MINIMUM IMPACT HOUSE
THE PROTOTYPE FOR SUSTAINABLE BUILDING IN THE CITY CENTRE AND WHAT'S BEYOND THE PROTOTYPE

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ABSTRACT: The Minimum Impact House in Frankfurt am Main is a sustainable solution for low cost living in city centres - a prototype typology with minimal footprint on a leftover urban space with a bottom-up approach The planning process itself became part of a scientific study.
In a comparative study we compared advantages and disadvantages of a single-family house in the centre versus new building zones. This included qualitative an quantitative comparison over a life cycle of 50 years with construction, running, maintenance, disassembly and location related mobility.
DGJ found out that in conventional construction the running uses about 50% of the primary energy, the rest is divided into the modules fabrication and mobility. The total energy use of the prototype is 63% lower than the compared conventional new building under existing rules. The climate-change effect could be reduced by 68% per housing unit.
KEYWORDS: project presentation, case study, sustainable building, green living in the city

1 INTRODUCTION

The Minimum Impact House is minimal in two ways. It fits a 150sqm house on a 29sqm parcel and it has minimal impact on the environment. In this paper, we would like to explain how the house and its construction can serve as an example to new agenda in urban planning. We wanted to prove that it is possible to construct a passive house standard in the heart of the city, and that construction as well as operation of the house should provide a significant reduction of environmental pollution, and especially of CO2 emission. These targets required a prototype of both individual and more general validation. Specificity and transferability of the design and research work were framed by these two aims.

2 SMALL HOUSE, LONG STORY

This house is not only the simplest accountancy unit for an ecological study, but it also represents a specific private microcosm. This project, too, was developed out of private imagination. For a house so small the Minimum Impact House has quite a long story. In 2004, Drexler Guinand Jauslin Architects started to search for locations of inner city low cost construction in Frankfurt. At that time some of our first buildings used wood construction, such as the photo studio Staub [1] just outside Frankfurt, and the Spiral House Pigniu in the Swiss Alps [2]. We had learned how this way of building could produce fast results at relatively low costs and with fundamental improvements to the environmental impact of construction and operation.

We where fascinated with the design potential of light wooden buildings; timber construction could actually meet our demanding expectations if applied in a different way. We used this method to enhance the experiential qualities of the space. The kind of architecture we were (and still are) keen on emphasizes the experience of a space in multiple ways. We see building not only as a technical problem but as a cultural expression of mankind - to combine both we seek new answers to each building task rather than relying on preconceived notions regarding construction, design, and production.

The results of our various timber construction techniques were very encouraging. Timber constructions are relatively simple to adapt to many situations. Timber has less problems in insulation than steel or concrete based systems, allowing more freedom in design with contemporary insulation standards. With timber, the architect also has much more control over the formal qualities of the design itself.

Having realized the easy and time saving qualities of timber construction we thought it might as well suit other demands. In Frankfurt, citizens, especially those with young families, often leave the city when they grow into their thirties - a common phenomenon in many European cities. This is an unpleasant development to our generation, which was born during the first oil crisis. Since the 80s our generation has developed an ecological awareness and practices a lifestyle of ecological responsibility. By moving to the suburbs we should have to give up these principles. We should have to spend more time, money and energy on mobility, have to use our cars more often - not only for our daily commute to work, shops, or schools, but also because the cultural activities take place in the cities and the intercity trains only stop in their centers.

The demands of the housing market has led to a dramatic increase of land consumption in suburban areas. By consequence the demand of houses in green surroundings voids the essential reason for this demand: green spaces are increasingly consumed by houses, roads and highways. A major part of these new dwellings consists of detached or semi-detached houses for single families, with a maximized land consumption. City authorities and the adjacent municipalities compete for new citizens with land sales. This competition often undermines planning of urban development and accelerates the destruction of natural or agricultural spaces. As a result, building an affordable and energy efficient house in a green area outside of town was not a viable option.

