House of tomorrow today

Lichtenberg, J.J.N.; Ham, M.; Hensen, J.L.M.

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Jos Lichtenberg
Prof. Dr.
Eindhoven University of Technology
j.j.n.lichtenberg@tue.nl

Michiel Ham
Assistant Professor
Eindhoven University of Technology
m.ham@tue.nl

Co-author: Prof. Dr. Ir. Jan Hensen Eindhoven University of Technology j.l.m.hensen@tue.nl

Summary

The House of Tomorrow Today is a project focussing on a healthy, energy producing dwelling to be realized with today's proven technology. The project aims at an energy plus level based on the principles as formulated in SmartBuilding (Slimbouwen) [1] ActiveHouse [2] and HoTT [3]. It can be seen as the logical successor of the Danish-Canadian Zero Energy House project [4] HOTT is focussing on a healthy indoor climate based on natural ventilation, the production of sustainable energy using PV panels and a limited ecological footprint.

Keywords: Human Comfort and Health, Energy plus, Smartbuilding

1. Introduction and ambition

As an initiator and promoter of Slimbouwen (an holistic approach for efficient, flexible and sustainable building) and running as a Professor (chair Product Development, department Architecture Building & Planning) the research on Slimbouwen at the Eindhoven University of Technology, it is a real opportunity to build a new house and to offer it as an experimental object in the frame of Slimbouwen and the complementary Active House concept. Where Slimbouwen is based on the process and material related sustainability, Active House is aiming at an energy surplus being compatible with a high performance comfort and healthy indoor climate.

Substantial changes are to come. It is a matter of years when we will run into significant energy problems (shortage and costs), that we will have to face material shortages and that for cost saving reasons we will have to revise our care and cure system. It then will be necessary to keep living independently in our houses instead of moving to residential care homes for the elderly. It is remarkable that whilst being aware of the environmental burden and the necessary revision of the construction industry, innovation only proceeds slowly. On the other hand there are lots of initiatives like Rethinking Construction, Passive house, home automation, industrial building, etc. Technology for building according future values is as a first generation already available today. The search is mainly to imply and combine (new) technology to valuable concepts. By just doing it, we will have the opportunity to learn quickly and to convince the market. Projects are more convincing than scientific paperwork and that's why this house is a big
opportunity for science and suppliers to set a new standard that will strongly contribute in solving major societal issues. The ambition is to set these new standards and to create new business opportunities.

The project will be a house for a family, but will also be a kind of living laboratory to build up experiences and know how regarding technology and its use, a showcase of possibilities and a basis for knowledge transfer regarding societal issues. In this project the focus will be on tangible market pull based concepts regarding energy, sustainability, material reduction, comfort and independency.

Maybe a house of the future but certainly not meant as a science fiction or an assembly of stand alone concepts or technology push gadgets. The tangibility is based on the availability and feasibility of (new) technology. For the process (development, construction and use) it will build on Slimbouwen, for the energy and comfort values on the Active House principles. Sustainability will be served by material reduction, flexibility and recyclability of materials used (according to the Cradle to Cradle (C2C) thesis: Waste equals Food).

2. Energy surplus

In 2020 new houses in the Netherlands have to meet zero-energy requirements. Meanwhile the standards are strengthened. The answer however is in many cases based on an isolated (non coherent) approach. The Trias Energetica is a useful strategy, but not as a standalone approach. At the end a house is primary to live in and only maybe secondly for generating energy. Active House is focused on energy saving but strongly respecting the livability including space, ventilation and daylight. This approach requires the active use of artificial intelligence (sensors, operation, ICT). The ambition for the House of Tomorrow Today project (HoTT) is energy surplus.

![Fig 1: The main issues in the Active House concept](image)

3. Sustainable

According to the Brundtland commission Sustainable Development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations. For the building environment this definition can be connected to enlarge the lifespan by being flexible, but also by sustaining design and indoor quality. It also may comprise the reduction of use of resources (material and energy) and waste. Livability (health, comfort, perception), flexibility, reduction of volume and material, Energy surplus, recycling (C2C), etc. are major issues in this project.
4. Adaptable

Adaptability of buildings in general supports sustainability. Adaptability is also useful to fulfill its function during life time. Especially people in the age of around 55 do invest in a house once more. In general these people are still in good shape but do concern about their future in case healthcare will be needed. Physical limitations can lead to a situation where people are no longer capable to live individually. An adaptable house and care on distance can be helpful to enlarge the period of living independently. That includes both physical and ICT solutions like in the Realive concept. The costs for care can be substantially reduced by this approach. The ambition is to make the house “future proof”.

Fig 2: Active House (Home for Life Project Lystrup Denmark)
5. Slimbouwen process

Slim in Dutch means both smart and lean, bouwen means „to build“. Slimbouwen starts from the appointment that the conventional way of building does not fit the today’s requirements anymore. Building does substantially affect the environment in many ways and the building process became quite complex. In the last century step by step services were added to the already known building structure, without re-evaluating the building tradition. Slimbouwen is based on a skeleton structure and the separation of services from the building structure. A crucial development for this approach is the use of double shell structures such as floor and wall systems, which enables the installers to mount their prepared and prefabricated services as a whole and the user to change the installations during the use of the buildings. In double shell structures a substantial reduction of material (weight) is obtained, without losing perceived quality such as acoustical insulation.

