oplossing in de practijk mijn pensioen in de zin van ophouden met werken nog even uitstelt. Al was het alleen al omdat het zoveel voldoening en dus plezier geeft na vele jaren bezig zijn met theorie. Laat ik, op grond van deze ervaring, eindigen met de stelling:

"Er is niets zo practisch als een goede theorie".

If only because it gives so much satisfaction and therefore pleasure, after so many years of theoretical occupation. On account of this let me finish with saying:

"There is nothing as practical as a good theory"

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Colofon

De bouw uit de knoop ...?/ Entangled building ...?

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Open Building Residential Construction

Background

In an Open Building multifamily project, a residential base building is constructed without determining the layout of individual dwellings. When the floor plan, equipment and finishes of each unit is determined, installation is completed on a unit-by-unit basis using a fit-out or infill system. Portions of the exterior envelope belonging to a unit can also be part of the fit-out decision. The building elements needed to complete the unit are organized and prepared off-site, containerized, delivered to the site, and brought into the unit through the front door. A multi-skilled installation team of three installs the fit-out. In the most advanced projects in Japan and the Netherlands, the elapsed time from determining the unit's design specifications until occupancy is three weeks or less. This strategy is useful in new construction and in the renovation or repositioning of existing buildings to meet new demographic and technical requirements.

Open Building is a new approach to residential architecture and construction. Projects are being realized in Europe and the Far East, most notably in the Netherlands, Japan and China. The approach has positive implications for design practice, architectural technology and construction management, as well as for property management. Open Building contributes to the making of residential architecture combining the dignity and freedom of individual dwellers and the coherence and stability of neighborhoods. Uniformity is no longer justified on the grounds that it is more efficient: it is now economical to attain a natural variety of dwelling unit space plans respecting the individuality of habitation. This approach has long been preferred by thoughtful professionals.

For decades, design, marketing and building professionals have been distinguishing between a base building and a fit-out level of activity in the office and retail markets. This strategy yields benefits that are not accountable strictly from lower first costs, although this is certainly the case, but from the delivered project's long term utility, desirability and adaptability. The distinction has spurred the development of new and more sophisticated hardware technology, software and management techniques. The benefits resulting from the separation of a base building and the fit-out are no longer debated for these uses, and should now be considered for residential buildings.

Benefits

Open Building employs a mix of innovative design, organizational, and management strategies. It has a number of points in its favor, including:

1. *A substantial percentage of total project cost - often as much as 50% - can be deferred until weeks before occupancy. This is advantageous in projects which take years from decision-to-build to occupancy, controlling uncertainty and reducing risk.*
2. *Construction operations at the front end of a project are simplified by removing from this stage the complex coordination of piping and other services, putting a large portion of this work in the fit-out, which can be complex yet well organized ,as in the Matura Infill System in the Netherlands.*
3. *In rental projects, hard-to-lease units are eliminated since unit design decisions are made at the time the lease agreements are signed. Move-in can take place two or three weeks later.*
4. *The delivery of buildings is speeded because of the reduced time to construct the base building, and the rapid and systematic fit-out organization and installation enabled by the use of design and logistics software.*
5. *New systems design concepts reduce technical interfaces between elements making up the fit-out, thus virtually eliminating the scheduling friction so typical of jobs in which all subsystems and work schedules are intricately entangled.*

6. *Buildings set up this way in the first place are easier to renovate i10 years n the future when marketing and technical requirements change. This is because of the technical and legal disentanglement of the individual dwelling from each other and the building they occupy.*
7. *Upgrading existing residential buildings such as public housing and repositioning obsolete office buildings to residential use are facilitated by adopting the Open Building approach.*
8. *The dramatic reduction of waste, debris and on-site cutting and fitting in the most advanced fit-out systems has many advantages. Minimal noise and disruption of other activities in the building and the potential for reduced construction related injuries are important advantages.*

The concept represents a better way to build. It matches demand and supply patterns taking shape in North America, and will be of increasing value in the future. Open Building can be the key to the successful upgrading of the existing residential building stock, and supports policies aimed at incremental upgrading and income mixing. Open Building, unlike traditional methods, is amenable to the advanced quality and productivity management techniques that are dramatically improving other sectors of the North American industry.

Issues

Adoption of this approach in North America requires that the building industry and the design professions adopt new concepts, methods and attitudes. While Open Building projects are now being realized in other countries, each locale will find its own match between the basic principles and the regulatory, administrative and practical issues particular to that market. This suggests a number of issues which must be understood if the approach is to be successfully employed in the United States and Canada. These include at least the following:

1. What kind of organization is positioned to license a foreign fit-out system, or to introduce a new fit-out system and in what region and/or market will it find the best initial fit?
2. Is the approach applicable to both concrete slab buildings as used in other countries, and to wood frame or steel frame construction prevalent in North America?
3. Are the needed code and procedural adjustments in approvals and inspections possible and how will they be achieved?
4. Can contractors deliver high quality base buildings at a good price?
5. Can the design professions adjust practices and attitudes to match Open Building?
6. Can Open Building compete with conventional methods in both new and rehabilitation projects?

Residential architecture constitutes the largest single inventory of buildings. Along with commercial and retail projects, residential buildings and renovation represent a major source of private and public revenue and are well known and important components of the national economy. The short and long term value of the residential stock is therefore of consequence. It is not a luxury but a necessity that buildings of all kinds be designed in the framework of life cycle accounting. Open Building residential architecture meets this requirement as a matter of course, while also providing a more efficient method of initial construction.

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Disentangling Parts, Disentangling Parties
An Open Systems Approach to Building Renovation

Dr. Stephen Kendall, AIA

Two main points may be of value in guiding the creation of systems approaches to revaluing buildings. First, the problems experienced in doing building renovation are caused principally by the *entanglement of building systems and therefore of the parties controlling them.*. Sound understanding of progress-to-date in disentangling parts - and parties - can be instructive as we develop new technical and organizational approaches to even more dynamic forces of change in buildings in the future. The concept of levels, outlined below, helps.

Second, *open systems are the sorts of systems we need to be thinking about*. Open systems are what we use when no one party can do it all. In such cases, our attitude should be one of taking-part-in, rather than controlling the entire story. It is actually more efficient that way, in the long run. This means that we have to learn how to cultivate open systems, an undertaking that requires new ways of partnering, collaboration, and a better understanding of how open systems operate. Taking part in open systems leads to the problem of mapping the relative positions of agents in complex value constellations, a methodological problem requiring tools a start on which is already underway.

Entanglement

The first issue is technical entanglement, a more realistic way of thinking about what some have called systems "integration". Entanglement of parts one with another causes chain reactions in design coordination, work sequences, and confusion of responsibilities over the life of a building, no matter how much good planning is done. A change of one part is propagated to many other parts, and the parties controlling them. Of interest to Steelcase, this also causes difficulties in innovation, both in technical design, off-site logistics, and in installation operations.

The entanglements of greatest concern today are those of the resource distribution systems intertwined with elements defining territories; for example, pipes and wires conventionally go with walls and floors. These resource systems have been with us a relatively short time - only four of five generations - and keep growing in number and complexity to the point of

strangulation. Our normal strategy has been to push them into convenient cavities which hollow walls and floor sandwiches offer. We are now in a period, taking several decades so far, of discovering the implications of this and doing something about it. There are other examples of this sort of entanglement if we know how to look for them.

Entanglement of elements establishes complex dependencies between parties controlling the parts. In most situations, concerned parties understand only vaguely, and by trial-and-error, the limits to their freedom to move, change or adapt parts they are responsible for. This confusion and uncertainty provides openings for conflict and poor quality, and the resulting legal procedures we are too familiar with. This is especially the case in times of rapid organizational and technical change, when conventions and habits are no longer good enough.

The conflict that we experience between parties can be attributed in large measure to the entanglement of the physical parts they control because people relate to each other - at least in the building industry, if not more generally - through the parts they are concerned with. Our most arduous negotiations are about who will control which part, be responsible for what element, and who will be free to modify what space or system. When the furniture is free to change without effecting the walls, the party controlling the furniture does not disturb the party controlling the walls. But when the party changing the furniture seeks a change of wiring buried in the wall, we see the potential for conflict between the party controlling the walls on the one hand and the furniture on the other. In situations of doubt, we impose rules blocking movement and adaptation, except by the power at the highest level. This, of course, is in clear opposition to the principle of "empowering workers at the lowest level" to take responsibility.

The first step in easing inter-party conflict under conditions of change, therefore, is not "integration", but disentanglement. What we really want is to minimize dependencies. Those we must have, we want to be predictable. Remarkable progress has been made in achieving this so far in a short time. More is possible if we develop a more sophisticated understanding of the principle of dependencies.

Levels

But it is not simply disentanglement that seems to be needed. Looking closely at environments that change, we can see that certain parts seem to go with other parts corresponding to the way change actually occurs. We also can observe that the distribution of control over a given technical universe may change. In the example of the furniture changing without making the walls change, it should be clear that if one party controls both

the walls, the buried wiring and the furniture, there are technical problems but no inter-party conflicts if the furniture is moved and with it the wiring. The control is, so-to-speak, all exercised in the family. It is when one party controls the furniture and another the wall and buried wiring that things become more difficult.

So, to solve this problem, a particular hierarchical structure seems to naturally emerge in the built environment, an order that goes along with easing inter-party conflict to make life easier. Thus, over time, some of the wiring has migrated out of walls in office buildings and into the furniture. This has made it easier, some believe, to change the furniture and it's wiring hook-ups, whether one party controls both walls and desks or whether control is distributed. It helped in both cases, which is part of the reason we see this as a common approach to advanced furniture systems available on the market today.

Watching environments change reveals this hierarchical structure. The following diagrams help illustrate this.

Building as an "Integrated Whole"

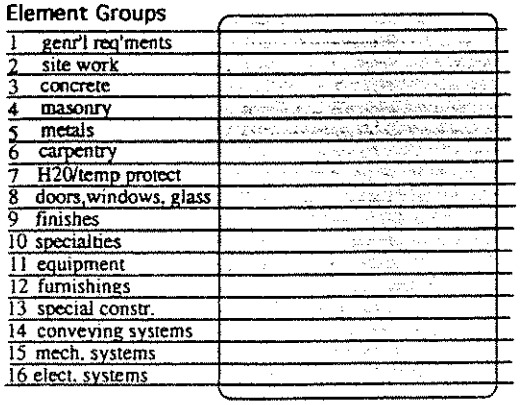


diagram 1

Schematic of Three Level Model used in Current Practice

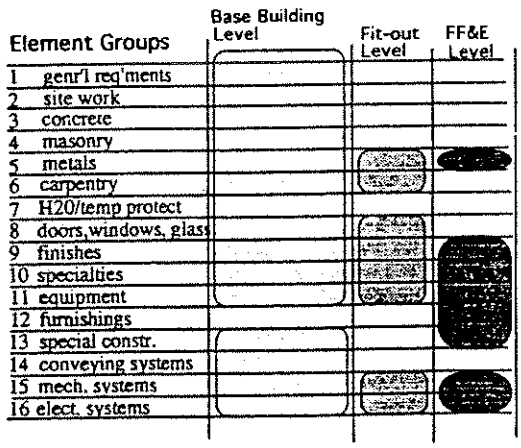


diagram 2

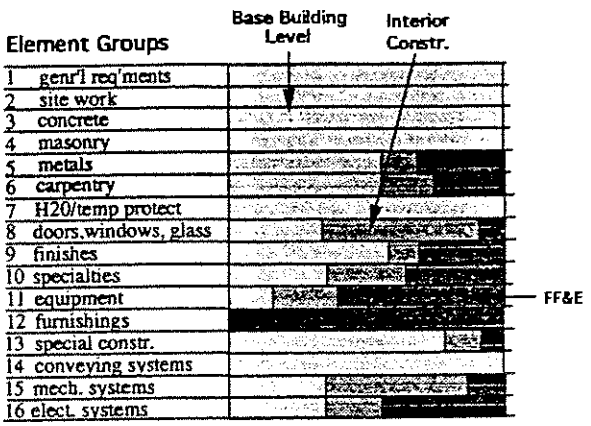
In *diagram 1*, a building is depicted as an "integrated whole". One party controls all elements (the 16 "divisions" are noted here in the fashion used by architects writing building specifications, developed by the Construction Specifications Institute and widely used in the building industry). It is a "one level" building, with no organizational or technical distinctions except those between the 16 divisions.

In *diagram 2*, we see a three level model of a building, in which a distinction is made between a base building level, a "fit-out" and an "FF&E" level. This characterizes current practice in most office and retail projects.

In *diagram 2,* we see that certain portions of the work belong to single levels, and in some cases, a given sort of work is distributed across two or three levels. When a new level emerges in practice, as "FF&E" has in recent years, two things happen. First, more parties can "play the game" with relative independence because there are more levels to play on. Second, these agents have to learn how to coordinate their activities and reach agreements, demanding new skills in designing, constructing and managing facilities.

Using the three level model, we can see more.

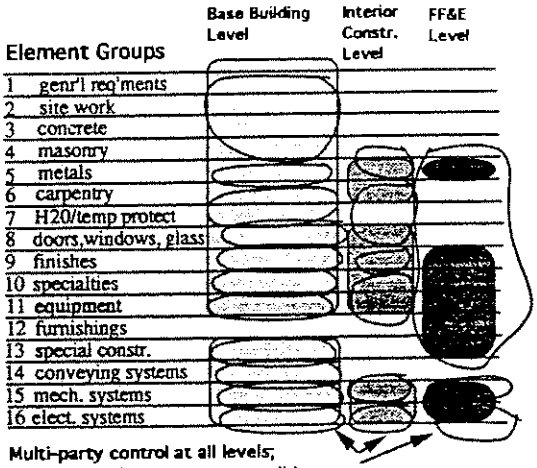
Schematic % of Work at Each Level



Note! The distribution of "scope of work" between Base Building, Interior Construction, and FF&E has been changing, with more work migrating to FF&E.

diagram 3

Schematic of Three Levels
(One Possible Distribution of Initial Installation Control)



Multi-party control at all levels; other control patterns are possible

diagram 4

In *diagram 3,* a possible distribution of "scope of work" in the three level model is shown schematically. This means that in a given project, for instance, a certain % of total HVAC system parts and costs belong to the base building, a certain % to the "Interior Construction", and a certain % to FF&E. This might be the diagram referring to an installation of Johnson Control's Personal Environments Work Station. The boundaries between the levels shown here concern technical questions of alignment, tolerances, capacity, and attachment, but also organizational issues such as timing and contractual responsibility. We also know that a gradual migration has been taking place, in which work - and value added - is moving increasingly from the hands of the contractor doing the base building into the "fit-out" level, particularly into the hands of manufacturers of materials and equipment.

In *diagram 4,* one possible distribution of installation control is shown in the three level model. A particular multi-party control pattern is shown. This diagram might refer to another systems furniture product in

which wiring and HVAC in the FF&E level are installed by two different parties, and all other elements are controlled by another party.

It is interesting to recognize that another distribution of control might be observed in adapting what was designed under a still different pattern of control. We can note also that at present, no single party produces all parts necessary for work on any given level. But we can see that a given party may produce parts for use on two or three different levels.

It appears that as building adaptation has come to be a major force in facility design and use, the hierarchical depth in the built environment has increased. Along with this, more and more specialists have come into existence to operate on these new levels. This proliferation of parties has put new demands on design knowledge and organizational theory, focusing particularly on problems of systems coordination.

This new reality has its consequences in the question of leveraging cooperation between parties designing new products and systems, some of which may, in their use, operate across or at the interface of different levels. Inadequate understanding of levels, disentanglement and dependencies makes cooperation in the developement of new approaches very difficult.

Mapping and comparing current practice on this three level model is a variation on the work General Electric does systematically in its "Best Practices" efforts. But neither the use of a "levels model" nor the GE "Best Practices" research solves problems or tells us what to do. Their value is that they provide an environment in which to account for issues too complex to keep intuitively in mind. Further, diagrams are helpful because they make palpable what is otherwise communicated only in words or numbers, subject, perhaps to more ambiguity than pictures.

Open Systems

When no one party controls everything but control is instead distributed and technical systems are organized as in *diagram s 3 and 4*, open systems are dominant. Open systems exist when parts making a given object - an air conditioning unit, a furniture system, a building - are available from a variety of parties, and in which there are, for most parts, equivalent substitutes from still other parties. The less this is so, the closer the object is to being a closed system, bringing with it a difficulty to move with changing circumstances. This predicament of wanting overall control but also wanting to be "nimble" is especially the case with high value added elements or systems, in which large investments are made to develop and produce complex objects which require large investments also by those acquiring them. This is exactly the reason that building owners are skeptical of any "single party system" that in itself claims an increasing % of total "fit-out".

At each level, efficiency and adaptability seem to depend on the extent to which open systems are present and healthy, giving many parties the opportunity to compete for a place while, paradoxically, stressing good coordination in both systems design and installation.

The rule seems to be that successful products or systems produced by any one party remain relatively low on the value added chains they are part of or "feed". On the other hand, higher value added products including many "divisions" (see diagrams above) can be organized by a single party if they are "open systems". Such an example is the Matura Infill System in the Netherlands, used in residential fit-out.

In the large, our most sound and enduring ways of building and manufacturing parts and systems rest on open systems principles. This is arguably inevitable, a result of our own political economy, and increasingly the result of international trade and the realignments in the global building industry. Pressures for variety, control by local powers, production efficiency, and change inhibit any one party from controlling too large a bite of any value constellation. Further, the concept that owners and users are vitally important in "co-producing" value, as IKEA and others have recognized, indicates that new circumstances are outpacing old paradigms.

As a result, many parties, especially manufacturers, are now learning how to add their parts to the existing repertoire instead of "inventing" new "total" systems. These more sophisticated players now pay attention to make sure that what they add can be used in a variety of situations controlled by other players.

Some few are learning how to enter into cooperative R&D activities to do "precompetitive" work on a collaborative basis, setting standards and performance "platforms" on which each player can develop proprietary parts that will go together in a variety of production chains controlled by other parties. An example of this sort of effort is the SMART HOUSE venture started by David MacFadyen at the National Association of Home Builders, under the umbrella of the National Cooperative Research and Development Act of 1984. It was the earliest and perhaps the only large effort in the building industry to do what is now needed on a much broader scope to advance building technology. Dr. Bruce Merrifield, a speaker at this workshop, mapped the organizational approach and was the keynote speaker at the kick-off of the SMART HOUSE effort.

The lessons from that effort have yet to be learned by the industry, but should be, in order to meet the challenges of open systems applied to building renovation.

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The Open Building Approach:

Examples and Principles

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The Open Building Approach
Examples and Principles.

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THE OPEN BUILDING APPROACH: EXAMPLES AND PRINCIPLES.

Introduction.

In this paper I will introduce a new approach in residential construction that has been developing on the last two or three decades in the Netherlands and now also finds application in other parts of the world.

This is called the Open Building approach and it is based on a increased systematization of building and manufacturing by way of which it is possible to combine improved efficiency with greater flexibility.

First I will show you a practical application of the Open Building approach from my own experience. This will give you an idea of the present state of the art, and it will also make a discussion of the general principle more concrete.

Then I will summarize the basic principles behind the Open Building approach.

Next I will say a few things about the recent history of the Open Building approach to give you a better sense of the context within which the development took place.

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The Use of an Infill System: Renovation.

Infill systems make it possible to renovate apartments following the individual wishes of the inhabitants. In new construction of apartment buildings they allow each apartment to be adapted to the needs of the individual inhabitants.

In both cases the dwelling unit is separated in two parts:
-the support which is the empty shell, including the facades,
-and the infill which comprises the interior partitioning with all the bathroom and kitchen equipment, central heating and electrical circuits for the individual dwelling.

Illustrations shown here are from a renovation project in the town of Voorburg, the Netherlands. Initially two units were renovated by way of a pilot project. Presently we are installing fourteen other infill packages in the same project.
The example is of a low cost rental housing project for middle class inhabitants in the Netherlands.
Obviously, the same process can be followed by renovation of owner occupied apartments.

First scenario
A unit in a public housing estate is vacated by users who move to another town. The housing authority in charge of the estate contacts new users from a waiting list. They are informed that the authority wishes to renovate the unit before they move in.
The prospective users, a young couple who both work, are given a number of alternative floor plans for their unit as worked out by an architect commissioned by the authority. They meet with the architect. As a result they decide that a variation on one of the initial alternatives answers their needs.
The new floor plan is very different from that of the unit which is now vacant. The original apartment (Fig.1) was designed in the early sixties for a family with two to four children. It had

three bedrooms, a very small bathroom with only a sink and no shower or bath, and a narrow kitchen. There was no central heating. All rooms were around a small hallway. The new apartment (Fig.4) has a single large bedroom with an adjacent bathroom with shower and laundry machine. The kitchen is in a new location in open relation to the living room. There is also a small guest room.

The new floor plan is approved by the housing authority and a new monthly rent is agreed upon. The authority sends the floor plan to a company that specializes in installing infill systems for residential construction. A small local contractor is called in to clear the existing apartment and prepare it for new infill. This takes about a week.

Beginning the second week a container is delivered in front of the apartment building. A small conveyor like those also used by furniture movers is installed to hoist parts from the container towards the unit's balcony on the fourth floor.

A crew of three people now installs the infill system. Within ten workdays they deliver the finished apartment to the users. The next few days the users have curtains and floor covering of their choice installed by a local interior decorator and their furniture is brought in.

Second scenario

A couple in their late fifties, users of an apartment in the same rental public housing estate as mentioned in the first scenario, decides that their apartment no longer fits their needs. However, they are reluctant to relocate to another, newer housing estate because they have lived in the present apartment for a long time. They like the neighborhood where they have friends and relatives and are familiar with shops and other public facilities. They decide they prefer to have their old apartment renovated and ask for the cooperation of the housing authority. (Fig.4)

This is the start of a procedure similar to the one described above, but in this case the couple moves out of their apartment to stay with their daughter and son in law for three weeks. Their furniture is put in storage. In the first week the apartment is prepared for infill. In the next two weeks the infill package is installed.

Within a month they live in a completely new apartment fitted out exactly according to their wishes.

Voluntary expenses.

As part of the normal procedure for renovation the users are asked to select the bathroom equipment and kitchen equipment to be installed in the new floor plan. The elder couple can afford to spend more compared to the young couple who are just starting. They select a very well equipped kitchen. Also the bathroom equipment they want is of high quality. The representative of the housing authority informs them that with their selection the costs of the infill package far exceeds the estimated costs on which the rent for the new unit was calculated. The couple responds that they are well aware of this and are prepared to cover the difference*1). Accordingly they pay the authority a lump sum and the equipment they selected is installed in their rental unit *1).

Advantages for the user

Seen from the perspective of the users the procedure described in the scenarios is of course attractive. It gives them an opportunity to select their own floor plan and they are free to decide on the quality level of the equipment to be installed. Moreover the process is quick. Within several weeks after the rental contract is agreed upon the units are ready.

If the user is also the owner of the apartment, getting a new infill is like buying a new car. We believe infill systems should be financed in the same way as cars. They last between ten and twenty years. The cost of an infill system is about the same as the cost of a car.

Advantages for the owner.

It can be expected that the owner of rental property will appreciate the procedure as sketched

above for social reasons. Tenants who have selected their own interior accommodations can be expected to complain less and will treat their environment with respect. Moreover, serving their tenants on a one on one basis makes it possible to take into consideration the differences of income among them. Those who can spend more, and are indeed willing to do so, can have more. It is no longer necessary for the owner to expect all users, regardless of their differences in life style and income, to accept the same single floor plan equipped on a level that is just affordable to those with the lowest income.

Economically attractive.

But the owner will also find this way of working economically attractive compared to the alternatives available to him.

First of all, custom floor plans by means of infill systems as sketched in the two scenarios are not more expensive in direct costs. The price of the single infill unit to be installed independently, including cleaning out of the building shell and preparing it for the infill system, is competitive with the price paid in traditional renovation processes.

If here things are equal, economic advantages for the owner follow because the whole process becomes much easier to control and can be done in a more gradual fashion. To illustrate this we may first consider the alternatives against which the new infill system approach should be compared.

Traditional alternatives.

Without the infill systems option the owner of an apartment building has basically two alternatives where renovation was concerned:

- In a first alternative the building will be vacated and gutted completely to be refitted, after which new tenants are admitted or former tenants may return. This procedure is socially destructive. It also takes extensive planning and a good deal of social engineering before the building is empty.

- In a second alternative the building is renovated while the tenants stay in place, in which case they are submitted to a long period of discomfort and noise when workers go in and out to redo bathrooms and kitchens and electric circuitry, taking apart most of the house before they put it back together again. This procedure asks much patience and endurance of all parties involved and also a good deal of cooperation between owner and contractor. It is not uncommon that a full time social worker is occupied with helping tenants to cope. Inevitably there are older people and those who are ill or already under stress for other reasons who now have to live through all this for months on end.

Compared to these traditional ways for renovation we now may consider from the owner's point of view the advantages of the new alternative offered by infill systems.

User friendly adaptation as a result.

In both traditional cases the contractor insists on some economy of scale where the same parts can be installed in the same way in all units. Uniform floor plans are required. For the owner it is difficult and very time consuming to come to a single proposal acceptable to all tenants. Usually the original plan is maintained as much as possible while better bathrooms and kitchens somehow are installed. Differences in life style, occupancy, and income can not be taken into consideration. In the end no one is satisfied. The lowest income tenants feel they cannot afford the new rents. Those with a higher income feel they do not get what they want.

In case of infill renewal, on the other hand, variety of floor plans is the natural outcome of the process and not more expensive than uniform floor plans. This is because the infill process treats each unit separately. All subsystems are installed by the same crew in a single procedure. Making two or more identical plans does not offer any advantages in terms of installation time or

costs. Neither does it matter if several units must be renovated at the same time or in the same building. At all times the infill system for each unit is delivered in its own container and installed by a separate crew.

No gradual deterioration.

In the one-on-one infill renovation process overall deterioration of the property is avoided. Renewal is now a continuous process of gradual adaptation to tenants' needs. Each time when a tenant leaves renewal and adaptation is possible. Because infill time is short vacated units can be renovated and rented again within a month. As we have seen in the second scenario, renovation of a unit can happen while a tenant takes a three weeks vacation. In this way renovation and adaptation become a form of continuous maintenance and violent swings in the condition of the rental property, from massive renewal after years of overall stagnation, can be avoided.

Obviously the same advantages apply for owner occupied apartments.

Separate renovation of the 'support'.

To renovate an apartment building not only the interior of the units must be renewed. The customized infill of single units must be complemented by improvement of the facilities shared by users like stairs, elevators, entry ways, parking facilities and landscaping.

Essential to the infill approach is that a clear distinction is made between the infill proper which is done in response to individual user's needs on the one hand, and the so called 'support' building that holds the individual units on the other hand. For the latter the building owner (or the association of owner occupants) must take responsibility. In the case of the two scenarios sketched earlier for instance, the housing authority has planned complete replacement of the existing stairwells and the addition of elevators for the four story apartment block. (Fig.3). It also plans for the replacement of some garage and storage space on the ground floor with new dwelling units. These works will be done in consultation with the group of tenants involved, but the work itself remains outside the units and is done at its own pace. In the same way the facades are cleaned and treated against moisture penetration and window frames are repaired at the outside.

These more general activities concerning the building as a whole for the benefit of all tenants no longer relate to the renovation of the units themselves. Bids can be put out independently. T summarize:

The building owner (or the collective of inhabitants) takes initiative for the renovation of the collective facilities: the 'support'

The individual inhabitant takes initiative for the renovation of the individual dwelling unit.

