LEARNING ON FLEXIBILITY FROM EXPERIENCES

REVISITING HOUSING ESTATES AFTER 25 YEARS

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LEARNING ON FLEXIBILITY FROM EXPERIENCES - REVISITING HOUSING ESTATES AFTER 25 YEARS

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Abstract
In the wake of the Second World War the Danish government tried to increase the capacity of the building industry by establishing new research facilities, stimulating the housing sector and developing a framework for industrialization. The dominating building method during this period became multi storey housing with cross bearing walls. Within multi storey housing the developed system design appeared to be less adaptable to later alterations. Therefore The Danish Ministry of Housing and Building in 1983 issued an initiative to stimulate technology development of residential non profit housing in three to five storeys the target being "to focus on the possibilities to create buildings which in the future can be adapted to new user demands and applications that we do not know of to day - and in the short term add flexibility which can create possibilities for individual housing projects" (The Ministry of Housing, 1984,1)

During spring 2011 DTU Management at The Technical University of Denmark has initiated an evaluation with the aim of showing how the ideas from the original competition have been applied during the 25 years period. Thus this paper will review the above governmental policy aiming at stimulating the development of new building designs with an improved technological adaptability to new demands and flexibility.

The data input to this review is extracted from 15 residential areas with a total of about 1000-1200 apartments which were built in the 1980s after a competition which attracted the leading building companies. This paper is based on the provisional results from the evaluation and will conclude in a "top six" for most successful steps in the planning and construction of buildings with capacity for incremental change.

Keywords*: housing, flexibility, user needs, experiences, evaluation*

INTRODUCTION

During the last years a new aspect of the design and planning of a housing project has been given higher priority: planning for future changes as a fourth dimension to supplement the interplay between economy, architecture and durability of the construction. This development reflects the fact that wishes from tenants, new technology and altered requirements from society after some years will be constituting new conditions for user well being and – with a generic term – for sustainability.

The traditional planning process has by and large been ignoring the need for future changes. While in the best of projects there have been some considerations concerning flexibility and possibilities to replace appliances with new ones - in the worst (and majority of cases), however, it is not unusual

that even new buildings must undergo basic alterations with costly consequences shortly after handing over of the building.

As indicated this paper will be looking at the empirical data from a governmental point of view as adaptability to alterations in the housing estates in the fourth dimension perspective was an essential and deliberate part of the governmental trial to influence the housing sector. Furthermore the paper is focussing on how a governmental institution in collaboration with a research institute can contribute to the development of new types of housing design. Have the specified solutions been successful - and if yes, how can they be utilized in future building projects?

BACKGROUND TO THE EXPERIMENTAL BUILDING COMPETITION

The basic philosophy behind the Danish efforts since World War Two, called the Danish Open System Approach, was to create an open market for factory produced – dimensionally coordinated – building components that could be combined in a variety of individual building estates. In accordance with this basic policy, it was the government's task to establish the framework for a development within which the building trade itself could create the necessary technical innovations, see figure 1.

For multi storey housing the developed system appeared to be rigid for later alterations. Therefore the Danish Ministry of Housing and Building in 1983 took the initiative to stimulate the innovation within residential non profit housing in three to five storeys. The target was *"to focus on the possibilities to create buildings which in the future can be adapted to new user demand and applications that we do not know of to day - and in the short run to add flexibility which can create possibilities for individual housing projects"*(The Ministry of Housing, 1984,2).

Flexibility was furthermore considered an important quality in connexion with urban renewal because new estates in cities must be adaptable to the architecture of existing buildings.

