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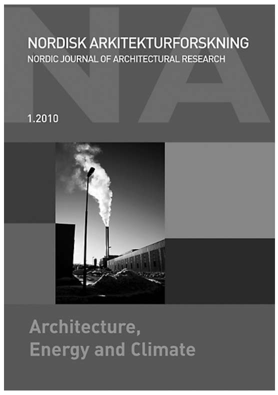

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How can we adapt education programmes to the architecture of the future?

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Abstract:

Architects and engineers in the building and construction industry are facing great challenges today due to the fact that energy consumption will have to be reduced to a considerable degree within the next few years in order to ensure that no further harm is done to the global environment. The industry is thus facing major changes in terms of public regulation and in the way building and construction is carried out in practice, whereby former habits seen in relation to energy optimisation of the building will have to give way to new and better methods.

It has been a logical challenge to develop teaching methods at the Department of Architecture & Design at Aalborg University that are tailored to dealing with current societal/technological, environmental and sustainability issues. In terms of both research and teaching, Aalborg University utilises an interdisciplinary approach to a considerable extent. At Architecture & Design at Aalborg University, we are working with environmentally sustainable architecture. We use a method called the Integrated Design Process, which is developed for this purpose and which is an interdisciplinary approach to designing environmentally sustainable architecture. Two examples of students' projects in which this method is applied for a low-energy building and for a zero-emission building respectively are included in this article.

Keywords:

Environmentally sustainable architecture, integrated design, interdisciplinary design approach, low energy, education, methods, zero-emission buildings

1. INTRODUCTION

The article will take its point of departure in why it is important to produce sustainable buildings in the future and point out why the education system can play a major role by educating new professionals to work in the building industry. The article will present a method developed at Aalborg University's master's degree programme in Architecture & Design. The integrated design methodology focuses on combining the architect's artistic approach with strategically selected technical parameters from engineering right from the start of the design process [KNUDSTRUP 2004]. This enables students to develop an interdisciplinary and comprehensive professional approach which prepares them well for the challenges related to design and construction of environmentally sustainable architecture. The goal is to reduce the consumption of energy for heating and cooling in the building environment and thereby reduce the emission of CO_2, whilst at the same time ensuring a high standard of comfort for the inhabitants of the building. The methodology copes with aesthetic as well as technical problems that must be solved in an integrated building design, and it focuses on the creative element in the design process. Two cases will be presented in which the method is applied.

2. THE RELEVANCE OF SAVING ENERGY IN THE BUILDING SECTOR

There is no doubt that sustainable architecture is a concept that is here to stay. In recent years we have seen an increase in interesting architecture based on different approaches to sustainable architecture, such as green, bioclimatic, low-energy, solar and environmental architecture, etc. [HANSEN 2007], [KNUDSTRUP ET AL. 2009]. It is generally acknowledged that over recent years the global environment has changed, exemplified in an increase in flooding and gale activity. Even though this is documented in scientific fact, it still seems to be, as Al Gore puts it, "an inconvenient truth" to many [GORE 2006]. Energy consumption in buildings worldwide accounts for over 40% of primary energy consumption and 24% of greenhouse gas emissions [IEA-SHC TASK 40]. However, the building industry is only changing its practices and traditional ways of thinking very slowly.

Another source of pressure with regard to new approaches to the building environment is that Danish plans for energy consumption in new buildings in 2020 will require a reduction of at least 75% compared to energy consumption as it stands today [www.kemin.dk]. Furthermore, the EU has recommended that energy-producing houses become standard by 2020 [TICAU 2008]. Reducing energy consumption in new buildings is thus essential to reducing the environmental impact.

However, it is not only the global environment that is in danger. There will also be an increasing need for clean and renewable energy in the years ahead, not only in USA and Europe, but also in the rapidly growing economies in Asia [MEREDITH 2007] and Latin America. We are clearly experiencing an energy crisis where the supply of fuel is unstable and the producers of fossil fuels, such as oil, gas and coal, can name their price!