**

The use of an Infill System: New Construction.

In new construction of apartment buildings and private houses the support infill separation has advantages for the developer and the house owner.

Differences of supply and demand.

Developers know that prospective buyers always demand changes in the floor plan of the units offered to them. The changes buyers want to make can vary greatly. Examples are;

The colors of the tiles in the bathroom, the place of a door, the removal of a wall to make one large room out of two, the layout of the kitchen equipment, the layout of the bathroom equipment, extra bathroom facilities, and so on....

The response of developers to such demands varies with the market situation. If competition is strong they may have to give in more readily than when there is a strong demand.

But, if they had their way, developers would prefer not to offer any choice to buyers at all because it will cost them money. The contractor's price is based on fixed, predetermined floor

plans and specifications. Any change will disrupt his planning, will cost more money and take more time. Contractors are well aware that the developer demands a change because otherwise the unit will not sell. This puts them in an advantageous position to negotiate the price of the change. But it is also difficult for the contractor to manage such individual changes and to determine their exact costs. Prices will be established accordingly.

This situation, which is familiar enough to all of us, basically puts developers, buyers and builders, on a collision course.

Reconciliation of Conflict.

The infill approach reconciles this conflict. The developer now asks for bids on the support building only and will be supplied with a finished building complete with facade, and all the collective facilities: entrance lobbies, elevators, public stairs and corridors, parking facilities and landscaping. In short, the building as finished will clearly establish the kind of lifestyle and quality of services that the buyer needs to know before he can decide if the location is of interest to him. But the inside of the apartments will remain empty and ready to be filled in. Floors are smooth and ceilings finished and painted. At a fixed place in each unit there is access to electricity, water, gas, and sewage for the infill system to connect to for further distribution in the unit.

Building this 'support building' should not offer any surprises to the builder. He will be in control of logistics for a well defined job. The builder is in fact freed from the part of the construction process that usually constitutes the greater risk to him and takes most of the overhead for on-site management and for coordination of subcontractors. It is well known that money is easily lost on finishing the interiors of dwelling units where it is gained in setting up the larger structure holding them. The builder, in short, now can do more with less overhead costs.

The developer from his part, now knows precisely what he can expect from the builder in terms of product and timing. For the infill he contracts the infill systems company. He is now in a position to offer the buyers exactly what they want and can structure his prices accordingly.

We can conclude that the infill approach has advantages for all parties involved: the buyer, the developer, and the builder.

-It gives the buyer the dwelling unit he prefers.

-It allows the developer and builder to offer superior service to the buyer in a way that can be logistically and financially well controlled.

-It gives the builder a clean and well controlled building job.

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Open Systems Approach, General principles.

Making sub-systems independent.

The principle of infill systems fits in the broader approach of Open Systems. Open Systems advocates the idea that a building is composed of many different sub-systems and that it is important to make each subsystems as independent as possible from all the others. The less interdependence there is among sub-systems, the easier it will be to improve, or replace that sub-system with another and better version.

For instance:

-In the past twenty years in the Netherlands, systems for hot water central heating have been changed from building wide systems to systems that serve a individual dwelling unit. These individual systems are easy to install and to repair. Therefore they are cheaper.

-Partitioning systems are now all standardized. This means that one can choose from different kinds of partitioning systems with different qualities and price without penalty for adaptation. The walls are all the same width and therefore can use the same door frames and doors. Conversely, many different door frames are available in different materials and always fit to all

available partitioning systems.

-Kitchen equipment now is sold as a separate system: industry offers a range of such systems of different design and price. They all are modularized to allow the endless combination of different parts.

-European manufacturers are working at comprehensive bathroom systems similar to kitchen systems.

Distinction of Levels.

The sub-systems mentioned above have become independent from the actual building. They can be chosen and installed without a need to change the building structure. This is what Open Building is about.

The sub-systems mentioned above taken together begin to make an infill system.

The remainder of the building: the load bearing walls and floors and columns, together with the facades and the public stairs, elevators and corridors, make the support.

This separation makes the building as a whole operate on two levels: the support level and the infill level. (See also Fig.6)

Each level has a important degree of autonomy.

It now is possible to design a support building without knowing yet what the exact floor plans of the dwelling units will Be. It is also possible to develop infill systems without having to know beforehand what the supports will look like within which they will be installed.

Supply lines also on two levels.

The problem that remained to be solved was that of the supply systems: the piping and wiring needed to make everything work.

Supply systems operate often on both levels at the same time. A sewage system , for instance, will run on the support level to serve a number of dwelling units. But it will also operate on the infill level to connect the kitchen and bathroom equipment with the communal drainage in the building. In the same way we have water, electricity and gas distributed throughout the building.

To keep the systems independent we must make sure that the supply systems also have two different levels.

So there will be a sewage system for the support and the sewage for the infill will connect to it. This must be done in such a way that the infill part of the sewage can be changed and adapted without interference with the support part of the sewage.

In other words: each dwelling unit must have control over its own drainage on the infill level.

For instance: good separation of support and infill does not allow that the drain of one apartment runs in the space above the ceiling of the apartment on the floor below.

Sub-systems on both levels.

Once the separation of sub-systems on support level and the infill level has been completed systems operating on each level can be re-organized to make them more independent from each other.

We already have seen how, on the infill level, the door frames, the partitioning walls, the kitchen equipment and bathroom equipment and the heating system have become indepenedent. Now all the supply lines that serve the equipment must be organized in such a way that their installation - on the infill level- becomes easy. This is the major challenge for infill systems design.

But also on the support level it is easier to develop the subsystems independently because they are free from the many systems on the infill level.

Sub-systems on the support level are for instance: prefab columns, prefab wall and floor elements. Windows, and other facade elements, roof elements, prefabricated elements for public stairs, and railings. Supply lines have become very simple. On the support level only major feeder

lines for gas, water, electricity and sewage are needed to serve the individual dwelling units.

Manufacturing.

Once the separation of all subsystems on the two levels has been completed it becomes possible for manufacturers to invent and produce better sub systems without having to worry too much about the interference with other sub-systems. They can be assured that their product will fit into existing open building organization. They know on what level - support or infill- their product will operate.

This is a great incentive for manufacturing.

As you see the Open Building encourages the use of sub-systems that are generally available on the market. It advocates the systematization of a free market in which everybody can use similar sub-systems..

This give great encouragement for manufacturing, because a new invention for a sub-system that is better than what was available before, can quickly reach a very large market.

Therefore infill system have the best chance to be successful when they minimize the design of new components, but rely on the orderly application of already existing sub-systems.

In the same way the building of a support building should be based on the use of already available sub-systems.

Means of the Open Building Approach.

Open Building approach sees the building as a well organized combination of available sub-systems. To use these sub-systems in the most efficient manner open building advocates everything that encourages the better development and coordination of sub-systems such as: performance specifications for sub-systems, rules for modular coordination in design, methods of systematic design of buildings including CAD programs that support systematization. It gives emphasis on logistics, organization, and prefabrication.

To summarize:

First systems are separated on two levels. Each level is independent in its design and development.

The support level allows standardization of components: making all the bays in the same dimensions is efficient and it does not lead to uniformity anymore because the infill will be different for each dwelling unit. Hence here we have the advantage of large scale building projects.

The infill level lends itself for advanced prefabrication and rapid on site installation with the means of computer controlled processes in the distribution center where all parts are brought in by the suppliers, cut to size, packaged and put in to the container for on site installation.

On both levels we can have continued development of sub systems. Each sub system is made out of industrially manufactured parts that allow for mass production because they can be used everywhere.

On the infill level subsystems are for instance: wall panels, door frames, doors, kitchen equipment, bathroom equipment, heating equipment, electric equipment, and all kinds of conduits and pipes and cables.

**

Past developments.

The general idea of Open Building did not come overnight. On the one hand it is simply a continuation in a more systematic form, of the general building practice. On the other hand it is a new way of seeing buildings. It should be expected that it is the result of a long period of gestation and development.

The original idea of the distinction between support and infill was suggested in the early

sixties *2), The basic methods for the use of position coordination of parts by means of a modular grid have originally been pioneered by the SAR research group *3). This group operated in the late sixties and early seventies with financial support of private architects offices and building manufacturers. In the early eighties modular positioning as advocated by SAR became formally recognized in the Dutch standards for modular coordination. The most important aspect of this development was, in my personal opinion, that it resulted from a concerted effort of an small number of dedicated individuals who succeeded in making positional coordination the topic of a broad based debate involving representatives of all parts of the building industry *4). This was the begin of an industry wide debate on first principles of residential construction.

Meanwhile other architects had implemented the support/infill distinction in a number of housing projects in the Netherlands. Their work demonstrated that the application of the distinction, with its advantages for user and owner, even without a sophisticated infill technology could be done within the constraints of costs and regulations of public housing *5).

One important result of the pilot support/infill projects was that they caught the attention of some builders who began to see the potential for cost efficiency in this approach. The topic became particularly relevant when in the late seventies a severe recession in the Netherlands caused by the international oil crisis forced the government to reduce substantially its financial support of housing construction. This, for the first time after the second world war, forced competition among builders in the lucrative field of public housing. As usually happens in times of re-examination, different directions were taken by different parties.

Where some sought to achieve a better competitive position by drastic cost cutting in management and materials combined with more economic design, others recognized that Dutch housing was already among the cheapest in Europe and decided that only a new approach could open a promising future. They organized themselves in a not-for-profit foundation called Open Bouwen (= Open Building) to push for an alternative way *6).

Among the more notable results of the Open Bouwen initiative was the organization of a center for technical and design studies, by the name of OBOM, in the Technical University of Delft, financed by this university and the government *7). In a separate development a number of studies about the economics and management of open building projects were done under the supervision of committees formed by representatives from the building industry and their consultants and financed by the ministry of economic affairs*8).

It eventually became clear that a more sophisticated infill system was needed to replace the ad-hoc systems that had been applied in the support / infill projects done so far. In the course of time technical developments in the Netherlands had already produced a number of more advanced subsystems for residential construction. Among those can be mentioned a number of partitioning wall systems, industrially produced door frames that can be installed in a few minutes, and hot water heating systems that serve a single unit and fit in a closet. In brief, the time was there for a more comprehensive approach utilizing recent technological innovations as well as the methodological knowledge developed so far.

The Matura infill system (fig.5) with the development of which I was involved myself was a response to this need for a 'second generation' infill system. Its development took about five years and it is presently licensed for commercial production in the Netherlands *9).

However, this is not the only infill system presently under scrutiny in that country. In another initiative, a combined effort by a number of manufacturers is under way under the name 'Esprit' *6). Esprit advocates a 'plug in' solution maximizing flexibility for the user, It aims for more advanced subsystems and new designs for integrated equipment in bathrooms and kitchen. Pilot projects have been implemented. Commercial production on a continuous basis is expected within a few years.

Another, much more pragmatic system has been applied in a few small office buildings and

will be demonstrated for residential use in a project that presently is under way. Under the name of 'Interlevel' this system offers a very affordable raised floor of minimum height (about 10cm) under which conduits can run freely and on top of which partitioning systems and kitchen and sanitary equipment from the open market can be installed *6).

This brief sketch may suffice to show that the approach I have spoken of comes from a broad-based development that was under way in the Netherlands for several decades. It is against the background of this steady development that I hope my paper may now inform a larger audience.

***

Notes.

1) In this particular case the lump sum paid by the tenants exceeded 20% of the costs of the infill package as delivered. Some observers believe that rental users as an average would be prepared to contribute 15% of the infill package price out of pocket. This extra money is not needed to make the infill package competitive with the traditional way of outfitting renovation units, but it is an indication of the willingness of users to invest in their dwelling environment if they get what they really want.

2) First suggested in the Dutch publication: De Dragers en de Mensen, Scheltema & Holkema, Amsterdam, 1962. First English edition under the title Supports, an Alternative for Mass Housing, the Architectural Press, London, and Praeger, New York, 1972.

3) SAR, Stichiting Architecten Research. (Architects Research Foundation), Eindhoven 1965-1991, of which the author was director until 1975.

4) Major players were, among others, Ir. John Carp, at the time director of SAR, Prof. Age van Randen at the Technical University Delft, and architect Frans van der Werf, Rotterdam.

5) Most advanced among the many attempts to implement the support/infill idea were the projects by architect Frans van der Werf. Particularly the Molenvliet project in Papendrecht, the Lunetten project in Utrecht and the Keyenburg project in Rotterdam influenced the Open Building approach.

6) For more detailed information about any of the organizations and systems mentioned in this article readers are advised to write to the Open Bouwen foundation: Stichting Open Bouwen.Post address:De Vries van Heystplantsoen 2628RZ Delft, The Netherlands.

7) OBOM ('Open Bouwen Ontwikkelings Model ' or 'Open Building Development Model'). Founded 1985. Prof. A.van Randen director until 1992. Presently led by Prof. R. Brouwer.

8) Among many others a major role was played by Karel Dekker, finance and management consultant, who authored a number of pathbreaking studies on new ways for financing and budgeting housing projects based on the support infill distinction.

9) The Matura system is licensed by Matura International bv, Delft, The Netherlands. It was developed by Infill Systems bv. a partnership of N.J. Habraken, Prof. A van Randen, Mr. Ir.F.J.M. de Vries, J. van Vonderen.

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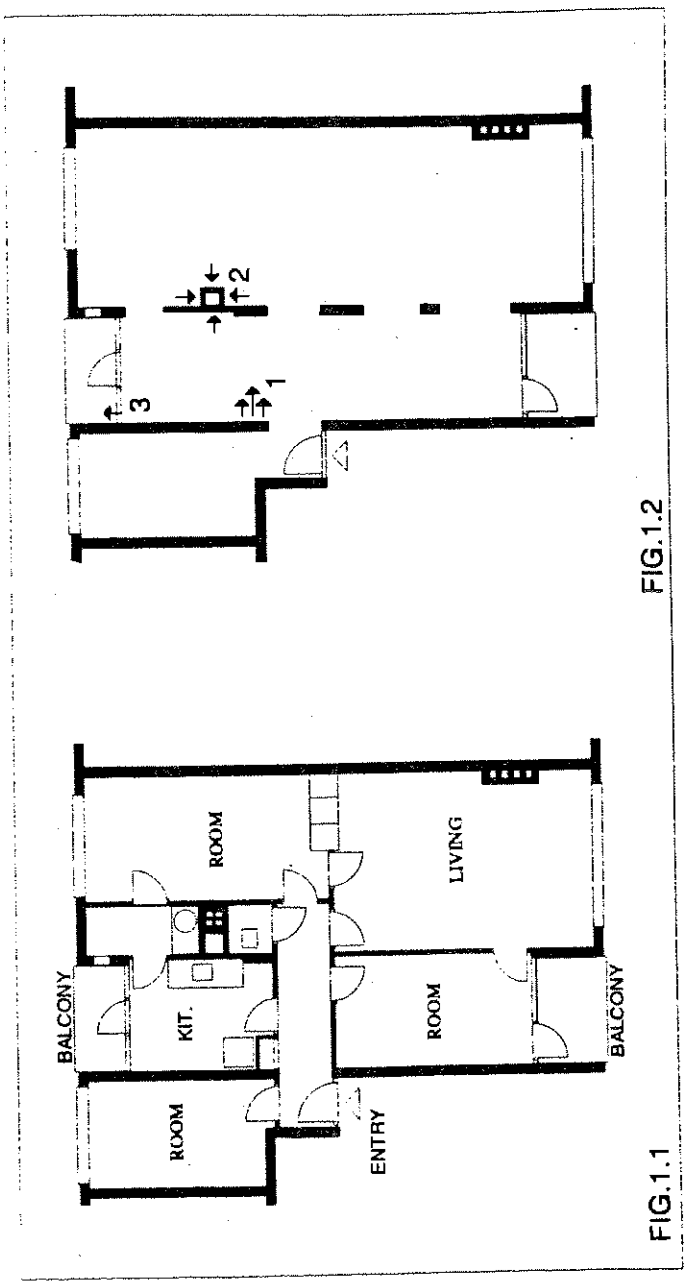


Fig.1.1: The original plan

Fig.1.2: The support building prepared for infill.
1. Connecting points for gas, electricity, and water
2. Sewage main and ventilation shaft.
3. exhaust for gas heater.

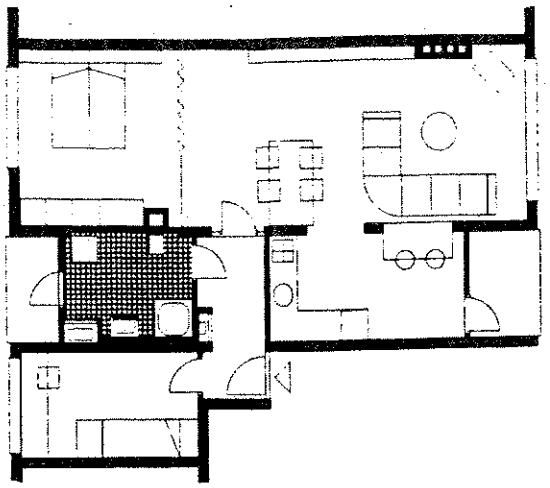


FIG.2.3

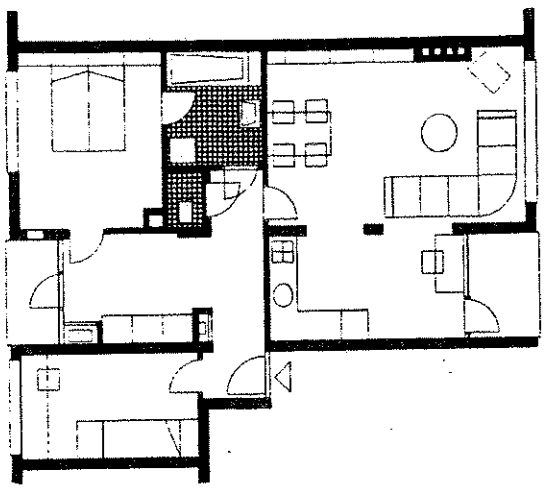


FIG.2.2

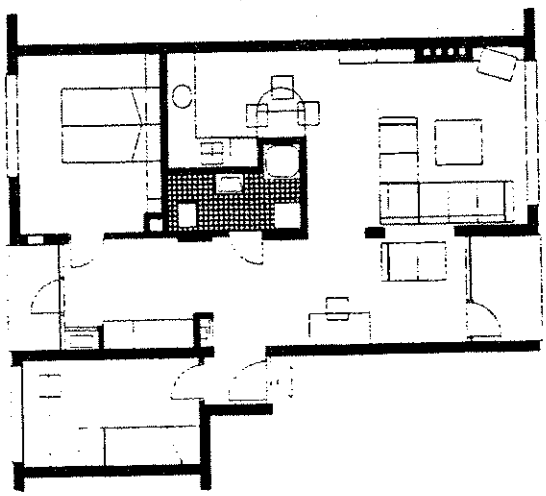


FIG.2.1

Figs.2: Three floorplan alternatives presented to the users.

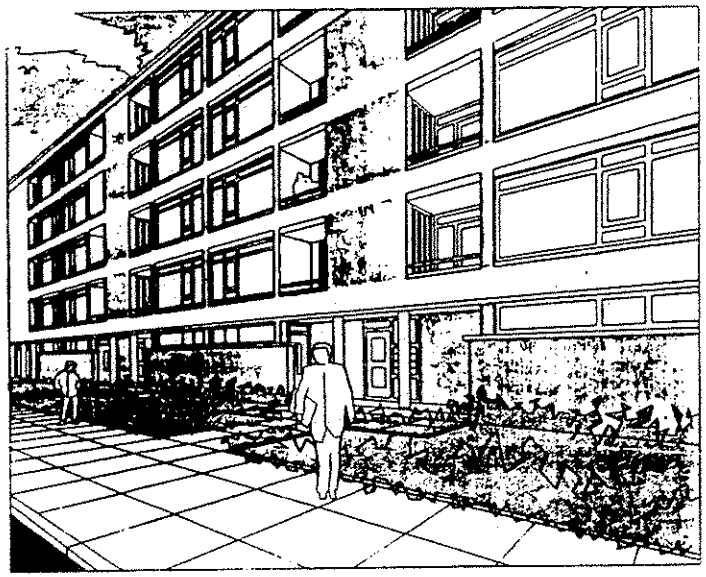


FIG.3.1

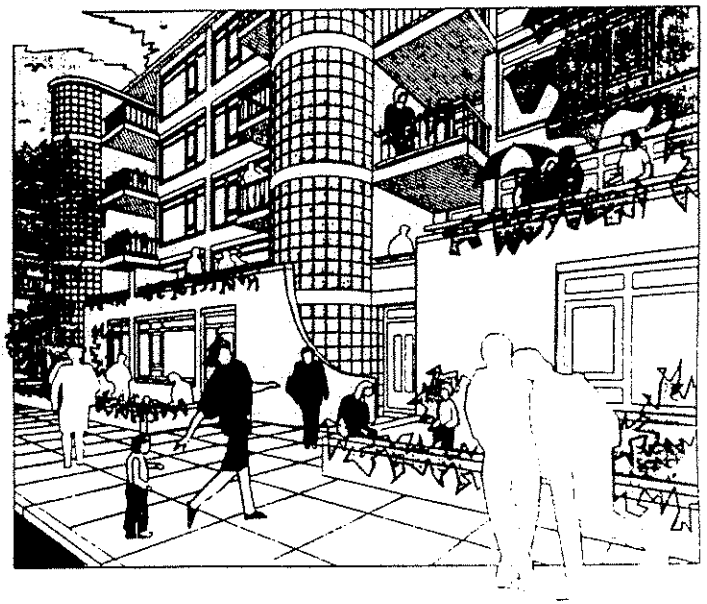


FIG.3.2

Figs. 3. The renovation of the public domain.

Fig. 3.1 The building in its present state
Fig. 3.2 The proposed renovation. In addition to a general face lift and improved landscaping, public stairs have been pushed out and glazed in while elevators are added inside. Balconies are enlarged and on ground level apartments for the elderly are added. All this is done independently from the individual renovations of the dwelling units.

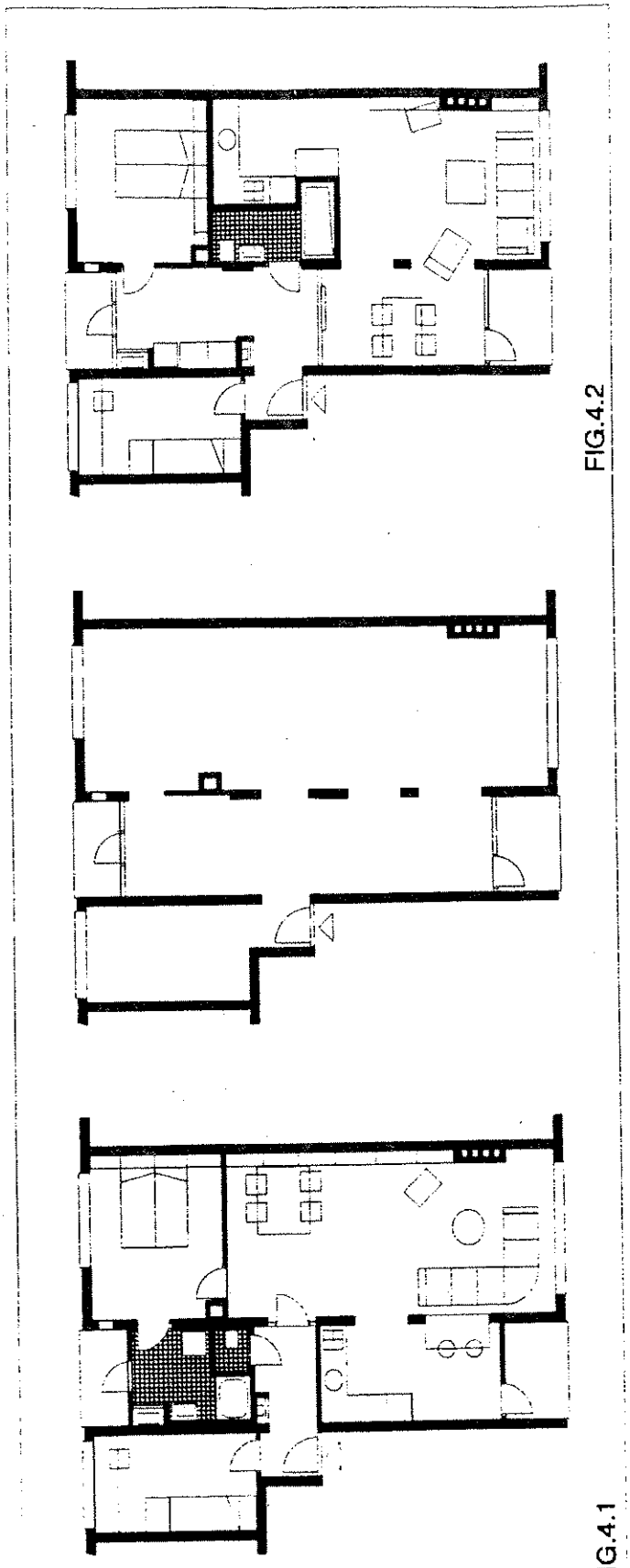


FIG.4.2

FIG.4.1

Figs. 4 : Plans as executed.

Fig. 4.1 : The plan of scenario one, compare with fig. 2.3
Fig. 4.2 : The plan of scenario two, compare with fig. 2.1

Fig. 5 : Organization of the Matura ® Infill System.

The so called lower system is structured by two new components.: 1. A Matrix tile holds conduits for water, central heating, and sewage, and is layd on the load bearing floor, and covered with a floor board. 2) A base profile holds all electricty and electronics. Elements of the upper system are from the open market and connected to the conduits of the lower system.