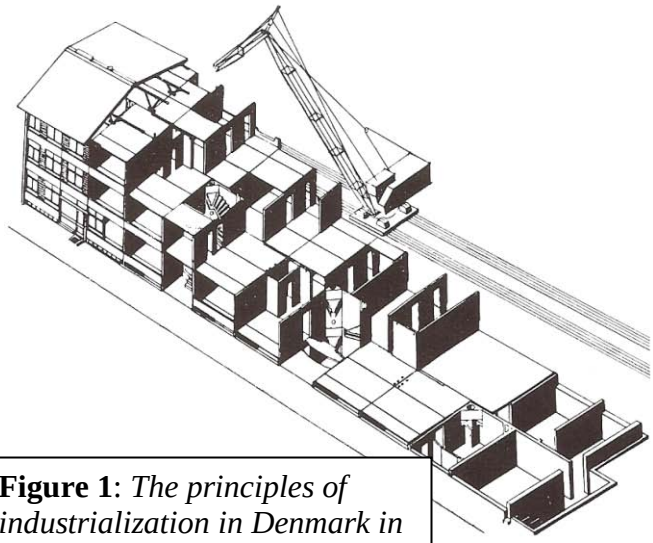
This governmental initiative was taken with the intention to push the industry in the direction of more flexible housing and buildings, open to incremental changes - but not to interfere directly with the production technology and businesses of the individual companies. An essential tool therefore was to create a market for new products and processes.

In Denmark since WW2 the non profit housing associations have constituted a useful instrument for realizing public housing and building policy thus having a significant impact on the development of the building industry. The associations act as clients who engage private firms for design and construction – and as a consequence of their accumulated, continuous building activity these housing associations has clearly been playing a decisive role in the long term development of industrialized housing (Bonke et al., 2001).

The above initiative and the competition marked a general wish to question and challenge the design and technology hitherto applied to industrial multi-storey housing. Since the collaboration and interplay between the industry, research institutions and the Ministry of Housing and Building started back in the 1960s the efforts had been concentrating on an effective use of prefabricated concrete load bearing cross walls and floor slabs with a minimum of component variants.

The main principles in the industrialisation approach consisted of

- Use of modular coordination
- Use of standardized components in the project
- Unconplicated buildings
- Not to focus only on the carcass but all trades
- Coordination between different clients



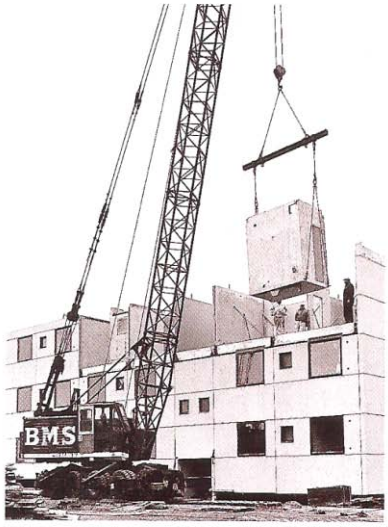


Figure 1: *The principles of industrialization in Denmark in the 1960s*

As a consequence of this policy a dominating characteristic in Danish housing industry since WW2 became an extensive use of prefabricated components (see above) which – because the development took place in an open innovation framework - without serious impediments entered all areas of the building industry and substituted traditional building technologies.

THE COMPETITION AND THE PROPOSALS

The competition was open only to groups comprising architects, engineers, contractors and, if applicable, sub-contractors and manufactures. An important feature was the requirement for a close cooperation between designers and contractors and in this way an exchange of experiences and ideas at an early stage with the aim of coming up with new ideas and innovations.

After a preliminary pre-qualification phase with 40 participating teams, representing leading Danish companies, six groups were selected in April 1984 for the actual competition.

The six groups submitted their project proposals in late 1984, and the jury's evaluation was available in December 1984.

The proposals for the competition indicated that the demand for greater flexibility in future multi storey housing, both during the planning and the occupation stages, points to changes in the

structural system. A general innovative feature thus encompassed use of columns instead of load bearing walls.

Specifically concerning the technical services the competition produced a variety of possible developments. One innovation was about an improvement of existing radiator systems. For example, radiators could be combined with injection of pre-heated air. Another possibility involved the use of hot air heating. For example, heat produced within the individual dwelling by means of a unit which also produces hot domestic water.