3. THE NEW MARKET

A growing number of firms of architects, studios and engineering consultants can see this emerging market for the building sector and are promoting a sustainable approach and environmental awareness with regard to the design of architecture, as for example Foster + Partners [www.fosterandpartners.com], Arup [www.arup.com], Grimshaw Architects [www.grimshaw-architects.com], ARKITEMA Architects [www.arkitema.dk] and Henning Larsen Architects [www.henninglarsen.com]. Sustainability is a mandatory element in the design and building process, whilst exhibiting responsibility in terms of the environment indicates that you are concerned about the future of the planet and its inhabitants.

This means that we can now see that sustainable architecture will acquire an increasing degree of focus in the years ahead. This requires changes in professional qualifications and possibly also in the way in which working processes are organised among architects and engineers. Sustainable architecture requires interdisciplinary collaboration on projects. It also requires that architectural and technical elements are intertwined in a new, more "seamless" manner in the design process. Last, but not least, it requires new integrated tools. It also means that the education system has a vital role to play in support of this new environmentally sustainable process by educating a new type of interdisciplinary professional who can bridge the gap between architecture and engineering and preserve good and holistic approaches to sustainable architecture.

4. THE DIFFERENT APPROACHES OF ARCHITECTS AND ENGINEERS

Danish architects are traditionally trained with an artistic approach and as generalists to provide an overview of often very complex projects. They therefore use specific professional knowledge with regard to architecture, aesthetics, design methods, spatial concepts, functionality and building structures, as well as knowledge about the users and their needs and preferences for good living and working environments. Architects posses a basic architectural knowledge, but besides this basic knowledge, a different and complementary knowledge of the design process depending upon the purpose of the building and the needs of the users is required. There are building types for different purposes, e.g. offices, residential accommodation, kindergartens, assisted living dwellings, schools, colleges, universities, airports, train and metro terminals, museums, hospitals, concert halls, etc. It is part of the architects' professional remit to be able to accommodate the individual building in terms of the specific function and set of users. The lack of technical skills at the existing architect educations has been the object of continued criticism [Dansk ARK BYG 2007].

On the other hand, most building engineers in Denmark are traditionally educated as specialists within more or less comprehensive areas such as construction, mechanical ventilation, natural and hybrid ventilation, light, heating, etc. The technical scientific aspect of design has been taught only in courses of engineering, which have in turn all but ignored the aesthetic dimension during the 20th century [ERIKSEN, KNUDSTRUP 2008].

When we look at the conventional way of building in Denmark, the architect shares or hands the project over to the engineer when he or she has pretty much finished the schematic design of the building. This means that the engineer assumes a reactive role in the design process instead of the proactive role which is required in an interdisciplinary approach to design [HANSEN, KNUDSTRUP 2009]. Sustainable architecture has not yet obtained a foothold in the industry or within the sphere of mainstream architects because it requires changes to the traditional manner of cooperation. Furthermore, sustainable architecture requires interdisciplinary collaboration on projects at the beginning of the design process, rather than the current methodology applied by the majority of the building industry. A new method is thus an important next step towards more sustainable building design [KNUDSTRUP ET AL. 2009], [BRUNSGAARD ET AL. 2009].

5. INTEGRATED DESIGN APPROACHES

In recent years a number of methods working with the integrated design process [Intelligent Energy Europe 2008], [IEA-ANNEX 44] have been developed to ensure a more holistic approach to sustainable architecture. Some of these methods will be outlined here. The overall goal is to establish integrated approaches between architecture and engineering in order to produce sustainable buildings which ensure comfort and fulfil stricter standards for the use of energy for heating and cooling. However, when studying these methods in more detail, many differences can be observed.

One method is called the Integrated Design Process from IEA-TASK 23. In this case the core element is the approach from the architectural design process as it is realised in practice: as the process progresses a number of professionals with engineering expertise are attached to the process to ensure the sustainability of the project. The group takes a multidisciplinary approach with a facilitator in an iterative workflow throughout the process. "In the simplest of terms, the IDP requires high levels of skill and communication within the team, involves a synergy of skills and knowledge throughout the process, uses modern simulation tools, and leads to a high level of synergy and integration of systems. All of this can allow buildings to achieve a very high level of performance and reduced operating costs – and at very little extra capital cost" [LARSSON, POEL 2003]. "The Integrated Design Process has an impact on the design team that differentiates it from a conventional design process in several respects: The client takes a more active role than usual; the architect becomes a team leader rather than the sole form-giver; and the mechanical and electrical engineers take on active roles at early stages of design. The team always includes an energy specialist, and, in some cases, an independent Design Facilitator " [LARSSON. POEL 2003].