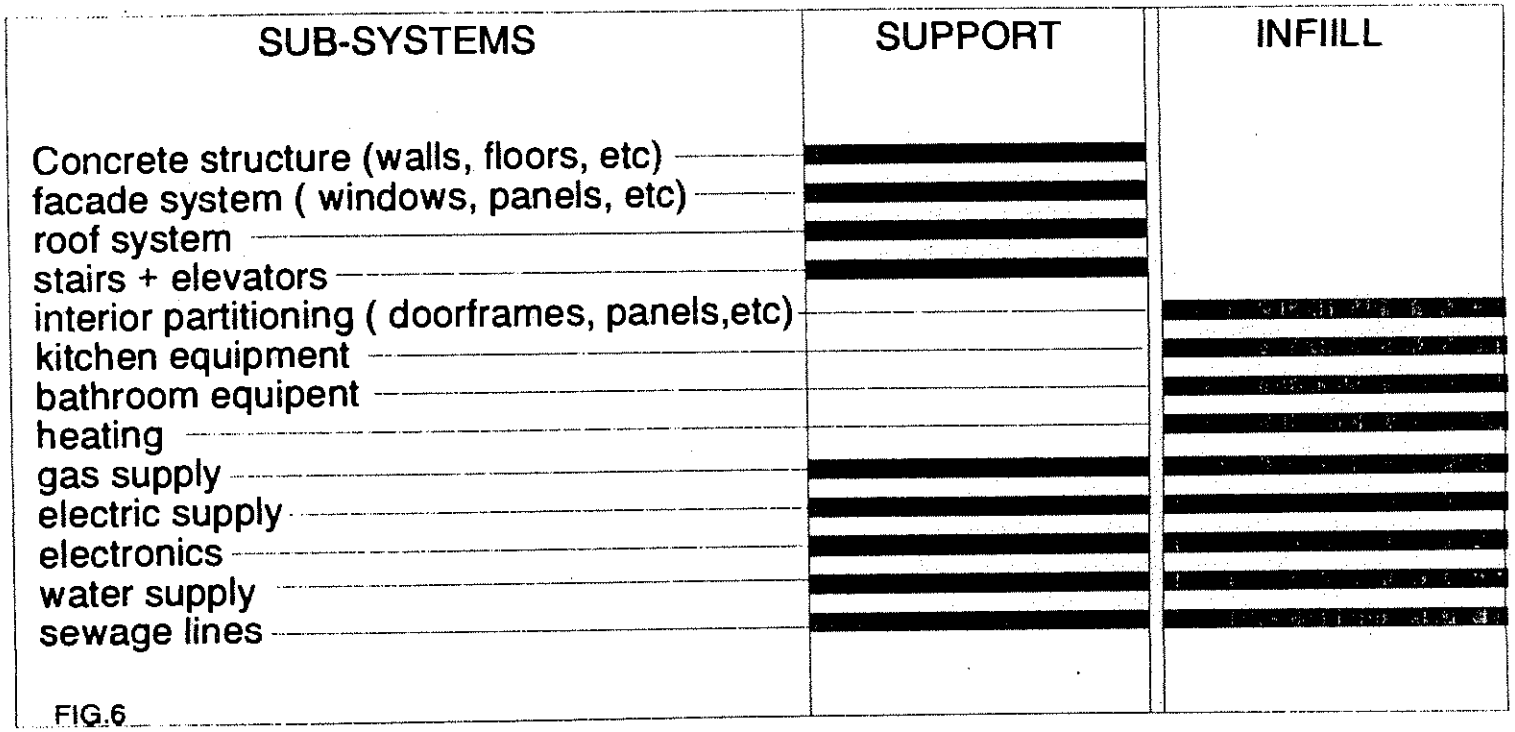


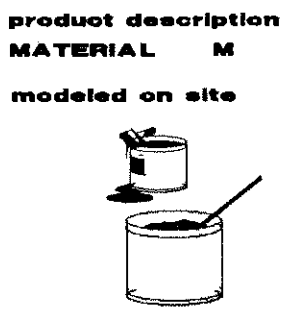
FIG.6: major sub-systems in a building and their relation to support and infill levels.

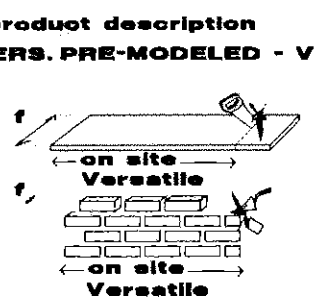
OPEN BUILDING

newsletter

The OBOM presents : The Building Node Study

More and more building is being done by assemblation on the construction site, ready-made products are trucked in and put together on the spot. However, the quality of the building is not determined by the quality of the products but by the quality of their connections : a high-grade frame which does not fit well makes a bad construction. Gearing the various building products to each other is of the utmost importance for enabling high-grade products to construct a high-grade building, the computer is an important aid in this process. The OBOM Research Group of the Technical University of Delft has given an initiative for this in their study "The Computerization of the Designing of Building Nodes", usually referred to as "Building Node I". These ideas are being developed in more detail in cooperation with the building industry.





The pretreatment and final processing of materials

We can distinguish building materials by denoting the difference between their level of pretreatment and the degree to which they can be finished and transformed on the construction site. This leads to three groups, namely O, V and M, respectively prefabricated Object, Versable premodeled, Material.

Material

In the traditional building process most materials are measured on the construction site and built in. All materials blend in in the building: the quality of the building is determined by the quality of the labour. An example of this is cement. It has a low level of pretreatment, it is not bound to the project and it is often produced industrially. Much labour is added to it on the construction site and it has a high level of adaptability in the connections.

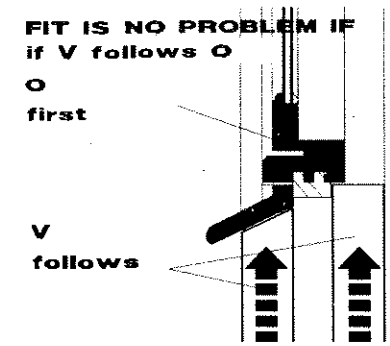
Form

In the present building process much use is made of high-grade materials which can only be made on the construction site. Facade panels are an example of this. It has a considerable level of pretreatment, it is not bound to the project and it is often produced industrially. Less added labour is required and it is less adaptable in the connections.

Editorial

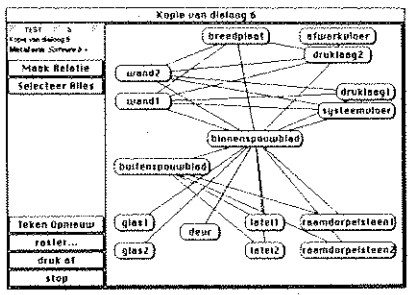
Open Building is a form of practical building. This does not imply overall simplification; Open Building has always been known to have a strong theoretical foundation. Research remains of continuous importance, not only for the practical implementation but also for the improvement of the concept of Open Building. In this information bulletin the emphasis is clearly on research. The OBOM Open Building Research Group has completed her study of "The computerization of the building node" and is on the verge of a continuation of this study. The Building Research Foundation (SBR) has presented the results of their study on their assessment of the flexibility installations of office buildings in the report "Flexis". Research proceeds and adds to work that has already been done and it can only lead to good results if the information is passed on, whether in written publications or orally. E-mail, in one of its many variations, can be a good medium for passing on this information, but also the information bulletin you are reading now.

1994 / 1



Part

More and more materials are being trucked in ready-made. An example of this is a window-frame. It has gotten its definitive form in pre-fabrication, it has a high level of pretreatment and it is often bound to the project. No added labour is required on the site and its level of adaptability is nil.



Dependency diagram

Any O - O connection (for example: a pre-fab frame in precast concrete panel) requires more gearing to and thus more exchange of information beforehand than an O - V connection (for example: a pre-fab frame in brickwork). In other words, an O - O connection has a level of mutual dependability. This is why it is important to know which building parts are mutually dependent, whether directly or indirectly. Changes are immediately incor-porated into a new dependency diagram.

Building Node II and Facade Research

The supply industry is highly interested in this research as it can be an important key to a project-independent product-development and for a guaranteed quality of the connections of these products in building. In the years to come this research will be followed up in close cooperation with the supply industry. Furthermore, the results of "Building Node I" will have a central position in the OBOM-research "The Envelope of Utility Buil-dings". The results of "Building Node I" can be ordered via the secretariat of the Open Building Foundation.

FLEXIS:

The Flexibility of Installations researched by the SBR

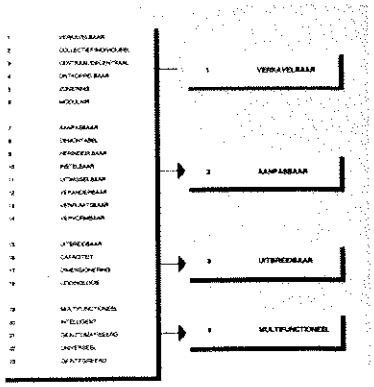
In a joint assignment of the 'Stichting Bouwresearch"(SBR) and the 'Instituut voor Studie en Stimulering van Onderzoek'(ISSO) in the field of building installations, R.P.Geraedts B.Sc.(KD/Consultants) completed a study titled "Flexis" at the end of 1993. The study "Flexis" is one of a series in which flexibility in the design, building and management process is central. It is a method for the communication and advising on and the assessing of flexibility between installations and office buildings.

FLEXIS

- A METHOD OF COMMUNICATION
- FORMULATION OF THE FLEXIBILITY DEMAND
- ASSESSING THE FLEXIBILITY DEMAND

Introductory

Developers are facing increasing problems in their exploitation of office buildings. Especially older office buildings on insignificant sites run the risk of losing their position on the market. More and more offen developers are faced with unoccupied buildings because their buildings were not sufficiently geared to tha changed needs. Unoccupied buildings cause waste, for the environment as well as the destruction of capital. Economic motives alone do not lead to a demand for more flexibility. Also for a personal feeling of well-being and satisfaction at work, flexibility is essential to enable the place of work to be adapted to the wishes of the individual user. Flexis can play an important and stimulating part in initiating measures for future flexibility.



What is "FLEXIS"?

Flexis is a method for the communication and advising on and the assessment of flexibility between installations and office buildings. With Flexis supply and demand of flexible installations can be keyed to one another. Flexis is a resource with which the demand specification of flexible installations can be formulated and with which the supply can be assessed. With this there can be a better anticipation of the changing functions of buildings and the installations which are part of them during the preparational phase but especially during the development phase of a project.

The User's possibilities of Flexis

Method of communication

Flexis is a resource to communicate on the flexibility of installations and the appreciation of it in office buildings. This communication can take place between advisors and clients or between the various advisors and specialists themselves.

Formulating the flexibility demand

With Flexis the performance demands can be formulated for the flexibility of the installation functions, for existing as well as new office office buildings.

Assessment of the flexibility supply

Owners and users can analyse the quality of flexibility of the installations of office blocks on offer.

One can check if the installation designs meet with the demands.

What is flexibility?

In general the concept of flexibility can be described as adaptable, pliable and easily adjustable to varying circumstances. For buildings and installations this means that they are adaptable to changing circumstances, functions and needs.

Four aspects of flexibility

One of the cornerstones of Flexis is introducing a distinction in various aspects of flexibility. To enable Flexis to be better manageable, a large number of aspects of flexibility have been grouped together to four aspects:

1 Possibility of Allotment
2 Adaptable
3 Extendable
4 Multifunctional

Functional Differences Installations

INTERIOR ENVIRONMENT:

1 Light
2 Sound
3 Temperature
4 Air

FACILITIES:

5 Communication
6 Gas
7 Water
8 Electricity
9 Transport
10 Sanitary
11 Fuel
12 .....

Functional Differences of Installations

Another cornerstone of Flexis is formed by introducing a functional difference in the installations.There are two main parts:

- Interior Environment Installations
- Installations for general and technical services

Installation functions such as Light, Sound, Temperature and Air belong to the Interior Environment. Headed under Facilities are all other supporting installation functions which are necessary to enable a building to function well, such as Communication, Gas, Water, Electricity and Transport.

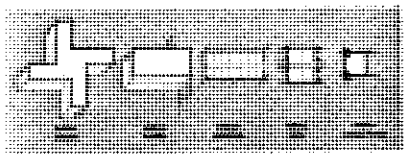
Six Installation Components

When looking at the technical installations more closely there appear to be six main components which occur regularly:

1 User's Facilities
2 Measuring and Control Equipment
3 Distribution Facilities
4 Supply Facilities
5 Building Facilities
6 Transport Facilities

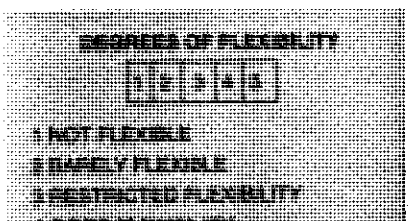
What is a profile of flexibility?

By passing judgement on the flexibility of various installation functions and parts, a profile of flexibility is created. A profile of flexibility is built up of a number of elements: weighing factors, degrees of flexibility and degrees of costs. The main element of a profile of flexibility is the distinction into five different degrees of flexibility. These vary from 'not flexible' to 'very flexible'. The flexibility quality of the installation function concerned can be determined on a scale of one to five.



Distinction of levels or modularity

In the detailed elaboration of Flexis, five different levels of consideration are distinguished: Building, Building Wing, Floor, Lot and Module or Bay. Also on the basis of these levels or modules of different scale level, the degree of flexibility of installations can be indicated. An important condition for the flexibility of installations is the fact that the different levels can indeed be disengaged. Changes in installations on a certain level will not have any influence then on the working or the use of installations on higher levels. Simple adjustments for this are for example plugable connections or backkick valves in distribution devices.



An example of the degrees of flexibility

Next to this column an example is given of a possible assessment of the various degrees of flexibility. It concerns a supply facility of a production unit (power station) of a light installation. The more it is divided and disengaged over the various modules, the more flexible the total installation is and the more equipped to deal with future changes.

How does Flexis work?

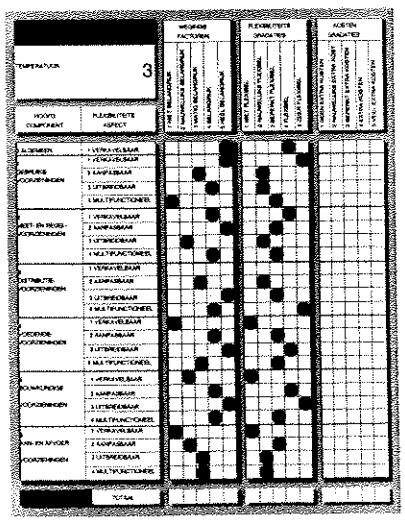
In order to make Flexis easy to use, a number of measuring lists were devised. With these it is possible to quote the various aspects of the methodology quickly.Also the demand specification of flexible installation functions can be numerically or grafically registered. Installation designs or existing biuildings on offer can be assessed with these lists. Supply and demand can be compared.

Surplus or deficiency of flexibility

A grafic account can be given of a demand profile as well as a supply profile. In other words, the demand profile represents the demand of the client or of the desired flexibility performance of the installation functions.The supply profile represents the installation design of the installation functions of the building on offer. By using these profiles, the discrepancies between demand and supply can be visualized immediately.

What is still missing ?

In this article an example is given of the degrees of flexibility. For a truely adequate practical administration of Flexis, more degrees of flexibility and standards need to be developed. It is the intention of the SBR and the ISSO to set up a continuation of the Flexis study somewhere in 1994. Especially all lacking degrees of flexibility or standards will be worked out. A test in the field will follow. Finally a publication will be made with many illustrative examples.



The Open Building Foundation presents the draft for the operational plan for 1994/1995

The executive committee of the Open Building Foundation has developed various ideas for the future of the Foundation during the past year. The most important objectives are : more publicity and an exploitation which covers the costs of the Foundation. Twice yearly one theme will be in the focus of attention. For the next two years the plan is as follows :

Spring 1994:
The Housing Consumer
An approach to building- and housing problems as proposed by Open Building may well be the answer to the changing housing demands of consumers. Only when the consumer makes his wishes known; policymakers will become interested in Open Building. The first theme will be aimed at making the housing consumer aware of the possibilities he has. Contact is being made with various consumer organisations for this theme.

Fall 1994
Housing Management and Open Building
Managers of house-building projects want a sound return of their property. This implies that on the one hand they want the costs to be able to be kept low, while on the other hand they want to have secured profits.
By means of the Open Building concept, building property can be adjusted continually to the market demand.
From a legal point of view, this approach is on a new territory and deserves further attention. The first step to take when starting out on an Open Building project is a well formulated assignment.
Experiences must be evaluated, those in new housing development as well as in renovation.

Spring 1995:
Building-in: Do-it-yourself or let it be done for you?
The consumer does as he pleases and with pleasure he likes to do it himself. Does this result in quality improvement of housing or does this threaten it? Does the do-it-yourself market oppose a threat to the existing building contractors or does it lower the barrier for the consumer to go to a professional building contractor? In the spring of 1995 a meeting will take place between representatives of the do-it-yourself branche and representatives of the small and medium-sized building contractors as well as the suppliers of built-in assembly kits.

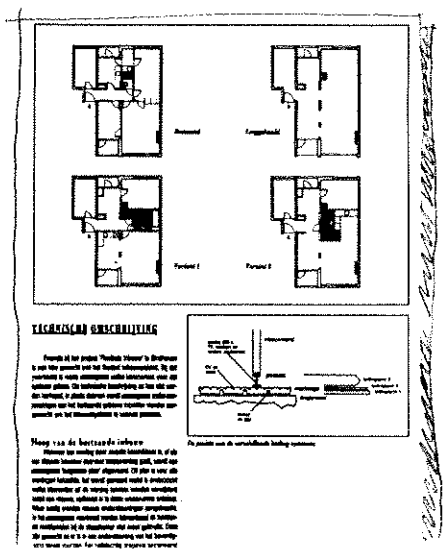
Fall 1995:
Municipal Environment and Infrastructure
The preceding themes are related to the consumer and the management. However, the consumer being interested has everything to do with the quality of the environment. For when choosing a dwelling, in the first place attention is payed to the neighbourhood and the environment. This is the reason for the necessary attention for this theme in the Fall.

Appeal for the Formation of an International Study Group

The study groups of the Open Building Foundation discuss and research various topics. At the moment the study group "Building Information Data Bank" is researching the possibilities of the latest Technological Information. Messages by fax and electronic mail are pre-eminently suited for the communications of the international Open Building community. The Open Building Foundation wants to form an international study group which will exchange views on advanced Open Building subjects such as the Building Node study and the Flexis study. The discussion will take place via fax or E-mail and the results will be gathered and published. If you would care to participate or if you have any suggestions, we would welcome you making this known to the Open Building Foundation.

Flexible Building

The Dutch Ministry of Housing, Regional Development and the Environment has published a brochure in Dutch titled "Flexible Building". This brochure gives a good impression of the current state of affairs of the Open Building in Holland. The OBOM Research Group hae made a summary of this brochure in English. The lavishly illustrated brochure and the summary are obtainable via the Open Building Foundation.



Colophon

The Open Building Newsletter is a publication of the Open Building Foundation.

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PRODUCT SYSTEMS IN THE BUILDING INDUSTRY

In traditional building, all composing parts that happen to be close enough to be connected, are connected. Most of the connections are fixed ones, not designed for disconnection.
OBOM's "Building Node I" research aimed at two goals. One to make proposals for product-development in the field of prefabricated building parts. Second to propose a basis for computer-aided design of the junctions of such parts.
The opening statement of this paragraph, may be taken as a rough conclusion of our investigation into traditional building. The underlying principle of junctioning -of it- seems to be; connect them all together as solid as possible. The result of this in practice is, that one cannot predict to what other part, a certain part, will be connected in the building to be. Therefore it is not easy to prefabricate it, or to handle it -or it's many junctions- by computer.
This brochure does not give a synopsis of the complete research of "Building Node I", but for clarification it may be mentioned here that it concluded in the following parts;

- A proposal for the abstract description of a building, which can serve as a "situation" to insert a building part. In order for the part to be evaluated in terms of fit and function.
- A proposal for description of building parts, compatible with the abstract description of the building.
- A proposal to describe, study an change the relationships of building parts.

This brochure deals with the last aspect, the change of relationships of building parts. It deals with that because we think we can make short-cut in long and laborious work. You must imagine that we are able to present the picture of the relationship of building parts on the computer as follows. Each part is represented by a label. Each junction between two parts is represented by a line between the two appropriate labels. We can shuffle the labels around and try to see wether there is logic to the arrangement of it all. Actually hardly any logic was found yet. We need stronger computer programs to be developed and bigger computers to get cracking with that. We will, but it takes time. We are sure that there is a lot to be understood from such studies. We do not know of any research, that has been done in the field of building construction.
There was one aspect of order however that we found interesting. Sometimes we were able to select a smaller group of parts that -while having complex relations among themselves- , were only connected to the main body of elements, by one or two lines. Imagine that through changes in design we cut the number of such junctions to one. Then we have a group of parts connected to the main

body of parts, by one junction. This would be a self contained and rather independent group of parts in comparison with all the other parts. Such a group we call a subsystem of parts.

ORDER IN THE RELATIONS OF PARTS

The sort of order discussed here, is the order in the diagram of relationships of parts. The diagram shows which part is connected to which other parts. This can be a gordian knot, it can be an well organised and simple diagram. As said, the diagram of traditional building is more like the gordian knot, and still hides many secrets. But we think, and this is the short-cut, that also without thorough understanding of what looks like chaos to us, simplification and organization of the diagram remains possible.

This simplification consists out of two steps of subsystemisation of the order. The first step is to divide the main body of all parts into a restricted number of groups. The rule in this step is that each group may have very complex internal relationships, but between the groups there will be single relationship lines. Within our field of study, we like to call such groups 'sub-systems' of the building.

The groups, or subsystems we like to make are:

-The casco, load-bearing and dividing floors and walls and foundation (of the building).
-The facade.
-The roof.
-The infill, the interior lay-out.

> To visualize such a thing is to see the washing machine and the electric network as two separate and complex groups of parts (sub-systems), which once connected form a unity. Yet they are connected with a single line. There emerge two important advantages from this situation. First, the connection is simple, second each of the two connected is selfcontained and largely independent from the other. Each system of parts can therefore be structured and developed according to its own specific needs.

The diagram... shows these subsystems, and also indicates which connections we intend to tolerate, between these subsystems.

Then follows the second step of subsystemisation.

This applies to the internal order of junctions among the parts within each subsystem.

Here three part-groups are proposed.

-A FRAME-system
-A COMMODITIES-system.
-A SERVICES-system.

We do remember the sixties' tongue in cheek wisecrack "structures within structures". It sure applies here. We see no way around it. To be able to talk to one another,

with a chance of ease and understanding, we propose to call the latter ones "Part-systems".

Each part-system plays it's own role:
-The frame-system provides the back-bone of the subsystem it belongs to. It governs the spatial lay-out of the subsystem and it provides the space and loadbearing capacity to the other part systems. Commodities and services will be connected to the frame, not to each other.

-The commodities system entails all elements that serve as fill or finishing or as user utensil. It is set aside as a distinct system because we think these are the things where the future client would like to have a wide individual choice. The commodities are connected to the frame.

-The services system entails all powerlines, pipes and maybe motors that make things work and flow.
The services find space in the frame, and are connected to the frame.

Now a diagram can be given for the pattern of relations of all parts.
First the subsystems. We want the casco-subsystem to play the role for the other subsystems comparable with the frame-system on the part-system level. All other subsystems are to be connected to the casco and not to each other. This reduces the number of connections between subsystems to three.
Opening up each subsystem we want that only the subsequent frame-partsystems play a role in the connections between subsystems. All other part-systems are only connected to the frame-partsystem of their own subsystem. It is hard to explain in words, the diagram is relatively simple.

Such a division of all parts -of a building- into sub-systems and part-systems, provides a framework for product-development. In order to end up, in a finished building-, with the desired diagram of relations between parts, all parts have to be redesigned. The aim of this brochure is the introduction of such an effort, to be done with the help of industry. It will fall into four major enterprises, namely the design of the four subsystems. This brochure contains four leaflets, one for each, explaining in more detail each subsystem, frame, roof, facade and infill.

THE AIM OF PRODUCT DEVELOPMENT
Product development should be so set up that many

advantages would be the result of it. We consider the following most important:

1. PRODUCT VARIETY

The new products must offer a far greater choice in assortment, quality and cost as we find in the existing building industry. There must be a development towards the quality long life consumer product. Like cars are, for instance. These products must have the potential to appeal to the end user. They must come into the market where Sony, Neckermann and Toyota compete for the client's attention. The new products must push the building industry towards a consumer-oriented industry. The future client should be offered the choice between a holiday in the Bahama's or a beautiful bay window all in with cherry-wood benches and bookshelves. Who'd go to the Bahama's.

-PREFABRICATION

The new products must score in the field of prefabrication. They should be effective in replacing labour on site for labour in prefabrication. They should for the same amount of labour be of better quality, because they'll be made in controlled environments.

-ELIMINATION OF TRADITIONAL LABOUR

In holland traditional labour is becoming scarce. Quite some education goes into good carpenters and masons, but the new generations are not in a hurry to come forward. They have already understood that it makes for a nice and adventurous job as long as you are young. But over fifty, chances are great that your back gave up and you are out of a job. So, good craftsmanship will certainly be needed, but it will only be available in controlled environments and it must be safe for body and soul.

-CHANGE, ADAPTATION AND GROWTH

In a living world, that which cannot change, will be left alone. To change a traditional building costs dear. You cannot take the building apart without destroying most of it. You cannot incorporate much of the old elements into your new design.

The new products must aim at greater flexibility of the building. Reusability of parts in general must be standard quality. This also opens the opportunity of growth. It would widen the sphere of consumers'choice over time.

-WASTE CONTROL

What cannot be reused is waste. Waste that cannot be divided into its original material components can often not be used for other purposes, it must be dumped. The new products must be aimed at

reusability, wether in their final state or as distinct material components.

THE DWELLING AS A RESULT OF SUB-SYSTEMS

This is what we want, the composition of a dwelling from subsystems of casco, facade, roof and infill.
Each system allowing for variety and change. Also each system to a large extend independent and selfcontained under the control of the makers.
Like the modern kitchen industry is totally independent from the larger building industry, but succeeds marvellously in the making and marketing of beautiful products, selling them straight to the end user. Attic and roof should follow that path, as well as the facade or the infill of the dwelling.
It is not a question wether industry can do this, they certainly can. The question is how long will it take?
Let' take the example of the modern kitchen. Before the war, kitchen making was an integral part of the contractors work. He made it on site, cupboards, sink and top. The development that the kitchen underwent is unthinkable had it stayed within this domain. After the war it became clear that it should not and it did not. Industry took over, made it a independent system of parts and started to develop from there. What we propose is basically the same approach, but now it concerns the other elements of the dwelling.

It will be clear that all the parts have to be rethought and redesigned. OBOM wants to do this with the help of industry.
The industry that makes these elements is there. We want to collect industry partners around each subsystem. For the facade these will be the makers of windows and window frames, facade panels, concrete beams and panels, masonry prefabricators etc. Nobody's got to learn a new job. The only thing for them is to begin to work in concert. They should not stop at what architects and contractors order. They must think of what potentially they could make. The independency of the subsystem that they control provides the leeway for that. This leeway makes them free to develop. In traditional building no such leeway exists, they must stay within the borders of traditional junctioning, quality and costs. There is no chance that they can ever show their potential to the end user. Inbetween are always the architect and contractor.

SUBSYSTEM STRATEGY

In this brochure you find four folders, each dealing with the characteristics of one subsystem.
You will see that we do not try to devise new materials or new production processes. We think that no such thing is needed. With minor changes in existing craftsmanship and production we think an improvement can be made in

the way the products communicate with each other. The subsystem collects craftsmanship within one comprehensive field.

BUILD BOSTON / CHANGING WORKPLACE SYMPOSIUM
November, 1996

Comprehensive Infill Systems: Solving the Problem of the Pipes and Wires

Dr. Stephen Kendall, AIA / Jack Beckering, PE / and Professor John Habraken

The problem: Entanglement of Parts and the Parties Controlling Them

Office fit-out and reconfiguration are difficult in part because cabling, ducting and piping are entangled with each other in walls, floors and ceilings. Because the parts are entangled, the parties controlling them are liable to conflict. This entanglement increases initial and future costs, produces logistics and coordination difficulties, and inhibits changeability in the future. The magnitude of the problem - and the market for solutions - is vast. While some R&D efforts are underway, most current thinking falls short of the mark of solving these problems.

An Integrated Approach

A current R&D effort at Carnegie Mellon University is searching for integrated solutions for the future office. In this project - currently chaired by Jack Beckering of Steelcase - all the systems making an office building - structure, enclosure, mechanical systems, interior partitioning, furnishings - are designed as an integrated assembly for optimum flexibility and efficiency, and are installed - and changed - in a coordinated operation. This project will be presented as an example of an integrated approach to solving the problems of the pipes, ducts and cables.

An Open Building Approach

Another solution is to find principles of ordering and combining subsystems in which interference between them is minimized. This is aided by making a clear separation between the base building level and the fit-out level of buildings. Rather than integrating for a whole building, subsystems are organized in an hierarchical fashion, according to the level on which they operate. This is the normal way of working in most commercial buildings today. In the United States, comprehensive approaches to office fit-out are being studied based on this separation. A fit-out system for residential application is on the market in Europe - the Matura Infill System, with Professor John Habraken on the development team - with potential applicability also for non-residential projects.

