Teaching Sustainable Strategies in Architecture
Learning from the global perspective

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ABSTRACT: The paper describes a teaching structure for sustainable architectural and urban design at the Graduate School of Architecture, University of Utah. The method is based on analysis of individual human behavior to reduce energy consumption at the source; it is based on our urban environment and its influence on the human being as well as the choices it offers to the individual; it is also based on comparing existing rating systems for energy efficient, sustainable buildings in the US and Europe. The structure includes basic introductory and sophisticated course content to develop environmentally friendly low-energy buildings and environments. The underlying concept is the communication of a solid understanding of the employment of energy-efficient, sustainable strategies and systems in the architectural and urban design process, with the objective of positively influencing our built environment and changing our cities, buildings, and our behavior toward a sustainable future. The goal is to sharpen the participants' awareness of the need to carefully handle global resources and to consider the environment to a high, sophisticated degree by using strategies that begin with the analysis of energy saving potentials and design considerations before utilizing expensive technology, at the same time promoting a modern, minimalist design approach.
Keywords: sustainable architecture and urban design, teaching, evaluation and rating systems, ecological footprint

INTRODUCTION

Good practice in sustainable urban design and planning projects in China as well as a comprehensive sustainable architectural and urban background in practice and academia from Europe concludes to a thesis that sustainability and energy efficient design should be taught as an integral part of the curriculum of an architectural school. This led to the development of an interlocking set of two sustainable theory seminars and design studios, which are offered at the Graduate School of Architecture at the University of Utah, USA.

In the US and Canada, architects and planners have recently begun to understand the seriousness of sustainable, architectural and urban design strategies and approaches that are highly energy-efficient; the author expects a high demand in knowledge transfer and applicable methods in the upcoming years. In a recent forecast by the American Solar Energy Society [1], it is found that "renewable energy and energy-efficient industries were responsible for the creation of nearly 8.5 million jobs in 2006, and by 2030 that number is expected to reach 40 million" [2]. Besides the implementation of specialized degree programs at universities that cover subjects like eco-commerce, ecological economics, and others, these numbers show the importance of and the demand for "green collar" jobs in the field of design, including students of architecture and urban design and planning, who need to develop strategies and skills for those future careers to serve the new market demands.

Based on this outlook, the starting point for the development of a comprehensive course structure is Germany's mandated Energieeinsparverordnung EnEV standard (the recent Energy Saving Regulation), which exists as an equal standard for buildings in Austria and Switzerland; it has been well implemented into the construction industry over the past three decades. The rating system provides approved benchmarks that can be compared to recent code regulations and to the fairly young rating systems in the US. The Energy Saving Regulation also provides an excellent background to learn from and to make a possible future system even better. Any build-to-code building in Germany/Switzerland/Austria consumes less than 50% of the energy that an equally build-to-code structure in the US would consume (Fig. 1, WSVO, EnEV, KFW are stages of energy-efficiency standards over the years). Furthermore, the mid-European counterparts would most probably obtain at least the lowest Leadership in Energy and Environmentally Design (LEED) rating, which is LEED certification, if not a higher rating, which would be silver, gold, or platinum. As stated above, the EnEV standard has been required for all new constructions since 1976, whereas LEED certification or Energy Star® rating is optional and associated with additional effort and costs among planners within the building industry.

This explains the huge discrepancy between the European and the US-American standard, both in architectural as well as urban planning projects.

The pros and cons of the different systems are analyzed in the class setting; this brings forward issues that are explored and discussed. The process supports a holistic approach toward sustainability for the participants. The urban theory seminar focuses on basic as well as advanced sustainable urban strategies, a topic that has just begun to be considered in the existing rating systems. It includes a consideration of other cultures, such as the European urban environment and the current Chinese expansion in the field of urban development. The architectural seminar communicates basic strategies of sustainable design and processes, including an overview of technical systems, as well as advanced strategies for building specific issues, including the building's immediate surrounding. Additionally, students have to analyze and document their own ecological footprint by looking at their living situation and consumption behavior, a method that greatly enhances the student's awareness. It emphasizes the importance of understanding the context beyond the border of the architectural site and the city limits. The analysis of the German rating system and the glimpse into the Asian market supports this idea and enables participants to widen their personal horizon toward a global perspective, achieving an understanding of how other nations in the world handle environmental challenges, and how the behavior of different countries influences the global situation. The goal is to enable participants to develop their own strong strategy and methodology for a responsible architectural and urban design behavior, challenging recent codes, methods, and systems en route towards a more sustainable environment.