On the other hand, land prices in a city like Frankfurt often are unaffordable. There do however exist little niches in the urban fabric - especially in those cities distorted by war. What if we could find in the city of Frankfurt such an empty space? We began searching the area around our Frankfurt office for minuscule sites to construct single family houses. We also studied the urban housing of Japanese cities where sites for construction often are extremely small. Thus we integrated our ideas on architecture and life into a new concept: We where going to construct a Mini-house in the very center of Frankfurt.

Along with these considerations and personal observations came the wish to see this project in a broader perspective. We wanted to find out whether the actual results would affirm our personal feelings. We examined the life-cycle energy consumption of the minimal size house and the environmental impact of its construction. Thus the Mini-house became the Minimum Impact House.

3 PROTOTYE AND COMPARATIVE STUDY

For the prototype new spatial strategies were developed: The house appears to be a lot bigger inside than its size suggest from the outside because of the vertical organization. The tall and high building leads to a vertical organization of spaces rather than the conventional horizontal layout. Each room has a specific relationship to the exterior, the city and the street. The ground-floor has an office; public rooms like kitchen and dining are situated on the next vertical levels, whereas the private rooms like bathroom and bedroom are on the top floor next to the roof garden.

The separation in levels basically leaves one open space per floor with no separation of circulation and living space - this concept makes the house very vivid, open and welcoming to visitors. Still, enough privacy can be established by moving up one level, increasing in the guest room and the roof terrace. This secret garden is cut off from sight, but has a wonderful view - the highlight is a glimpse of the Frankfurt skyscrapers from the tip of the roof terrace suspended high above the birch-trees below.

To guarantee a long usability for the building it has to be adaptable to different usages and inhabitants. The house combines and mixes shop, office and living even from initial occupation. DGJ meetings and design workshops are held in the living room and office work is built on the ground level while the first floor is currently sublet to a graphic designer via a friend in the neighborhood. The bed of the owner/architect is also a show room model to visitors which can be bought at the same place by the designer/distributor.

We developed the facade from the history of the site: Since it was not used after the war, wild trees located on site had been grown there to an impressive size, which gave the place a unique atmosphere. The initial design concept was to build the Mini-house as an urban tree-house which grew into two large poplar trees. Further studies of the trees unfortunately revealed that they suffered from root rot. The municipal environmental department cut down the trees to prevent them from falling onto the street, before DGJ could

get hold of the land. The real trees disappeared while we were integrating them metaphorically into the design. The facade to the building still shows the shadows of those absent trees.

In a research project the prototype was compared to a typical suburban house. A life-cycle-analysis quantified the amounts of energy, material in investment and consumption during an estimated life-span of the buildings of 50 years. We developed our own excel-based software and used this as a design-tool during the process for optimizing the prototype-building in terms of energy-consumption, construction and materials.

The urban environment of the prototype was compared to a typical suburban settlement in the north of Frankfurt called 'Riedberg'. Mostly former agricultural land has been transformed into a housing quarter for 15,000 inhabitants. The Sabina House was built to rather normal standards but sold as an "ecohouse". Several aspects of the two houses like accessibility, mobility, social structure, green spaces and facilities in the surrounding were compared. These "soft facts" were equally considered them the "hard facts," which included: calculations of the primary energy consumption divided into non renewable and renewable sources and the global warming potential, GWP (Global Warming Potential expressed in kgCO2eq).

The energy consumption and CO2 emissions where monitored for 7 different aspects: Construction, Operation, Maintenance, Mobility, Deconstruction, Infrastructure, and Land Use. The comparison shows that while the gains in operational energy (the main focus) are important, other aspects gain enormous importance once a relatively high standard is reached. In other words, if the detailing is good, the impact of bad placement in an urban context becomes even more important for a good overall result.