This Seminar

Both of these approaches and representative projects will be presented. The larger point concerns the premier 21st century challenge for architecture: to assure both efficiency and variety as well as long term adaptability, respecting the freedom and dignity of individuals and the coherence and stability of the larger environment.

BACKGROUND

Facts in the Changing Work and Living Environment

Most agree that changes are occurring at a rapid pace in the organizational and technical reality of work and daily living for many people and organizations. These changes include rapid churn of communications technology and built form. They also include flatter organizations, increased teamwork, smaller, more interdisciplinary teams, home offices, telecommuting, diversification of job descriptions, and flex-time, as well as a diversity of family structures and life styles.

Many studies assert that improvement in worker productivity in the office environment has to do with environmental quality and the ability of workers to control their own environmental conditions in a demonstrable way. Some research argues that the pent-up needs for investments in the workplace environment are not recognized by building owners and developers, and when they are, are dismissed as infeasible or having no suitable payback. Other studies suggest that short term investment practices see buildings as cost centers rather than as contributors to success. For their part, workers have little or no organized voice to articulate their needs in terms of comfort, health, and job satisfaction, despite the fact that they are essential to productive, flexible organizations. Similar studies concern the changing nature of residential environments as well as mixed use environments.

The Integrated Systems Building Approach

Studies proposing total building systems integration have been at the forefront of efforts to solve the problems of complexity, standardization, and building flexibility at least since the SCSD (School Construction Systems Development) program in the 1960's. That pioneering work resulted in a new generation of building components and specification methods which have yielded substantial benefits to building users, owners as well as the many players in the design and construction industry. Product manufacturers have also reaped the benefits based on improved standards in HVAC, lighting, and ceiling systems particularly. While the SCSD program itself did not produce a large number buildings, the basic principles had a wide impact in the evolution of performance standards and in modularity and interchangability of parts from a variety of manufacturers.

Thirty years later, the concept of total building systems integration remains a powerful - if illusive - paradigm in the industry. Organizing all decisions and components under one team has its attractions. Coordinating all manufacturing, design and construction decisions so as to enhance communication and solve problems of interfaces in one well worked out planning document has been an attractive goal.

The ABSIC project at Carnegie Mellon University is perhaps the latest comprehensive effort in this tradition. It has brought a large number of parties in the manufacturing, design and construction communities into an integrated team. The resulting building is now going to be monitored to evaluate the performance of its various subsystems, and renovation of parts of the building will now be done to evaluate the success of the systems approach in supporting the "revaluing" process.

This project should set a new standard for the total building systems integration approach to solving the problems outlined above.

The Emergence of a Levels Model

Another framework for an advanced response to the most recent trends and problems in office and living environments may already exist. Conventional office building development in North America has operated on a three-levels model for some time, a strategy which may be primed for solving the problems of efficiency and responsiveness to the needs of all parties over time.

In this approach, a base building is constructed without determining the interior layout of individual territories. It is designed to meet local zoning, building traditions and climatic constraints. When the equipment and interior non-load bearing walls and other elements are determined, the fit-out work is completed in quick order. Next, the finishes and furnishings are determined and applied. Each is an autonomous level of control and activity. Because of this approach, future reconfiguration on each level is possible with reduced reverberation onto other levels. The lower level can change without disturbing the next higher level, but the inverse is not the case: when change occurs at a higher level, the lower level must adjust.

The three level model of working is part of a formal recognition of the complexities resulting from the gradual emergence of supply systems in buildings and the need for parts of buildings to adjust while the whole remains stable. The advent of ducted air for tempering indoor air, heated and chilled water for space conditioning, the increased number, kinds and distribution of plumbing fixtures, and the massive increase in cabling for power, lighting, data and security are a part of the story. So too is the increased number of players needing to be coordinated.

As this complexity has grown, one technology at a time, the physical entanglement of these supply systems has followed, giving rise to problems in the design, construction and service life phases of buildings. This physical and therefore organizational entanglement is a major constraint on the kind of dynamic flexibility now desired by individuals and organizations.

Disentanglement of Systems

The disentanglement of these systems has therefore become a matter of urgency. The problems concern not only technical interfaces but the interference of the parties controlling the different subsystems. When freedom of action is constrained, we find an increased reliance on dispute resolution techniques, instead of solving the problems through good design, construction and facilities management practices.

The basic method of solving these problems is sorting out subsystems according to their level of control. This has been resolving itself on an industry-wide basis into the three level model: the base building, the fit-out and the FF&E (furnishings, finishes and equipment). This approach has become formalized, impacting designers, contractors, and entire new kinds of consultants, specification guides, performance standards, and product manufacturing.

Thus, we see the gradual emergence of an infill or fit-out level between the building and furniture. Within this level, the non-load bearing partitions, equipment and much of the pipes, cables and ducts serving them are being taken out of the building level and given their own, independent deployment. This restores the building level as the essential provision of space and shelter. In turn, this means that the infill or fit-out level can cater more directly to the specific needs and preferences of inhabitation or tenant occupancy, a solution which is not purely technical but has to do also with the control of technical systems by various agents.

What's Next ?

Total systems building integration remains illusive, in part because of the complexity of bringing agreement at one time to so many decisions. In the case of the levels approach, the infill or fit-out level is not yet stable. We do not yet speak about an independent infill or fit-out system or a fit-out industry as such. Fit-out is not yet a product with well understood interfaces and rules. The strategy of working on levels does not yet have a name. Base buildings are being constructed with less than optimum capacity for either a variety of fit-out decisions or long term fit-out adjustability. Buildings constructed a decade ago face economic and technical obsolescence because they cannot adapt. But some buildings constructed in the last century or early in this century are better suited to changing needs.

Many problems remain to be solved. At the base building level, improved methods are needed to optimize capacity for lower level systems. This includes structural systems that allow efficient infill installation. Facade systems are needed that solve problems of thermal and weather isolation and a variety of occupant preferences. Improved mechanical systems and other utility systems are needed which operate satisfactorily on the principle of levels.

At the fit-out level, the ordering and combining of subsystems remains in a state of disarray. Questions of which parts of the entire cabling of a contemporary office building should be in the base building, the interior construction or the furniture are hotly debated. Similar questions apply to the movement of air and fluids, lighting and acoustical treatments.

Further, the installation of products at the fit-out level remain the work of many independent subcontractors, each responsible for labor, materials and quality assurance at the job site, adding overhead, waste, scheduling, safety, quality and coordination burdens. Regulatory inspections remain tied to individual subsystems with inadequate assurance that their technical interplay has the requisite quality and safety.

A New CIB Working Commission on Open Building

A new Open Building Working Commission is being formed as part of the CIB (International Council for Building Research Studies and Documentation). The new commission's aim is to take stock of and advance the evolution of the way of building based on the principle of levels. It will stimulate further developments in the building industry as well as produce and disseminate documentation of results in practice and research through workshops and virtual conferencing on the World Wide Web. Initial projects of the Working Commission include:

> The preparation of a Status Report on Open Building Developments Internationally, concerning both residential, mixed-use, and non-residential building uses;
> Development of a long term strategy for the Commission;
> Recommendations for an information infrastructure for the Working Commission;
> Report on the availability of expertise and technical needs in the building community related to Open Building methods and principles;
> Report on the current state-of-the-art in "test fit" or "capacity analysis" tools for evaluating base buildings for short term variety and long term adaptability.

Upcoming meetings of the Commission are planned for Delft, the Netherlands, in May, 1997; Washington, DC in November, 1997; Stockholm, Sweden in Spring, 1998 (in conjunction with the Civil Engineering Research Foundation); and Tainan, Taiwan, Fall, 1998.

For Information on the Subjects of the Seminar

For information on the CIB Open Building Working Commission, please contact

Dr. Stephen Kendall, AIA, 604 Winona Court, Silver Spring, MD., 20902 / tel/fax:301.649.6803
email: skendall@pipeline.com

For information on the Matura Infill System, please contact

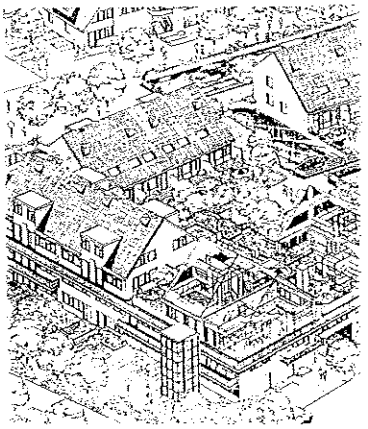
Professor John Habraken, 54 Trowbridge, Unit D, Cambridge, MA., 02138 email: njhabraken@aol.com or contact Professor Kendall.

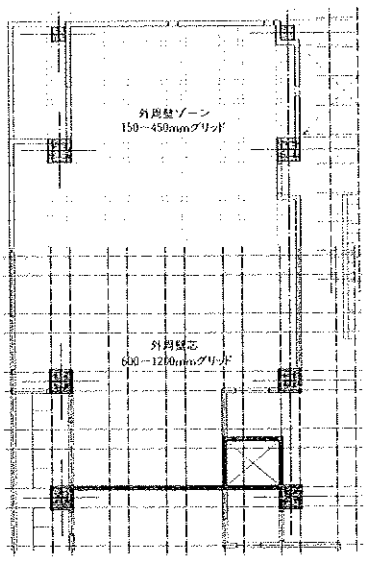
For information on the Carnegie Mellon University ABSIC project, or Steelcase ,please contact

Jack Beckering, Senior Manager, Advanced Systems Technology, Steelcase North America, CD.5N.02, PO. Box 1967, Grand Rapids, MI., 49501.1967 / tel: 616.698.4611 fax: 616.776.8946. email: jbeckering@steelcase-research.com

CIB Work Commission on OPEN BUILDING

Coordinators: Karel Dekker, TNO, The Netherlands
Dr. Stephen Kendall, AIA, USA





Objectives / Scope

• Open Building is a way of designing and constructing neighborhoods and buildings in which parts are given optimal freedom for layout and production. The idea is to find principles of ordering and combining parts in which interference between them is minimized. This disentanglement allows efficient design and construction processes and results in reduced reverberation of one system's change through the whole form.
This Commission will study and document these principles.

• Design, construction, and management are aided by adoption of the principle of levels. Examples of levels are "support" and "infill" in housing, and "base building" and "fit-out" in commercial buildings. In the levels approach, there is stability and coherence at the higher level while adjustments can occur at the lower level with reduced conflict and confusion, improving efficiency and economic value. It also enables control to be effectively distributed to all levels, including that of building users.
The Commission will report on the uses of levels in practice.

• The problem of complexity in buildings results from, among other things, an increased uumbers of roles and players, a need to balance individual and group freedoms and responsibilities, and the introduction of many utility systems in buildings. The interplay of physical systems and those controlling them will be a primary focus of Commission work.
The Commission will report on trends concerning Open Building.

• The goal of the Working Commission is the stimulation of improved design methods, software, manufactured products, strategic planning and management tools, and construction practices at all levels and in all sectors.
The Commission will foster industry - public sector - university collaboration.

Proposed Activities

The Workiug Commission will organize and document:

- Interdisciplinary meetings;
- Open Building site visits
- Design research exercises;
- Demonstrations of methods and products.

Proposed Meetings

- 10/29 - 11/3, 1996. Tokyo
- 5/97, Delft (?)
- 10/97, Washington, DC (?)
- 5/98, Stockholm
  CIB World Congress

Developments Toward Open Building in the United States

Stephen Kendall, October, 1996

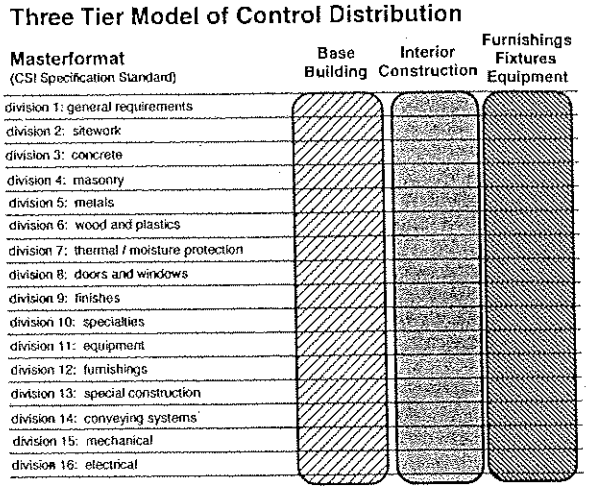
Evidence of Open Building in the non-residential sector

Most multi-tenant office and retail buildings in the United States are organized on Open Building principles. Specifically, base buildings are constructed without determining the division of floor plates into separate tenant spaces, the interior layout of individual tenant spaces or their individual furnishings and technical equipment. When individual tenant spaces are sold or leased, they are "fitted out" to suit.

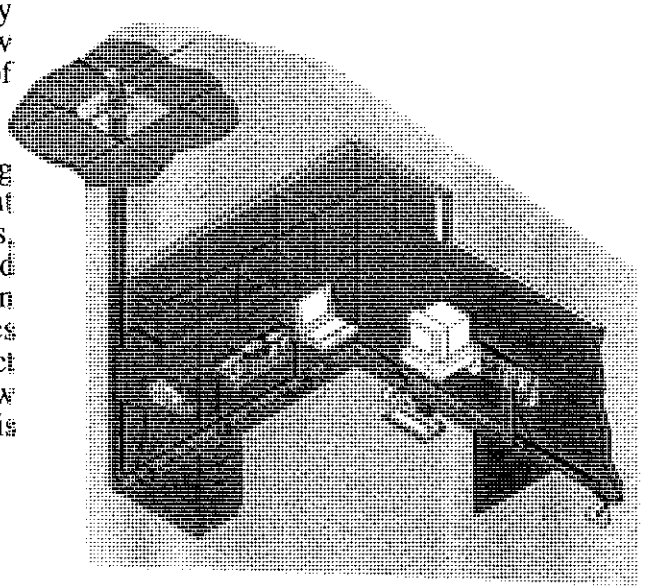
Later, individual tenant spaces are altered on a regualr basis with minimal disturbance of other occupants, and new tenants move in replacing former tenants. Demising or party walls separating individual tenant spaces are frequently removed to enable in-place or new tenants larger or smaller units of occupancy.

Financial lending institutions, building designers, construction companies, tenant service organizations, real estate brokers, regulatory officials, building owners and users expect this process. Design software tools and construction logistics are changing to match. Product manufacturers are bringing new technology and services to bear on this market segment.

Three Tier Model of Control Distribution



This diagram presents a basic three tier model of decisions. Later diagrams give examples of its use to describe actual (or hypothetical) situations in which control is distributed in a particular way. It also allows technical interfaces to be identified, as later diagrams show.



Examples of developments toward non-residential Open Building:

The term "Base Building" is conventional. It means the entire building minus the individual tenant space "improvements", thereby including building structure, envelope and roof, "core" vertical circulation and egress system, building level mechanical, electrical and plumbing risers and laterals.

The term "Fit-Out" is conventional. It refers to the building elements decided and installed specifically for an individual tenant or building occupant. Fit-out includes interior non-loadbearing walls under occupant control, the lighting, ceiling and access floors in the tenant space, the environmental control systems, ducts and controls specific to that space, and the built-in equipment, storage and finishes.

The term "test-fit" is conventional. This is the process by which spaces in base buildings (existing or proposed) are evaluated in terms of their capacity to accommodate the present and anticipated program of requirements of organizations seeking new space. Sophisticated software is often used in this process.

The Interior Design profession claims the fit-out and test-fit activity. Interior design has come to maturity at the same time that the distinction between base building and fit-out has become the norm in the non-residential sector.

Construction companies become specialized according to levels. Separate divisions of large construction companies are formed to specialize in either base building or fit-out work. Other companies specialize in one or the other arena of work.

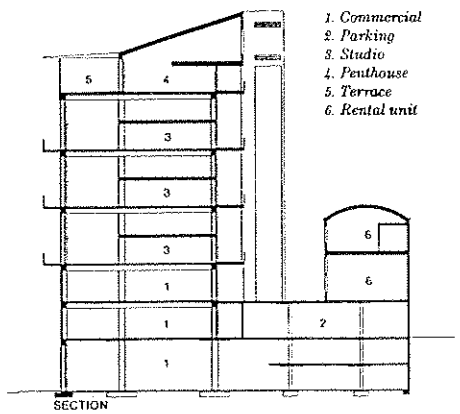
Manufacturing companies develop products on Open Building principles. Steelcase North America is developing a "slab-to-slab" infill system called Pathways in collaboration with other product suppliers to provide customized, software driven interior solutions for clients. Its introduction challenges interior design and interior construction practices. Access floors or raised cable management floors are becoming more common place. They are advertised as part of the changable element of buildings.

Evidence of Open Building in the Residential Sector

Residential multi-tenant buildings have not yet seen the emergence of the distinction of base building and fit-out to any extent, for two reasons. First, they are more technically complex and thus more difficult to disentangle. Second, residents of apartment or condominium buildings have no organized economic power equivalent to that of corporations driving the adoption of open building in the office and retail sectors.

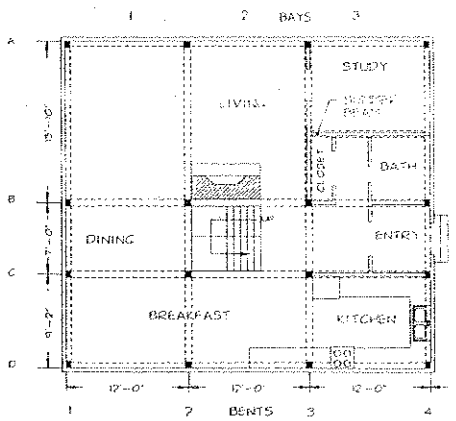
Examples of developments toward residential Open Building:

Some developments approach Open Building, indicating a nascent demand ready to be tapped by an advanced fit-out system:



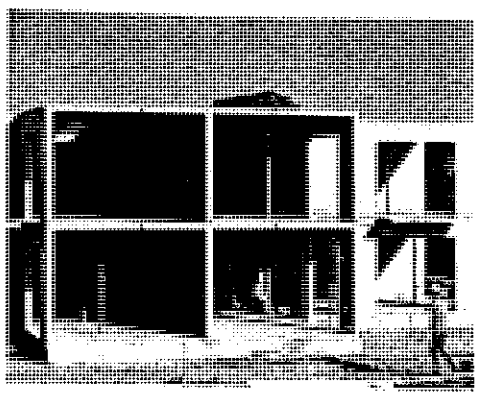
Hadley Holdings, Seattle, Washington. A multistory concrete building was erected. Dwelling spaces were sold empty, and fitted out on a custom basis as they sold. Cost control and on-site logistics were a serious probem during the fit-out process.

DiVosta Homes, Florida. A homebuilder in Florida uses Outinord tunnel forms to build structural shells. They are outfittted with elements pre-cut in an off-site fabrication center. Efficient logistics and standardization of the base building construction allows rapid project completion.



Benson Woodworking Company, New Hampshire. A leading builder of timber frame houses has decided to adopt Open Building principles in the design and construction of its homes, to help solve the problem of utility system routing in a building type in which the structural frame is exposed and piping and cabling routing is a major technical and design problem.

Lnxury townhomes are sold as base buildings. A luxury townhome development in Alexandria, Virginia was built without determining the interior layout of spaces. Units were sold as empty, serviced shells. Owners worked with a designer to specify the interior layout, fixtures and finishes. The units were fitted out in a second operation by the base building contractor.



Conversion of office buildings to multifamily residential projects. With increasing frequency obsolete office buildings in desirable locations are being converted to residential developments. In most cases, new common utility shafts are inserted to enable a variety of floor plans on different floors to be fitted-out.

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THE POTENTIAL FOR RESIDENTIAL OPEN BUILDING IN THE UNITED STATES

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ABSTRACT: Adoption of Open Building in the United States housing industry can occur in the coming decade, based on experience in office and retail construction which already operate with an "INFILL" or "FIT-OUT" level. Conventional housing construction and renovation face technical and management problems caused by severe systems entanglement, leading to increased conflict, lower quality, and reduced capacity for long-term adaptability. The paper reports on developments in the US that set the stage for adoption of Open Building in the housing industry.

1. SUMMARY OF OPEN BUILDING PRINCIPLES

- First, systems are separated on two levels: the "base building" or "support, and the "fit-out" or the "infill". Each is independent in its design and construction. This is aside from whether one company makes all the parts or the parts come from many suppliers.
- The "support" or "base building" level allows standardization of basic construction: this does not lead to uniformity because the infill will be different for each unit. Here is the advantage of large scale building projects.
- The "infill" or "fit-out" level lends itself to advanced prefabrication and rapid on-site installation by means of computer controlled processes.
- On both levels, continued development of improved subsystems is possible. Each subsystem is made out of industrially manufactured parts that allow for mass production because they can be used everywhere in any project.
- On the "fit-out" level, subsystems are, for instance, wall panels, door frames and doors, kitchens, bathroom , heating, cooling and electrical equipment and all kinds of conduits, pipes and cables. Parts of the facade may also be included, such as windows.
- To use all of these subsystems on both levels in the most efficient manner, Open Building advocates all possible steps that encourage the development and coordination of subsystems such as performance specifications for subsystems; rules for modular coordination in design; methods of systematic design of buildings including CAD programs that support systematization; emphasis on logistics, organization and prefabrication.

2. CHANGES IN THE US CONSTRUCTION INDUSTRY LEADING TO OPEN BUILDING

The US construction industry is very large. Investment in new building constitutes 10% of a $7 trillion US Gross Domestic Product. Investment in new residential construction last year was $210 billion, while investment in housing renovation and repairs was $115 billion.

The construction industry is highly disaggregated, is dominated by market decisions and is changing, due in part to advances in information technology. Several trends are worth noting.

One of the biggest changes is in the distribution system. It is loosing layers, and those remaining are restructuring. Manufacturers sell direct to retailers. Intermediaries are being eliminated, effecting manufacturers, suppliers, and the design and management professionals.

Second, the construction and building product market is more consumer oriented. Consumers can bypass traditional intermediate organizations such as independent design consultants and suppliers, effecting the construction and housing industries in ways that are not fully understood. Ikea, for example, found that consumers want to participate in "creating value". Their emphasis on good design, instant delivery, and "assemble -it-yourself" products is a result. Another example are the "Home Projects Centers", such as Hechingers and Home Depot. These are very large building products suppliers for the "do-it-yourself" market. Hechinger's employees 20,000 in over 130 stores in 19 states, and had revenue of $2.4 billion last year.

Third, the roles of contractors and subcontractors are changing. An increased volume of the on-site work is done by subcontractors. General contractors are loosing share of the work. But subcontractors also find their positions changing, with the introduction of higher value added manufactured products. They are burdened by obsolete boundaries between trades, causing friction. A new emphasis is placed on teamwork skills rather than competitiveness.

Fourth, there is an increasing variety of specialized materials and component suppliers. Some product manufacturers sell their products installed by their own forces. Currently, this activity is limited to simple products like roofing, roof trusses and windows. The trend is projected to expand. Some materials dealers now organize complete interior fit-out packages for a tenant job and supply them to the remodeler to install.

Fifth, changes in the market for buildings point to changes in the labor force. The US construction industry is facing a labor shortage. There is also a shortage of skilled workers, and industry analysts predict that the problem will get worse. Even with an increase in training programs, the incentives are lacking to attract the present generation of young people, as it was in the past. Now, immigrants are seen as the only large, available labor pool.

Some observers suggest the need for multi-skilled "installers" who can do many kinds of work in teams. Most smaller contractors are "installers". They know how to do every job. Building and apartment maintenance programs are increasing multiskill training through the US Department of Housing and Urban Development and cities around the country. The US Department of Housing and Urban Development recently asked the AFL-CIO Painters Union and Carpenters Union to enter into non-jurisdictional contracts to speed rehabilitation of public housing.

All building trades in the United States, unionized or open shop, are burdened by jurisdictional boundaries that are not well aligned with emerging strategies in the building industry.

Sixth, more knowledge is now embedded in products. Gradually, more complex design and technical decisions are being made farther up the value chain - by the manufacturers. The use of higher value-added products, despite their higher first cost, may result in lower total project costs, because on-site work can be done faster or eliminated. This effects architects and engineers, making their work easier and faster while requiring new roles and knowledge of systems coordination.

In the US, we now are at a threshold. Adjustments in construction management techniques alone no longer produce needed efficiencies. Increased pressures for both variety and efficiency in building require new generations of products and processes to reduce technical interfaces and speed installation and alteration work, using already available products on the market. There is reason to believe that the principles of Open Building offer important answers in how to do this.

3. AN UNRECOGNIZED DEVELOPMENT IN US DESIGN AND CONSTRUCTION

There is a major unrecognized development in US construction practice concerning the introduction of a new level in the built environment. It can be called the FIT-OUT LEVEL. "Base building" and "fit-out" are now common terms in the US industry.

Today, many kinds of non-residential buildings in the US are organized in exactly this way. A "base building" is constructed without determining the configuration or layout of individual territories. These spaces are then "fitted-out" according to the requirements of each. This makes sense because the interiors of such buildings are subject to more rapid change than the buildings they occupy. This reality matches organizational and economic forces at work in society.

Within each of these general levels there are other levels. For example, we have what is called FF&E. This stands for furniture, furnishings and equipment. Components previously classified as interior construction are now found in the FF&E category. Some access floors are an example.

Different contractors may be involved: one general contractor constructs the base building, while completely independent organizations are hired by each tenant to finish its space. Still other contractors are hired later to replace one tenant with another.

Exactly the same thing happens regularly in office buildings, corporate headquarters, and government buildings. Medical centers also follow this model. This has been the convention for years, and is becoming more sophisticated. It constitutes a huge market for design and construction services and for manufactured building systems of all kinds, and is gradually producing two industries, each with its specialized service providers, materials, systems, and construction organizations. This distinction will become more important in the future as more attention is focused on the huge renovation needs of our existing building stock.

This strategy is not first of all a technical development, although technology is involved. It is first of all concerned with new distributions of responsibility in the society and the building industry. This practice has evolved slowly and is now so widespread that its impact is not discussed. This is a problem, because the improvement of this practice depends on its being clearly understood. When this understanding exists, buildings and the building process can be improved, allowing businesses and users to profit in many ways.

4. SIGNS OF BASE BUILDING / FIT-OUT PRACTICE IN THE UNITED STATES

The Design Professions

The clearest result of the introduction of this new level among the design professions is the emergence of the interior design profession in the last decade. An agreement was recently reached between the AIA (the American Institute of Architects) and the largest organizations representing interior designers. Architects may claim responsibility for all aspects of a building design, with their consultants. Licensed interior designers may claim responsibility for the design of the entire building fit-out. This can include non-load-bearing walls, heating and air-conditioning systems, lighting, finishes and furniture. This scope of design decisions constitutes more than half of the cost of many buildings today. Schools of Interior Design now exist to educate people for these new roles.

Construction Organizations

Many construction firms have separate divisions specializing in base building construction and fit-out work. Some specialize only in base building construction. Others organize everything needed to finish a tenant space, bringing together access floors, systems furniture and furnishings, walls, cabling, heating and cooling ducts and equipment from many suppliers. They establish good relations with preferred suppliers who deliver quickly.

Systems Furniture Companies

Large furniture manufacturing companies have begun to study broader roles in providing complete interior fit-out "packages" for large clients. Steelease North America, for instance, now is well along in the product development of a "slab-to-slab" interior fit-out system. It adds a very low-profile wire management access floor to its existing systems furniture products. In coordination with ceiling providers, Steelcase may soon offer a complete fit-out package.

