The "BASYS"-house - From a Research Project to Practice - a house in a day

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Abstract. *From 2000 to 2002 a building system was developed within an applied research project for creating individual planned, but widely prefabricated building-elements consisting of "Brettstapelholz". These are massive wood elements, fabricated by a CNC-machine.*
Two years later the results were transferred to the building industry. Most of the developed innovations had been adapted, the virtual enterprise worked together spatially separated via a common internet platform. The building elements developed by the architect were used. Although working properly, the complete integration of the CAD/CAM chain hadn't been completely adapted.
The house was shown at the "Bau"-exhibition in Munich. The following day it was mounted 350 km far from Munich and finished at the same day.
Overall, it took only one day to mount the house, from the bottom to the roof.
The article will show the building system and discuss the experiences gained by transferring research to industry.

Keywords. *Multidisciplinary Design for Sustainability, CAD-CAM, Massive Wood Construction, Industrial production of buildings, sustainable construction, low-emission buildings, Virtual Enterprise, Integral Planning Process*

Introduction

From 2000 to 2002 an applied research project examined the possibilities to construct buildings with "Brettstapelholz". This is combined wood to gain solid elements. It is made of laminated timber, put together with wooden dowels. The elements are manufactured by a CNC-machine and can be prefabricated individually.

The joint-research project 'Life cycle optimized system solutions for densified housing with massive wood technology', short form "Basys" [BSY00], was a demonstration project examining the development and application of an open building system for sustainable construction in a virtual enterprise. Four partners from the building industry and a university institute [IFIB] developed the building system in a comprehensive planning process. "Brettstapelholz" can be used for walls, ceilings and roofs. In contrast to the usual construction with wooden frames, it is massive and able to store heat and absorb acoustic noise. While in this

case the wooden elements are put together maintaining the natural vertical position of the trunk, the traditional method used for building wooden cottages, for example, applies the horizontal form of the trunk which rises problems as the wood warps following the growth of the trunk. As the vertically put wooden elements don't need to be tightened, our method implies significant advantages. As a flexible solution, the interior walls have no electricity or tubes and can easily be moved or replaced completely in case of a change of use.

If the owner doesn't want anybody to recognize at first sight that it is a wooden house, the use of plaster for the exterior hull is possible. The interior can be painted or trimmed with gypsum plasterboard e.g.

Two years after finishing the project, the results are now transferred to the building industry. A complete house [BSH04] with two storeys and one hundred square meters was completely prefabricated and shown during the "Bau"-exhibition in Munich [BAU05].

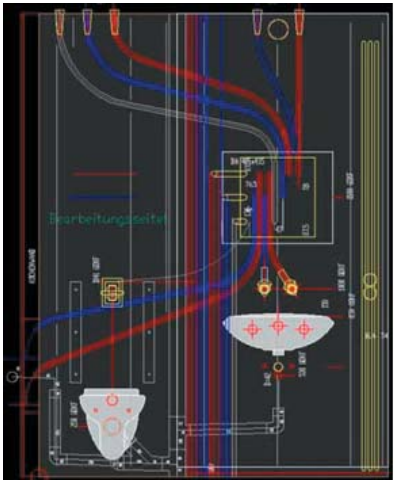
The general scope for the building system "Basys" are residential buildings with two or three flats. It is constructed as a passive house with no need of internal heating. All elements are reversible and can be recycled. All materials are balanced and the building consists of more than 80% of renewable resources.

The CAD-CAM integration

In the research project the usage of a complete cad-cam chain was developed. This was also used in the industrial project.

The possibilities of creating dynamic blocks with the entities of the IFC-convention [IAI02] had been examined. Having an architect drawing with pure AutoCAD on the one hand and a specific CNC-machine with its own proprietary format on the other hand, led to the implementation of an own translation algorithm enabling to transfer the AutoCAD files on a machine with the Operating System MS-DOS 5.0 running on. MS-DOS 5.0 is a software standard applied often in industrial machines until today. Overall, the code depends on every single corresponding CNC-machine used.

An additional sub-target was the direct integration of water tubes and electricity inside the wall



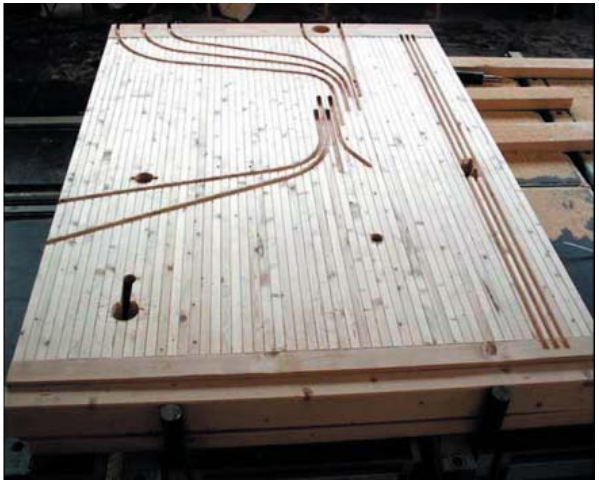


Figure 1. CAD-model of the wall with integrated tubes / result of the CNC manufactured wall

