Slimbouwen®, adaptability on an economic basis

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1 Introduction

Slimbouwen might be translated as Smartbuilding. Slim in Dutch means smart but in the Netherlands we use the English meaning as well. Slim might therefore also be translated as lean and mean.

In the 20th century technological and market developments, have so to say surprised the building infrastructure. After many centuries of relative standstill the society and its needs developed quite rapidly, but at the same time we basically maintained our building methods. Fortunately the conscience is growing now that our building tradition causes severe societal damage. Taking this into account, the conclusion is that we cannot continue our traditional building approach.

On the other hand the question does rise to what extent the building industry is capable to react? The building industry is fragmented into many small parties and none of them plays a leading role. Everybody feels like being a follower. For this reason the obtained and existing innovation is carried out on a component level and is hardly of a conceptual nature. As a consequence the achievements are to be characterized as ‘innovation by addition’.

In this contribution the author presents the history of traditional building with a special focus on ancient Roman architecture and the influence of casting iron techniques since they both have still major influence on the today’s building technology.

The Slimbouwen concept will be presented and explained and elucidated with some examples of practical experiences. The presentation will also give an overview of the research field including some present research items. In other contributions at this conference some of these research items of the Slimbouwen Research Group are explained in more detail.

2 Structural building innovation up to 1900 AD

The traditional building process is also nowadays strongly based on ancient lines. Often it seems that certain phenomena in building are invented at a certain point, but in many cases they evolved slowly and remained through the ages. Sometimes they even were forgotten and had to be reinvented, not to speak about the never reinvented values which might even still be hidden for us in our era.

The ancient Romans applied the stacked construction method (building with stone or brick) on a large scale. Building with stone was already well known for centuries, but the techniques were revolutionary developed and exploited by the Romans.

In the Roman building technique the development of the masonry in particular is of great importance. The Romans already invented cement mortar and for efficiency reasons they contagiously developed a kind of poured concrete method. This method was named ‘Opus Caementitium’ ‘fig 1’.
On what remained from the Roman building technique is not representative for the reality. Also the ancient Romans constructed a lot with timber, but since wood did not stand the time of ages as well as stone does, a misrepresentative impression remains. Frame technology was also a regular technology.

In the 18e en19e century cast iron and steel was introduced as a new construction material. Cast iron already existed, but Abraham Darby discovered in 1709 in Coalbrookdale that by using cokes as a fuel, higher temperatures could be achieved. This discovery facilitated the realization of larger foundries, larger casting-ladles and thus larger parts. His grandson Abraham Darby III produced and built in 1779 near Coalbrookdale an iron bridge over the river Severn. Yet it lasted up to almost 20 years for this new technology concurred a broader basis. After that it became clear that a basis was created for the industrial approach of building and especially steel frame construction methods.

A famous example is Crystal Palace of architect Joseph Paxton, a world exhibitions building in short time erected in 1851 in Hydepark London and designed on the necessity of moving the building ‘fig. 2’. It has been demounted and rebuilt in 1853 in Sydenham London where it functioned for many years. Unfortunately in 1936 it was destroyed by fire. Crystal Palace was an early example of building in glass and steel. One of the examples of disintegration of structure and fill in.

3 Innovation by addition in the 20th century

Through the ages we maintained the existing stacking and frame techniques and we only added lots of technology on a component level. That is what is meant by ‘Innovation by addition’. Adding to the existing creates inefficiency at the end and that is exactly what happened in the construction industry.

The inefficiency mainly is caused by adding lots of installations and services during the last century. In 1900 the installation technique was limited to a sewerage system, water supply and a chimney.
Now, 100 years later, the installation technique is about 30-40% of the total building budget. Nowadays we use to hide them in walls in milled chases, being covered afterwards or we hide them into poured concrete constructions. We hang them under floors covering it with suspended ceilings. Through this way of stacked innovation the interweaving of services with the building parts has become very high.

This is an important conclusion since it has caused an inefficient building process. For one thing, the consequence is that the finishing process has become very complicated and is carried out by many disciplines with a high rate of mutual interdependency. All in all it is remarkable that the building method as a whole never was rethought.

4 When is change to come?

A number of eye-openers show that the traditional way of building in the contemporary context is no longer tenable. The statements are based on the Dutch situation, however the effect is quite similar in other Western and industrialized countries.