New building products are being introduced because this distinetion between base building and fit-out is the industry convention. This requires better coordination, not integration. US businesses and developers are not interested in complex, closed systems, because they think that their decision flexibility is limited in negotiations about price and quality.

5. THE NEXT STEP: RESIDENTIAL OPEN BUILDING

Retail and office developers in the US have learned the benefits of distinguishing base building from fit-out. The products, services and distribution channels serving these building types are organized to match. After almost 25 years of evolution, many believe that this arena is poised for a second generation of infill systems product development.

Residential developers have yet to see the profit in adopting the Open Building strategy. The reasons for this are complex, and deserve more study. This will change out of necessity. More mechanical sub-systems now appear in residential buildings, and are increasingly entangled. The complexity and the pressures for efficiency and variety are increasing.

The use of advanced fit-out systems will start in residential buildings whose construction is similar to office buildings. But it will eventually become profitable to distinguish two levels of activity even in buildings constructed in the 2x4 tradition. As manufacturers learn how to make higher value added systems that solve on-site problems, they will have to adopt the principles of Open Building in order to manage the complexity. Several forces point in this direction.

First, demographic and social conditions. The population of elderly people with money will increase. Elderly households often have special needs and preferences. The next occupant may have very different preferences, and the financial means to accomplish them. Buildings will have to be adaptable, and builders and designers will have to learn new roles and methods to serve the demand. People are marrying later in life, and have fewer children. More unrelated individuals live together. More young people continue to live at home for a longer time. Units built to suit yesterday's household types will not be suited to today or tomorrow.

Second, patterns of urban growth. Multifamily high-rise housing will remain concentrated in central cities, and will remain a small percentage of total housing production. The fringe cities ringing large US metropolitan regions have ample space for row-house units within reasonable commuting time of jobs. With an increase in telecommuting, distances to work do not matter so much, decreasing the demand for high rise housing. But the demand is for individual choice while also cutting costs and getting more amenities. More efficient building techniques are needed to resolve these apparent conflicts, and to renovate older buildings.

Third, costs. In a calculation of costs of a single family house, the items reasonably placed in the "fit-out" column account for nearly 45% of total house costs, including electrical, plumbing and heating/cooling systems. [3] Land costs are increasing as a % of total costs while construction costs remain temporarily stable, suggesting higher density and more complex development patterns.

Increasing costs of new construction will make rehabilitation more attractive, especially in multi family buildings. The huge bubble of housing built in the 1970's - 25 million units - now face modernization, ranging from "gut-rehab" of the entire interiors, to selective rehabilitation of mechanical systems and finishes, roofs and windows. New strategies are needed to cut costs of modernizing the millions of obsolete multifamily buildings.

The technical problems facing current residential construction. The confused interweaving of systems inside the walls and floor cavities of the traditional 2x4 house building system is a matter of fact. Complex environmental control systems have been added into the technical repertoire for houses only over the past 3 generations. Architectural inventors in the first half of the 20th century tried to solve the problems by "integrating" these systems with the space defining elements of houses. As the number and complexity of these resource systems increased, the problems of integration became overwhelming, both technically and organizationally. The ideal of "integration" could not be matched in practice. [4] This was particularly the case given the highly disaggregated structure of the US economy and building industry, and the highly varied market of consumers.

6. RECENT STEPS TOWARD THE ADOPTION OF RESIDENTIAL OPEN BUILDING

In 1994, an effort was begun to inform the U.S. housing community about Open Building. Articles were published in national professional journals. Armstrong World Industries, a world leader in the manufacture of ceiling and floor materials and products, hosted a national workshop in January, 1994. Thirty US and foreign organizations, companies and government agencies were represented. In May, 1994, the Office of Housing Research at FANNIE MAE in Washington DC hosted a second workshop. [5] Fannie Mae is a $2 billion public / private enterprise owned by shareholders and chartered by the Federal Government to support financial lending for affordable housing. It is an intermediary between primary mortgage lenders and the global capital market.

Several residential projects in the US have recently been built which begin to move in this direction, but without the benefit of residential fit-out systems. One is the Banner Building

Condominiums, Seattle, Washington, a new building offering "shell" space for 14 two story "live-work" dwelling units, each with access to all utility systems [6]. Another is the renovation of the Richard Allen Homes, a large, distressed public housing project in Philadelphia, Pennsylvania [7] which is being completely gutted, with new unit sizes and layouts, new mechanical systems and some new additions.

7. CONCLUDING REMARKS

In retail buildings, the basic unit of territory to be manipulated and controlled is the individual shop. This is conventional. Construction processes await a next generation of fit-out systems from product manufacturers, to reduce costs, improve on-site installation efficiency and improve quality.

In office buildings, the basic territorial unit is the work station, the department or the tenant. Again, the distinction between base building and fit-out is conventional in this type of use, and the tax code, building regulations, financing, and the roles of brokers, designers and owners reflect it.

In the residential market, the time is right to introduce the Open Building strategy for both new construction and renovation of the existing stock. The household as the basic social and territorial unit in residential environments should be supported by introduction of residential fit-out systems.

Those advocating Open Building in the US residential market see the need for two kinds of activity. First, an independent "think tank" should be formed to examine the implications of the Open Building strategy in residential building. There are many independent, non-profit organizations in the US devoted to housing and urban policy, but none dedicated to the examination of a concept which links policy and physical issues as Open Building does. Detailed public domain studies are needed on regulations, finance, mechanical systems and other interior installations, construction and design methods, and marketing strategies. Funding is being sought.

The second process that must be stimulated in the US is the commercialization of fit-out systems. This will require investments in market and technical feasibility studies of existing technology, and the development of new systems. I also believe that this should include the transfer and licensing of foreign "fit-out" products in the North American market, from Japan and Europe. "Fit-out" technology is uniquely suited to international trade. Investors are being sought.

The US housing industry is very large, parochial, and slow to change. However, the housing process has reached a certain threshold which must be crossed. The present condition of combined organizational and technical entanglement must be confronted directly. Realignments already underway in construction logistics, demographics, and roles point strongly toward the adoption of Open Building practices in the residential field in the United States. For that reason, Open Building is not either a utopian vision or an academic theory, but a practical strategy. It can provide answers to difficult technical problems. In the process of solving these technical difficulties, the natural relationship between people and their direct living environment can be strengthened. The concern for the well being of the built environment and its inhabitants is after all our central motivation.

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Europe's "Matura Infill System" Quickly Routes Utilities for Custom Remodeling

Housing System Like U.S. Office/Retail Approach Where Base Building is Fitted Out

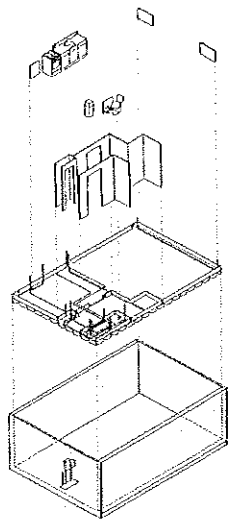
By Stephen Kendall, PhD

Breaking even financially can be difficult for builders of any size, especially in multi-family and townhouse projects. As one builder said, "Everyone wants our house the way *they* want it." The result is that builders either limit variation to a few simple choices or move to high-end projects where margins are large enough to give buyers anything they prefer. Anything in between causes higher prices and many headaches.

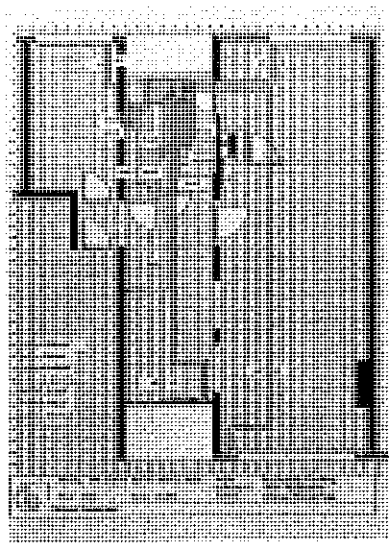
This is unfortunate, because the middle of the market for multi-family housing—households earning $60,000 to $100,000 per year—is an obvious place for major improvements in technology and a very important place to make money if the know-how is there—because the market is so large. This includes new construction and also the already large and growing multi-family and townhouse renovation market. Not only elderly or retired empty-nesters, but younger and middle-aged couples who like urban amenities are demanding customization at a reasonable price.

The place where customization matters most is interiors. In multi-family or townhouse projects, this is the only place where significant variation is even possible. Of course, buyers can get special windows or exterior treatment. But interiors are the place where money is spent; where the most extended discussions occur over finishes, equipment and floor plans.

Can we do better supplying this market?



Conceptual drawing of "Matura Infill System" and space to be fitted out. Lower system is comprised of "Matrix Tile," piping, "Baseboard Profile" and cabling. Upper system elements include partitions, equipment, cabinets and finishes. Pipes, cables and upper system elements are off-the-shelf building products.



Technical drawing generated by "Matura-CAD" shows water and hydronic lines, partitions and doors. All are laid out in the "tartan grid" positioning modules measuring 4" X 8".

European product ready for licensing in United States

In Europe, the fully prefabricated "Matura Infill System" provides residential customization at a competitive price. The idea is akin to our office/retail construction, where a "base building" is constructed without determining the "fit out." Once the interior layout and equipment is decided for an occupant, it is quickly installed. It works in office/retail projects, so why not in residential? One reason this has not worked so far in residential is that residential is more complicated and more entangled with pipes, wires and ducts per square foot than commercial fit-out. So it is important that a system is now on the market that solves the problem.

The Matura Infill System, is an "open system" utilizing sub-systems and parts that are available on the market. All of these subsystems are integrated into an adaptable whole by means of two newly developed elements: the "Matrix Tile" and the "Baseboard Profile." These elements provide flexibility in design, fast installation on site, and changeability in the future.

Matura is based on a radically new distribution of resource distribution lines—sewage, water, heating, electricity, etc.—made possible by the Matrix Tile and Baseboard Profile. Interfaces among these lines and between them and the partitions is minimized. Their routing is organized so that each is installed freely without interference with other systems. And because these lines are not buried in structural walls or floors, their installation is extremely rapid. No pipes or wires from one unit penetrate the space of any other unit.

One of the advantages of this system is that it fits in any physical context. Installation does not pose special demands on the structure or facade. Thanks to the free distribution of resource distribution lines, the location of vertical service shafts does not determine floor plans any longer. This makes

Matura factory worker building system components before they go to the site. MaturaCAD software provides design information enabling all parts to be accurately pre-cut.

the system attractive for renovation projects.

Matura dealers use trained teams of three workers to install each unit one at a time, complete in about two weeks per unit. This means that large projects with uniform floor plans are no longer a prerequisite for efficient residential construction. By employing several teams at once, each doing a different floor plan in different units, more units can be filled in simultaneously.

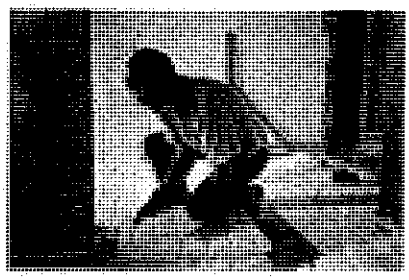
All of this is made easier by the use of proprietary software which allows the quick translation of a floor plan into a technical design of all subsystems. The technical design, in turn, automatically feeds a database which steers the selection, dimensioning and cutting of all parts needed for one dwelling unit and determines their packaging order in a container. The container is delivered to the site and parts are brought into the space for installation. Included in the software is proprietary know-how concerning the dimensional coordination of all parts allowing these parts to be cut to size before they reach the site.

Benefits

The Matura Infill System offers advantages for all parties involved.

For the builder, on-site installation of interior work goes faster, with less overhead and fewer logistical problems.

For the developer, there is freer choice of floor plans which can be decided only weeks before installation. There is also a choice of wall types, doors and door frames, wall finishes, HVAC, kitchen and sanitary equipment and cabinets in a Matura package.



Worker at the site lays Matrix Tiles on the structural floor. When the tiles are set, utilities will be routed through the tiles' grooves.

For the household, there is the possibility—if they want—of determining their own floor plan. Any decoration and finishing scheme can be accommodated. Outlets for electricity, telephone and television can be moved or upgraded to correspond to chosen arrangements of furniture. Adaptation of the floor plan and technical systems can be done in the future.

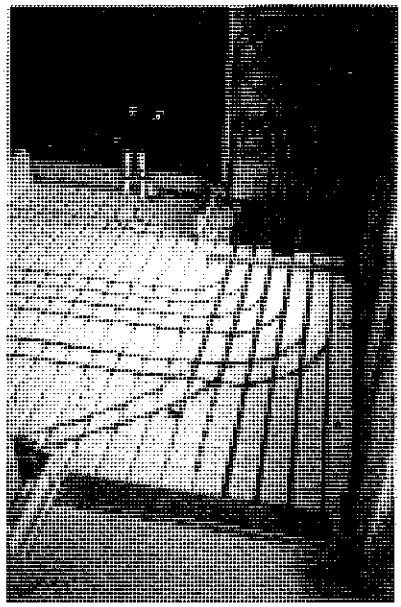
For manufacturers, any technical system in the Matura Infill System (including HVAC, kitchen and bathroom equipment) can be replaced by a newer or preferred version without interference with other subsystems. This means that alternative or improved subsystems can be offered swiftly and economically as part of the total infill system.

Application in Netherlands

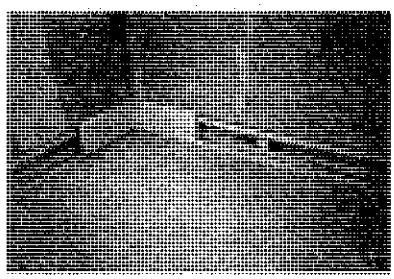
A residential unit became vacant in a concrete, flat-slab, five-story multifamily building constructed to normal Dutch standards in the early 1960s.

The building owner decided to gut and modernize the unit, while at the same time starting a long-term project to upgrade the base building. The Matura company was contracted to do the fitout for the unit and asked an architect to work alongside. Two weeks were required to gut the unit. During that time, the new tenant met with the architect and a floor plan was decided from several options. The architect's drawing went to the Matura company. One month after being vacated, the unit was ready for occupancy with an entirely new interior matching the new tenant's preferences.

Later, an elderly couple downstairs decided to modernize their apartment.



Water and hydronic heating pipes fit in the top grooves and converge on the utility closet where the gas-fired water heater is located.



Pre-terminated cable is in place along Baseboard Profile. Finishing work is about to begin. If wanted, outlets be easily relocated later.

Flooring and baseboard cover feature stained-wood finish. The remodeling job is complete.

They discussed their requirements and preferences with the architect, stored their furniture, left on vacation and returned a month later to a completely modernized apartment with a special kitchen which they wanted and paid for above the standard that the building owner was willing to purchase.

Between the apartment blocks on the site, a number of new, two-story town-

house units were built and fitted out using the same system.

Currently, a 50-unit, new construction project is underway in the Netherlands. Other clients are lining up. Costs are competitive with traditional construction, but Matura offers many advantages not available in traditional construction.

A German developer is planning to use the Matura Infill System in a large project in Berlin to help him control costs. A company in the United Kingdom is assessing the system for adoption in the large rehabilitation and privatization market there. Developers in Finland and Sweden are also taking a serious look.

The Matura Infill System, or a similar product based on the same principles of separating base building and fit-out should be introduced in the U.S. housing market. It will solve problems and satisfy a growing market for customized interiors in new construction, in renovation of older multi-family buildings and in converting obsolete office buildings to residential use. The concept may also be applied to detached wood-frame houses in time.

A World Wide Web site is now under construction to describe the Matura Infill System. The address is: "http://www.access.digex.net/~david /OB.html".

Apartment building in the Netherlands after units were upgraded with the Matura Infill System. The first-floor units are designed to provide housing for senior citizens.

For more information on infill systems contact: Stephen Kendall, Architecture Plus Interior Systems, 604 Winona Court, Silver Spring, MD 20902. Phone and fax: (301) 649-6803.

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The Entangled American House

Stephen Kendall

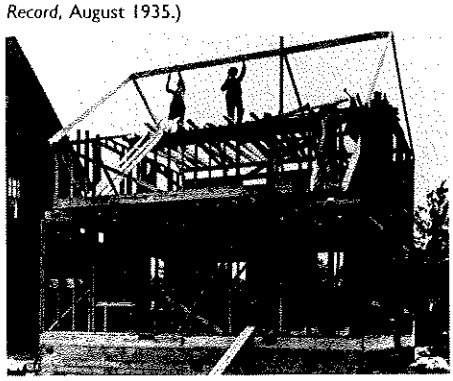
A visit to an ordinary dwelling or apartment building under construction in any neighborhood in the United States, just before the sheetrock is hung, is a good way to assess the state of entanglement in American housebuilding.

Imagine what we will see. Amidst the normal jumble of building-in-progress, the smell of sawdust, remnants of wiring insulation, dried mud and debris on the subfloor, and empty styrofoam hamburger containers, a keen observer will see the exposed wall and ceiling cavities crammed full of parts. Immediately evident is an almost unbelievably confused array of installed pipes of varying types and sizes for supplying and carrying away fluids, air ducts of several shapes for moving air, thousands of feet of wires for electric power and communications, and, in some jurisdictions and some building types, sprinkler lines for fire suppression.

It was only five generations ago, around the time my grandfather was in his teens, that plumbing and central heating, and later wiring, became commercially available at reasonable costs and were promoted by architects and developers for use in apartment buildings and houses. [1] These entrails now dominate housing processes in ways unimagined at that time or even thirty years ago.

The entangled service systems in the floor cavity of a normal residential project, 1993.

A balloon frame house in 1935. (*The Architectural Record*, August 1935.)



A State of Entanglement

In virtually all construction types, multi-family and detached, wood frame and concrete, the technical and organizational entanglement of American residential building has reached a critical state. The overall lack of order of the relation of resource distribution parts to the rest of the buildings they serve is an indication of the problem.

What we can see of the interweaving of parts lacks the clarity and elegance still attributed to wood framing or other structural systems. Today, walls and floors of sticks of wood or substitute materials—the main elements of the beloved and ordinary 2x4 system which first came into use in the 1830s in Chicago [2]—are filled to overflowing. Many of the wooden or steel structural elements are fastened in place and then pipes, wires, and ducts knitted haphazardly into them. This is especially destructive now in traditional wood-frame construction, where holes are bored on-site as needed and, often at random by each trade, frequently with no coordination.

Each part of these service and structural systems no doubt represents, in itself, the best product for the least cost, available from the world-wide building products industry, each installed by a different trade and each serving a perceived need.

This interweaving process seems to have worked up to now for four main reasons: the remarkable structural redundancy and forgiveness of wood or steel framing, the expectation that the next stage of work in this conventional chain of events will cover any depredations of the previous player, the relatively low cost of materials, and the availability of skilled workers. None of these can be taken for granted today.

Because the cavities between wall studs in all construction types and floor joists in framed buildings have been available by nature of frame construction, they have been filled in no particular anticipatory order in a historical progression by the first to get there. Trade jurisdiction work rules, starting in the craft guilds but having migrated into the work force in general, followed the emergence of new parts and processes, dividing the work accordingly. Now, separations of work patterns, incrementally added over decades, are as antiquated and convoluted as the paradigm of house building they accompany.

This entanglement is the fault of no one in particular, making it difficult to establish cause or to measure responsibility. It is therefore difficult to remedy. In an important way, the diffused responsibility for this "system" is both its liability and its strength: it is a living system controlled by no one trade or company but is shared and gradually improved by all who use it.[3]

The Interplay of Technical and Organizational Patterns

The situation of entanglement would not be so much a problem if it were only technical in nature. However, as with many situations made visible by observing technical hardware, the issues are not divorced from their organizational and social ambiance. Now, the entire constellation of actors—manufacturers, designers, constructors, regulators, and users—is likewise enmeshed, producing conditions ripe for poor quality, higher costs, disputes, and loss of decision flexibility.

Among the many social and organizational forces at work, five stand out.

Demographic Shifts
Most of us have read about or directly experienced the rapidly shifting demographics in our neighborhoods and regions and the changes of household types and sizes accompanying the larger statistical perturbations. In part because of these social dynamics, housing developers today build for specific market niches and unit mixes in their projects. The way buildings are organized today, building income may suffer, and operating costs increase if piecemeal or even substantial upgrading or "repositioning" of a building is needed to maintain its attractiveness in the market.

If these statistically targered buildings are not entirely obsolete, facing abandonment or mistreatment, they at least may not make a good fit with the next statistical cohort of households. While in a very large aggregate sense all of these mismatches may even out, in any one building or locale the discontinuity can have telling but difficult to measure negative effects on household well-being, contributing to a sense of powerlessness over the place of dwelling ar a very personal level where dwellings mean rhe most to us as inhabitants, an effect often felt in tbe community at large.[4]

Decision Deferment
We also know that, in housing developments that take several years from planning ro occupancy, developers seek to defer the cosrliest decisions and most-likely-to-change decisions as long as possible. They want to keep rheir options open in order to quickly change unit mixes and layouts when new household formations appear in their market research. These are the costliest decisions. But the impulse to delay sends ripples through the entire chain of actors, pushing all action to the last possible moment, compressing an already difficult and entangled process. Unless well organized, this decision-deferment process, which is desirable for some, can cause major cost and construction management conflicts for others.

Control
Many households want a direct say in major interior layout, fixtures, and equipment decisions, no longer content with moving into dwellings someone else has decided have "good layouts and feel." This may be a case of households wanting to reclaim "territorial control" of housing decisions from experts remote from the realities of living in the house being built, experts who, often lacking other means, base decisions on statistics rather than actual individuals. Organizing for variety without driving up costs is a constant challenge for builders and development teams. Many are pushing variety as far as they can within the present paradigm of housing production efficiency.[5]

Change
Industry statistics show clearly that expenditures on house renovations, adaptations, and upgrading are mounting beyond $100 billion each year in the U.S. market.[6] These commitments to dwelling adaptation are more difficult and expensive for both professionals and do-it-yourselfers to realize because of the enranglements of parts and the parties involved, as discussions witb contractors or building owners and inhabitanrs reveal.

Organizational and Supply Chain Reconfigurations
Finally, many industries are reorganizing their supply chains in response to new concepts of value creation. Ikea is an example of a large organization, wirh sophisticated supply chains in tow, that offers a new division of labor, including customers taking on certain key tasks of assembling well designed but lower-cost products. The Hechinger Company and Home Depot represent other organizations restructuring to new demands. They offer surprisingly comprehensive design and construction services and the logistics to make it happen. The concept of "mass customization" is now discussed among industry forecasters, including the Global Business Network in California. Robert Reich, Secretary of the Department of Labor, discusses the concept of "multi-disciplinary work cells" in a recent book.[7] The United Brotherhood of Carpenters and Joiners now takes interest in new cross-trade affiliations to alleviate jurisdictional disputes, and is exploring various proactive training and apprenticeship programs that they believe may be needed in the future, as unions seek market recovery in residential construction.[8]

The latter reconfigurations, taking place nationally and internationally, are good examples of responses ro new social, economic, and technical conditions having a direct bearing on housing processes.

An important threshold seems to have been crossed in a fascinating incremental process accomplished without anyone trying or perhaps even noticing. No one has sufficient autonomy to act, change the direction of their decision path, or adapt what is already built, without engaging—often in conflict—dozens of other actors, each controlling some physical parts, each with their own problems and priorities.

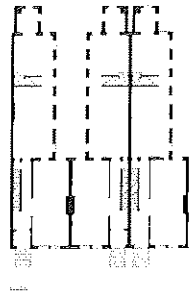
This is truly a situation of loss of freedom across the board, not at all what we have expected from our way of building houses and the mythic democratic, market-driven housebuilding culture that has grown up with it. This loss is significant because it is happening in a political economy in the United States that we have traditionally associated in very strong terms with household level control of housing activiry and housing improvements. Paradoxically, in a society stressing individual rights and responsibilities, we find that control of design decisions by occupants, apart from expensive custom-designed single family houses, is considered a nuisance or disturbance by many housing experts who take an inside-out view of the market.

This view, which still holds a constricted view of efficiency and is based on obsolete concepts of standardization and unified expert control, is very much at odds with the very nature of healthy housing activities.

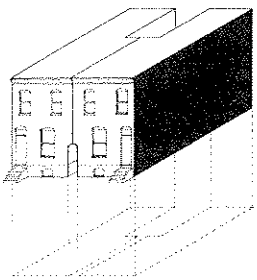
A Short History of Entanglement

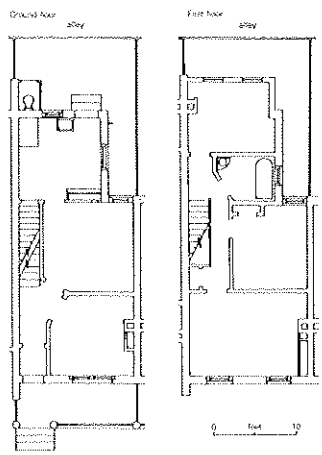
Early American Houses
American houses built in the eighteenth and nineteenth centuries are a good background against which to trace the evolution of our present entanglement, because then, neither electricity, plumbing, nor central heating were present.

In these early houses, which people could afford to build, often following principles of compositional clarity and formal simplicity brought from European traditions [9], the few spaces were organized in such a way that they could be and were used for many household activities. Often, sleeping, living, bathing, and cooking occurred in one space in a time-sharing approach. It was normal to have change of use in harmony with the seasons and, of course, change of activity patterns when a new family moved into a house. This was accomplished by the repositioning of furniture and

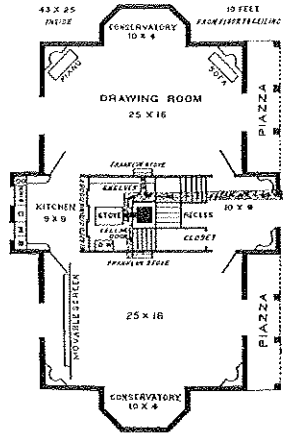


Plans of nineteenth-century rowhouses in Reading, Pa., showing general spaces with kitchen or bathroom at the rear. (Steven Holl, *Rural & Urban House Types in North America,* Pamphlet Architecture 9, New York, 1982.)





A plan of a Philadelphia mechanic's house in the early twentieth century, showing a kitchen in the rearmost space, a toilet attached to the back of the house, and a bathroom without toilet on the second floor. (Parish, H.L.. *One Million People in Small Houses,* Philadelphia, 1911.)



Drawing of the central utility core proposed by Catharine Beecher in 1869. (from *The American Woman's Home.* Catharine E. Beecher and Harriet Beecher Stowe, 1869. in Russell, Barry. *Building Systems, Industrialization and Architecture,* Wiley, New York, 1981.)

storage elements such as wardrobes, armoires, and the like. Rooms were labeled "hall," "north parlor," "south parlor," "chamber," etc. Few could afford to build use-specific rooms. Indoor toilets and bathrooms were non-existent, and kitchens were found in any room where a fireplace provided a place to cook or located in a shed attached to the back of the house.