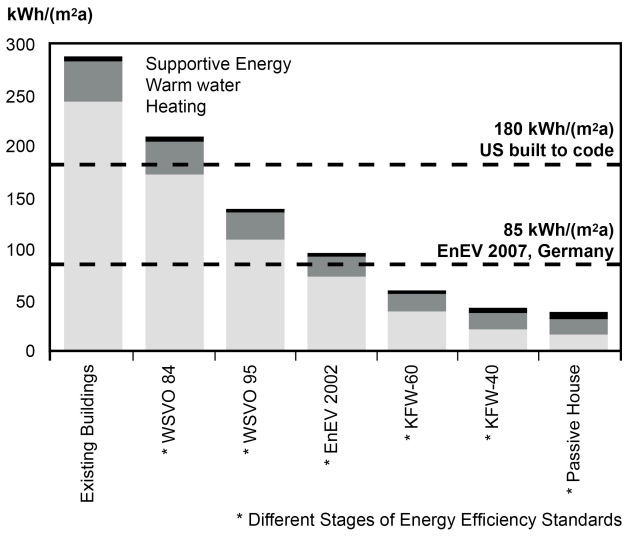

Figure 1: Energy-consumption of an average built-to-code building in the US and Germany

TEACHING METHODOLOGY AND STRUCTURE

Through the experience of teaching theory and technology seminars as well as architectural design studios in the US during the last three years, the author encountered a high level of inquisitiveness for concepts of energy-efficiency and sustainability among architectural and urban design/planning students, which is a strong base for a forthcoming implementation of appropriate strategies into the curriculum. The newly developed classes are a very positive challenge for all participants; educating the designers and decision-makers of our prospect build environment in sustainable and energy-efficient planning and building methods changes their perception of urban and suburban challenges and sharpens their awareness for future environmental and sustainable architectural as well as urban issues.

To date, the teaching methodology has been applied to a total of four graduate seminars, two graduate design studios and two graduate thesis project studios. The courses are interconnected through a link that is based on basic and sophisticated strategies to reduce energy consumption, and to develop sustainable designs. Centerpieces of the teaching structure are two seminars *Sustainable Urban Design and Theory*, and *Sustainable Design*; architectural design studios that include an emphasis on urban design supplement those. Generally, each seminar and studio can be taken independently, since they all mediate a basic understanding of sustainable strategies as a natural part of every design process and development. In any case, it is expected that students take at least one seminar to establish a solid theoretical knowledge of sustainable issues, and learn about possible strategies. By proceeding in a parallel or consecutive comprehensive design studio, they can build upon the acquired knowledge and will be able to deepen their knowledge and specify certain fields within the offered bandwidth of topics. The different settings are described in the paragraphs following this exposition.

The content of the seminars serves as a source for an ecological architectural and urban design inspiration, with the goal of providing students with a theoretical framework and tools to represent a continually expanding repertoire of sustainable architectural and urban design strategies. Especially when coupled with a design studio, the seminar structures allow for an engagement both in theoretical and practical related topics and issues. Through a number of theoretical or technical papers and essay presentations, the courses explore either technical issues of sustainability in building design and construction, or historic and contemporary urban developments, focusing on future aspects of sustainability within the field of architecture, the built environment, or urban design and planning. Through a number of practical assignments, urban design problems, site related topics, or architectural issues have to be

resolved. The results from theory and practice are critically evaluated and frequently discussed in the course setting, culminating in a final review that includes practitioners, educators, architects, urban designers and city planners.