1. For the realization of 1 m² net floor surface 1,000 up to 1,500 kg of building material is applied. To compare: A mobile home weighs 80-100 kg per m²;
2. The building industry is responsible for 35% of the total waste production;
3. 25% of all road transport of goods is building related;
4. The production of building materials represent 8-10% of the total energy consumption;
5. 25% of a building volume is packaging. Customers rent or buy gross volume of which about 25% is taken in by building structures or hollow cores.
6. The price of houses is compared to consumer goods considerably risen;
7. Buildings are built with a technical life span of 100 year or more, but often they are demolished already within 35 year. The market and users are obviously significant more dynamic than the flexibility of buildings permit;
8. The traditional building process requires a lot of building site personnel and expertise that is not sufficiently available;
9. In an industrial environment profits are in the range of 10% of the turn over and failure costs in the range of 1-2%. In the building industry (contractors) it is the other way around;
10. The progress in the early stage of the building process (structure and shell) is experienced as rather fast The top of the building is generally realised quite soon after the foundation ceremony. After that it looks like there is no progress at all.

The eye-openers can be considered as symptoms that support the theorem that rethinking the building industry is unavoidable. The building industry, including technique, process as well as organization has, by the addition of many incremental innovations, evolved to the present mayor inefficiency and source for environmental damage.

5 Slimbouwen

Industrial and flexible building has been subject for analysis and developments for a long period. In 1914 Le Corbusier came up with the Dom-Ino concept. It was based on separation of structure and fill in. However in those days Le Corbusier hardly had to deal with services. In 1972 Professor John Habraken published his book “Supports, an alternative to mass housing” (already published in 1961 in the Dutch language). In that book he made statements about a separation of structure and infill and later he was also involved in developing technical solutions for the separation of services. These developments were primary aiming on variation and/or the possibility of customizing houses. In addition Slimbouwen is strongly aiming on the efficiency of the process and the reduction of materials and volume. Through the economical advantages of this approach adaptability and sustainability, mostly considered as an additional performance, become feasible.

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In the eighties and ninetieth, at Eindhoven university, experience with the separation of services was embodied in a research and development project, the so called ISB project (fig. 3) that has lead to two prototype houses and a broad discussion about how to build with breakthrough results.

Figure 3. The ISB project

Slimbouwen is a strategy to obtain integral solutions. Important objectives are the reduction of fixed parts and the detachment of installation parts, both physically and from an organizational point of view. This detachment makes the building process transparent, makes buildings adaptable, does substantially improve the efficiency of the building process and also reduces the use of material, transport, energy, CO$_2$ emission, dust, etc.

Crucial is the detachment of services which enable to organize the building process in a sequential way with only a few subcontractors responsible for structure, skin, services and infill.

Figure 4. Traditional parallel process (l) vs. Slimbouwen sequential process scheme (r)

Figure 5. Examples of detachment of services

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6 Research

Within the restrictions of available technology, Slimbouwen is already being practiced and applied in quite some projects in the Netherlands. Apart from the direct benefits the Slimbouwen strategy also leads to and gives direction to scientific research and individual development efforts in business. Recently a foundation was erected a.o. reasons to provide for structure for the benefit of the diffuse building market at one hand and to give financial support to research at the university at the other hand.

The author started up the research programme in 2004 and right now about almost 4 research employee equivalents are working in the programme, the most of them in the starting phase of their research.

To give an overview of the main present research items:

- Slimbouwen tools for design and organisation of the process (Jos Lichtenberg);
- Productdevelopment for Slimbouwen (Mark Cox);
- Flexible structures (Roel Gijsbers);
- Building for the elderly and the role of domotics (Masi Mohammadi);
- Energy saving in existing housing market (Michiel Ham);
- Free form technology (Arno Pronk);

Some current research topics from other cooperating research groups at the University in Eindhoven that are fitting in the Slimbouwen program are:

- Vibration in light weight structures (Sander Segers);
- Industrial foundations (Dr. Faas Moonen);
- Market adoption of Low cost housing (Zakari Mustapha);
- Prefab Housing (Maarten Willems);
- Polynorm (Guus Timmermans);

Some of them also contribute at this conference

7 References

Lichtenberg, J. 2005, Slimbouwen®, Aeneas, Boxtel

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