In conventional construction of the Sabina House, the operation uses about 50% of the primary energy; the rest is divided into the modules fabrication and mobility. The total energy use of the prototype is 63% lower than the compared to the Sabina House. The GWP climate-change effect could be reduced by 68% per housing unit from Sabina to Mini-house. With highly efficient buildings the annual running of the building is only a part of the ecological impact. To consider the impact more has to be taken into account.

The results show that even in conventional building the construction has a greater impact on the GWP and about equals the amount of energy used for heating during 50 years.

4 BEYOND THE MINIHOUSE

The Minimum Impact House is a micro study which examines every environmental aspect of a single living unit. Even though developed from an individual project, the results can be generalized. This shall be considered here in a larger scale: An EU study [3] sought to discover why between 1990 and 2000 individual traffic in 15 countries of the EU had produced 20% more CO2. The emission of exhaust gas causing climate change was compared to three indicators: growth of population, gross national product, and uncontrolled urban spread. The correlation between the third indicator and CO2 emission is the most significant one. Simply put, this means that the economy and population could grow without harming the climate if they would not produce more traffic through decentralization. By consequence we need growth in urban areas where infrastructure is already established. The quoted study also shows that in Europe, planning measures most likely are easier to accept by the public than restrictions on individual traffic or higher taxation. Planning methods are considered to be more effective than limiting CO2 values for cars with combustion engines. Thus the EU research study and the Minimum Impact House report lead to the same direction: Ecological housing in green areas or suburban low energy houses for single families, as have been promoted since 2000 in many European countries, are well-intentioned but ultimately cause enormous environmental damage. Measured in energy consumption, the standards of new buildings are getting better so that an improvement of their energy balance will soon be optimized. As a result, contextual determinants will get more important - traffic, infrastructure, and consumption of resources through construction or CO2 neutral materials. We have to choose a new way to achieve sustainable construction in existing dense settlements and we should promote urban densification and preservation of natural and agricultural areas. To us, anti-consumerism or reduction of quality of life don't seem to be realistic options; we believe that compared to living in suburban districts, living in an urban Mini-house offers a surplus of comfort and quality of life and saves significant amounts of energy and cost.

The common apartment in town is still regarded as unsuitable for families. So it was of great importance to us to build a house that, being evidently sustainable, would also realize the dream of a single family house. An improved sustainability requires that attitudes about location are no less important than

innovations in design and technique. This new awareness leads to a non site: the building gap.

There are different types of building gaps - some exist because a building is temporarily missing, in general because of questions of ownership, juridical disputes, or financial problems. In some locations, these gaps are able to be filled in by conventional buildings. We are interested in gaps which under the actual conditions cannot be used for a conventional building - for example because access to some inner court has to be guaranteed, or a traffic area has to be respected, or because in a high-grade building complex (for example a multistoried housing estate) there is a worthless shed left over occupying the ground. The gaps all have something in common: they are always in areas with an extreme urban density. The exploitation of these types of gaps in the city can avoid a new building in the country.

Unlike the heterotopias described by Michel Foucault (4), our prototypical gap is not situated at the urban fringe where prisons, madhouses and cemeteries have been located since the eighteenth century. Its situation is in the center of an urban residential district with houses, pubs, offices, and shops - and not far from important cultural institutions and public traffic facilities. The void of the urban building gap is in contrast to the district's building density. We call such a place a fracture in the urban structure. These fractures refer to the failure of other (ideal) urban building strategies. It is of some interest that they exist at places where an ideal solution meets another-one, which is likewise ideal. There is a fracture in Frankfurt-Sachsenhausen, where the late 19th century architecture of the Gründerzeit meets the structures of the 1960s, when priority was given to the car-friendly city. Or in Amsterdam-Nord, where social-democratic planning of the 1970s collides with the structures of the 1930s. Each of these fractures is complicated and they do not grow together like broken arms or legs. They result from a clash of different concepts of thought. Usually such gaps are covered with poor remains of vegetation, mostly superfluous and weedy, planned at the best, but even then unused and rarely free from rubbish. The fractures are like symptoms of an unconscious disease; as one has to live with them, one has to make them evident at the surface. For urban architecture this has many implications: most significantly, architecture should reveal these fractures of urban structures. Thus our strategy for construction at such a place is to emphasize the contrasts, opposing the idealistic urban patchwork to the ideal planning of new towns.