Classes are held twice a week; they last 1 hour and 20 minutes. The design and technical oriented classes of the *Sustainable Design* seminar follow an introductory lecture series that gives a comprehensive overview of topics that will be covered during the course of the term. Each topic session covers one specific theme in a presentation that includes technical standards, construction and technical system drawings and diagrams, and necessary data and background knowledge. Class participants are asked to discuss specific issues during the presentation; a more general class discussion follows afterwards. In the *Sustainable Urban Design and Theory* seminar, classes begin with a 30-minute presentation on a specified topic, which is based on assigned readings for the entire class. Thereafter, the class discusses topic-related issues and sets them into the context of their practical assignment. These are research or case study projects in the technical seminar, or mapping processes or site analysis in the urban theory and design class. The session is chaired by the presenting student(s), with support from the professor.

Classes on the practical assignments follow an equivalent scheme: they begin with a presentation on the acquired information on the projects (i.e. presentation of the energy analysis, the case studies, or the description of a chosen area in images and texts, presentation of quantitative [statistic] and qualitative [building or site research] data). Subsequently, the group acts as a project critique with a discussion that is chaired through the seminar professor. By the end of term, all essays and presentations are collated in an InDesign booklet that is available to all participants as a digital PDF document through the seminar website [3]. The progress of the seminar is documented in bi-weekly episodes on the seminar's website, which is seen as an important part of the teaching methodology to allow for continuous access to all work for all participants through the Internet.

SUSTAINABLE URBAN DESIGN AND THEORY

The theory seminar as an urban strategy seminar derives its thesis from the fact that we have to consider the greater urban context before we employ sustainable strategies such as better site consideration, better building envelopes and generally better buildings, the LEED rating system, the Energy Star program, or the EnEV regulations, into our design processes. As a basic understanding, the seminar communicates that environmentally friendly buildings need to be coupled with sustainable urban planning strategies, avoiding the further spread of suburbia and technoburbia [4] with all of its negative components such as extensive commuting, unnecessary land consumption, degrading of population, etc. The content of the seminars shifts the students' focus from superficial urban or suburban agendas (such as neat, super clean and "safe" appearances of developments, the attempt to build for specific target groups [often the upper middle-class], etc.), toward a real densification of the cities. In the future this will enable our society to abate our dependency on individual motorized traffic, and lead to the utilization of the unused spatial potential that exists in many US cities.

The seminar's main goal is for students to acquire a solid understanding of how the urban environment is organized and functions, and how architects and planners can change it toward a more sustainable system. The significant strategy of urban densification is still one of the least considered policies in most states and cities in the US – it finally will be considered in the newest version of LEED. The course discusses how this strategy's implementations can provide spatial and social quality for the city's inhabitants, in order to draw people from the outskirts of the city, with its suburban development, back to the heart of the greater downtown districts. Simultaneously, students consider opportunities of public transportation vs. motorized individual traffic, which is another key issue in suburban America.

These tendencies, in combination with the spatial and future social potential of existing cities, serve as a starting point within the theory seminar to re-think the American city. Understanding urban rules and structural prerequisites of historic and contemporary town developments, the seminar addresses questions toward the situation facing our existing cities: where are the deficits, will it be possible to acquire a higher degree of urban sustainability by re-urbanizing the additive city of Modernism with its tedious monotone functions in favor of a complex and patchwork-like city space, as it works well in the European city? The patchwork of different morphologies or settlement patterns of urban spaces and buildings requires its own urban and sustainable design strategy. It is the author's thesis that there are no single legitimate or illegitimate urban design strategies, but rather one city with many different urban morphologies, requiring multiple approaches.

To touch on such issues, the course is based on readings that cover a good portion of the development of cities in Europe and the US, including the development of early Garden Cities in England, Le Corbusier's visions of the modern city, European city planning processes, and the New Urbanism movement in the US. Furthermore, class participants analyze recent

developments and trends in global city growth, looking at places such as Shanghai, Bangkok, or Mexico City.

