

## Flex-buildings: ‘Designed to change’

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### Abstract

Flex-buildings are buildings that are literally designed to change. A flex-building must be able to accept different infill and its users must be able to easily adapt their surroundings. Flexibility is defined as the capacity of a building to undergo modifications and accept changes of function with limited structural interventions. More than 40% of the activities housed in a flex building can continue to function during modification.

Studies into flex-buildings (commissioned by the Dutch Government) have elicited a number of insights. These are not hard-and-fast conclusions but more in the region of statements and reminders for those involved with flex-buildings. These studies show that it takes more than civil engineering to successfully realise such buildings. Aspects of use and management are at least as important. Besides, it requires designers who are willing to let go of their design after it is finished. For the result is not a completed ‘architectural’ product but a continually changing object. Following insights (among others ) will be illustrated with built and un-built projects in the Netherlands.

*-The façade design, for example, figures prominently in designing flexible buildings. It makes special demands on the design's presentation during the design process, as the building can assume different appearances over time. The double facade is a promising concept that allows for expressive and/or open facades in flexible buildings. It can also help to reduce a building's energy consumption.*

*-Also by deliberately incorporating excessive space and construction a building has the necessary leeway to accommodate future developments. A building's flexibility is enhanced by oversize in structure as well as space.*

Projects by Rapp & Rapp, Erick van Egeraat Associated Architects, De Architecten CIE, OMA, Maccreeanor & Lavington and RUIMTELAB are presented as case-studies. These are an inspiration for architects and planners looking for design tools to help achieve an open architecture. The RUIMTELAB architectural practice is a laboratory for flexibility. Architects René Heijne (1964) and Jacques Vink (1964) liaise with a network of experts. RUIMTELAB's starting point is that ground breaking projects can only be achieved through a combination of research and design.

**Keywords:** Flexibility, Design Tools, Architectural expression, Case studies, The Netherlands

## Groothandelsgebouw, Rotterdam

The Groothandelsgebouw in Rotterdam is an interesting example of a flex-building. It's a constant source of inspiration for many architects in the Netherlands.



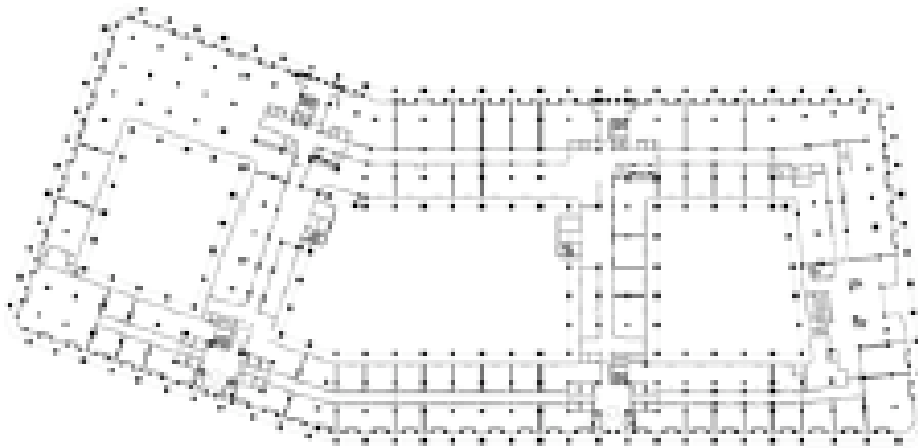
**Fig 1.** Façade facing Central Station

Due to the bombing of Rotterdam in the Second World War most of the merchants and traders lost their commercial spaces. After the bombing, but before the end of the war, they had already decided to work together to create one big new building for trade and commerce in the new city centre of Rotterdam. This 128.000m<sup>2</sup> building is the enduring symbol of Rotterdam's resurrection. It's designed by Maaskant en Van Tijen and opened its doors in 1953.



**Fig 2.** the Groothandelsgebouw in 1953

The commercial spaces are organized around three courts. On the lower levels trucks can deliver goods. The roads are stacked on three levels with a total length of 1km, 40% of all the commercial spaces are directly accessible by cars and trucks.



**Fig 3.** Typical plan: three courts and five vertical cores

Five vertical circulation cores and a double horizontal corridor system provide guaranteed accessibility to all levels. Oversized corridors were easily accessible by fork-lift trucks, fork-lift trucks were considered by Maaskant to be a revolution on the scale of the conveyor belt.

The flexible nature of the spatial organization of the building had specific consequences for its design: behind every window in the Groothandelsgebouw one could expect a workshop, or a warehouse, or a showroom, or an office to be realized. The window would have to be suitable for all these different spaces as the use of different window types was unrealizable.