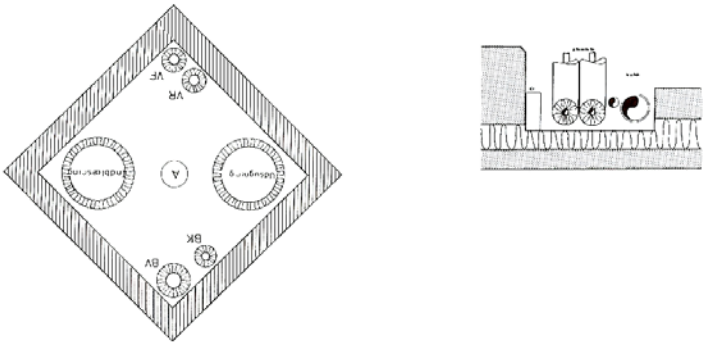


Figure 2: *Two proposals concerning the placing of a unit for installations: in the middle or at the façade of the building. In both cases is it possible to change the connections to the individual flats during the construction phase as well as during the use of the building. In some proposals it is furthermore possible to place the pipes for heating, electricity and water supply in factory produced concrete elements designed as an U, thus offering the same flexibility as above.*

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In the winning project the ground floor may be used for common facilities and the upper floors can contain two-storey flats. An access deck on the floors and wide corridors provide a transition zone between the public and private areas. The building can be adapted to existing, high density urban areas or may be designed as unattached housing blocks in open suburban surroundings.

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The structure is based on a column/deck system. The columns may be round or square in section and visible on the exterior or interior of the building. The solid, square deck elements can be prefabricated in vertical shuttering.

The proposal follows the above described general development towards use of prefabricated components in Danish housing industry and is at the same time inspired by thinking from Habraken (Habraken, 1982). Furthermore the partition walls and the façade elements are kept free from bearing parts of the carcass. In this way they are easy to substitute, also by new contractors and manufactures.

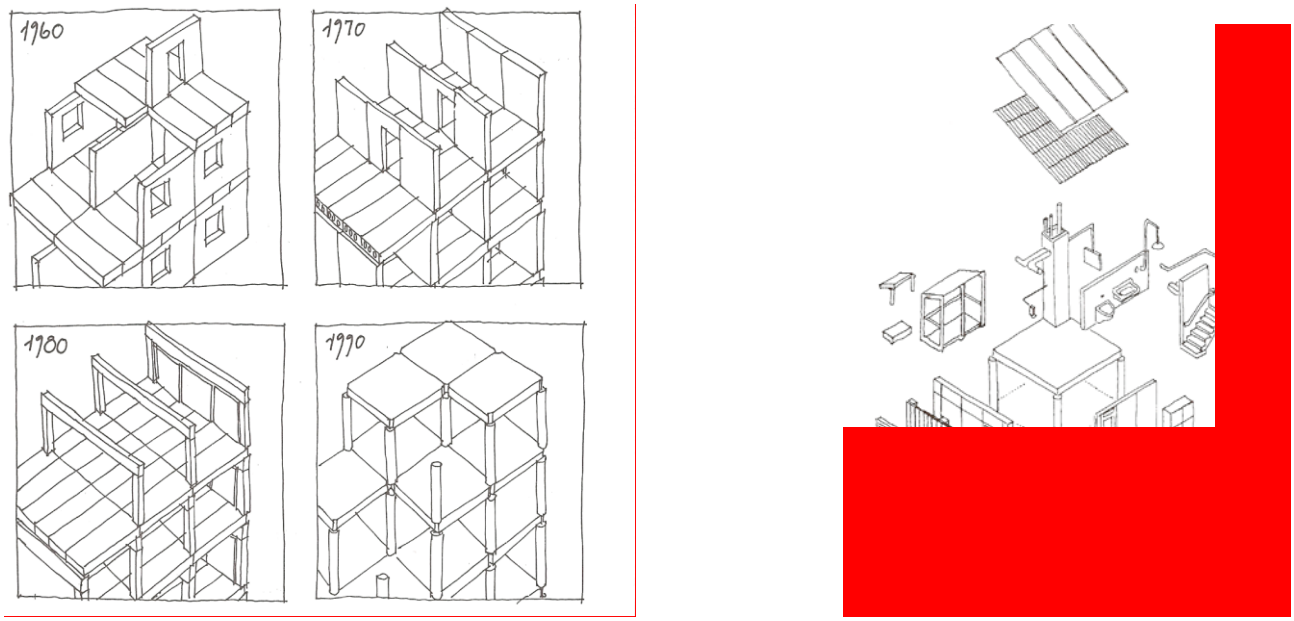

Figure 3: *The development of the structural systems since the 1960s and the vision for the 1990s (left), showing how the winning project proposes a system consisting of prefabricated components (right).*