Another method called Integrated Building Design System (IBDS) has been developed at The Martin Center for Architectural and Urban Studies Cambridge [IEA-Annex 44]. The approach to the integrated building design system – the IBDS methodology – provides a flexible system for assessing the interrelationships and levels of integration of design parameters for low-energy design in an urban context. The method is flexible in that additional and alternative parameters can be included in the analysis. Thus if the emphasis of a project shifts to include, for example, interior planning issues (such as interior finishes, visual and thermal comfort, etc.) or wider urban issues (such as the microclimate, transport, green space, etc.), these aspects can be incorporated by the design team in the IBDS method. However, the variables presented here are considered to be the primary ones. [IEA-Annex 44]

The second category focuses on the tasks that Danish graduates of the future shall resolve as they are designing environmentally sustainable buildings for the future. They are implemented in new courses of study aimed at future professionals in the building industry. The professionals of the future are being prepared to enter the labour market and find solutions to the new kinds of problems that the building industry is facing. This second category encompasses the Integrated Design methodology taught at Denmark's Technical University (DTU) and the Integrated Design Process taught at Architecture & Design at Aalborg University. The methods have the same name, but closer study will reveal that there are differences between them. The IDP method at A&D has the architectural design process as its starting point, where strategically chosen parameters from engineering are integrated from the very beginning of the architectural design process and throughout the process, and are integrated as interactive elements in an iterative workflow in the interdisciplinary design approach [KNUDSTRUP 2004].

The integrated design methodology at DTU, on the other hand, takes its point of departure in the engineering perspective and the specific building unit such as a room or section is then added, before generating a proposal for the total building design. The integrated design process here is led by a facilitator [PETERSEN, SVENDSEN 2008]. The overall idea is as follows: "By designing rooms before buildings, the building designer is capable of ensuring the quality of indoor environment in each room of the building while the corresponding energy performance of the room is included in an integrated evaluation. If the room designs are fulfilling design goals regarding energy performance and indoor environment, then a final buildings design composed by these rooms is also most likely to fulfil the design goals" [PETERSEN, SVENDSEN 2008]

This means that even though the different methods all work with architectural and engineering input to the design process in order to produce sustainable buildings, they are still performed in different ways.

6. THE EDUCATION PROGRAMME AT AALBORG UNIVERSITY

It has been a logical challenge for a relatively young university like Aalborg University to develop teaching methods that are tailored to deal with current societal/technological issues. In terms of both research and teaching, Aalborg University utilises an interdisciplinary approach to a considerable extent.
The approach is characterised by working on practical problems, by a so-called problem-based learning approach, PBL, implemented in a project-organised learning environment, POL [KOLMOES ET AL. 2004]. This approach means that knowledge can also be acquired from the practical trade or profession in project work. Aalborg University offers a full graduate programme in Architecture & Design (A&D) as an engineering degree with specialization in Architecture as well as Industrial Design, Urban Design and Digital Design. The degree course began in 1997 and today there are about 45 teaching staff and about 580 students. Today, the Architecture & Design degree programme at Aalborg University is based upon the Bologna model: with a three-year bachelor and two-year master's programme. The title awarded to the graduate student is Master of Science in Engineering with specialisation in one of the four fields of specialisation and a M.Sc. in Engineering which has been offered in English since 2005 [CURRICULUM 2009].
The curriculum is organised such that engineering lecturers from the Department of Civil Engineering and lecturers in architecture and design from the new and more aesthetically oriented Department of Architecture & Design teach the core competencies of their professions in a well-balanced blend supported by lecturers from departments of technical science at the university.