**Fig 4.** detail of the facade

Not only its size but also its constant state of change and its clear defined image makes this building unique within the modern architecture of the Netherlands. At the moment the building undergoes a big renovation while the majority of the companies go on.

### **Why Flex-buildings?**

Our living and working environment is subject to increasingly frequent change. Unlike in the past, buildings will easily change a few times within a single lifetime. The cycle of building and demolishing has become visible for everyone, as is the influence of fashion on buildings.

Functions merge; the role of the car is getting more and more important. This demands new forms of living/working spaces and buildings which deal with changes of function in a flexible way.

Our study into flex-buildings has elicited a number of insights. These are not hard-and-fast conclusions but more like statements and reminders for people involved with flex-buildings. I will present several of these insights using projects by RUIIMTELAB and by others as illustrations. We research in order to bring the design to a higher level. Our aim is to share knowledge of research and construction with other designers. With this aim our research is clearly different than an academic research.

Flex-buildings are buildings that are literally designed to change. A flex building must be able to accept different in-fills and its users must be able to easily adapt their surroundings. The study into flex-buildings has elicited a number of design insights which are summarized below headed by a relevant key term. It should be stressed that these are not hard-and-fast conclusions but more in the region of statements and reminders for those involved with flex-buildings.

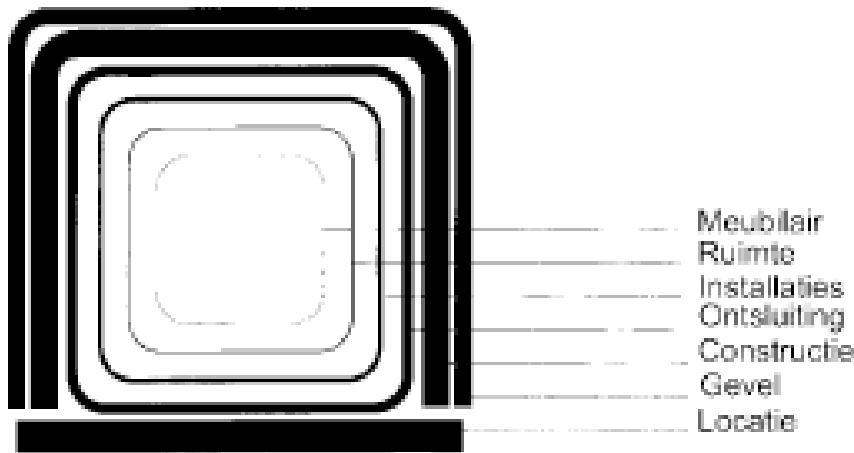
1. Flexible is...Flexibility in a building is its capacity to undergo modifications and accept changes of function with limited structural interventions. More than 40% of the activities housed in a flex building can continue to function during modification.
2. An observation: Building regulations are not geared to buildings developed without a pre-established brief. Thinking in terms of function begins with the land use plan.
3. Cycles Buildings aren't just buildings. They can be divided up into seven system based layers. Each of these has its own lifespan, all the way from centuries down to a couple of years.

### **Diagram**

To realize a flex building one has to bear these internal dynamics in mind. Flexibility can be greatly reduced when the different layers are combined. For example installations those are to be found deep in the structure of the building whereby the building would have to be gutted in order to be changed. In the high-tech Centre Pompidou in Paris designed by Piano, Rogers en Foster in 1977 the installations are all placed on the outside

in order to create the most flexible spaces possible. In any case the installations can be reached very easily.

In our view one layer is to be added to the diagrams as proposed by Francis Duffy and Stewart Brand. The circulation system within a building is crucial to the future possibilities



**Fig 5.** Diagram showing building layers including circulation

#### **4. Intensive**

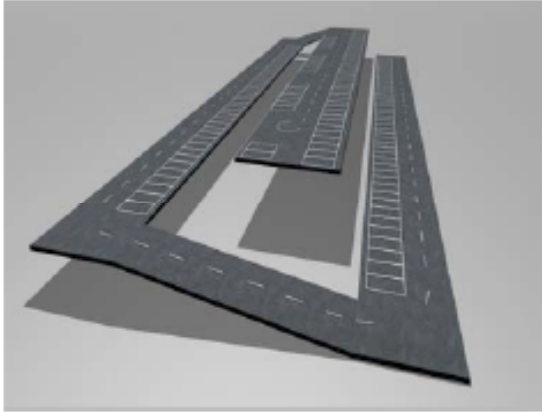
Flex-buildings enlarge the dynamic of a city by enabling a more intensive land use.