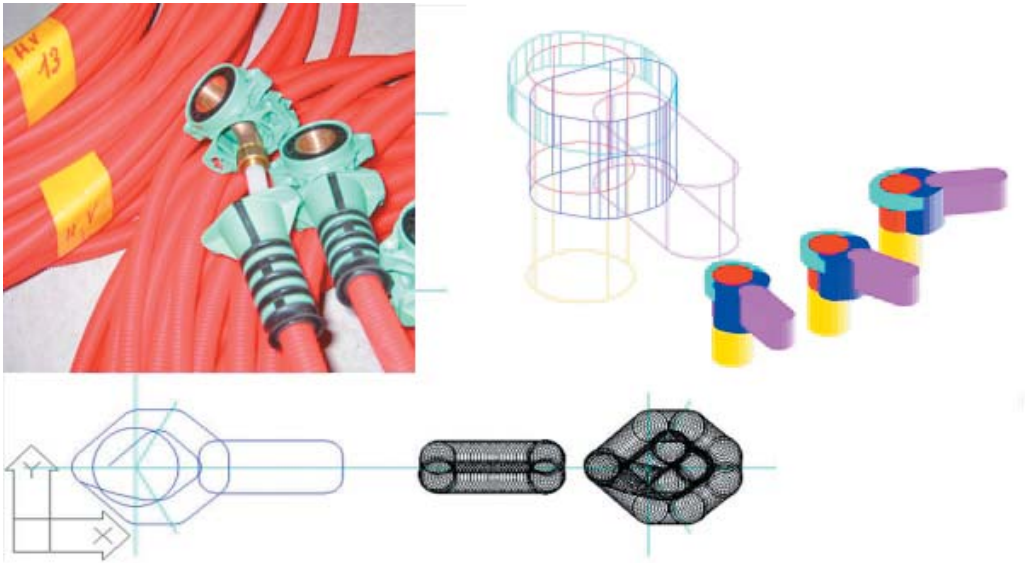


Figure 2. CAD-Chain: 3D-modell and CNC-milling-paths and steps for the tubes

with the usage of a CNC milling cutter. Although successfully tested in several elements, this process innovation was not used in the exhibition house. A non-computer solution had shown to be more effective to implement tubes into a wall.

CAD/CAM tubes

How to implement tubes into a massive wall? The conventional walls made of concrete or bricks are slit to put the tubes inside. This takes a lot of time, creates a lot of dust and is very expensive. Overall, the results are not recyclable and problematic composite materials.

The "Basys"-house aims at private building owners who need to save money and have a high percentage of self contribution concerning the construction itself. The above discussed and shown solution is working properly, but as the private building owners usually want to save money, the usage of a high qualified CAD-drawer is too expensive.

The shown milling solution for the tubes was not used in the current "Basys"-house.

Later the research team developed a simple but effective method how to ease the implementation of tubes into the wall. Alternately the CNC-machine takes narrow and broad boards side by side, creating slots in the wall in which the tubes can be inserted vertically (see figure 3).

Creating the missing horizontal slots using a circular saw can easily be done by the building owner. These elements are particularly effective in case of floor radiation heating. There is no need for cast plaster floor or spacers. The dry coating is screwed on the elements and can be easily removed in case the floor radiation heating has a leakage. A vertical heating wall creates an even better interior climate. Even though it works very well, the non computer-based solution is cheaper and easier to use for the building owners.

But this contains only the direct integration of the tubes. The CAD/CAM chain for the elements themselves had been completely adapted.

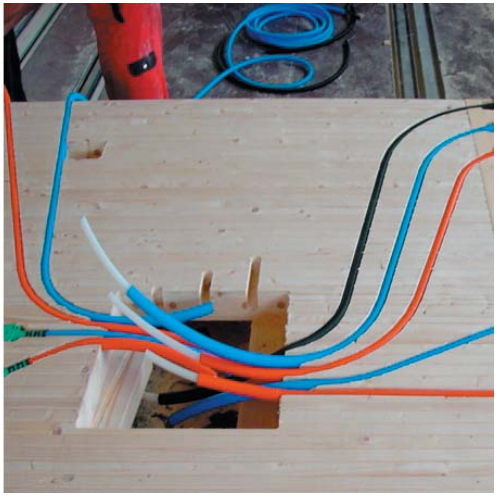


Figure 3.Simplicity (left) with narrow and broad boards vs .milled CAD/CAM

Working in a virtual enterprise

During the research project the usage of a net-based collaborating system had an impact on the sustainable quality of buildings and changed the circumstances of work. The ad hoc planning at the construction site is replaced by systemic planning from the beginning. It enforced the integration of the executor's knowledge already at early design stages. The decision to present the house during the "Bau"-exhibition was made in November 2004. With the use of the common internet platform the necessary documents and information could be distributed directly. The former documents of the research project were accessible to all participants. They worked spatially separated. In the middle of December 2004 the construction of the elements began and in the second week of January 2005 they were transported 360 kilometers from Mannheim to Munich. The responsible architect worked in the city of Tübingen which is also situated 250 kilometers far from Munich. The communication and co- operational part of the research project had been widely adapted.