Practical assignments consist of mapping tasks of urban and/or suburban areas, which will link the theoretical readings, essays, and substantial discussions to a project-based approach to sustainable urban planning and architecture in its context. Assignments also include the analysis and documentation of urban wasteland, and visions for its proper future use. Based on the knowledge that is acquired in the theory part of the seminar, the students have to analyze urban areas in the mapping assignment. Possible strategies for a sustainable future city redevelopment and city improvement will be discussed and illustrated in a divers layered, physical city map apparatus. This exercise deepens the students' understanding of the important influence of the urban context onto the built environment and architecture, and vice versa. Furthermore, the mapping process provides participants with a comprehensive database for future projects in the city.

The list of seminar readings includes, but is not limited to, essays and texts on the topic of the city and sustainable urban developments by authors such as Richard LeGates, Friedrich Engels, Howard Ebenezer, Le Corbusier, Peter Calthorpe, Michael Southworth, Peter Katz, M. Plater-Zyberk, Kenneth T. Jackson, Robert Fishman, Saskia Sassen, Ali Mandanipour, Edward Soja, Manuel Castells, and more. Two film sessions are included in each semester: Al Gore's: *An Inconvenient Truth*, which is to be seen in a general context, and Peter Weir's: *The Truman Show*, which is set into the context of New Urbanism and US American society in general. Both films are intensively discussed. Several short lectures on sustainable urban design strategies and meetings with the city's authorities and divisions from the planning department complete the overall seminar setting.

As a result of the class, students sharpen their perception of the larger scale impact of their future architectural or urban interventions. Strategies such as the walkable city, orientation toward public transportation, car sharing, the use of the bicycle, utilization of urban wasteland, etc. are well established in their minds during the course of the class. Although only roughly touched in this specific urban theory class, participants also acquire a basic understanding of the principles for designing energy-efficient and sustainable buildings. More importantly, the student's perception of the regional environment and city (or suburban setting) changes toward a very critical view that includes the greater impact of their behavior. Being in a key position as young, emerging architects, urban planners and designers, they understand their responsibility to adapt to new future strategies.

SUSTAINABLE DESIGN

This seminar is an architectural strategy seminar, it's goal is the acquisition of a comprehensive understanding of the importance of sustainable strategies for the future development of the built environment. An ecological environment and sustainability are issues that touch many aspects of architecture, construction, and design, a variety of which are covered in the seminar. Its structure allows engagement in both theoretical and practical projects and issues. Emphasis is on sustainable architectural design and construction theory and practice, on passive as well as active sustainable systems, and on aspects of sustainable urban development. Included herein are strategies concerning the larger urban scale, an aspect that is repeatedly neglected by many students on the building scale itself. Despite the recent tendency toward more environmentally friendly buildings in the US, the standard of most structures is relatively low compared to buildings in countries with a high sustainable building culture. The class addresses these deficiencies on several levels, among other things by comparison and analysis of existing rating standards and building codes.

The opening of the seminar, an eight session lecture-based introduction, includes topics such as basic design and site considerations, the super insulated building envelope (including roof, windows, building openings, frames, etc.), thermal mass, passive solar strategies, natural night ventilation and cooling, building re-vitalization, and more. In communicating those basic issues, more sophisticated, often technology-based topics follow: concrete core activation, radiant heating and heat recovery systems, phase change materials, earth channel heating and cooling, geothermal energy, solar thermal and photovoltaic systems, water conservation and rainwater systems, adaptive reuse, use of biomass, and more.

In parallel, seminar participants work on their first assignment, the "Home Analysis". Based on the new building law that requires an Energy Performance Certificate for every building in Germany [5], students document and analyze their own energy consumption pattern and ecological mini-footprint. This is followed by an in-class presentation where the results are critically discussed and proposals for improvements are made. The bandwidth of consumption patterns is huge; due to the utilization of the energy pass model, a direct comparison among participants is immediately possible. As a result, very fruitful discussions emerge on topics such as personal behavior, waste of resources, economic improvements on the existing building stock (most participants live in older buildings), etc. Changing the attitudes and behaviors of occupants, which results in a reduction of a building's energy requirements, is the most cost-effective and efficient way to save energy.