What we love in urban culture is its antagonism, the variety of potentials, the simultaneity of cultural, economical, and social life. The Mini-house at the fracture has a view on lively house fronts and busy streets; a vital urban feeling is granted by the various views and perspectives. And the front itself enables an open dialog with the city. What originally seemed impossible in this conflicted urban fracture is suddenly palatable and real. This approach has a long tradition in modern art. By emphasizing the contrasts through architecture, an almost surrealistic image is created. In Walter Benjamin's words, "there is nothing as surrealistic as the true face of the city." (5)

The Mini-house is not a common urban house - many people stop when they see it for the first time: Its timber clad façade cantilevers out over the sidewalk. It seems to be loved more by the public than by architects - perhaps because it disproves many prejudices of the guild. Such reactions make us proud.

The Mini-house is about responsibility; it demonstrates holistic thinking and differentiation. It is also an idealistic house, though not naive, and it is built, functioning, and inhabited. Its energy balance during the first (and cold) winter of 2008/09 even showed a slightly better performance than the calculations.

5 FOLLOW-UP PROJECTS

At present our Frankfurt office is developing a follow up, Mini-house II. Its site is occupied by a small kiosk. The owner intends to rent the house as a private investment. Mini-house II shall be built above the kiosk. Its timber construction is completed by several steel columns to reinforce the corners and by an extensive glazing. Mini-house I served as a reference to this project and it is interesting to compare similarities and differences throughout design and building process. Compared with Mini-house I, the project has advanced remarkably fast; by the time this is written the application for a building permit will have been turned in at the city administration of Frankfurt.

The problems of urban development which led to the Mini-house project still preoccupy DGJ. A research team of the Chair of Landscape Architecture of the Delft University of Technology is developing, in collaboration with DGJ and the TU Darmstadt and a Dutch real estate developer, additional studies on the conditions of Mini-house construction in the Dutch context. In the Netherlands, too, the tendency of urbanizing the countryside still is unrestrained - with all the negative consequences seen above. In addition to

these there are specific threats such as water management and the rise of the sea level. The research project Green Living in the City should explore new typologies for the construction of sustainable housing in urban centers. With 500,000 new homes to be built in the decades to come, the Dutch metropolitan Randstad region is not expected to become any greener.

Green Living in the City suggests two main fields of green innovation: An improved use of public and private green space by ways of combining architectural and landscape design, and green building: promoting sustainable technology for building, running and maintaining the living space. For the Dutch context we propose 3-8 types of green Mini-houses. Our study tries to identify left over potential for minimum impact housing in the core of one of the larger cities, most likely Amsterdam.

Proceeding on the assumption of 500 new Mini-houses, the study compares in a life cycle analysis their operating energy balance to those of a reference group of equal size homes representing the current state-of-the-art in Vinex and urban high density housing.

Since the 1990s in Netherland, sustainability has been pointed out as a target of urban planning; but at the same time the tendency of urban sprawl was reinforced. The Vinex Programme of the 1990s for example proposed the growth of cities along existing infrastructure and promoted densified building, but nevertheless counted on individual motor traffic. The current economic crisis set an end to building "behind the noise barrier", but the Vinex model still is praised as successful. Even in 2009 a competition, "Hardop Dromen" ("Dreaming Aloud"), was published by the province of Nord-Holland, in order to get proposals for sustainable building in an agricultural area. As might be expected, there was a great number of excellent proposals with nice houses covered with green. DGJ had proved that it would make more sense to realize the 200,000 living units in question in the 18 largest towns of Nord-Holland and thus proposed 500 units of housing along a green ribbon in northern Amsterdam. This feasibility study couldn't provoke a change of mind. The project is still mentioned here because it shows that even for cities with extremely different structures and problems, potentials for the realization of green living dreams can be found - if only there is a will to find them.