Houses of the Industrial Revolution

During the last half of the nineteenth century, indoor plumbing for water distribution and drainage was gradually and then rapidly introduced into houses and apartments, accompanying rapid urbanization, gradual increase in household affluence, and justified fears of threats to public health, safety, and welfare. This was supported by the development of inexpensive, mass-produced, cast-iron and lead piping, and public water systems. The first vented trap to remove sewer gases from toilet rooms was introduced in 1875, the introduction of the first really sanitary water closets took place about 1890, and publicly funded sewers and waste treatment plants were built in the same era. These public and private initiatives enabled bathrooms to migrate, in stages, from the privies in backyards to attached toilet rooms tacked onto the back of houses, and finally to take their place inside, even in multifamily apartment buildings.[8] Building regulations in most large cities required indoor plumbing by the end of the nineteenth century. [11] Even so, 45 percent of households did not have complete indoor plumbing as late as 1940. [12]

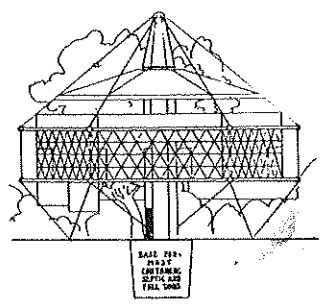
Other pipes brought natural gas to give illumination, still other pipes brought steam for heat. In the period between 1900 and 1920, wires began twining through walls and floors and behind baseboards, replacing gas as a means of illumination and serving a burgeoning supply of electrical appliances plugged into convenience outlets.[13]

The mechanical removal of odors and humidity, and the addition of cooling to the technical services load, with the need for more equipment and distribution lines and ductwork, waited until decades later to make an appearance inside houses as standard features. Then, these developments happened quickly, in the span of several generations, following World War II.

Functionalism

The migration indoors of bathrooms and kitchens attached to their resource tethers, taking place from the 1880s onward, coincided with the Victorian concept of dividing indoor space into distinct "functional" territories.[14] Particularly with the detached house, this concept of spatial order related directly to specific uses was a distinct departure from long traditions. These traditions were rooted, in many cases, in the principle of types, in which "functions" or "uses," and even "territorial distributions," would be decided independently by those who inhabited buildings.[15]

Thus, during the Industrial Revolution, house design experienced an important evolution.



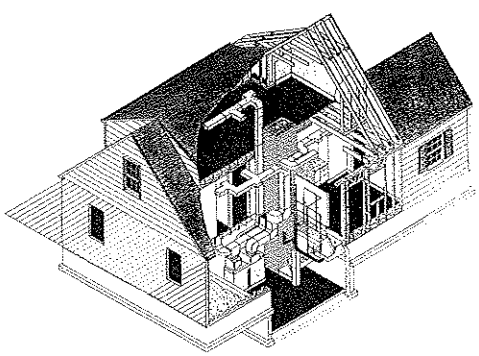
R. Buckminster Fuller's Dymaxion house, showing a central service core. (*Building Systems, Industrialization and Architecture,* Wiley, New York, 1981.)

From spatial and geometric orders offering a certain *capacity* for a variety of habitation patterns, house design took on *functional determinism.* This way of thinking locked in specific uses by two means: the arrangement of walls tightly wrapped around the spatial requirements of an activity, and the attachment of resource tethers serving these specialized spaces. In short, spatial arrangements and uses, distributed for reasons established by convention even prior to the introduction of mechanical systems, were now captives both of "arrangement and dimension based on function" and the resources needed to serve them. Thus, for example, cooking equipment went into spaces previously called "kitchen" prior to the use of gas and electric appliances, and bedrooms became special purpose spaces by the introduction of built-in closets, replacing wardrobes and movable cabinets, which had previously allowed any space to be a sleeping room.

There were efforts, however, to radically rethink the distribution of services in houses in ways independent of the particular distribution of functions or uses in a house. In 1869, for instance, Catharine Beecher's proposal for an American Woman's House clustered all services in a central core serving all rooms in the house, each claiming adjacency to the central core. [16]

Much later, but in the same spirit of efficiency and rational planning, Richard Buckminster Fuller's first Dymaxion House of 1927 had a central mechanical and structural core from which services were to be distributed to surrounding living spaces. He made this proposal while criticizing what he called the International Bauhaus Movement's superficial approach to mechanical systems, an approach that, he said, "never went back of the wall-surface to look at the plumbing...." This was an important but seldom voiced criticism of a movement that had been precipitated in the first place by the invasion, before 1914, of houses and streets by mechanical services. [17] The criticism was accurate, but the proposal seems to have missed the mark, given what is known today.

These early efforts at promoting a "standard, functional" mechanical core for all houses can still be seen in standardized floor plans in so-called "low cost housing schemes" in which bathrooms and kitchens are repetitively back-to-back, an arrangement argued to be more efficient and less costly than any alternative. While this efficiency argument may have held at one time in circumstances of bureaucratic management, it has certainly not been particularly relevant as a "standard" in the American



An integrated house from the Modern Housing of Washington, D.C., development. — "In its construction, modular design, standardized plans, a studied production "flow pattern," and novel construction practices combine to effect substantial cost-and time-savings..." (*The Architectural Forum*, November 1937.)

experience, except when organizations based on bureaucratic control have built for an economic class denied control of the act of dwelling. Even here, doubts are beginning to surface about the correctness of those assumptions, given the realities of housing dynamics.

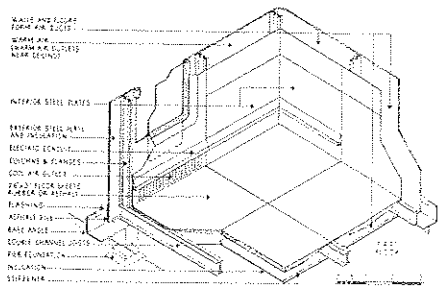
Early Years of Experimentation

The building technology and architectural journals of the 1930s, following directly on the new and widespread availability of resource distribution systems in houses, are full of evidence of tremendous experimentation with improvements in house building. This surge of work, almost all of which sprang from private initiative, lasted until the Second World War and took place during the Great Depression when relatively few new buildings were built. Aside from the experimental work, much of the practical efforts of the time were spent correcting and modernizing existing buildings with current mechanical systems, efforts that accelerated after the Housing Act of 1937 and the formation of the Housing and Home Financing Agency in the same period.

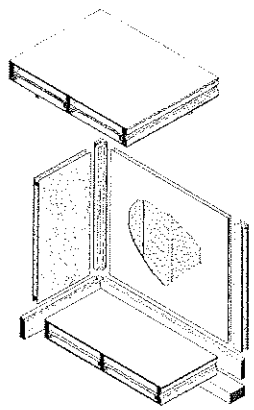
Despite or perhaps because of the newly introduced resource systems, these published experimental efforts from the 1930s reveal a curious lack of attention to these systems. With only a few exceptions, published accounts in the architectural press of the time focused hard on new ideas for the space-defining elements of houses, their construction, and appearance: walls, floors, roofs, foundations, and all the elements of which they are made. At the same time, most ignored or only grudgingly accommodated the pipes, ducts, and wires needed to make the houses liveable.

In these schemes, if cavity walls of new materials and shapes were proposed—and many were—the new resource systems must have been assumed to go between, inside, and through the cavities. Some explicitly stated that this was the intention. When solid-core prefabricated walls and floors were proposed—and there were and still are many—there is seldom any mention of where wiring, piping, and duct work are to be placed. Presumably, they are placed in dropped ceiling plenums in basements, hidden in closets, or otherwise "put in afterwards."

The reason these newly present systems largely escaped the attention of the architectural and building inventions of the 1930s is worthy of



A diagram of a Van Ness Steel House. (*The Architectural Record*, 1935.)



A prefabricated all-wood house assembly. (*The Architectural Record*, August 1935.)

speculation in more depth than can be accomplished here. But whatever paradigm was at work then is still at work today: these non-architectural elements will be put in later, after the important work—usually, in architectural thought, the structure and spatial enclosure—is completed, or, they will be "integrated."

The Post-War Period

Many fine histories of housing design, technology, and production chronicle the period World War II and the early 1970s when the now infamous Operation Breakthrough project of the federal government closed its books. After that, the literature becomes markedly thin, as though all the enthusiasm of the previous fifty years had dissipated.

A careful reading of efforts that were recorded reveals only passing references to the creeping entanglement involving pipes, ducts, and wires. This absence is understandable, since, until the widespread introduction of forced air for heating in the late 1940s and air conditioning in the late 1960s, the technical repertoire had not changed markedly for over forty years. For

example, by the 1940 census, fewer than 58 percent of households had central heating.[18]

When resource systems are mentioned at all in the housing innovation literature during the period after 1972, the discussions are frequently framed in terms of systems integration. This is a concept that has directly or indirectly dominated much of the research thinking about housing and other building technology since the 1960s.[19]

The basic principle of integration is to put as many subsystems as possible into one unified, preferably mass-produced assembly. This was, and in some quarters still is, thought to be the key to better results. In fact, this approach can be described as an effort to rationalize and standardize the physical positioning of parts currently found in practice: pipes, wires, and ducts within floors and walls. In a significant departure from daily practice, however, many proposals for systems integration suggested that the interweaving of parts could be standardized to enable mass production of elements so configured, independent of any particular project. In what now seems a curious linkage, this strategy was thought to be a way to achieve "flexible" and "adaptable" housing schemes.[20]

Whereas placement of service lines within walls and floors could, on a project-hy-project basis, meet the highly variable demands of construction and market requirements until recently, efforts to standardize this intricate interweaving—and thus reduce the variety of configurations—could not possibly succeed. No one wanted to build standard floor plans in large enough numbers to make an investment in such mass-produced, high value-added, integrated component production worthwhile.

This was especially so as increasingly complex systems were introduced in the last twenty years: humidification and dehumidification depending on the season, more sophisticated and complex heating and cooling systems, central vacuum systems and other appliances and fixtures each requiring several service hookups, more power and communications cabling, a diversification of power or energy sources, ventilation systems, fire suppression sprinkler systems, and the like.

By the late 1980s, faith in systems integration had largely waned, with the exception of such rare industry development efforts as General Electric's Living Environments Project and the follow-up IBACUS consortium. Systems complexity had increased, demand for variety had continued unabated, but no new paradigm emerged on the screen of the American housing industry to help sort out and simplify the tasks.

Shedding the Limitations of Functionalism and Entanglement

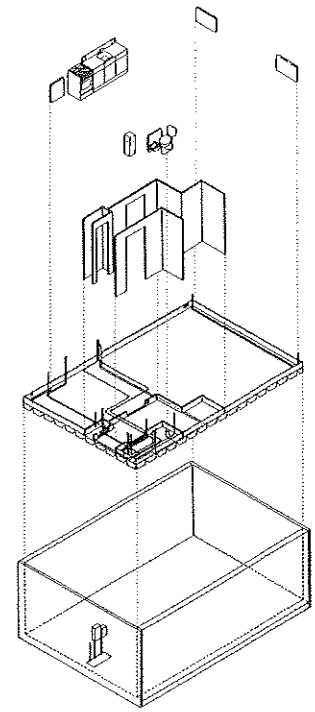
The principle direction of thinking dominating housing technology up to now, can be called the *unibody / integration* view. This view corresponds closely to attitudes held in currency by many industry leaders, writers, and academics up to the 1990s, but is now obsolete. It is fundamentally a static, technical view in the narrow sense, trapped in a model of centralized control and standardization. Because of this, it is unsympathetic to the full reality of healthy housing processes in the United States.

The *unibody / integration* perspective ignores one old reality and one new idea in housing, which the state of entanglement we have now reached compels us to see in a new light. Recognized together, these two concepts may hold promise for shedding the limitations of functionalism and entanglement.

The first old reality is the fact that as dwellings change, they undergo gradual, fine-grained adaptation to remain current and healthy, a process often initiated by households or for their benefit, making for a widely distributed pattern of control. This is pervasive, constituting a vital economic and social activity, only partially accounted for, and is certainly not a heroic activity concerned with style or winning awards. Further, this characteristic of housing has long eluded those professions blinded by an obsession with self-expression and the belief in the superiority of professional values.

The second somewhat new idea is the principle of levels, which concerns the way the built environment organizes itself hierarchically according to the distribution of control over it. [21]

This later concept is evident in nonresidential projects such as office buildings and retail facilities, where it has been conventional practice for some time in the U.S. to organize on the basis of levels. In these projects, a "base building" is constructed, consisting of loadbearing elements, shared spaces, and common mechanical systems. This part of the whole is designed to last



A diagram of a dwelling organized on the principle of base building and fit-out. All installations specific to the dwelling are in the fit-out, except for the main supply and return pipes and ducts. This approach is applicable to both new construction and renovation. Matura Netherlands™. (from *Entangled Building?* (ed) E. Vreedenburgh. OBOM, Technical University Delft, The Netherlands, 1992.)

longer than any activity at the "fit-out level," about which each occupant may decide and for which each is individually responsible.

The facts of change and distributed control converge in the levels concept. The base building is meant to be "fixed" relative to the more variable fit-out. One party (the aggregate of individual occupants or a separate entity) controls the base building, and a number of independent parties each controls its own "fit-out," retaining a degree of technical and legal autonomy and responsibility set out in the agreements of occupancy

This approach is applied as a matter of course in the office and retail section, taking many forms. It may have merit in U.S. housing as well, to liberate a process now so entangled. A model of this practice has been patiently moving forward in the Netherlands, dealing with a difficult mix of government and market forces. Hundreds of housing units have been built using it. According to people doing the work there, a new stage of application has now been reached. New multifamily residential

projects, as well as renovations in both the subsidized and private markets, are being built. In them, base buildings are being "fitted out" with units meeting household preferences, at a cost equal to the unibody/integrated approach, which is conventional there too and equally outmoded. These projects offer developers the new benefit of matching rather than anticipating user requirements and getting the work done more quickly than before. They demonstrate how variety, previously considered to be the source of higher cost and more difficulty, can actually be more efficient.[22]

This base building/fit-out approach also has an interesting dimension that should satisfy architectural formalists and functionalists alike. Well-designed base buildings can be constructed following sound and enduring principles of built form, offering capacity and giving opportunity for a wide variety of territorial distributions and functional layouts. Thus, architects and builders can literally "give" form and space to others who then have the freedom to put the given forms to use in their own and changing ways. It is an important kind of organized hand-off in a complex process, one which may now be able to respect the fundamental need for historical continuity at the level of the building as part of the public environment, while respecting the need for continuous though slow cultivation of the interior spaces in respect to evolving household needs.

A Turning Point in Housing

A real turning point in meeting the problem of entanglement in American housing will come when several events occur. First, wiring, piping, and duct management following the unibody/integrated paradigm in currency today—"just put the pipes and ducts in the cavities or anywhere they will fit"—will have to become an economic burden to most actors in the housing game, especially builders and users. It may already have reached this point, both in initial construction and in down-stream alterations.

Second, there will have to be widespread recognition of the ubiquity and magnitude of investments in altering existing dwellings as a percentage of toral investments in housing. This data is relatively well known, but our building traditions are only slowly waking up and adjusting to this reality.

Third, the unibody/integration model will have to be displaced by the levels model as a normal basis for organizing complexity. Despite the many differences between commercial projects and housing—many fundamental differences in their respective places in our social, economic, and cultural fabric—the base building/fit-out strategy is a useful model that should be carefully studied and tested in housing practice.

The reality of tecbnical entanglement is being recognized in many industries and countries. It is given many different names,"sorting out," "design for assembly," "disentangling," "base building/fit-out," "working on levels." There are, however, advantages beyond those gained in solving technical problems, critical as they are to improving the state of the art in housing. The concepts of levels and the principle of disentanglement also enable us to rethink again the organizational question of the balance between the community and the individual, mediated as always through the control of the built environment.

A visit to a multifamily residential project under construction and organized this new way offers a tangible image. Opening the front door, our future occupant sees an enclosed but bare space, with columns or bearing walls at certain locations, and exposed vertical plumbing and ventilation lines in a cluster. With the assistance of a designer, or by referring to several prepared model-unit designs, an interior design is prepared matching our household's preferences perfectly. Because a sophisticated computer software program is used, the design is transmitted directly to an off-site facility where all specified parts—including walls, equipment, cabinets, fixtures, piping and wiring, and heating and cooling equipment—are prepared or organized. Accompanied by a trained, four-person installation crew, this package of parts is transported to the building, or delivered just-in-time from other suppliers, one week after the order has been placed. In a carefully choreographed sequence, parts are brought into the dwelling space and installed. After one week , carpet installers arrive, followed by drapery hangers, and rhe furniture is brought in. The elapsed time between the initial visit to the bare space and completed fit-out and occupancy is less than three weeks for an average size dwelling, at a cost equal to that had the conventional approach been used, and offering the additional advantage that future changes will be easier to accomplish."

This scenario represents a new paradigm. The question is how to shift paradigms, in an industry and a process characterized by individual parties acting individually. We need to learn how to intentionally embark on a new concept pathway, on which each will find opportunities unavailable if the path isn't established in the first place. This would be a rare event in the building industry.

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Open Building: A New Multifamily Housing Paradigm

Thousands of multifamily housing units have been built in a number of countries following what is called the "open building" approach, and hundreds of millions of dollars are being invested in new technology and methods to improve it. In the open building approach, a base building is constructed without determining the interior layout, equipment, and finishes of occupant spaces. When individual units are determined, they are fitted out to match the new occupant's budget and preferences.

Open building employs a mix of innovative design, organization, and management strategies. It offers opportunities for dramatic advances in quality, cost control, and efficiency in off-site operations and on-site work and in upgrading or fitting out obsolete office or loft buildings. It also supports policies and marketing strategies aimed at incremental upgrading and income-mixing in subsidized projects.

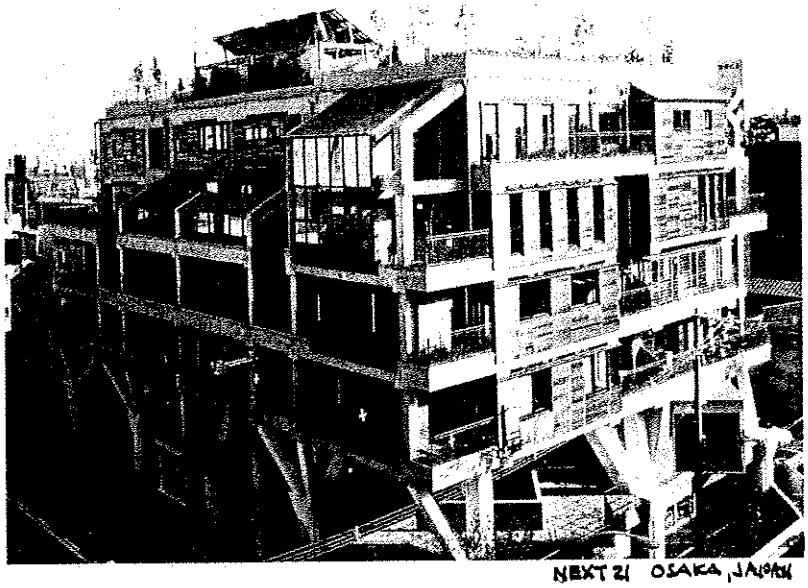
This approach to residential development, which started in the Netherlands, has been in the making for more than three decades. It closely matches existing U.S. practice in the nonresidential office market. Like any building industry paradigm shift, it has taken a long time to come into its own, but it has evolved to a stage at which an advanced, software-driven residential interior fit-out product is on the market in Europe. This product brings together in one package all the elements needed to finish a residential shell space, and it is attracting interest among developers, contractors, government agencies, and architects in Japan, China, the United Kingdom, Sweden, Finland, and Germany.

The Matura Infill System is a fully prefabricated, commercially available system that provides residential interior customization at a competitive price. It uses 23 ordinary subsystems available on the European market. All of these parts are integrated into an adaptable whole by means of two newly developed elements: the Matrix Tile and the Base Profile. Supported by customized software, MaturaCADS, the Matura system provides flexibility in design, fast on-site installation, and future adaptability. The company that developed the product is interested in finding partners to bring it to market in the United States and Canada.

The Matura system is based on a new distribution of utility lines made possible by the Matrix Tile and the Base Profile. The system fits in any physical context; therefore, installation does not pose special demands on the structure or facade. Due to the free distribution of utility lines outside any structural elements, the location of vertical service shafts no longer determines floor plans, making the system attractive for renovation projects and new construction.

A software program enables the quick translation of a floor plan into a technical design, locating and sizing all subsystems. The design, in turn, automatically feeds a database that steers the selection, dimensioning, and cutting of all parts needed for one dwelling unit and determines their packaging order in a container. The container is then delivered to the site for installation.

Base buildings are simpler to design, and fit-out specifications can be completed or changed quickly, with instant cost information. Floor plans can be decided only weeks before installation. There is also a choice of wall types; doors and door frames; cabinets; finishes; and HVAC, kitchen, and sanitary equipment to match the individual household or the developer's specific market niche. Buildings constructed in this fashion are easier to renovate in the future to meet new lifestyle preferences and technology. The floor plan of each unit can be changed without disturbing adjacent units or those above and below. Any decoration and finishing scheme can be accommodated. Electrical, telephone, and television outlets can be moved or upgraded without difficulty because these lines are located behind removable baseboards. Any technical system (including HVAC, kitchen, and bathroom equipment) can be replaced with a newer or preferred version without interference with other subsystems. This means that alternative or improved products can be offered swiftly and economically as part of the total infill package.



A residential rehabilitation project in Voorburg, the Netherlands, entailed gutting and modernizing a five-story multifamily building constructed in the early 1960s. To avoid social dislocation costs and loss of revenue, the property owner decided to upgrade units one at a time as they became vacant or as tenants wanted to improve their units. An architect was hired by the housing association to design new balconies, add elevators and new stairs, improve the common spaces inside and around the building, and upgrade the common mechanical systems. Ground-floor storage rooms were removed and placed elsewhere on the site, and apartments for the elderly and handicapped were designed in their place, with patios facing the sidewalk. The Matura Company was contracted to do the fit-out for newly vacant units and for the new ground-level units. It asked the same architect to work with it to design a range of floor plan options.

It took two weeks to gut one vacant unit, including all inner nonloadbearing partitions, finishes, kitchen and bathroom equipment, and associated piping and cabling. During that time, the tenant chose a floor plan and new equipment. The architect's drawing went to the Matura Company. One month after being vacated, the unit was ready for occupancy with an entirely new interior that matched the new tenant's specifications. Other units in the Voorburg building are currently being fitted out, one at a time, in a process that is cost effective and creates little disruption. A new building with 50 dwellings is also under construction; the dwelling unit fit-out will be provided by the Matura Company. Because this approach was initially experimental, government financing helped pave the way. Several other infill systems (Interlevel BV/ACTIBO) are on the market in the Netherlands that are competitively customizing detached houses and rowhouses, in both for-sale and for-rent markets.

Developments toward open building in Japanese multifamily housing have been underway for more than 20 years. A 1995 survey in Japan revealed that in the last five years more than 25 projects following open building principles either were built or are now under construction or in planning. The most technically far-reaching project to date is the NEXT 21 project, sponsored by the Osaka Gas Company, a future-oriented 18-unit project intended to anticipate the more comfortable life that urban households will enjoy in the 21st century.—**Stephen Kendall,** *a design educator and researcher at the Department of Interior Design, Marymount University, Arlington, Virginia*

Capsule Description:

Open Building:

An Approach to Sustainable Architecture

Open Building is an approach to the design, construction and long term adaptation of buildings, based on principles at work in historic environments which have remained vital. Open Building applies to both residential and non residential architecture: a base building - designed to last - is built without specifying the interior fit-out - which is designed to have a life related to individual households and other kinds of occupancy. The paper gives examples of Open Building architecture in the US, Europe and the Far East, and discusses professional tools for making sustainable architecture in keeping with the complexities of our times.

Stephen Kendall, PhD, AIA . June, 1997

Open Building: An Approach to Sustainable Architecture

Abstract

Open Building is an approach to the design, construction and long term management of buildings. It distinguishes between the parts of buildings which can have a long life and those which can change more quickly. The long term qualities and physical elements of buildings are those which, in most cases, represent long term community values and investments. They are the parts of the whole which contribute a sustained sense of place and environmental coherence. The short term physical elements represent values of a more individual nature, and shorter term investments. These are elements which wear out sooner or which should be replaced by new and better ones, but which also reflect the preferences, the care and investment of individuals or individual organizations in the context of the larger group.

Open Building is also a set of principles for professionals to use in controlling the complexity of contemporary environments. With more parties involved, with more sophisticated products and technology, and with more rapid change in all respects, creating sustainable environments is increasingly difficult. A key to making sustainability real is a clear understanding of the relative life spans of physical and social orders in complex interplay. Open Building offers tools for professionals to use in meeting these challenges.

The most familiar example of Open Building is the standard office or retail building. Aside from the question of architectural style - a distinct but critical architectural skill which needs work - this kind of building distinguishes clearly between a long term investment - base buildings meant to be sustained over a certain time period - and a number of shorter term investments comprising the interior fit-out. Base buildings are constructed, without determining their fit-out but instead offering capacity for change. Subsequently, installation and later reconfiguration of short-lived interiors takes place. This represents a tradition attuned to our contemporary requirements for both stability and change.

Developed over a 30 year period, this way of building is now rapidly evolving, in direct relation to the changing nature of work and retailing. New forms of organization in the design and construction professions are taking shape around it, and new building technology and materials are being produced to suit it. Building standards, regulations and financing are changing to match it.

Open Building is not only for offices and retail. It is also being used in residential architecture. Developments have been underway in Europe and Japan for two decades. In Europe, an advanced interior fit-out system, using for the most part ordinary manufactured building parts, is on the market for both new multifamily housing and for renovation of obsolete apartment buildings. Open Building is also being adopted in the United States by at least one national home building company, which is in the process of developing a version of the European fit-out system for the US market.

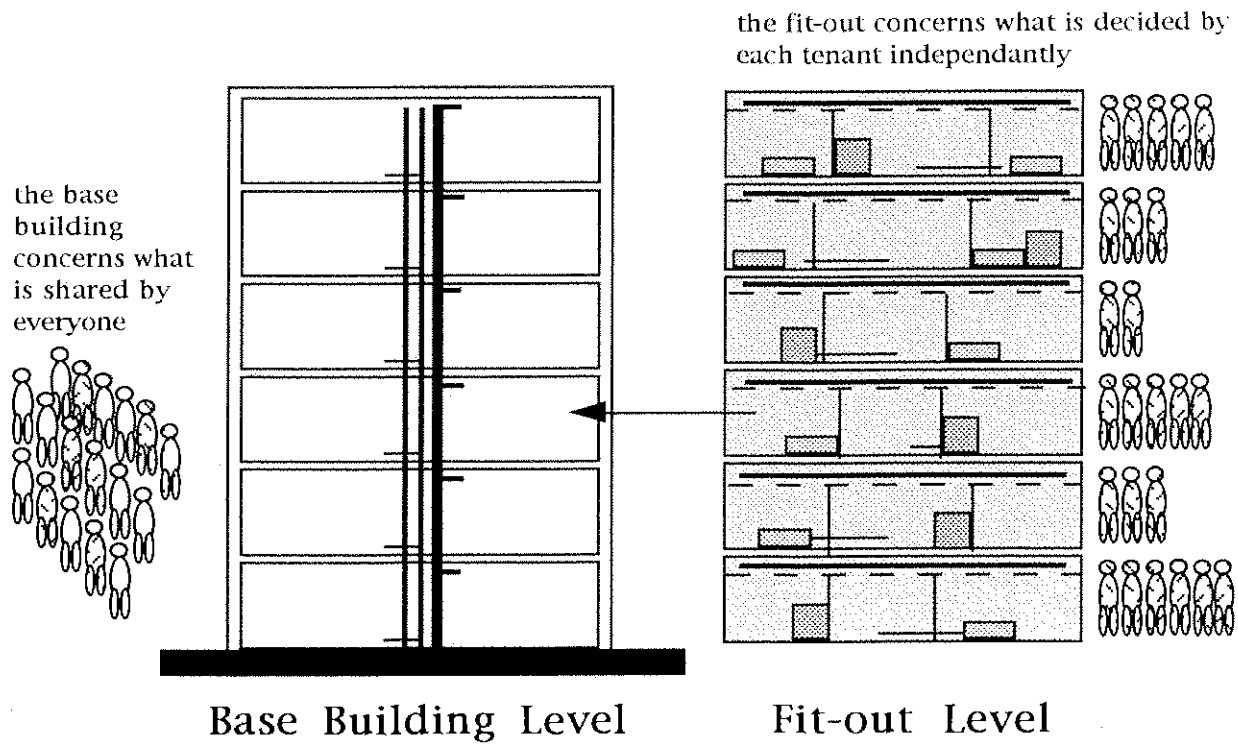
Despite the fact that Open Building is not new, it is not discussed or studied as such. As a result, improvements to it's practice in support of sustainable man-made environments are difficult to make. Many problems remain to be solved at both the base building and the fit-out levels and their interface, both technically and organizationally. The implications for all parties are significant and deserve closer scrutiny. Despite the enormity of the problems to be solved, this is perhaps the most fertile ground for advances in sustainable architecture.