##### **Prisma1, Bleiswijk (mixed use building)**

**Prisma1 is not only an example of intensive land use but also an illustration of the importance of the circulation system within a building.**

In boomtown Zoetermeer near The Hague, at the intersection of the A12 motorway from The Hague to Utrecht and the high speed railway line to Paris, a new industrial estate has been planned. Large infrastructure dominates this site. The main topic is intensive land use. In ordinary industrial areas the ratio between site (lot) and brief is about 0,5. In this new industrial estate the value known as FSI, 'Floor Space Index' should be minimal 1,0. Another important aspect is that the future building stands on the Zoetermeerselaan. A lane which will have a public quality and will be car orientate.

Since the program was not clearly defined, but a large number of parking spaces had to be built we proposed a building that could contain a variety of programs. The drive-in helix would make all of these programs accessible for cars. The shifted section would show the stacking of program from the Zoetermeerselaan.



**Fig 6.** Drive-in helix Fig. shifted section



**Fig 7.** Shifted section

This may sound complicated but actually the plans are very simple, also due to the limited budget. A structural grid of 14,4 meters allows for a lot of programs to be incorporated. The architecture is inspired by the highway, drive-in culture that is why we used lampposts, railings, billboards, metal cladding. The big logo PRISMA1 is orientated towards Zoetermeer and marks the entry of the industrial estate and functions as a billboard pointed towards the highway.



**Fig 8.** Drive in building on the Zoetermeerselaan

## 5. Vacancy

A new development is to strategically reserve extra space (over measure) to accommodate future growth, and to accept temporary vacancy to enhance a building's flexibility. Until a few years ago it was customary to avoid leaving buildings vacant because of the bad image: Times change.

## 6. Nodes

The developments at nodes in the personal transport network are dynamic and difficult to predict. Flex-buildings are able to take up these changes.

## 7. Shrinkage

Building flexibly is not just about growing but also about getting smaller.

### Master plan for the university campus in Wyong, Sydney, Australia

This master plan for a university campus in Wyong, Australia anticipates shrinkage. The Internet enables education to reach the most inaccessible areas. For the moment a relatively large complex is still required but in the future the university will be able to manage with far fewer buildings.

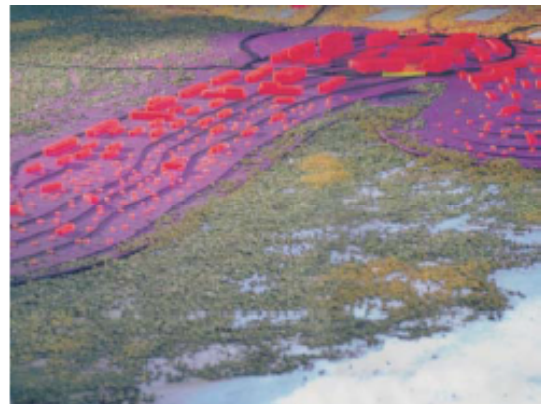
The university consists of two types of buildings:

- Lightweight structures that can easily be moved and serve to house some 2500 students
- The heavier, thus more durable working buildings are situated in the centre of the site.

We combined these with the public facilities (conference centre, library, theatre). If in the future the university disappears, these buildings can be integrated in the communities of Warnerville and Wyong. The originally virgin wetland area is left behind with a minimum footprint.



**Fig 9** Shrinking in time



**Fig. 10** Lightweight and durable buildings in the wetlands

## 8. Dilemma

Buildings should be able to change quickly to keep abreast of the city's growth. At the same time there is an urgent need for buildings that act as enduring landmarks in the city. Flex-buildings have an answer to this dilemma.

## 9. Cultural durability

Cultural durability can make a flex building in good working order a major success, but it can also obstruct change, say if there is resistance to demolishing a poorly functioning building.

## **10. Spontaneous**

Sometimes buildings are flexible without this being calculated beforehand. Many warehouses are able to accommodate different kinds of uses through the sturdiness of their architecture.

### **Scouting club, Reeuwijk near Gouda**

Farms and stables have also proved suitable for many kinds of use. The modern modular construction used for the agricultural industry seems to have saved the day for a scouting club (Cornelis de Houtmangroep) in Reeuwijk near Gouda. Although it didn't have enough money for a new clubhouse, it did have enough enthusiastic and practically-minded members. So the club commissioned a construction company to erect an inexpensive and roomy stable that its members could fill in themselves.

## **11. Designing**

Many architects (certainly Dutch ones) have been trained along functionalist lines. Functional design assumes buildings with a clearly described brief. In flexible buildings however both the use and the future users are largely unknown.