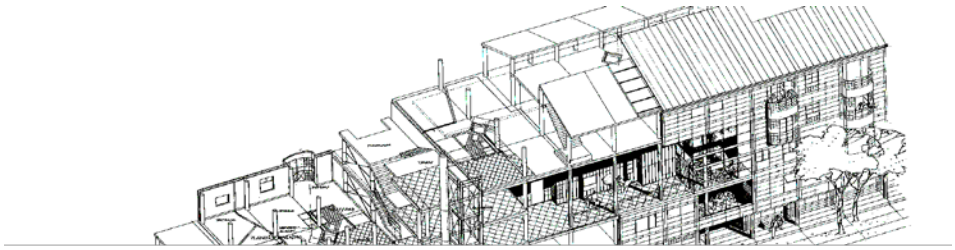

Figure 4: *A view of the winning project proposed by Arkitektgruppen i Aarhus A/S, architects, Viggo Michaelsen A/S, consulting engineers, and Højgaard & Schultz A/S, contractors.*

During the second half of the 80s the selected teams constructed 15 residential areas with a total of about 1000-1200 apartments (as shown in figure 5 below). Elements of the innovative ideas were furthermore used in other residential projects.

Figure 5: *The first estate based on the project*

EVALUATION

In Denmark the normal practice is to evaluate a building after one and after five years but only concerning technical defects. These evaluations are elements in the standardized conditions for contracts between clients and companies.

There is an increasing interest for evaluations which go beyond those evaluations and take into account user experiences as well as opinions concerning the architectural aspects and the operation of the finished buildings. And at the same time also an interest to make evaluations after a longer period of time.

The above described development initiative was evaluated after about ten years in 1994 by the Danish Building Research Institute to see whether the short term flexibility goals has been reached and used. This evaluation focused mainly on technical topics such as the building system, architecture and user value, indoor climate and installations, construction elements and building technique plus market and economy.

DTU Management at the Technical University of Denmark has now initiated an evaluation with the aim of showing how the development results of this experimental building programme have been exploited after app. 25 years (say during 25 – 50 % of the expected lifetime of the buildings. This evaluation will include topics such as alterations due to new user demands during the 25 years, modernization, technical replacements, maintenance and the development of the surroundings.

EXPERIENCES - GATHERING OF DATA

In the early evaluation from 1994 the Danish Building Research Institute found that the flexibility in the winning system had been used to create many different and new forms of dwellings, of accesses to the dwellings and of common areas and surroundings, see figures 4 & 5.

Some excerpts from the evaluation: 'It would seem from the housing projects completed that by transferring the quality of low-dense housing to multi-storey buildings, the latter have been added with important new qualities'. And furthermore: 'architecturally as well as in terms of use, the projects on Ålekistevej and Engen in Rødovre, (see figures 4 & 5), serve to widen the concept of multi-storey building' (The Danish Building Research Institute, 1994).

On the technical front the competition has shown new ideas concerning structural elements mainly based on prefabricated components and new form of installations with an eye on sustainability (The Ministry of Housing, 1984, 2).

In this way it actually seemed possible to change the normal design of multi storey housing, hitherto used in the non-profit housing sector.

The use of columns which was a main element in the competition has been applied in different ways. Based on development work and testing it became possible to create new principle for joints between columns and slabs and in some cases also beams.

A leading principle for installations was use of pipes in special shafts in the interior of the building or at the facade – vertically and in some cases horizontally, see figure 2. But otherwise the proposals contained different forms of heating – from traditional use of radiators to heating based on hot air and in some cases adjustments with electrical heating plates.

The 1994 evaluation concluded that 'There is no doubt that, together with the considerable flexibility, their design and layout will affect the future design of multi-storey residential housing'.