7. THE INTERDISCIPLINARY APPROACH IN THE INTEGRATED DESIGN PROCESS

The idea behind the development of the

Integrated Design Process, IDP, from 2000–2002 was therefore to focus on the ability to integrate research-based knowledge from engineering and architecture in an interdisciplinary design approach [KNUDSTRUP 2002]. The approach was integrated into the study guide for the 6th semester and today the Integrated Design Process is applied on most semesters in the master's programme for architecture specialisation and on some semesters in the bachelor programme. The education bridges the gap between the architectural and building engineering courses of study in Denmark, with the aim of bridging the professional gap between architecture and engineering. The IDP runs through five phases of the design process in which it deals with different tasks related to design projects in general, as well as tasks related to environmental building design [KNUDSTRUP 2004].

What makes the IDP interesting is that it enables the designer to control the many parameters throughout the design process which must be considered and integrated in order to achieve better sustainable solutions when creating a more holistic approach to environmentally sustainable architecture.
The method copes with aesthetic as well as technical problems that have to be solved in an integrated building design, and it focuses on the creative element in the design process in order to identify new opportunities and come up with innovative solutions in new building design. The architect's artistic approach to the creation of ideas, as well as his or her ability to see new solutions, work strategically and to take an interdisciplinary approach in interaction with engineering parameters, is very important. Applying this ability without losing creativity in the process is always very important when designing new sustainable architecture [KNUDSTRUP 2006].

The IDP includes work with architecture, design, spaces, proportions and light in rooms, functional aspects, energy consumption, comfort (cooling, ventilation), technology, and construction. Hence, the IDP supports the students' efforts to create a building environment that people feel comfortable living and working in. In the following section, the various phases of a design project are briefly described in order to give a general picture of the different phases of the IDP.

The Integrated Design Process taught at A&D consists of the following main phases:

7.1. Problem formulation / project idea, 2. Analysis Phase, 3. Sketching Phase, 4. Synthesis Phase and 5. Presentation Phase.
The process is described as a linear process, but it is very important to be aware that it is an iterative process [KNUDSTRUP 2004].

7.2. Problem Formulation or Project Idea
The first step of the building project is the description of the problem and, very importantly, the project idea for an environmentally sustainable building or zero-emission building.

7.3. The Analysis Phase
The Analysis Phase encompasses an analysis of all the information from architecture as well as from engineering that has to be procured before designing the building. This includes information about the municipal development plan, the site, the architecture of the neighbourhood, topography, vegetation, sun, light and shadow, predominant wind direction, access to and size of the area and the clients' demands, and, not least, architectural references. It is also very important during this phase to specify the targets for energy consumption (heating, cooling, ventilation, and lighting) and the quality of the interior environment (thermal comfort, air quality, acoustics, and lighting quality of the new building), as well as criteria for the application of passive technologies. Other criteria or wishes from the client such as life cycle assessments on materials, solar cells, etc., can be integrated at this stage. The tools utilised may be hand-drawn sketches, architectural references, pre-designed spreadsheets regarding energy consumption, internal heat gains, CO_2 and sensory pollution, 24 hour average, max and min temperature and the daylight factor.
At the end of the analysis phase, room programme and architectural and technical design parameters, as well as the goals for the building, are incorporated into an architectural programme.

7.4. The Sketching Phase
The Sketching Phase is the phase where the professional knowledge of architects and strategically selected parameters from engineering are combined through the architectural design process. This implies the demands for architecture as an aesthetic and good living or working environment with good visual

impact, as well as the requirements concerning functions, logistics, construction, energy consumption, conditions for the interior environment and other quality criteria to be met such as architectural quality, thermal comfort, view of the surroundings, lighting quality, etc. During the sketching phase, all defined criteria and target values are considered in the development and evaluation of design solutions.
In this phase the professional parameters from architecture and engineering are merged into the IDP and interact with each other. The precondition for designing a low-energy or sustainable building in an IDP is as follows: In the sketching phase the designer must repeatedly make an estimate of how his or her choices regarding the form of the building, the plans, the architectural programme, the orientation of the building, the construction and the building envelope influence the energy consumption of the building in terms of heating, cooling, ventilation and daylight – and how these choices inspire each other. The mutual influence and inspiration of all the above parameters when carrying out the design process must meet the specifications which have been set up for the architectural, functional and technical aspects of the building.
Typically, the different solutions have different strengths and weaknesses when the fulfilment of the different design criteria and target values is evaluated. The tools utilised are hand-drawn sketches, foam or cardboard models, digital sketches in Sketch Up, 3D MAX, Rhino, pre-designed spreadsheet calculations regarding natural ventilation, Build desk or PPHP or Be06 and BSim, Dial Europe or Dialux, EcoTect and Radiance.