Seminar participants begin to understand that every watt not used is a watt that does not have to be produced, processed, or stored, a fact that is highly influenced by people's personal behavior.

From here, rough calculations concerning the life cycle of a building creates a bridge to the value of existing structures, pointing out the importance of adaptive reuse. The expected lifetime of a residential building in the US is between 100 to 150 years, compared to the life span of 15 to 30 years for commercial and industrial buildings. Replacement periods in the residential sector are much longer than in any other building type, which offers a good example from which to consider aspects of future use, energy consumption over a building's life span, concepts of flexibility, etc. The architect's responsibility to design sustainable as well as well-designed, timeless buildings that do not follow an ephemeral "architectural style" is included in the topics of discussions. Finally, a closer look at the existing building stock in the home (sub-) urban environment gives participants information concerning the enormous potential and/or problems that come with those structures regionally, both in terms of energy saving aspects as well as the material's life cycle, which includes production cost and energy, transportation, and final reuse/disposal. Supported by LEED that gives valuable directions, the seminar proposes strategies to deal with this potential.

In addition to the compilation and discussion of user behavior, basic strategies, design applications, technical knowledge, and existing buildings, the seminar considers energy and/or sustainable rating systems: LEED, Energy Star, and the German EnEV standard are analyzed and discussed with their attendant numbers: comparing the differences in the systems demonstrates actual strengths and weaknesses. Furthermore, the class discusses a qualitative comparison between existing LEED-certified buildings, Energy Star homes, and EnEV rated buildings and case studies of Low-Energy-Houses, Passive Homes, and Energy-Plus-Houses. The presentations and discussions are supported by a number of case studies that underline specific topics or utilize discussed strategies and systems. The case studies include an array of national as well as international buildings to give an overview of technologies and standards beyond the borders of the own region and country. The learning objective includes the development of design and building strategies that are well adapted to the local market, while at the same time learning from and considering global issues and approaches.

For the final group assignment, the class is divided into several groups. By implementing their newly acquired knowledge, each group has to develop a highly energy-efficient building. One project is a new residential construction in the urban setting (Fig. 2); the other project challenges students to redesign their own school building toward a more sustainable structure. In the first case, students are given a simple, modular, design scheme, which they might use and adapt to the regional setting; this has to be proven as a successful strategy due to time constraints during the semester. For the latter project, participants have to develop ideas and technological strategies to transform an architectural award-winning concrete structure that was built in 1972, into an energy-efficient, sustainable building, without radically altering the structure's architectural appearance. For the learning experience so far, students have been able to successfully integrate necessary strategies and systems and adopt their new knowledge very well into these design challenges. As in the *Sustainable Urban Design and Theory* seminar, all results are posted at regular intervals on the seminar's website, providing a common and growing resource for all participants during the course of the semester [3].

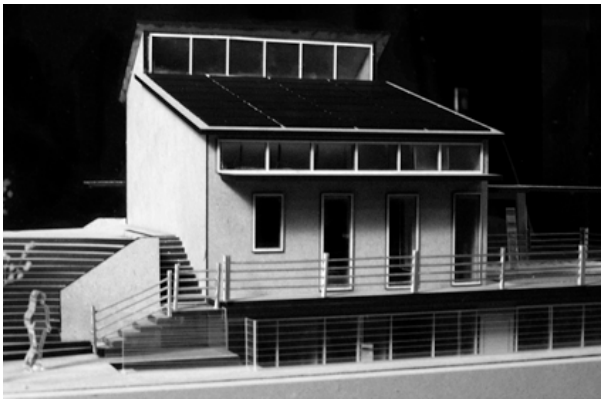

Figure 2: Sustainable Strategies in Architecture final project, utilizing a given lot and a simple design scheme

STUDIO EXPERIENCE

In the studio setting, the sustainable approach is first reflected by the choice of topic: the predominant setting is the urban environment, including the local urban environment, as well as locations as far afield as Frankfurt, Germany, which provides a good learning background for an extremely dense urban setting (Fig. 3). Topics are developed around urban densification and multi-use projects, and will include future topics that will challenge the urban planning strategies of the past decades, such as the reactivation of main train stations, adaptive reuse toward TOD developments, etc.