Non Residential Open Building

For decades, the best non-residential office and retail design, construction and management practice has adopted and rationalized Open Building principles, developing a strong working tradition. Commercial and retail base buildings in any style and construction type are routinely built without determining the interior layouts, and are then fitted out to suit individual occupancies. Older buildings are "revalued" by investing inside - and refitting - existing shells. Even new "build-to-suit" facilities are designed for the time when the owner will sell the building and vacate it, making room for other tenants who require different interior spaces, equipment and systems suited to their own organizational and technical needs.

Construction, manufacturing, cost accounting, building design, management and regulation have adjusted to suit this technical and organizational approach. For example, witness the trend toward complete slab-to-slab fit-out systems in commercial office projects; the increasing use of access floors and modular cabling for adaptable infrastructure; the increased use of decentralized mechanical and air conditioning systems; and the sophistication of tall building facade systems. In addition, we see a shift in investment patterns in buildings and equipment, first noted in the 1980's. To a significant extent, major components of building subsystems and subcontracting are migrating to the fit-out and FF&E levels of work and investment, with important ramifications for all parties involved.

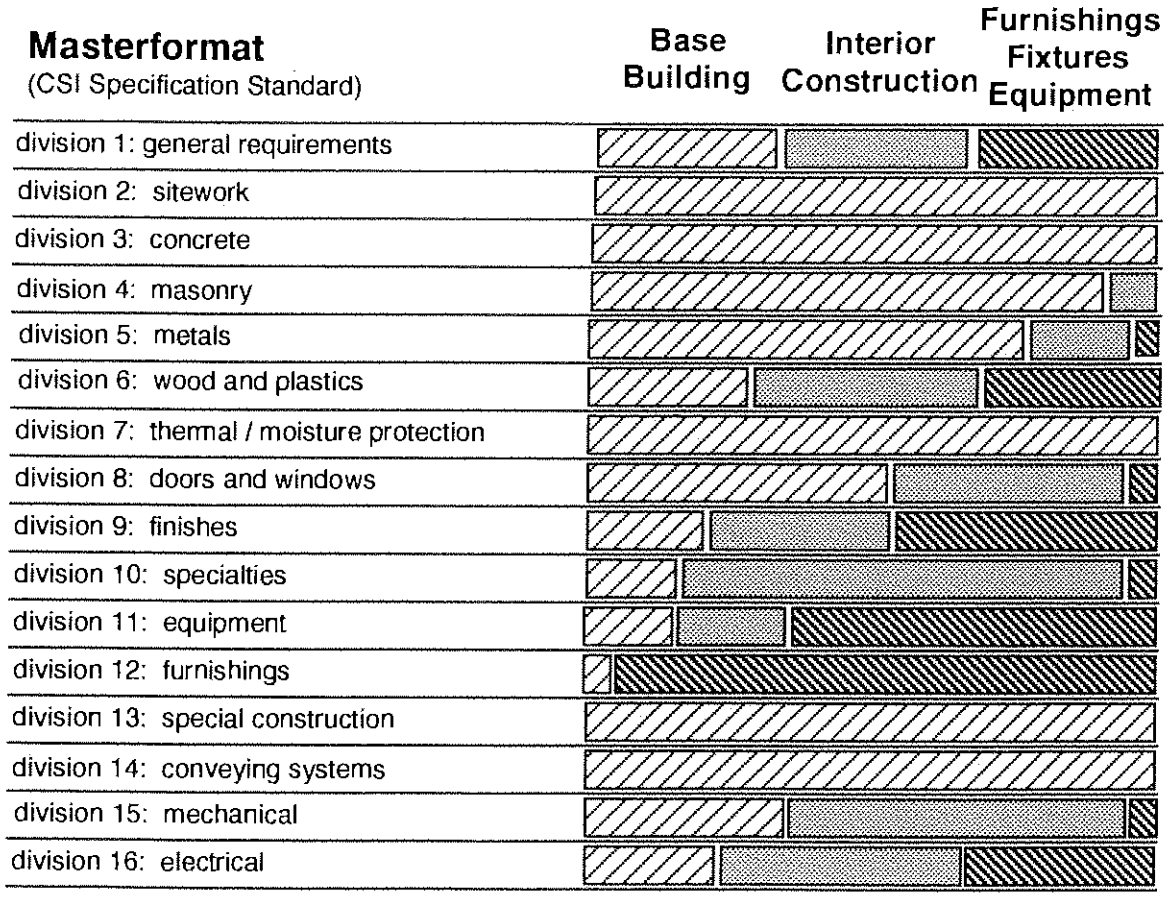
The following diagram shows the distinction between a base building and a fit-out level:



Building procurement methods are also changing to match the separation of responsibilities among levels. The best practices - both in terms of technical hardware and organizational procedures - are clearly changing.

Another way to see the distinction between a more permanent part of buildings and the more changeable is in a diagram based on the Construction Specifications Institute Information Divisions. In this diagram, both technical subsystems and distribution of control (base building, interior construction and FF&E) are shown together.

Three Tier Model of Control Distribution



In this diagram, each "tier" of responsibilities is adjusted according to the value of work-in-place for an hypothetical project. Some work - e.g. concrete - is entirely in the base building , while in other cases - e.g. finishes - work is distirbuted between all three tiers, but most is in the FF&E tier.

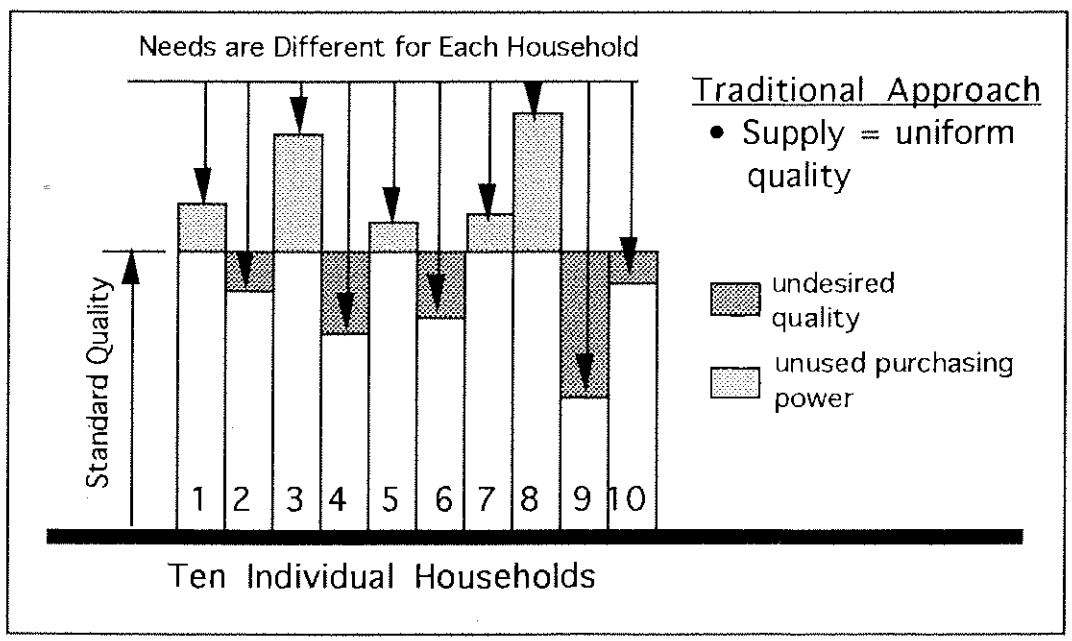
Another project will have a different diagram because, while it shares the same divisions of parts and products, work - investment - will be distributed differently. For example, it may have more interior construction and less base building work and very little if any FF&E work. This may be a project with built-in furniture and few finishes. Another project may have very little interior construction and most work distributed between the base building and FF&E work.

Residential Open Building

At the same time that North American office and retail projects have been evolving toward a model of sustainable architecture using the distinction between base building and fit out, many professionals - architects, contractors, lenders, manufacturing companies, government agencies - have been engaged in developments toward residential Open Building design, manufacturing, construction and management. In the Netherlands and Japan, for example, the idea of constructing residential "supports" (base buildings) without determining ahead of time the individual layout of dwellings has become increasingly practical. Even where the approach is not yet economically viable, government agencies and private corporations are reorganizing in advance to accommodate Open Building practices, recognizing that it is a good, and probably inevitable, long term trend for new construction - to prevent early obsolescence, and for reusing existing housing in an efficient but consumer oriented way.

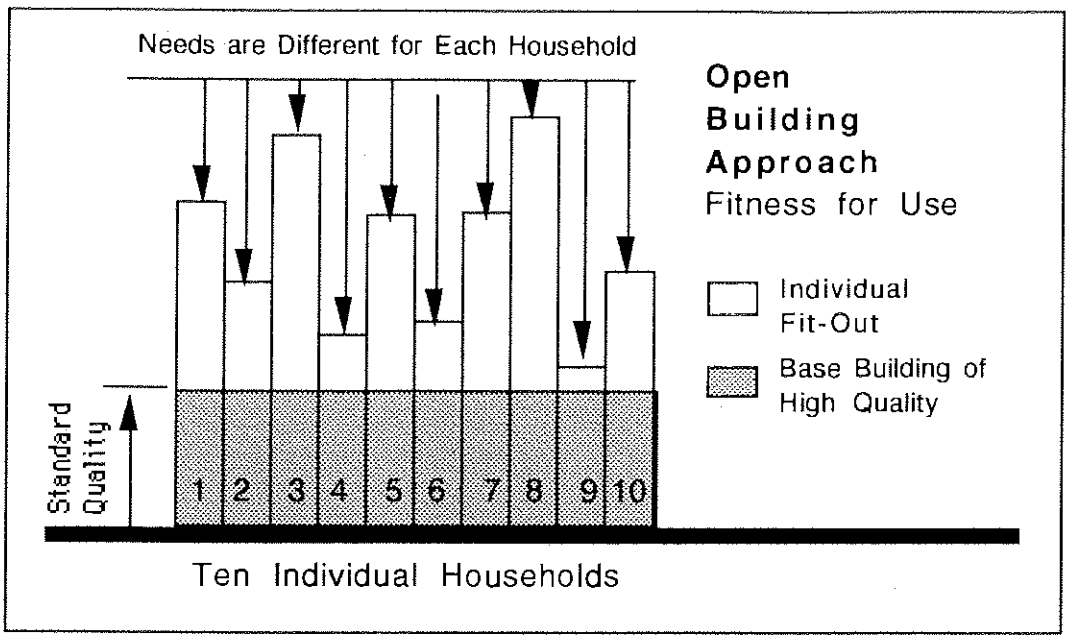
For decades, residential Open Building projects remained experimental, hampered by existing patterns of production and the lack of economically viable "fit-out" or infill systems. Within recent years, several competing infill systems have come onto the market throughout Europe. They enable affordable, customized dwellings to be rapidly completed in multifamily base buildings - in new construction and in the renovation of obsolete structures.

The question of income and household diversity in a sustainable environment - so familiar in many urban neighborhoods which have matured over decades - is recognized as an important social policy goal in a variety of countries, including the US, Japan and European countries. Open Building is a way to accomplish this goal with no added cost: variety is no longer more costly than uniformity. The following diagrams indicate this principle:



In this diagram, ten individual households are forced to adapt to a standard which fails to recognize or harness their individuality, to no one's advantage.

Open Building offers a solution by distinguishing the more enduring, common part of a building from the more changeable, individualized part:



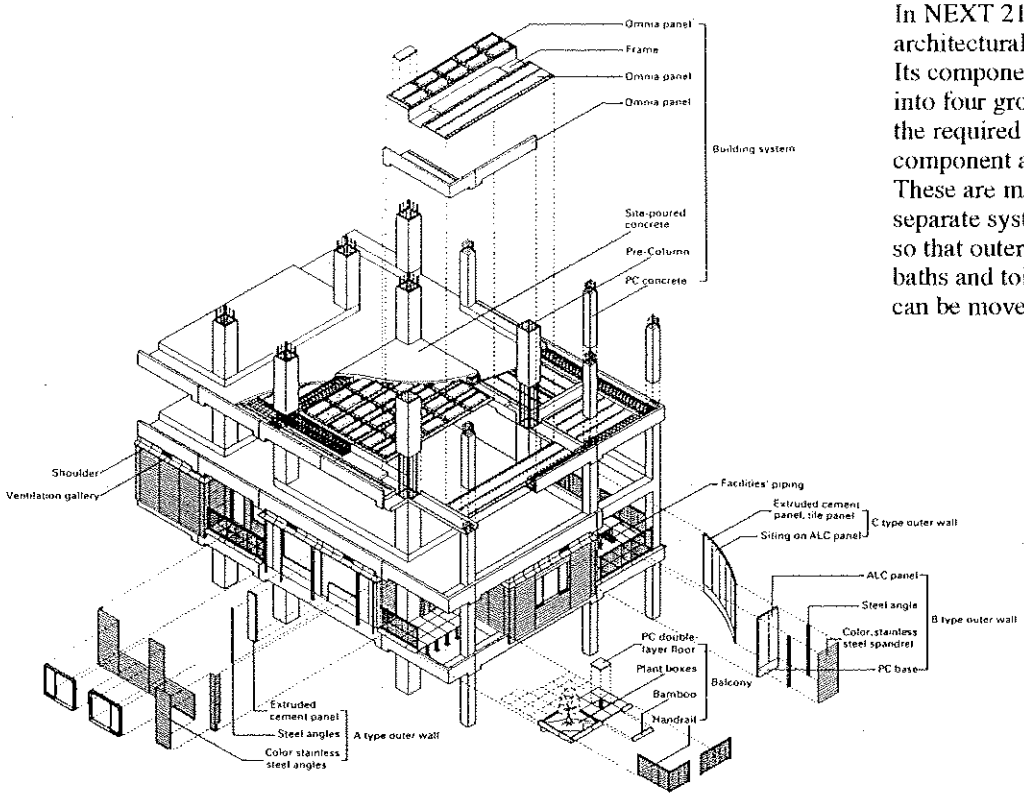
Here, the same ten households share a high quality base building with a long life because it is not designed for a "market" or for current "space and equipment standards". In this case, each can have a fit-out suited specifically to its budget constraints and preferences. Having set up the process and the building in this way, the base building has the capacity for a sustained relevance, while the fit-out can remain in place as long as it matches the priorities and preferences of individual households. The basic unit of social life - the household - can now be matched by the way building are organized. This is in contrast to most multifamily residential architecture in which the individual unit is largely subjugated to the needs of the whole, making a rigidity out of touch with the way society is moving.

In Japan, many corporations, the Ministry of Construction, the Department of Housing and Urban Development, and local Housing Authorities are setting the trend, investing billions of yen to make the separation between the long term part of buildings and the more changeable, individualized parts efficient and cost effective.

One of the most advanced projects in recent years to have been realized is the NEXT 21 project in Osaka. Sponsored by Osaka Gas Company, this is an experimental housing project designed for coming to terms with urban living in the next century. It focused on several questions concerning the right mode of housing in a changing society:

> where lifestyles are becoming more diverse
> where the information society is becoming more advanced
> where the problems of natural resources and pollution countermeasures that come with increased energy requirements become more severe
> and where the problem is to construct houses that can adapt to changes in society and our lifestyles.

NEXT 21 was completed in 1993 and is currently being modified and monitored as part of a planned series of trial and error projects. It is now occupied and acts as a living laboratory of advanced technology and energy conservation processes.



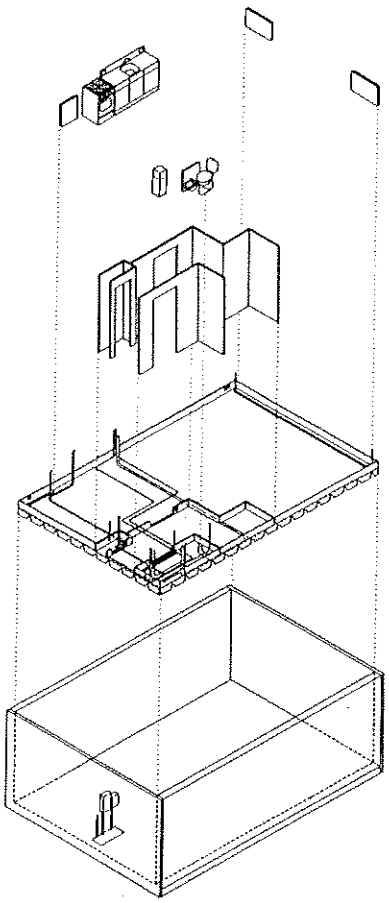
In NEXT 21, a highly flexible architectural system was used. Its components were divided into four groups, according to the required life of each component and production path. These are manufactured as separate systems and modules so that outer walls, kitchens, baths and toilets and gardens can be moved.

NEXT 21 Experimental Housing Project in Osaka, Japan

In Europe, a major German company will soon begin routinely using an infill system developed in the Netherlands in its residential projects in Germany. The same product is already being used in multifamily rehabilitation projects in the Netherlands.

This infill system is a so called "open system". Given an empty shell, Matura® offers a fully prefabricated and adaptable infill system for residential construction. It includes spatial partitioning as well as all technical subsystems and kitchen and sanitary equipment, providing a fully equipped and habitable dwelling unit.

It utilizes subsystems and parts that are readily available on the market like wall systems, doors and door frames, various finishes, as well as kitchen and bathroom equipment. It also can accommodate new developments of such off the shelf products. All these subsystems are integrated into an adaptable hole my means of two newly developed elements: the "Matrix Tile" and the "Base Profile". These new elements provide flexibility in design, fast installation on site, and changeability in the future.



The Matura Infill System fits in any given physical context. Installation does not pose special demands on the base building or the facade. Thanks to the free distribution of pipes, ducts, conduits and cables, the positiou of vertical shafts does not determine floor plans. This makes the Matura Infill Systeu particularly attractive for renovation projects.

Schematic of the Matura Infill System

In Finland, rehabilitation of 30 year old multifamily buildings following Open Building practices is starting. In the United Kingdom, a number of private companies and government ministries are actively engaged in Open Building developments, both for new construction and renovation.

In China, work is moving beyond experimental projects to wider applications. Open Building is becoming more popular though a variety of terms are used: "empty shell" houses; two-step houses; adaptable houses. More significant, the Open Building concept has been accepted by the authoritative bodies such as the Ministry of Construction as a major direction in the development of housing technologies.

For the time being, North American residential development does not follow Open Building principles, except for a few high end condominium projects which nevertheless do not have the benefit of a comprehensive infill system. While we understand the historical reasons for this reality, evidence from other countries and from current trends in North America suggest that we should - and ultimately will - also adopt Open Building in our residential architecture. Already, an American timber frame home builder is committed to Open Building in its operations. Several US companies are interested in licensing a European fit-out system for use in their new and retrofit residential projects.

A Watershed Period for Architecture

Such developments - in residential and non-residential work - are clearly of major interest to those in design, construction and allied industries throughout the world. We are without doubt experiencing a watershed period of change. Yet no one has achieved a comprehensive total picture of this phenomenon. Working independently, we can neither document nor analyze these developments.

Sharing available expertise in Open Building practice in North America and abroad, and the different experiences from nation to nation and between residential and non-residential work will create unparalleled opportunities for improving practice. To this end, CIB (the International Council for Building Research Studies and Documentation) has formed a Task Group on Open Building. Members come from Europe, North America and Asia and represent the design, construction, manufacturing, regulatory, lending, and academic research fields, and meet twice each year, in different countries to discuss their work, organize studies, and otherwise collaborate in improving this approach to sustainable man-made environment.

Open Building as a way toward sustainable architecture

In residential and non-residential Open Building alike, no one is naive enough to believe that all of the problems have been solved. In fact, significant technical, procedural, financial and code related problems remain. New initiatives are needed to clarify and extend the basic principles of Open Building - to more effectively organize and coordinate work by different parties on levels such as base building and fit-out; to reorder technical interfaces so as to reduce conflict and ease replacement and substitution of parts; and to make better, more adaptable and more sustainable and ecologically sound buildings and neighborhoods.

But despite the many problems to be solved, the basic principles of Open Building are aligned exactly with the goals of sustainability in buildings and man-made environment for several reasons.

First, sustainability concerns a movement away from the tendency toward a total throw-away culture. In a throw-away culture, value is placed on short-term gratification and rapid obsolescence at all levels. When this set of preferences is reflected in investments in the design, construction and maintenance programs for buildings, the results are familiar. Buildings are made to last only a short time in a technical sense, but equally important, investment incentives are even more powerfully aligned for short term value extraction from real estate investments.

In Japan, the result of this tendency was the "scrap and build" tradition in which buildings were constructed quickly, based strictly on current standards, with little thought to long term capacity to change. Now, this investment strategy is widely rejected in favor of a movement toward a "stock" approach, in which much more emphasis is being placed on maintenance programs and designing - and building - for change. In the US, the historic preservation movement was an early indicator of widespread dissatisfaction with the long US tradition of destroying old buildings and neighborhoods in favor of new trends and new styles.

Open Building makes a strategic contribution to the question of long term vs. short term. By making a clear distinction between the parts of a building that should last for 100 years and

the parts that should -and realistically cannot - last so long, it is now possible to make an accurate accounting of value and responsibilities, and to decide clearly about longevity of a building's subsystems. The separation between a base building - designed for capacity for change - and the fit-out - designed for individual freedom and for a shorter span of use - is, in one sense, an accounting method, enabling all parties to discuss unambiguously what physical systems should last a long time and which should be less enduring, but still reusable.

Second, Open Building methods support the development of "click-together" components whose re-use value is higher because they are "open" products with high degrees of compatibility. The question of product re-use has direct bearing on the issue of sustainability. Too much of the fit-out of office buildings, for instance, is discarded upon reconfiguration of space, in part because it is priced without accounting for embodied energy or "cradle to grave" costs. But equally important to the problem is that even the higher value-added components - too expensive to become throw-away products - are not easily reusable in new circumstances because interface standards are not yet mature.

Open Building has a goal of "manufacture and design for assembly and disassembly". This means that product manufacturers will make products compatible with other products having tight interfaces, but which are made by other companies. The problem is significant. On the one hand, manufacturers make many more products today which have substantial embodied knowledge in them. They are expensive. They are not commodity products in most cases, but high value added components and systems. Most are incapable of linking to similar products of other companies.

For instance, Molex's cabling and power distribution system used in Haworth office furniture is not compatible with Steelcase's equally sophisticated wiring system used in its own office furniture, or Amp's power distribution cabling used in the PowerFlor access floor. The present reality is that a Molex cable will not attach to a Square D, Amp or other termination. This cannot continue long. Standards of product compatibility in building subsystems made by different manufacturers are inevitable. Open Building provides a logic to help achieve this.

Third, aside from strictly technical issues, there are questions of social and individual choice and values. There is good reason to believe that the increasing physical entanglement of the parts out of which complex built environments are made has become a barrier to healthy balancing of group and individual domains and responsibility. This entanglement therefore thwarts advances in the evolution of a sustainable man-made environment.

When it is not clear who is responsible for which parts of the physical fabric we occupy and transform, any accounting for common purposes - and the corresponding physical setting - is almost impossible. This is a key point. Sustainability concerns - in great measure - that which is held in common. It is community values, community interests, and community power to act on its behalf. In this context, individuals act on their best interests.

When the community - the commons - is indistinguishable from the individual's terrain, how can there be any means to sustain what is shared? In this respect, Open Building is a recognition of and extension of principles found in historic environments around the world which are outstanding examples of sustainability.

CIB Task Group 26
Open Building Implementation

Technology and Processes for Making People-Centered Buildings and Neighborhoods

What Is Open Building?

Open building is an innovative way of producing - and renovating - neighborhoods and buildings. Its methods are aligned with the most advanced building technology, information management and construction logistics coming to market around the world, and is thus essential in stimulating developments toward a new consumer-oriented building industry. In practical terms, open building structures the building process so that in large projects, a variety of interior layouts is no less difficult to produce than uniform unit designs - enabling an improved balance between supply and demand, reducing rework and waste, and making happier customers. Open building assures that decisions made now - in new construction or major renovation - will enable buildings and urban fabric to retain their value as stable physical assets well into the future, because they are planned for change and a kind of variety respecting the variety of people in contemporary society.

Guiding Principles

To accomplish these results, open building projects are based on certain principles, the most basic of which is the use of levels. Decisions and physical parts are grouped according to distinct levels such as urban fabric (tissue), base building (support), fit-out (infill), and FF&E (furnishings, fixtures and equipment). Each level may include parts of several technical systems (e.g. fit-out may include a complete dwelling layout including bathroom and kitchen, with partitions, electrical, plumbing, mechanical, fixtures and cabinets). The physical systems making a level are delivered as a distinct "bundle", with its own contract, responsibility and conformance with regulations. That is, levels correspond not to the normal division of building systems (structure, facade, mechanical systems, etc), but rather to a particular distribution of control which cuts across technical systems and jurisdictional boundaries.

By use of levels and other principles including disentanglement and modular coordination, form and space can be fixed at one level while offering capacity (and defined limitations) to the next lower level. For example, an urban design enables a variety of buildings to be erected and replaced without altering the urban patterns of space and infrastructure; a base building - the parts shared by all occupants - enables freedom of layout for the individual unit; a fixed arrangement of walls enables a variety of furniture arrangements. One of the most important benefits of the levels approach is that it ensures that as buildings and neighborhoods are constructed and altered, each social unit (e.g. neighborhood council, condominiumn association, individual occupant) is assured a clear measure of freedom and responsibility, critical to the physical and social health of a neighborhood or building complex.

The use of levels and disentanglement are particularly helpful in organizing work in environments made more complex by the increase in mechanical equipment infrastructure, the increased pace of change and pressures for quick, risk-free results. These mechanical systems, in normal construction, are completely intertwined with structure and partitions belonging to different parties in a legal and trade jurisdiction sense. This entanglement leads to disputes, higher initial and long term costs, reduced quality, confusing regulations, and is also an obstruction to systems upgrades and spatial reconfiguration at any time. Open building disentangles building systems by reducing subsystem dependencies (therefore reducing conflicts among the various parties), and organizes parts according to their life span and level, leading to more sustainable buildings and neighborhoods.

Sustainability

Recognition is growing worldwide that environments which achieve sustainability do so in part because they can adjust with reduced waste and disruption. Many now realize that making sustainable buildings involves not only better planning, technical systems and know-how, but the direct involvement of professionals and everyday citizens. In that sense, open building is an alternative to the functionalist paradigm of design and construction inherited from simpler times, in which activities are fixed and physical systems are wrapped around and entwined with these "functions". Because human activities change in unforseen ways at varied time cycles, such entangled buildings prove to be disfunctional, wasteful and a burden on society.