7.5. The Synthesis Phase

The Synthesis Phase is the phase where the new building attains its final form, and where the demands in the programme are met. The designer reaches a point in the sketching and design process where all parameters considered in the sketching phase interact – architecture, plans, visual impact, functionality, client's goals, aesthetics, spatial design, working environment, room programme, principles of construction, energy solutions and targets and indoor environment form a synthesis. In the synthesis phase the various elements used in the project should be optimised, and the building performance is documented by detailed calculation models.
In this way, the project reaches a phase where each item can be said to "fall into place", and other possible qualities may even be added. The project attains its final form and expression and fulfils the architectural programme. The tools which can be used are hand-drawn sketches, cardboard models, digital sketching in Sketch Up (more detailed), Dail Europe or Dialux, BSim, ADT, 3D MAX, Rhino.

7.6. The Presentation Phase

The Presentation Phase is the final phase that includes the presentation of the project. The project is presented in such a way that all qualities are illustrated and it is clearly pointed out how the aims, design criteria and target values of the project have been fulfilled for the client and that the performance of the building is documented.

It is of course nothing new for building designers to perform analyses before designing a building. The innovative aspect in this case is to combine the architectural viewpoint with the engineering point of view as early as the analytical stage and the beginning of the design process. By connecting the two professional perspectives in the analyses of, for example, light and window ratios to the south, east, west and north, different implications for the consumption of energy in the building, the solar gain, the comfort level of overheating or underheating and so on are generated. These implications will again vary between different building types from apartments to offices, from museums to institutions, etc. To cope with the challenges of environmentally sustainable building now and in the future the architect has to understand and be able to work with a number of the professional parameters from engineering. This is what our students learn in their course of study and through this method. The idea is to emphasise and challenge the design of a building to bring down the consumption of energy to ensure that the building meets the demands concerning environmental sustainability as well as good architectural quality. By primarily utilising passive technologies for reducing energy consumption, the final step towards an energy-neutral building can be achieved by using active technologies such as solar cells, geothermal heat, etc.

The integrated design process approach has been tested in several projects and semesters in recent years with great success. The following cases show housing proposals from the 2nd and 4th semesters respectively of the master's degree programme.

8. THE CASES

The case examples describe environmentally sustainable building complexes with very low consumption of energy and a comfortable indoor climate. They have been drawn up by two different student groups which have utilised the integrated design method for designing their proposals. The first case fulfils the passive-house standard [www.passiv.de] and the other is a zero-emission building. The building proposals also represent high architectural quality in terms of expression, functionality and spatial expression and good living conditions for the inhabitants. Both building proposals fulfil stricter standards than we can find implemented in Denmark in the Danish Building regulations that are applicable until 2015 [KNUDSTRUP ET AL. 2009].

8.1 The first case

The goal for the first project, the Garden City [CZAICKI ET AL 2008], is to utilise the advantages of the multi-storey apartment block and integrate the qualities of the single-family house by providing access to terraces from every apartment and access to space between the houses. The project on the 2nd MA semester in Architecture focuses on an integrated design process in the development of an architecturally sustainable housing complex in a local environment in a western suburb of Aalborg.