To date, the transfer of the seminar student's knowledge into the design studio setting has not been as successful as the author expected. Participants have difficulties adopting sustainable strategies into their early design processes. In many cases they are more or less fully

occupied by the challenges of the design process itself. When it comes to the conceptual implementation of passive as well as active solar and sustainable strategies, students tend to overlay an already finished design scheme or concept with technological schemes, rather than having the design and development process influenced by the implementation of a certain sustainable strategy, beginning at an early stage. In terms of an energy-efficient, sustainable approach, this often concludes with fragmental, non-consistent projects that lack the necessary integrated conclusion. To solve this problem in future studios, the author will include an initial research phase on strategies as an integral part of the studio setting; at the same time the conceptual integration into the design process will be required at a much earlier stage in the overall process. This will be a challenge in itself, because at the same time the design quality and depth shall not be compromised.

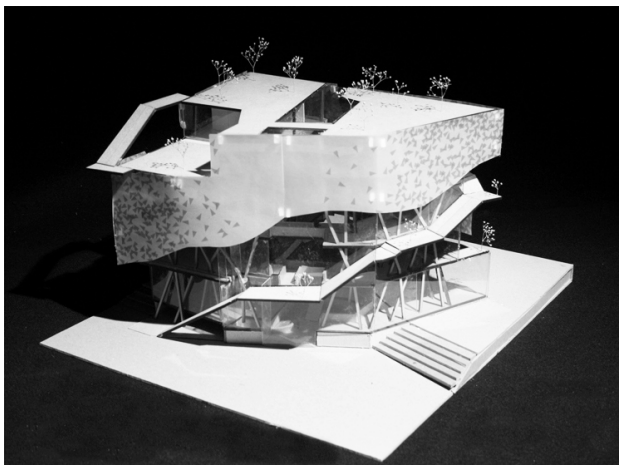

Figure 3: Final library project from the Frankfurt studio

CONCLUSION

It is the author's belief that a successful strategy to communicate sustainability in an architecture and urban planning curriculum is to naturally include it into the existing program, without the necessity to develop a specific design education that covers the field of sustainability isolated. Sustainability is about a holistic approach; it is about the sum of the single elements as well as the element itself. Sustainable projects cannot be successful if we only consider concepts, design processes, or technologies in isolation. Beyond that, all students have to be reached during the course of their study, avoiding possibilities of bypassing the topic in general.

The content of the described seminars is intended to cover recent aspects of sustainable urban theory, design methods, and environmental architectural as well as urban strategies. These are naturally integrated in the context of an urban design and theory seminar and an architectural technology class. The same applies for the design studios, which have not so far dealt with sustainable architecture as a primary issue, but incorporated basic and important aspects of the topic. For the seminars, this method has proven successful. Participating students responded entirely positively to the newly acquired knowledge. Furthermore, it was perceived that they began to re-evaluate their existing living patterns and urban values. These values were strongly formed through the influence of the society in which they grew up. In the discussions and the final assignments, participants applied these attitude changes toward possible interventions in the field of architectural and urban design, understanding aspects of sustainability in most cases to its fullest extent. The final exercises consolidate the student's learning experience much better than a common test, due to the project-based character.

As a next step, the author will improve the implementation of the acquired knowledge into the design studios by providing a more distinguishable studio structure that includes the obtained strategies from the start, with the ultimate goal that participants naturally apply attitude changes toward possible interventions in the field of architectural and urban design in every design process. The author has confidence in the importance of these mindset-changes as a tool to successfully and deeply change thinking and behavior patterns in those who will shape our future cities, the built environment, and our society. The knowledge about the European city and sustainable urban and architectural developments in the US, Germany, Austria and Switzerland, and the possibility to constantly compare between the systems has proven to be a successful tool and was extremely helpful for the participants to understand aspects of sustainability not only regionally, but in a global, integrated context. To sharpen the understanding of the importance of sustainable strategies in the field of architecture and urban development even more, the pattern of linked seminars and studios will be further developed by the author.

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