### **Uncertainties**

Maybe the most important of all design recommendations is that architects must learn to deal with uncertainties. Often the brief for the building is out of use or economically outdated by the time the building is finished. Designers should unlearn the traditional certainties.

Nothing is for sure in a flex building! So we learned from experience in student housing Wageningen (see below).

## **12. Time horizon**

A time horizon is the span of time assumed in a design brief: 20 years means making other decisions than when the horizon is 200 years. It's not just about what a design should do but also for how long.

### **Ice-chapel**

There are specialized architects and engineers who are exclusively concerned with ice and snow constructions. For example the Fin architect Kino Kuismanen and engineer Seppo Makinen are the founders of 'Snowhow Ltd.'. They strive to make designs of snow and ice that make optimal use of the special qualities of this short lived building material. Even in the cold north of Sweden ice has a limited life span. Every year in Jukkajarvi a hotel, a chapel and exhibition spaces will melt away in the sun.





**Fig 11.** Interior of the chapel

### 13. Bandwidth

A flex building need not necessarily be able to take up every possible function. 'Functional bandwidth' is a current term: which functions are involved? You don't always need flexibility.

#### Student housing, Wageningen

Define the bandwidth of the brief together with your client, which uses can be, and which uses are unlikely to be expected? Matrices can help! To accommodate the process of defining the bandwidth you can use this tool. It shows the client the potential new functions (bandwidth) combined with the technical demands (floor loads, sound insulation, daylight requirements etc.). From the matrix the client can choose the degree of flexibility and investments.

Matrix: student housing / working / health care			
function	bandwidth	technical demands	investment
student housing	100% (100% of the building)	100% (100% of the building)	100% (100% of the building)
working	100% (100% of the building)	100% (100% of the building)	100% (100% of the building)
health care	100% (100% of the building)	100% (100% of the building)	100% (100% of the building)
other	100% (100% of the building)	100% (100% of the building)	100% (100% of the building)
total	100% (100% of the building)	100% (100% of the building)	100% (100% of the building)



**Fig. 12** Matrix as a design tool

**Fig.13** Façade facing square

Façade: just like the Groothandelsgebouw with simple means we have tried to create an interesting image: single glass planks on the exterior spaces and staircase, double in front

of the rooms, so a box within a box appears. This student accommodation in Wageningen was designed to be able to change in the future. Not everything is possible however. The construction is such as to accept hybrid forms of dwelling and working. But you can't park on the roof! The structure includes reserved space and again 'oversize prize'!

#### 14. Not everything

The flex building concept suggests an opposite pole: a building made to measure. Not all functions are suitable for inclusion in a flex building. A printing works for instance, with enormous floor loads, is better off with a building made to measure.

#### 15. Oversize

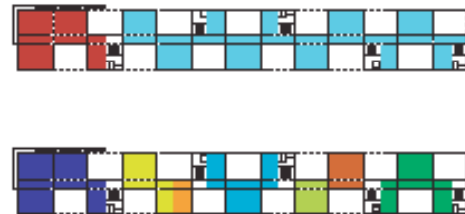
By deliberately incorporating excessive space and construction a building has the necessary leeway to accommodate future developments. A building's flexibility is enhanced by over-measure in structure as well as space.

#### North West, Rotterdam (mixed use building)

Trucks and container ships were models for this building in the North-West industrial estate in Rotterdam. This not only for their formal qualities but the building should function literally as a collection point for trucks. The lower level contains various provisions such as a large transport café/restaurant, a bank, a post-office and shops. By means of oversizing the vertical circulation, different layouts of a floor plan are possible: one or several clients per floor. The offices in the upper level can be filled and linked in different ways.



**Fig 14** Image of a container ship



**Fig 15.** Oversized circulation allows different plan layouts

#### 16. Facade

The facade design figures prominently in designing flexible buildings. It makes special demands on the design's presentation during the design process, as the building can assume different appearances over time.

#### Twin houses, Amsterdam

The facade design figures prominently in designing flexible buildings. It makes special demands on the design's presentation during the design process, as the building can assume different appearances over time. Avoid anonymity; design a building with a

façade that gives the building a clear identity. In the evening when the lights go on inside, the facades of these twin houses on the Borneo Island in Amsterdam becomes transparent. During the day, the position of the hatches makes for a changing image. The cladding of the façade with Robinia hardwood also changes in time: yellowish when applied, silver when the patina process has finished.



