Sustaining Health With Architecture

A sustainable design approach to promote healthy living

A Recreational Facility

by

Lauren Brumley

"All architecture is shelter. All great architecture is the design of space that contains, cuddles, exhalts, or stimulates the person in that space."

~Phillip Johnson

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by Lauren Brumley

A Thesis In Architecture
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MASTER OF ARCHITECTURE

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Dedication

This thesis project is dedicated to all of the people in my life who have been involved in my education. Thank you all for helping me accomplish my dreams.

Preface

The proposed community recreational facility defined in this project is to provide a design solution that benefits the users, the environmental context, and the City of Lubbock. Lubbock is envisioned as a place of desire and beauty for its citizens to be personally involved in its growth and development. This vision can be carried on by stepping in line with Lubbock's 1966 master plan of the Canyon Lake System. The Lake system provides a location that encases natural topography and scenery, city history, and a open space to bring the communities together. By designing a facility that is sustainable, the environmental impact to this area will be minimal. The healthy built environment becomes a play on the recreational function of the facility. Together with sustainability and design, the recreational facility will bring to Lubbock a positive and creative solution to exercise, sustainability of natural resources, and community involvement.

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Abstract

Thesis Statement:

•Achieving a sustainable environmental and human ecological integrity can establish a relationship between the user and the built environment that stimulates man's physical and mental needs for well-being.

Facility Statement:

•The facility will be a sustainable recreational center for the purpose of providing a place that is a healthy built environment and a place of encouragement of man's needs for healthy living and well-being.

Context Statement:

•The context for the built environment is a location that assists the facility and its functions as a recreational facility.

THEORY

Theoretical Overview

Achieving a sustainable environmental and human ecological integrity can establish a relationship between the user and the built environment that stimulates man's physical and mental needs for well-being.

Sustainability is rapidly becoming a word that is part of everyday language: sustainability of our natural resources, our atmosphere, our buildings, our vehicles, and even our personal well-being. Sustainability describes the act of maintaining at a certain rate or level, or conserving an ecological balance to avoid depletion. Ecological balance concerns the relationship of organisms to one another and to their physical surroundings. In architecture, ecological balance can be seen in both the relationship between the built environment to its context, and the built environment to its user.

Environmental ecology, between the built environment and its context, can be measured by "energy consumption, durability and maintenance of materials, waste, impact of resource extraction, resource limitations, and most importantly, the long-term effect that a structure has on the environment over its life-cycle".[1] An architect or designer's understanding of sustainable design works with the climate of the region, in which the context is located, to develop harmonious relationships with the built environment and its context. Knowledge of prevailing breezes, temperature, solar patterns, precipitation, and materials can all work together to achieve a design that enhances the comfort of the building for the user, but also achieves a design, that over its life-cycle, generates little to no impact on the site on which it inhabits. Energy efficiency is the key to conserving an environmental ecological balance between the built environment and its context.

Human ecology, between the built environment and its user, can be measured by a users experience and overall emotional or behavioral reaction of a space. Day lighting, ventilation, colors, materials, and indoor/outdoor space connections are all human issues can all used to define the experience in which a user interprets their built environment.

1 Ed. Watson, Donald. Time Saver Stndards for Building Materials & Systems. New York: McGraw-Hill, 2000

Each of these issues triggers a physical or emotional response, which if designed successfully, harmonizes the relationship with the user and the built environment.

Therefore, if understanding the requirement to provide environmental ecology to a space, human ecology is to directly follow. The strategies in designing a sustainable environmental ecology correlate to the strategies used in designing a sustainable human ecology. For example, studying solar patterns and solar heat gain, educates a designer to incorporate natural day lighting responses that are energy efficient to negate potential solar gain, as well as respond to the human emotion of visual connection to the outside from within a space. If a built environment is consistent in providing sustainability, comfort, and shelter, the experience of the user both physically and mentally will be agreeably balanced.

S. Richard Fedrizzi, President, CEO, and founding chairman of the U.S. Green Building Council states that "a growing body of evidence about the significant- and positive- impact green buildings (sustainable buildings) have on the environment, public infrastructure, and on human health and productivity in our homes, schools, and workplaces is helping to further the transformation of our built environment, changing how cities, companies, and institutions think about and plan building development." [1] 'Green' or 'sustainable' buildings have been talked about in the media since the 1990's, however, the explanation to what classifies a structure as 'green' has not been so clearly defined. The U.S. Green Building Council and Leadership (USGBC) in Energy and Environmental Design (LEED) are the two groups responsible for the green building movement. USGBC and LEED have defined the following strategies must be incorporated into the design in order to classify the building as sustainable.

A building is sustainable if: (List provided by the USGBC)[2]

- Its construction reduces the consumption of natural resources, like wood from old growth forests.