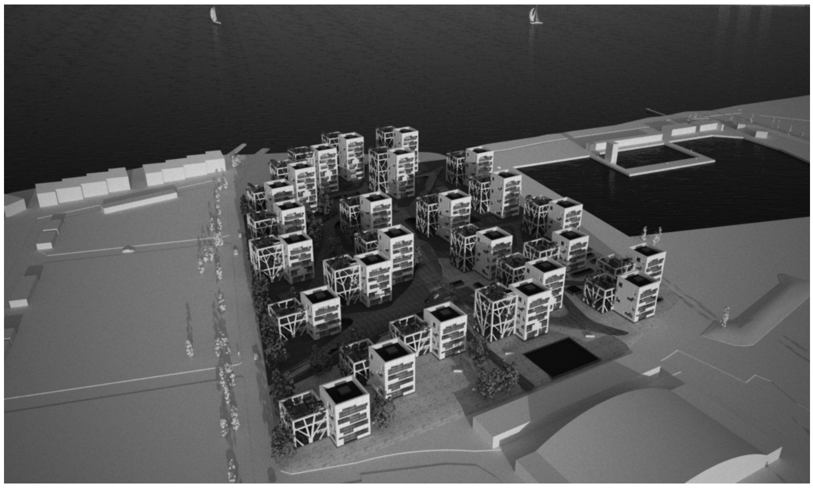


Fig. 1:
A 3D view of the site

The housing complex called Garden City is designed such that it fulfils the technical requirements associated with a passive house standard of 15 kWh/m^2 per year for heating [www.passive.de]. The apartments are situated in towers and each tower has a garden tower attached to it in order to provide each apartment with a garden (see fig. 1). The project challenges conventional wisdom and perception of what a garden city looks like.

The layout of the overall concept for the urban planning and site plan is the underlying grid structure in which the building and its garden tower are situated. The grid also ensures that the building volumes on the site are placed at the same angle and orientation, thus providing

Fig. 2:
The site called Garden City

Fig. 3:
View from the boardwalk

a strict and clear expression of the urban layout. The next layer of the site plan contains organic pathways for pedestrians as well as for cars with the walkway elaborated. The two layers shape empty spaces between the constructions in the grid structure and the organic structure. These spaces are used for different purposes, such as green areas, playgrounds, herb gardens, wetlands and courtyards for the residents living in the buildings (see fig. 2). The positioning of the buildings also takes into account the fact that the buildings need sunlight for passive heating. They are therefore located to take into account the climatic impact of height, sun/shade and space between the buildings at all times of the year. The lowest buildings are to the south and the highest to the north. The urban concept is generated by two large-scale elements which contrast each other on the site: an urban grid and an organic infrastructure. In addition, the buildings are situated on the site so as not to disturb the qualities of the surrounding environment.

The organic structure that flows into the site has the shape of a boardwalk that runs between the towers and creates a continuous walking path in the area. In some places the boardwalk is elevated to a height of 4.2 metres (see fig. 3). The elevated boardwalk separates the traffic by placing a car park underneath the structure. The car park is located centrally to ensure a short walking distance to each building. The boardwalk also connects the site and the fjord, creating great views towards the fjord and a physical connection by means of a pier reaching out into the water.

The project aims to combine the qualities of the single-family house, i.e. privacy and a large terrace close to the apartment, with the urban qualities of the dense city. The complex contains three apartment types of 100 m^2, 150 m^2 and 200 m^2, which can be combined in towers of 4, 5, 6 and 7 storeys. Each apartment building has a garden tower attached to it to provide each apartment with a garden. The external automatic blinds on the windows have a positive influence on the indoor climate in terms of preventing overheating in the summertime. The drawings and 3D visualizations give an impression of the good qualities and living conditions which this project gives to the families in their new living environment (see fig. 4).

8.2 The second case

The second project is called (CITY) building [MUSKADELL 2009]. This project is a proposal for a new building complex on the waterfront facing onto the fjord, "Limfjorden". The complex lies in the north-western part of Aalborg on the edge of the dense city. The buildings