Focus in the DTU Management evaluation of 2011 is on the subsequent utilization of the innovations for greater flexibility. The evaluation has taken its starting point in a division of the overall flexibility and possibility for incremental changes within the following 9 themes:

- Which bigger alterations have been executed?
- Which types of alterations have not been feasible?
- To which extent have dwellings and common areas been altered?
- Which alterations concerning connections to public supply and sewage services have been executed?
- To which extent and when have installations been altered or replaced?
- Have there been alterations in the surroundings?
- Have there been barriers to the operation of the finished building?
- Have elements in the building carcass been altered?
- Other alterations

Furthermore the evaluation will draw upon the guidelines for value stability, as defined in the German system for environmental evaluation DGNB, which is due to be introduced in Denmark.

The main points here are effectiveness of the use of the area, adaptability (modularity and connections to public services) and possibilities for change to other uses.

In the 2011 evaluation answers about experiences have been collected from five building owners, a member of the 1994 evaluation team plus a civil engineer from the winning project, still occupied in the same company. As the prize winner constructed 5 of the 15 estates the gathering of data has been focussing on those projects. The answers were procured by telephone interview with the responsible estate manager for the daily operation and maintenance. In the coming work it is considered also to ask the users about their opinions. Finally an option is also to investigate how the involved construction companies have utilized their learning.

The question in focus is whether the innovations developed in connexions with the competition have made it easier, compared to traditional industrialised housing design, to make alterations and incremental changes to adapt the estates and buildings to new demands. It is important to note that a feature in the selected projects in the competition also was the flexibility of the proposed building system to be adapted to different surroundings as for example the architecture of an existing city as well as in new areas, see figures 4, 5 and 6.

Figure 6: *The estate shows how the winning project, see the figures 4 and 5, due to the in-built flexibility can be adapted to existing surroundings of a city.*

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The experiences can be summarized in the following statements:

- It is possible to use and adapt the developed building systems and the innovations to different surroundings in inner cities as well as new areas. They are open systems.
- The technical innovations in the structural system have up to now not been exploited. There have been some alterations within the individual dwellings, made possible by the new system.
- Up to now there has been no interest for changes in the façade, apart for maintenance purposes. However, such exterior changes are not particularly difficult to execute even in traditional designs when the facade elements are not load bearing
- The outside tower for the elevator in the winning project, as well as the elevator itself, is a vulnerable construction.

- There have been some smaller problems with the heating system installations due to their innovative character. In some cases it has been necessary to compensate with new installations and the in-built flexibility has not foreseen such problems.
- More considerations on the operation during design and construction phases would have made the cleaning and maintenance tasks easier.

DISCUSSION

In the design and construction phase of new buildings the normal practice has been to focus on the execution phase. An example is concerning costs. In this way the operation of the finished building and to some extent also the use of the building has been neglected. For the moment in Denmark there is a growing interest to involve the coming tenants in the design phase. But a problem here is that it can be very difficult for the users to anticipate up to100 years – or more – which is a normal lifetime in Denmark for a building.

Therefore experiences from existing estates can be valuable. Especially in this case as the buildings are the results of a competition with the target to challenge professional owners and companies to come up with new ideas and suggestions concerning in-built flexibility.

From the research perspective, a method of evaluation of finished buildings can give numerous possibilities for further studies. For example, the preliminary findings presented in this paper could be extended through more contacts to the involved parties – administrators as well as users and companies. Doing so may further help to understand how buildings can be designed and constructed to make incremental changes possible and thereby more sustainable.

CONCLUSIONS

On the basis of the competition and preliminary experiences from the cases it may be concluded more generally that clients, designers and contractors have to take the following six steps into consideration when targeting design of buildings with capacity for incremental change:

- In the overall design of the estates as well as of the individual buildings and dwellings considerations shall contain possibilities for flexibility in the use of the space.
- The structure in the individual dwellings can be based on columns which permit use of light weight partition walls with the possibility to later alterations. A solution is also large floor elements supported by heavy wall elements.
- For walls between dwellings it is more convenient to use heavy elements due to demand of reduction in noise and costs.
- The installations shall take into account possibilities for replacements and new systems of energy, electricity, garbage and sewage.
- It is important to consider operation and maintenance aspects of the finished building during the design and construction phase.
- Special care must be taken for the possibilities of replacement of exposed and vulnerable parts of the structure as use of timber in the façade and steel construction for lifts.

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