1 Ed. Beaver, Robyn. Mainstrem Green: Sustaiable Design by LPA. Austrailia: Images Publishing, 2005.
2 www.usgbc.org

- Most of its construction waste is recycled or reused rather than sent to landfills.
- Its operation reduces the consumption (and costs) of energy and water.
- The development footprint is limited, open space is restored and enhanced, and landscape architecture is designed to provide wildlife habitat, storm water management, and beauty with minimal water consumption and maintenance.
- The site and building designs minimize or eliminate heat islands- asphalt and other dark, non-reflective surfaces on roofs, walkways, roads, and parking lots that absorb and slowly release solar heat. Heat islands raise surrounding temperatures by as much as 10 degrees, increasing, both heating, ventilation, and air conditions (HVAC) loads and landscape irrigation needs.
- The majority of the interior spaces have natural day lighting and outdoor views.
- High efficient HVAC systems and low VOC (Volatile Organic Compound) materials like paint, flooring, and furniture are used to improve the indoor environmental air quality.
- Building materials, from structural steel to carpeting and furniture, have recycled content.

“Green buildings provide a healthier quality of life, because they use non-toxic building materials, and they provide abundant fresh air and natural light. That healthier quality of life brings many benefits.”[1]

1 Ed. Beaver, Robyn. Mainstrem Green: Sustaiable Design by LPA. Austrailia: Images Publishing, 2005.

Issue. Building Envelope

Goal:

The goal is to design a sealed building envelope that maximizes the isolation between the interior environmental conditions and the exterior environmental conditions.

Performance Requirement 1: fig.1

The exterior envelope will be well insulated to minimize heat gain and heat loss.

Performance Requirement 2: fig.2

The design of the layout will isolate the interior spaces from the hot summer and the cold winter climate. Low-use spaces will also be used as a climate buffer.

Performance Requirement 3: fig.3

Subdivision amongst interior spaces will create separate heating and cooling zones.

Performance Requirement 4: fig.4

Developed construction details for materials will minimize the amount of air infiltration and exfiltration.

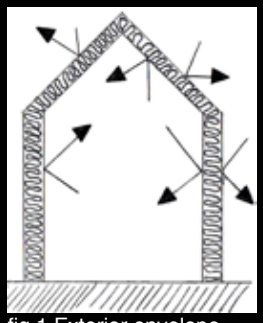

fig.1 Exterior envelope Insulation

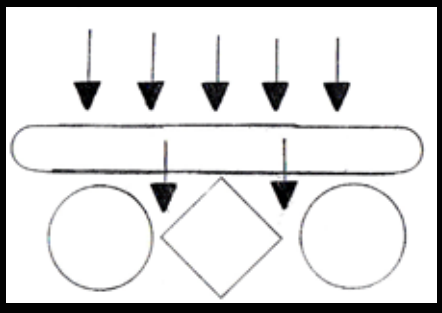

fig.2 Climate buffer with low use spaces

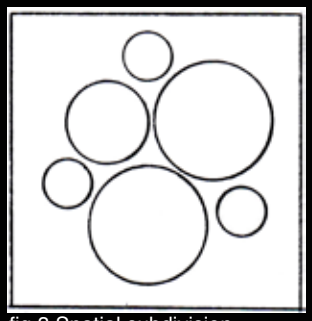

fig.3 Spatial subdivision

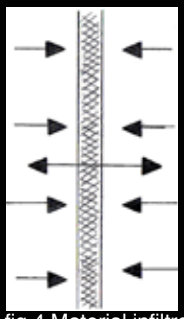

fig.4 Material infiltration and exfiltration

Issue. Materials

Goal:
The goal is to use materials that are energy efficient and have low life-cycle impact on environment and occupant health.

Performance Requirement 1: fig.5
Choose materials that will not off-gas indoor pollution that is harmful to occupant health.

Performance Requirement 2: fig.6
Design applications to minimize energy use. Choose materials that can be used in a high energy-efficient manner. Example: low-E glazing on windows

Performance Requirement 3: fig.7
Choose construction products that have a long life span, low-impact earth extraction, low maintenance requirements, and made of recycled content.

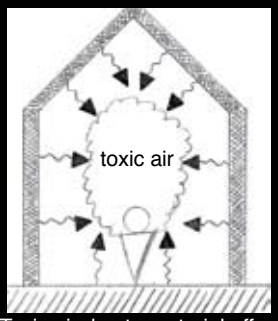

fig.5 Toxic air due to material off-gasing

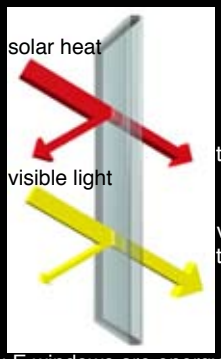

fig.6 Low-E windows are energy efficient


fig.7 Recycled content materials are more environmentally friendly

ISSUE. CIRCULATION

Goal:

The goal is to create space circulation organization that allows user's apparent capability to find one's way to specific locations throughout the facility.