Fig. 4:
3D visualization of the living room

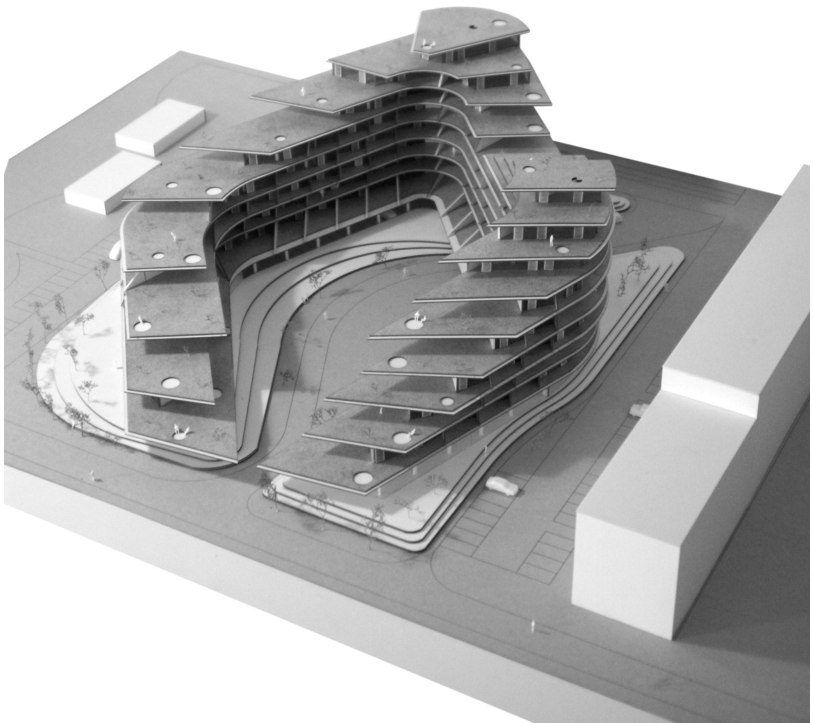
contain dwellings for families with children, for singles and for couples. The project combines qualities such as a view of the fjord and access to terraces from every apartment in a multi-storey apartment house with mixed functions.

The main concept of the project is to elevate the terrain in order to protect the complex against the rising water level that is experienced in this area. Another important element of the concept is an organic, terraced look from the outside as the building rises like a staircase from the water level to the highest level of the building. The terraced building construction supports passive solar heating and provides very good daylight conditions in the apartments as well as in the courtyard (see fig. 5).
The (City) building contains apartments, a small café in the southwest wing of the organically shaped block near the fjord for people walking by and a space for a small office in the southeast wing. Daily production and consumption of energy in the building break even and in the design process the consumption of energy is optimised to ensure a lower level than a passive house standard. Complementary to the passive heating there are solar panels integrated in the terrace deck to the south, south-east and south-west which provide the building with the remainder of its energy.

Fig. 6 shows the design principle for the building.

Green oasis: green vegetation on and around the building makes it a green oasis at the border between the city and the open areas by the fjord.
Sun: The apartments are oriented so as to achieve maximum benefit from the sun.
Outlook: The apartments are located in order to give everyone a view of the fjord and the surroundings.

Fig. 5:
The concept



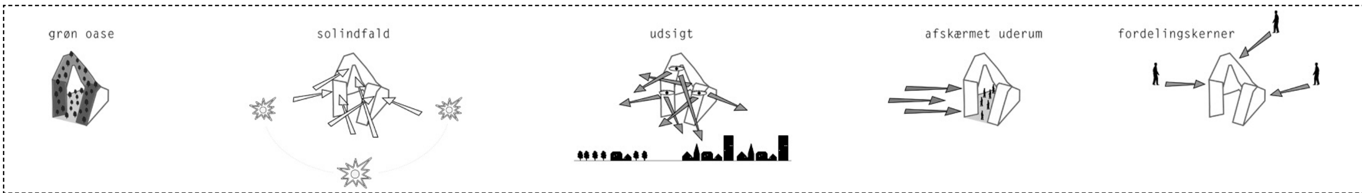


Fig. 6 The design principle

Distribution cores: The three north-facing staircases are the building's distribution centre.
Outdoor shielding: The outdoor areas are shielded from the prevailing westerly winds by the west-facing body of the building.

The mixed use building is placed on an elevated plateau to prepare it for an increase in the water level of the Limfjord. The plateau consists of a mixture of staircase constructions and platforms. Here inhabitants and visitors are able to sit and enjoy a view of the fjord or the relaxation area inside the building complex. At the building's northern plateau a car parking garage is located inside. The design and distribution of apartments is based on a desire to transfer typologies from a typical Danish town to the complex. The idea is that the apartments shall appeal to different segments of the population, and thus create an infrastructure containing a broad social spectrum. In addition, the intention is to give as many of the building's residents as possible the opportunity to benefit from its location next to the Limfjord through a mix of private and common terraces, shelter and dining facilities. These aspects can also help to increase the residents' mutual social relationships.