The separation of services facilitates a simplification of the process and a substantial gain of time. Slimbouwen is a new approach for construction and a source for research in the frame of the chair „product development“ at the Eindhoven University of Technology. The research programme is named “Innovation in Building Technology (IBT)“. As a spin-off of this research also concrete product development is already established.

One of the main objectives is to rearrange the building process from an onsite parallel process into a serial process existing of only a few main steps with a minimum of interdependency.

This needs to be explained. The conventional building process and especially the finishing process, can be characterized as complicated in which the participants do carry out activities with a high rate of interdependency to other participants. The result is a lot of overlap, inefficiency, failure costs, complex coordination, lack of mutual respect, etc. Participants do have to return on site several times since the proceeding is dependant of the progress of other participants. In fact this process is a complex process, where facades, roof, services and infill more or less are shaped in parallel (fig. 3, left scheme)

A sequential process containing limited number of major sub activities can only be obtained by a separation of services from the process (fig. 4, right scheme). In the conventional process the services are interwoven with almost all building parts and in a new approach this has to be avoided. Only then it will be possible to divide the building process into a limited number of sub processes with a low interdependency rate and therefore these sub processes can be carried out sequentially.

Each main participant is responsible for preparation, production, mounting, guaranties, etc. for the total sub system. This is similar to other industrial branches. For example in the car-industry, the electric wiring is installed in only one operation. This is facilitated by the design
and engineering where the process of wiring already has been taken into account. The installation in one operation also enables the development of a cable-tree. Actually this is basically where an industrial process is all about. At first a proper division into sub processes and next comes the prefabrication and then the automation.

The sub processes as already shown in fig. 3(right) are:
- Structure (including Floor);
- Skin (façade and roof);
- Services (Electrical (including home automation), heat, air and sanitation);
- Scenery or Infill (partitions, finishing).

![Fig. 4 The Slimbouwen production sub processes](image)

On site the process is sequentially and disintegrated, during prefabrication the processes are still disintegrated but in parallel. In the engineering phase the process is also integrated. At this stage the core suppliers for structure, skin, services and infill contribute actively in the
designing and engineering process (fig 6). This is actively supported by a communicative ICT or BIM (Building Information Model) environment.

6. The design

The house will be erected on a building site in Sterksel in the municipality of Heeze-Leende (The Netherlands). De arrangement of the house is a modern interpretation of the ancient Roman atrium house, where air and daylight were already important issues. The plan is still in the design process, Fig 7 shows the preliminary design in section.
7. The research:

The experiment can be divided into the next sub sections:

1. The **process** (efficiency of preparation and assembly, incl. BIM, economical evaluation, analysis utility process);
2. De **building technology** (facilitating the process, flexibility, material savings, recycling (C2C, adaptability for elderly and care);
3. A comfortable **use** (sense perception (light, sense (temperature, humidity, CO2), noise / sound, health, wellbeing;
4. **Energy control** (input, output, analysis of use)

On all these aspects data will be collected and analyzed. The program has to be elaborated. Part of it will be a daily based registration of use and experiences to be compared with measurements. Also the visitors of the Bed & Breakfast will be questioned. This will enable us to acquire an interesting volume of data.

8. Knowledge transfer and promotion

The project results will be communicated as open source information with exceptions of company based confidential information. The initiator will give lectures about Slimbouwen, Active House and in particular this project. The results will also be presented in education
and in the frame of the research program Innovation in Building Technology. In general but also
On invitation of participants it is to estimate that during the next 2-3 years each year about 40
lectures will be given. In addition publications for professional magazines and papers will be
prepared and a website will be set-up. Participants will be mentioned on this web site and in
addition also for two years in the project on a panel.

9. Participation of industry

It is the intention to establish this project as a kind of mission to show and prove the potential
of Slimbouwen and the Active House approach. We want to go into the project, to do the
experiment, to carry out measurements, to share the results, to actively cooperate in
publishing the result(s), to give lectures, to host meetings, to generate ideas for product
development and new business, etc. All in all we hope to set a new standard for living
contributing to solutions for some major societal problems and to give access to new venture.
What we expect from participating companies is a firm contribution, among others: full
cooperation with know how and engineering capacity, advice, participation in research and
measurements, materials.
The time schedule is to start the project in 2011. Preparatory arrangements like the building
permit are already been made. While writing this paper the preparatory process with the
selected participants (system integrators and industry) was still ongoing.

10. Discussion

Lessons from the past learn not to rely too much on new technological concepts not yet fully
tested and proven in the real world. Also focussing on one item only e.g. saving energy will
not bring a feasible result. The project is now under construction. Ideas, simulations and
concepts may be inspiring, yet the real thing in the form of a working project is more
convincing than piles of scientific paperwork. Nevertheless also this pilot will be a source for
research and findings concerning energy, indoor climate, building technology and process.

11. References

[1] www.slimbouwen.nl