**Fig 16** street façade at night



**Fig 17.** Closed shutters in street façade during daytime

### **17. Integration**

It can be advantageous financially to integrate and combine layers in a building - such as the construction and the frontage in a load bearing facade. This can be extremely impracticable however where flexibility is concerned. Necessary changes can lead to the building being demolished prematurely.

### **18. Compartments**

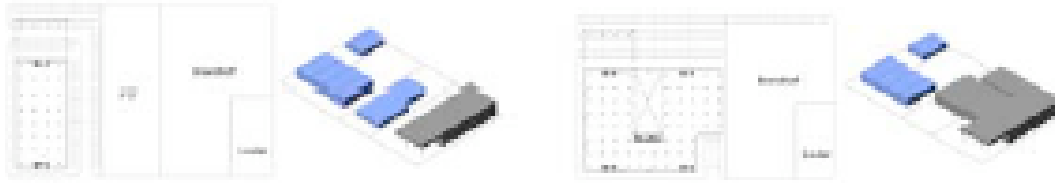
For large buildings erected in stages it is handy to work with compartments. Parts that are finished combine as one large complex. They can always be recast as individuals at a later date.

#### **New Auction Building, Hoorn (mixed use building)**

For large buildings erected in stages it is handy to work with compartments. Parts that are finished combine as one large complex. They can always be recast as individuals at a later date.

In Hoorn, a small town of on the IJsselmeer, 50 kilometres north of Amsterdam we had to deal with this problem. For the municipality we designed a service building on four different lots on an old industrial estate in decline, one owned by the municipality, the other three by private companies.

Since it was unclear when where could be built we had to phase the design in different compartments. The column grid was defined by the need to park in or under the building.



**Fig. 18** Two stages in the phasing

### **19. Double facade**

The double facade is a promising concept that allows for expressive and/or open facades in flexible buildings. It can also help to reduce a building's energy consumption.

#### **New Auction Building, Hoorn (mixed use building)**

This mixed-use building in Hoorn sports a double facade. This renders the activities inside the building visible in the exterior. The facade works as a display window in which each of the companies can present itself.



**Fig 19.** Detail of double facade

### **20. Active management**

Flex-buildings require active management. Besides the day-to-day business of upkeep and repair, there needs to be a policy for the building's infill. This includes deciding which users and uses are desirable and in which proportions, and fixing the requirements for user representation in the facade.

## North West Building (mixed use building)

In large buildings lots of different sorts of people work and visit: white collar workers/businessmen and blue collar workers can be separated. The building management can stimulate companies to stick together: synergy can emerge

In a flex-building different functions can profit from their proximity, for instance they can share the garage, the reception or the cantina. Also energy management and rubbish processing are synchronized. The plants in the garden centre flourish with the excess heat from the offices. Furthermore building advertisements zones were anticipated in the facades (see

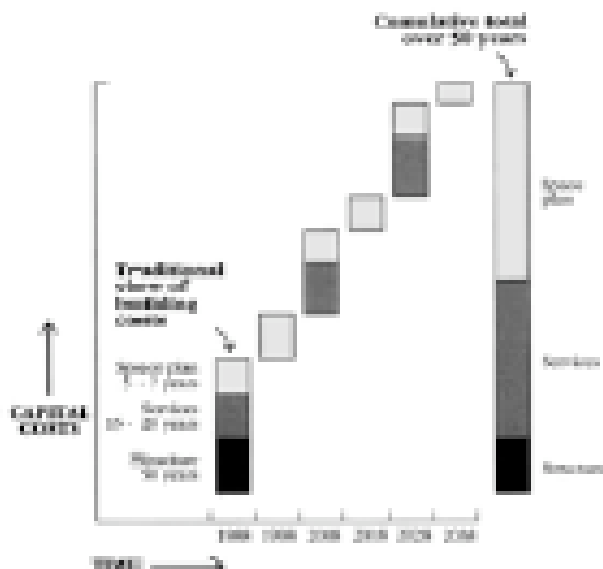
### 21. Energy

It is sensible to tailor the energy management exactly to the use. So in a flex building the energy management is flexible too.

### 22. Costs

A flexible building isn't more expensive than a conventional building. It depends on how you look at it. Calculations where savings on future renovations are compared to the higher starting costs show us that a flex-building will in the long-term easily earn this initial investment back.

During a period of 50 years the installations of a building will be modified twice on average. The interior will change on average 5 times. The structure will remain unchanged. When we add up all the costs we find that the original investment in the structure is low.



**Fig 20.** Diagram showing costs in time

Source: [www.smartarch.nl/ruimtelab](http://www.smartarch.nl/ruimtelab)