The complex contains 3 different types of dwellings in single floor or two-floor flats: 14 of 60 m^2, 20 of 120 m^2 and 14 of 180 m^2, all with good facilities. The variations create an interesting expression of the buildings and fulfil the different needs of the target groups.
The construction principle in this proposal is based on the curtain wall. The facades are light and the inner walls are load bearing and stabilizing.

Sustainability is ensured by the compact shape, good U values, and the use of hybrid ventilation, including heat recovery and other passive approaches in the design such as the use of natural ventilation in summer. In addition, the cold bridges between the building and the terrace deck as well as in other areas of the construction are eliminated wherever they may occur. Furthermore, the project makes efforts to minimise the ducting for ventilation and other installations in order to reduce the consumption of energy. The blinds on the terraces function as sun collectors as well as devices for preventing overheating. The depths in the facade also have a positive influence on the indoor climate in terms of preventing overheating during the summertime.
The drawings and 3D visualizations give an impression of the good qualities and living conditions this project offers the families in their new living environment (see fig. 8).

9. CONCLUSION

Many firms in the building industry talk about sustainability and integrated design, but at the same time we can also see that there is a huge difference as to how this is realised from firm to firm. There is no doubt that the traditional degree programmes in architecture and engineering in Denmark support practice by well educated graduates who are trained and qualified to perform practical work in the conventional way. However, as the need for a new kind of sustainable environment emerges, the professions must accommodate new methods and ways of working that in turn require new types of professional competencies. There is thus a need for an alternative approach to solving the problems we will be facing in the building envi-

Fig. 7: An infill photo collage of the site

ronment in the years ahead. It is not sufficient to simply employ more or less tacit vocational knowledge and technical engineering skills to ensure the optimum design and sustainability of a new low-energy building.

Working with IDP gives the student a new kind of knowledge developed in close collaboration between architects and engineers in the design process. As an outcome of this process, the students learn the language of both architects and engineers since they are supervised by both professions. Today, the graduates from AAU are highly valued in industry for their well developed expertise in terms of group work and their focus on problem-solving in context [Ingeniøren 2004],[Graduate survey 2006], [Graduate- and employer survey 2008-09].

In order to develop this new interdisciplinary professionalism with the students, we have to overcome the barriers created by the different ways in which the established professions solve problems. The IDP provides the students with a different understanding of the design process as it facilitates an integration of technical and architectural aspects of the process. Moreover, we can see from the case studies that they can design good quality housing proposals in which they can also document the performance of the buildings. Thus the graduates acquire an interdisciplinary approach that also enables them to work as facilitators between engineering and architecture in practice. They are well equipped to ensure that the final product not only fulfils technical standards as defined by engineers, but also has architectural qualities in terms of good living or working environments for the inhabitants. However, it is very important to point out that simply adding together the design parameters and calculations in the design process does not produce the building itself. Architecture is not the result of performing complex calculations, as some may be tempted to assume, but rather a new way of approaching or thinking the design from the very beginning of the design process. Calculations can only be used as guidelines in the integrated architectural design process and must be combined with other tools and creative ideas that are provided through the architectural design process. The students' design cases illustrate that it is certainly possible to design buildings where the architectural qualities and technical approaches are well integrated into the function and expression of the building.

Fig. 8:
3D visualization of the living room

Seen from the perspective of an architect, it can be a huge challenge and extremely time consuming to work with building engineers and vice versa. You have to adapt your professional profile and open your mind to what can be learned from the other professions. Then you have to implement this new knowledge in the design and construction of buildings in order to improve the integration of technical, architectural and environmental elements in sustainable solutions. In order to achieve this goal there are a number of theoretical and practical issues to take into account in the preliminary as well as in the later phases of a building project. Good compromises have to be made so that architectural requirements and qualities of the project will co-exist with technical requirements and qualities. It is also our experience that you have to take very good care of the design of the building and the "soft" qualities of architecture, as they are often under pressure from the "hard facts" of engineering.

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