Open Building Implementation

Task Group 26 Open Building Implementation is one of more than 50 working commissions and task groups within CIB - The International Council for Research and Innovation in Building and Construction. (see below). Initiated in 1996, TG26 now has more than 40 members from 15 countries, representing such fields as architecture, engineering, construction, product manufacturing, government and academic research, building technology and management consultancies, facilities management, real estate, housing finance, and building economics.

The mission of TG26 is to document, stimulate and support implementation of open building in practice, and to disseminate the results of research aimed at improving open building.

TG26's mission is comprehensive

TG26 advocates the comprehensive adoption of open building principles and tools in respect to the built environment: neighborhoods, buildings and the internal make-up and products of buildings. Because residential and mixed-use environments are the most complex of all, both socially and technically, they receive much of the attention of the TG members. For example, the renovation of the multifamily residential stock built during the "mass-housing" era from 1955-1975 is receiving special attention in many countries, including but certainly not limited to the Netherlands, the United Kingdom, Germany, Finland, Eastern European countries, Japan and China. Because the mistakes of that era should not be repeated, TG members are working to establish open building as an alternative to mass housing - to combine stability and change, efficiency and variety, and community and privacy. In countries where the legacy of mass housing is not the issue or has been overcome, open building is a means to create a more consumer-oriented residential stock in both public and private sectors. The introduction of a distinct fit-out or infill level in residential construction - using the full potential of industrial production - is a significant opportunity for the building industry to come closer to a consumer oriented industry. Developments in this direction can be found in the Netherlands, the United Kingdom, Finland, Japan, China and the United States, among other countries, based on the special conditions in each country or region.

Work at all Scales and Levels

While residential environments receive primary attention in the TG, other sorts of environments where people spend time receive attention. In mixed use, office , school, laboratory and other kinds of buildings, and in the fabric of exterior spaces which connect buildings, work is being done and more is needed to assure that the interests of individuals are not lost in the pressures to use new technologies and processes, to lower costs, speed decision making, and to standardize.

The need for concentrated work on all these scales of environment and kinds of buildings and uses differs in the places where TG members provide professional services and conduct research. The need to focus on new environments on the one hand and the renewal of existing environments on the other hand also vary from place to place. Thus, while housing is the most pressing issue, it is not the exclusive focus of the TG. Other work toward open building at other scales and in other kinds of buildings complement each other within the Task Group's program of activities.

All of the work of the Taks Group shares the committment to making people-centered, sustainable environments using the most advanced products and processes available.

What is the TG26 doing?

The central purpose of TG26 is to support its members in their practice, research, or training at the local level. It supports developments toward open building by

> serving as a platform for TG members to initiate research projects involving TG members;
> documenting research work and lessons from practice and disseminating the findings in the proceedings of its meetings and in journal articles written by its members;
> providing a forum for discussion and information exchange among members;
> organizing public symposia, technical workshops and displays about open building.

To realize this mission full participation is needed by professionals in many fields related to open building. The Task Group enthusiastically invites those interested to contact our coordinators and to search our web site: www.decco.nl/obi

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What is CIB?

CIB is the International Council for Research and Innovation in Building and Construction, with headquarters in The Netherlands. With over 5,000 professionals in its network, it represents the largest and most comprehensive international forum for the exchange and dissemination of research and best practices concerning the design, production and management of built environment.

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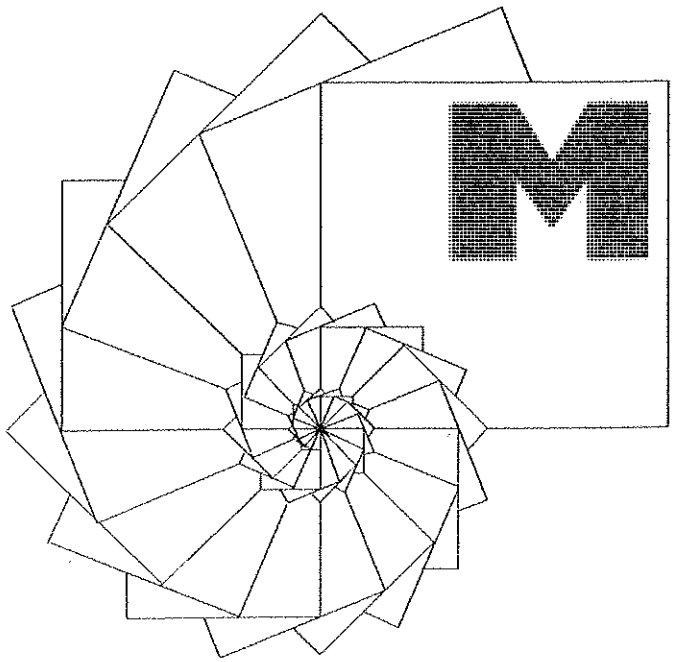
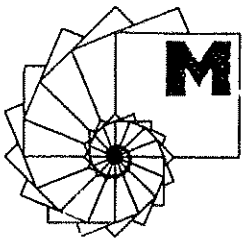


THE
MATURA
INFILL SYSTEM



THE MATURA® INFILL SYSTEM

Given an empty shell for a dwelling unit, MATURA® offers a fully prefabricated and adaptable infill system for residential construction. It includes spatial partitioning as well as all technical installations and kitchen and sanitary equipment, providing a fully equipped and habitable dwelling unit.

The MATURA® Infill System:

***Is a so called 'Open System'**, utilizing subsystems and parts that are readily available on the market like wall systems, doors and door frames, various wall finishings, as well as equipment for kitchens and bathrooms. It also can accommodate new developments of such 'off the shelve' products. All these subsystems are integrated into an adaptable whole by means of two newly developed elements: the **'Matrix Tile'** and the **'Base Profile'**. These new elements provide flexibility in design, fast installation on the site, and changeability in the future.

***Is based on a radically new distribution of technical conduits** made possible by the Matrix Tile and the Base Profile. Interface among conduits (for sewage, water, heating, electricity etc.) and between conduits and walls is minimized. Each conduits' deployment in space follows specific rules of positioning in the matrix grid, by means of which it can run freely without interference with other systems. Moreover, all conduit deployments are independent of the support structure of the building. All this assures extremely rapid installation of the technical systems serving the dwelling unit.

***Fits in any given physical context.** Installation does not pose special demands on the support structure and the facades. Thanks to the free distribution of conduits the position of vertical shafts does not determine floorplans any longer. This makes the MATURA® Infill System particularly attractive for renovation projects.

***Responds to user needs.** The systematic deployment of all parts makes future adaptation to user needs easier. Outlets for electricity, telephone, and television can be arranged by the users at any time.

***Is installed unit by unit** by a well trained team of two or three workers. A single team installs the complete infill package for one dwelling unit in a short time. This means that large scale projects with uniform floorplans are no longer a prerequisite for efficient residential construction. By employing several teams at the same time in one project, each doing a different floor plan, more units can be filled in simultaneously.

***Utilizes proprietary software.** This software allows the quick translation of a floorplan into a technical design of all subsystems needed for its realization. The technical design, in turn, automatically feeds a database which steers the selection and dimensioning of all parts needed for one unit and determines their packaging in the container from where the infill unit is installed on the site. Included in the software is proprietary know-how concerning the **dimensional coordination** of all parts allowing these parts to be cut to size before they reach the site.

***Offers advantages for all parties involved:**

- **For the builder:** Faster installation on the site. Shorter time needed for interior finishing, less overhead, less logistics problems.
- **For the client:** Free choice of floorplans per unit. Determination of floorplans only a few weeks before installation. Choice of different wall systems, doors and door frames, wall finishings, and kitchen and sanitary equipment.
- **For the user:** Possibility to determine their own floorplan. Future adaptation of the floor plan and technical systems to changing needs. Easy adaptation and augmentation of outlets for electricity, telephone, and television to correspond to the chosen arrangement of furniture in the rooms.
- **For manufacturers:** Any technical subsystem in the MATURA® Infill System (including kitchen and bathroom equipment) can be replaced by a newer or preferred version without interference with other subsystems. Therefore improved or alternative subsystems can be offered swiftly and economically as part of the total infill system.

**

THE MATURA INFILL SYSTEM

The MATURA ® Infill System is made available for licensing by **Infill Systems BV,** which has worldwide rights.
These rights particularly relate to the deployment of technical conduits for drainage, gas, ventilation, heating, water, electricity, electronics etc., by means of the Matrix Tile and the Base Profile.
Infill Systems BV also has rights to the software used for technical design and related data.
Matura ® is a registered trade name.

Infill Systems BV
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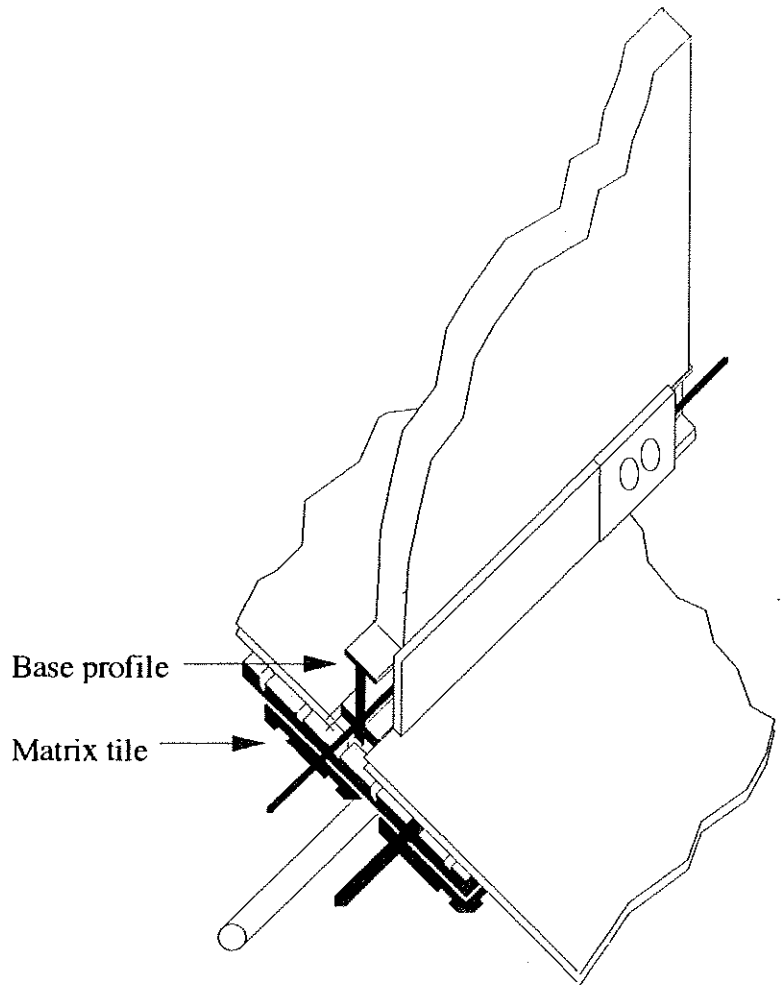


The MATURA infill system offers a new way to distribute ducts and cables in a dwelling unit.

This re-organization of the technical systems reduces significantly the interference of conduits with one another leading to faster installation and increased flexibility. The new deployment of conduits in the dwelling unit is achieved by the introduction of two new parts: the 'Matrix tile' and the 'Base profile'. These are closely integrated and together make an infrastructure within which all cables and ducts have their own place.

Apart from these two new components the Matura infill system uses only parts that already are available on the market. This makes Matura a truly 'Open system' that can always utilize the newest products avaliable.

This new way of organizing the hardware goes hand in hand with advanced logistics supported by custom made software. This powerful combination allows each dwelling to be installed individually in a short time. There is no longer a need for a sequential on site organization \requiring a number of identical units. Each unit can have its own floorplan.

In the Matura system a distinction is made between the Lower System and the Upper System.

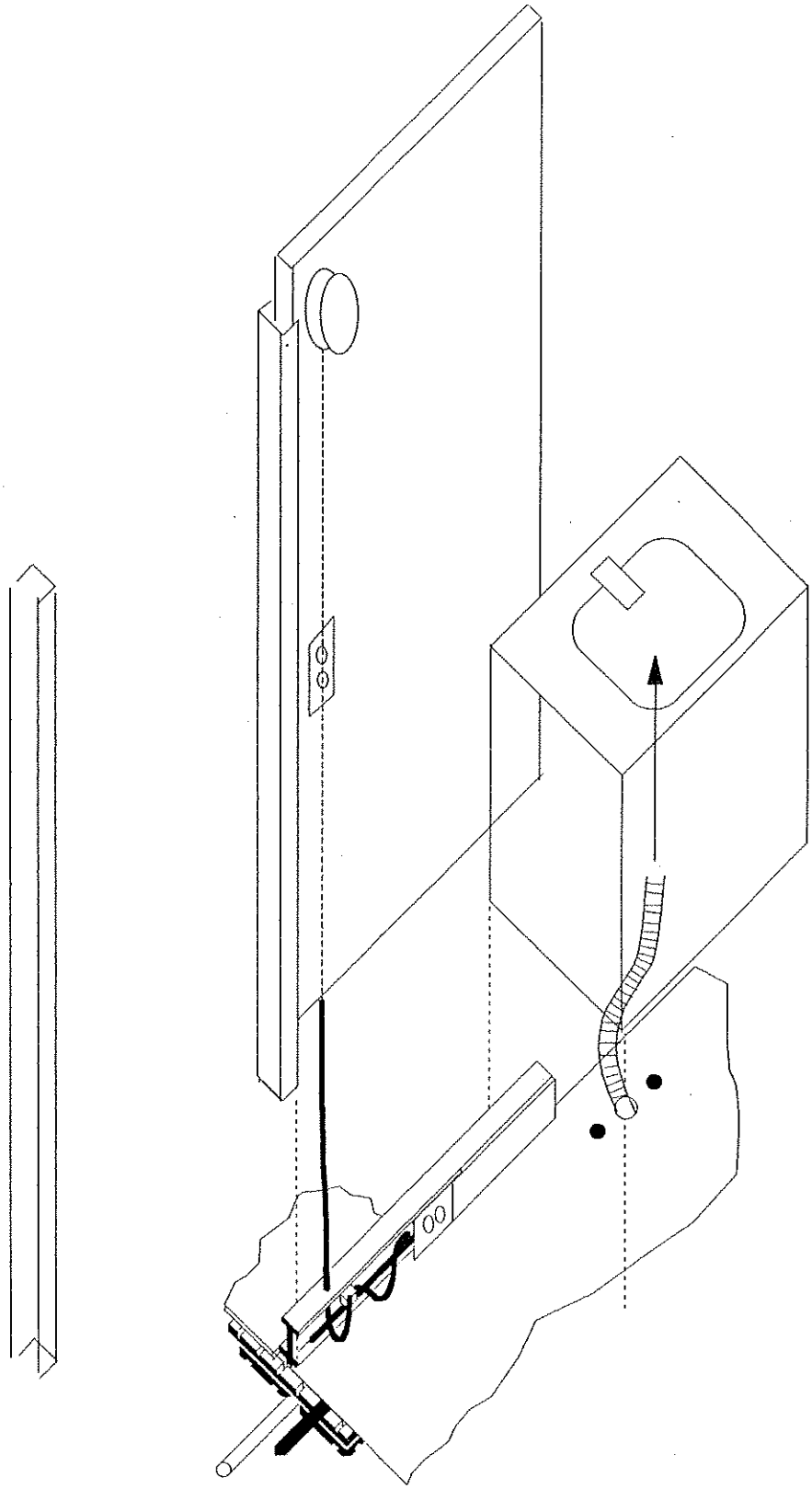
The lower system contains the Matrix tiles and the Base profiles and the tehnical systems accommodated by them.

Next, partitioning walls, doorframes, doors, and equipment for bathrooms and kitchens are installed: these togehter make the upper system.

The components of the upper system are integrated with the lower system by means of plug-in sockets and flexible connections.

All parts of the upper system are readily available on the market and can be chosen by the client. They are subject to fashion and taste and variably priced.

The parts of the lower system are primarily selected for technical performance. Fashion is not an issue but the newest innovations can be incorporated.
The lower system , therefore, makes for a relatively stable base on which different upper systems, geared to user preferences, can function.



OPEN BUILDING and RESIDENTIAL INFILL SYSTEMS

Dr. Stephen Kendall, AIA, CIB

Residential development and construction have remained unchanged for many decades in the US, while commercial development and construction have evolved dramatically. State-of-the-art office buildings now demonstrate a level of efficiency, flexibility and customization to user preferences that could not be dreamed of several decades ago. This use-type is poised at a critical stage in its evolution, and now awaits further developments in methods of delivering base buildings with demonstrated capacity for change, and advanced fit-out systems that are capable of offering multi-service functionality (including heating, cooling and plumbing systems) well beyond the present state-of-the art.

At the same time, residential construction – both single and multifamily - remains tied to obsolete practices that no longer match the present or future needs of the market for residential environments.

There is no reason not to expect the building industry to learn to deliver residential projects at a level of sophistication equal or superior to office buildings, with equally close attention to balancing the individual freedom of residents with the interests of the community in which they live.

Closely paralleling recent developments in the office market, there is now reason to think that the next phase in residential development and construction lies in a two-step process, using integrated residential fit-out technology. For new construction, renovation of existing residential properties, and the conversion of non-residential buildings to housing, RESIDENTIAL INFILL SYSTEMS are the most promising development on the horizon.

A RESIDENTIAL INFILL SYSTEM is to housing what office fit-out or infill is to a tenant space in an office building: everything needed by the tenant to occupy a blank space in a building shared with other occupants. With the adoption of this two-step process, the complexity of a large project is "bundled" into two decision clusters, rather than one unwieldly, entangled and "lumpy" product which most large residential buildings are. Because of this, the introduction of improved planning methods and technology is more likely because the two steps correspond to realistic clusters of decisions – one related more to the site and the public interest, the other related more to the individuality of each unit and the more market-sensitive components and spaces of a building.

RESIDENTIAL INFILL SYSTEMS are such an improved planning method and technology, and they focus on the individual dwelling unit as a consumer oriented product. By using RESIDENTIAL INFILL SYSTEMS, it is no longer necessary to decide every detail before building construction can start. It is possible to defer many of the decisions that need to be keep open, but can't be now, because they have traditionally been tied into the total building package, both by entangled technical systems and by entangled decision-making and construction phasing directly related to technology.

INFILL SYSTEMS allow more efficient customization in for-sale projects, and better market matching in for-rent properties. INFILL SYSTEMS also make one-unit-at-a-time renovation in existing projects easier and allows the rapid, customized conversion of obsolete office and warehouse buildings to prime residential properties. Use of INFILL SYSTEMS allows the upgrading of individual building parts without disturbing all other related systems, reducing waste and allowing the substitution of more advanced, ecologically sound products and materials as they come to market without having to demolish the entire building.

Surveys of residential construction in Japan and Europe, conducted over the past decade, have revealed a quiet evolution in the way housing can be delivered, a way that is inherently sound because it matches new and changing technology, computer software, and social realities. Responding to demands for cost and quality control, consumer satisfaction, appropriate community control as well as long-term maintenance of real estate asset value, residential construction has been moving toward a new process model, called OPEN BUILDING. In Japan, many thousands of units following open building principles have been built. Advanced R&D by the Ministry of Construction, the Ministry of International Trade and Industry and by private companies continues to push the frontiers of open building technology. In Europe – especially in the Netherlands, Finland and Germany, but also in the United Kingdom – a number of infill systems are coming to market and developments in the financial markets – including large pension funds – are pointing to the desirability of a more consumer-oriented, flexible housing process.

HOW DOES AN OPEN BUILDING PROCESS WORK?

In an open building process, a residential base building is designed and constructed without determining the specifics of unit layout. Just like in most office buildings designed for a varied and changing occupancy, a residential base building is composed of the building's overall exterior form, building structure, thermal envelope and facade, as well as the public circulation spaces, stairs and elevators, and the main mechanical risers. Unit demising walls can be fixed at the time of the base building construction, or left to be decided later. Then, in a second step, the unit plans are fixed. This is possible because the base building has been designed with a carefully analyzed capacity to accommodate a variety of layouts.

A surprising number of buildings have been built this way in the US, without declaring it as a special method. However, they are fitted-out in the conventional way. A general contractor coordinates a number of subcontractors, each of which brings the materials needed for its part of the work, making multiple visits interspersed by visits of other trades, producing on-site storage and waste problems as well as the usual uncertainties of scheduling and coordination.

In an advanced open building project, however, the fit-out delivery process is reengineered. At an off-site facility, a container is loaded with the products needed to fit-out each individual dwelling unit. Many of the products are prefabricated for that unit, while some are simply taken from the loading dock – having just been delivered from a regular supplier – and are put into the container. A trained crew – in the best cases a crew of multi-skilled workers who work as a team - goes with the container to the site, the container's contents are transferred into the unit and the crew installs the infill system. With good planning, the finished unit can be ready in less than two weeks starting with an empty space, using a crew of three or four installers.

To make this process work, some conventional processes are changed. For example, in an open building process, architects don't design dwelling units first and then compose the building in coordination with the structural and mechanical systems. Instead, in the first step, they design a good building with a carefully studied capacity to hold a variety of units – perhaps the unit mix and certainly the individual unit layout. Mechanical, electrical and plumbing engineers divide the mechanical systems into two bundles: the base building parts servicing all the dwelling units, and those parts specified for each unit. Especially with the mechanical systems, the design problem is to optimize the location of vertical risers to enable a variety of unit layouts, including a variety of bathroom and kitchen schemes which are decided as part of the second, unit layout phase.

The bundle of parts belonging to each unit's infill package includes the unit's partitions, doors, cabinets, plumbing fixtures, unit heating and cooling equipment, power and data cabling, and the kitchen and bathroom(s). Demising walls separating units are part of the base building – they cannot be determined per-unit, but are part of the shared elements. Cost accounting is also organized on a two-step basis, one for the base building, and on the other for each individual unit. The base building is a single "project", as is each individual dwelling unit. Building permits are obtained for the base building with documented capacity and life-safety, but without committing to the units which will eventually be installed. A certificate of occupancy is obtained when all units are completed, or floor-by-floor, or as each unit is completed, a process that can go more rapidly than conventional construction if needed, or which can be phased to match marketing targets.

MATURA INFILL SYSTEM®

While ordinary technology can work to support a reorganized two-step process, available new technology makes the process faster, more flexible and more suited to customization. The best example of this new technology is the MATURA INFILL SYSTEM®, a patented product developed, certified, code approved and used in Europe.

The MATURA INFILL SYSTEM® is a fully prefabricated product offering customized, just-in-time residential units at a total delivered cost competitive with the conventional approach. The added cost of a few of the products used in Matura is off-set by the short completion time for each unit (on average less than 10 working days from delivery of the package to availability for occupancy), quality control, and the ability to offer fully customized units. Further, when the building has to be updated later, each unit – having been set up as an independent project – is easier to change with fewer disturbances to neighboring occupants than is ordinarily the case.

MATURA® is a patented system, registered in the US, Japan, and many European countries. The patent covers two new products – the Base Profile® and the Matrix Tile®, and their integration, as well as a sophisticated software program. The software, called MATURACads®, employs state-of-the-art product specification, graphics and accounting principles. This software supports the entire MATURA process, from design of the unit to cost estimating to sizing each component for factory production, to labeling and packing in the dedicated container assigned to each infill package.

The system has been used in enough projects in the Netherlands over the past eight years that it is no longer a question as to the technical solutions it offers. Feasibility studies have been conducted by leading companies in Japan. Its adoption in the German, UK and Finnish markets is being explored. Some additional development work is needed for full adoption in the United States – especially in HVAC systems suited to the diversity of climatic conditions. Code issues concerning electrical distribution using modular cabling systems, and plumbing systems employing low-slope gray water drain lines will have to be resolved, but are not technically difficult, according to the leading US electrical and plumbing consultants.

THE MARKET FOR MATURA in the UNITED STATES

Several markets are ripe for the widespread introduction of open building and the Matura Infill System®.

In the first place, condominiums are an existing model of residential development in which a distinction already exists between "common" parts (base building) and "individual" parts (infill). Open building clarifies this distinction, while also allowing the number of physical elements assigned to the ambiguous "limited common" category to be reduced. By strictly separating

physical elements so that no elements belonging to or serving one unit (e.g. drain pipes or cabling) enter another unit's space, open building reduces the potential for conflict and disputes between individual owners and the association of owners. Use of Matura Infill System®. also makes the custom design and the subsequent alteration of units less difficult.

The second market for Matura Infill System® is the conversion of existing residential or non-residential buildings to housing. For years, developers in Seattle, Florida, Denver, New York and elsewhere have been converting obsolete warehouse and office buildings to live-work lofts. Some cities are taking this seriously and are investigating and adopting incentives to encourage conversions to bring residential uses into urban areas where it makes sense. In these conversions, blank units are divided by demising walls, with utilities provided at key locations, and are individually out-fitted. In many cases, these buildings have higher floor-to-ceiling volumes and large windows, making them very attractive living spaces.

Other markets may also open up for use of the Matura Infill System®. Gut-rehabilitation of existing multifamily buildings on a whole building or on a one-unit-at-a-time basis is a prime opportunity for well-organized infill systems. Timber frame construction is also an excellent building type in which open building can be and in fact is being adopted, led by Bensonwood Homes in New Hampshire.

Finally, some kinds of office uses such as medical facilities, especially small- scale ambulatory clinics, could benefit from the Matura product. With the need for rapid installation and easy reconfiguration when departments shrink or grow, such uses would benefit from the bundling of trades and products into a single source supplier. Also, the use of the extra floor layer (Matrix Tile) and inclusion of drain lines in the floor layer solves a number of problems.

Early adopters of new product technology succeed best when the process of building is already aligned to support the new product. Residential infill, and the idea of integrated installation teams, is new. But the distinction between a base building bundle of decisions and products, and individual unit fit-out is not new in the industry, just as the distinction between individual freedom and community coherence are not new social concepts.

However, as technology has become more complex and entangled, as more players take part in development, and as regulations have increased in number and complexity, the possibility of individual households realizing their own dream home in multifamily urban environments has largely been lost. While developers and builders may be reluctant to declare outright that they would rather not have individual households involved in the process, this is in fact true. Current design, development, approvals, and construction processes are not consumer-oriented. They are not organized to support individual household preferences, a difficult realization in a culture that in other aspects is so fully oriented toward the individual's freedom of choice and action within community standards.

Open building, and the Matura Infill System, provide a remedy for this basic shortcoming in the way we build residential projects today. They help to restructure the housing development process, reducing the conflicts inherent in current practices and more closely matching the dynamics of society, and the yet-to-be-harnessed potential of real industrial production. Open building helps to open the housing industry to sophisticated technical processes so evident in the consumer electronics industry, the automobile industry and in other fully industrialized sectors.

INTRODUCING MATURA IN THE US

The first steps toward full realization of open building may come using ordinary products in a more sophisticated two-step process as outlined above. There is no reason not to take these steps. When the merits of this reorganized process are clear, those taking advantage will find that more advanced products will be needed. Some of these products are ready for introduction.

In anticipation of that, the developers of MATURA – Infill Systems, BV - are interested in selling the rights to MATURA for a lump sum to a party who sees the merits and wants to bring it into the market. Parties in the United States who are interested should contact Dr. Stephen Kendall, tel/fax: 301.649.6803 or email <skendall@pipeline.com>.

October, 1998