The "Bau"-Exhibition in Munich

The "Bau"-exhibition with 172.000sqm space and 1.900 exhibitors showed a wide area of the current building industry. The main interest of the "Basys"-house's visitors focused on the standard of passive houses and the interior climate.

Made of 80% of renewable resources, it can surely play a role in the debate concerning sustainable construction. People worried that the wooden elements might start warping or catch fire easily, but none of these doubts had come true so far.

The building system "Basys" allows the individual finish of the interior surfaces. People who like wood and open surfaces can leave them with a furniture like quality.

a house in a day

After being shown at the exhibition, a low-loading truck brought the "Basys"-house to Karlsruhe where the building shell was put together in less than a day. Although it is prefabricated by an in-

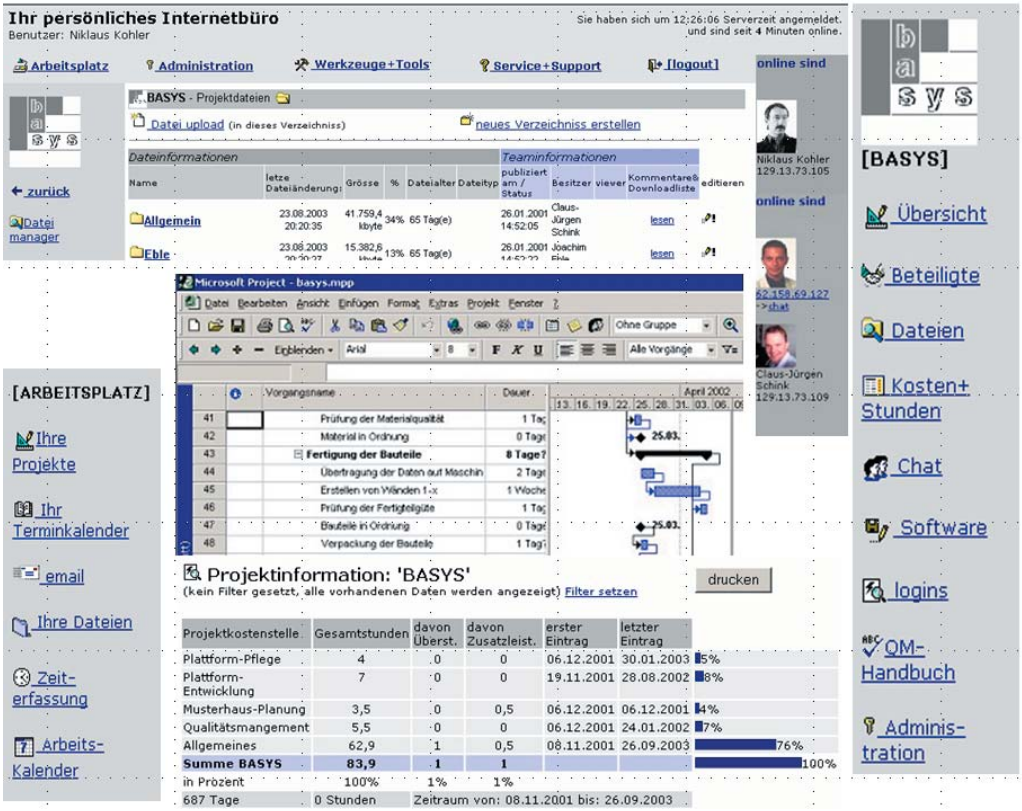


Figure 4. Components of the net-based collaboration system of "BASYS"

dustrial machine, it can be put together by a traditional team of carpenters. It took four people to mount the house. One for steering the crane and three to fix the elements and to put them together.

The house will now be used as a model house for interested constructors. By taking the house to pieces and putting it together again, the wooden elements suffer of course, but we consider it possible to move the house three or four times. The shell of the building is put up in a day. The insulation and the windows were built according to the standard of passive houses. Now the constructor can finish the interior. Using wood as building material it is easy for him to achieve it on his own.

We think that this could be a chance for small and medium enterprises of the building industry. Except for Switzerland, the technology of Brettstapelholz is hardly known in Europe. Especially for the countries in Eastern Europe which are rich in wood, this could be a possibility to establish a new sector. The main advantages are the flexibility to change plans if children are leaving the house, for example, and the healthy interior climate.

What could be gained of this real-life project was the transfer of academic results to traditional crafts, but it also reflected and leads back effective innovations from traditionally work.

Figure 5. Examples of "Brettstapel"-building elements (without final surfaces)

Figure 6. The "Basys"-house during the" Bau"-exhibition in Munich in 2005

Figure 7. one day after the exhibition, mounting the house in Karlsruhe, finished at the same day

Figure 8. mounted house with solar absorber

References

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[IAI02]: International Alliance for Interoperability; http://www.iai-international.org/

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