Exploring new technologies and methods for the combination of landscape and architectural spaces is a central subject of another research project, "Architecture with Landscape Methods" - which was initiated by us with the Chair of Landscape Architecture at Delft University of Technology. In this study we examine a wide range of projects created by architects with often extremely different concepts; the research concentrates on the formal qualities of the projects as landscapes. Architecture as landscape is a subject that was often treated by DGJ in their own designs and buildings. Now a theoretical ground should be defined by a systematic analysis of the different projects. Our research is based on the analytical methods developed by Clemens Steenbergen and Wouter Reh at Delft University of Technology [7]. In nearly every classical and modern treatise, architecture is understood as contrary to landscape. But buildings that claim to be landscapes are a striking phenomenon in recent architecture, with little theoretical support so far. The research should enable us to develop new methods of design or to apply old methods in a new way - as we did with the Mini-house project.

6 CONCLUSION

From a generally accepted awareness that the building industry is a key player in energy consumption, many colleagues, and even entire governments, have gone about new efforts for renewal and sound planning; in this a new trend towards sustainable building appears to be slowly materializing. To us, it is not only important how to reach energy goals but also where. If we do not recognize the connection between emplacement and sustainability, many sustainable developments might just miss the point.

As architects, we are trained to connect holistic ideas of design to any small detail. Our grandfathers' generation called this "design from the city to the door handle." In our generation, the gap between the scales is increasing; we have to connect our concepts from global warming to physical microstructures of materials. We have to master even more complexity and still be able to build at the highest level. We should become aware of a global impact of even the smallest scale of detailing without losing the larger picture and missing our initial targets altogether.

The role of the architect as a humanistic generalist must be practiced and propagated if we are seeking a truly sustainable solution to our current problems. When describing, by the end of our Mini-book, the applicability of the Mini-house project to other and maybe new fields of work, we had in mind the

methodical proceedings. The range of problems building has to deal with in this day and age is extremely complex. The solutions demand a refinement of methods and the confidence in architecture as a discipline strong enough to cope with them.

Even though it uses traditional techniques and materials, the Mini-house at Walter-Kolb-Strasse in Frankfurt is a built peculiarity. And in being so, it is not transferable. But one can transfer its technical and conceptual strategies, its architecture. Architecture is not a question of building but of thinking. So, what matters in this project is not only the sustainability of the construction but above all the sustainability of the theoretical approach of its design. The result of a sustainable design is the point of departure to new projects: Our building changes our thinking - as our thinking changes our building.

ACKNOWLEDGEMENTS

For illustrations and further reference http://www.minihouse.info

This paper is a supplement to one of the the project presentations of young architects in collaboration with the Roal Institue of Dutch Architects BNA.

Parallel to this conference a *minibook* about this project with comprehensive research data of approx. 90 richly illustrated pages will be published: Drexler Guinand Jauslin, Minimum Impact House, Wuppertal, Verlag Müller + Bussman, 2009 or 2010 (expected).

Hans Drexler, Daniel Jauslin and Marc Guinand are co-founders and principals of Drexler Guinand Jauslin Architects since 1999 in Frankfurt, Rotterdam and Zurich with currently 6 emplyoees.

Minimum Impact House is a result of research at TU Darmstad with Drexler Guinand Jauslin Architects sponsored by Deutsche Bundesstiftung für Umwelt. The Minimum Impact House was awarded in 2008 with „Besondere Annerkennung vorbildlicher Bauten in Hessen“ and „Holzbaupreis Hessen“ and the DENA Award Effizienhaus 2009.

The authors would like to thank Ulrike Simon (Zürich) and Andrew Mc Gee (Boston) for their advice in English writing for this paper and the above mentioned book.

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