Performance Requirement 1: fig.8

Spatial circulation for a user to establish ease for interaction or communication with other users.

Performance Requirement 2: fig.9

Provisions for both private and public spaces with semi-public and semi-private spaces to buffer between.

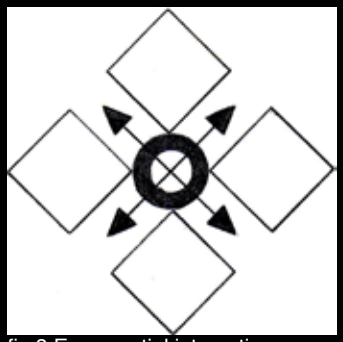

fig.8 Easy spatial interaction

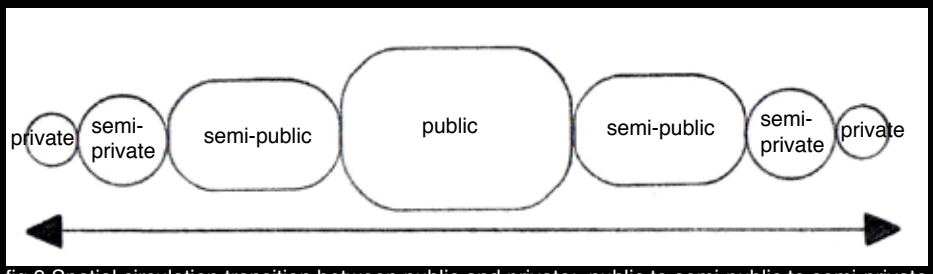

fig.9 Spatial circulation transition between public and private: public to semi-public to semi-private to private

ISSUE. HUMAN CONNECTION WITH NATURE

Goal:

The goal is to create a connection between the user and the natural context both visually and physically.

Performance Requirement 1: fig.10

Transition spaces between interior spaces will be broken up by nature either physically or visually.

Performance Requirement 2: fig.11

The design layout will coordinate with the site to provide ample spatial opportunity to perform physical exercise both indoors and outdoors.

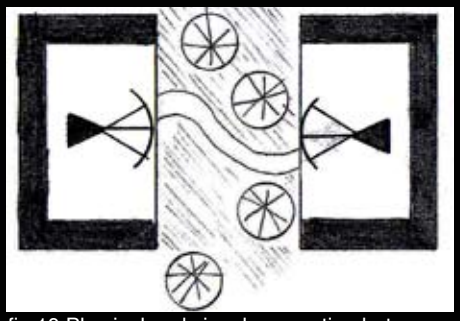

fig.10 Physical and visual connection between interior spaces

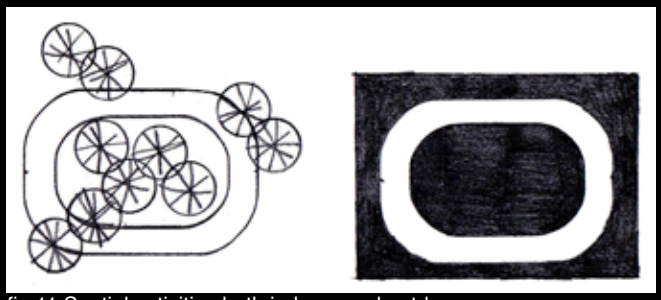

fig.11 Spatial activities both indoors and outdoors

ARCHITECTURAL.PRECEDENT

Architectural Precedent 01

Project. Toyota Motor Salesí North American Headquarters South Campus Office Development Expansion

Architect. LPA
Location. Torrance, California
Size. 624,000 square feet
Construction Cost. $82 million

Green Features:

- Energy performance meets and exceeds LEED requirements
- Single largest commercial solar rooftop electric system in North America
- More than 50% (by value) of the building materials have recycled content
- None of the HVAC, fire suppression, and refrigeration equipment use ozone depleting HCFC, Halon, or CFC based refrigerants
- Copy room and janitorial facilities have their own ventilation systems
- Low VOC paints, adhesives, and composite wood products
- Low-flow plumbing fixtures reduced building water usage by more than 20 percent
- High use of drought-tolerant plant and tree species

fig.12 Exterior night view

fig. 13 Landscaping continues up to the building

- Buildings and the surface parking lots are heavily landscaped with trees to minimize heat islands
- Campus-wide drip irrigation system uses reclaimed rather than potable water
- Landscape water usage reduced by more than 50 percent
- Pedestrian circulation system encourages walking rather than short car trips between campus buildings
- Electric vehicle shuttles to off-site public transportation systems, bicycle racks for bicycles, and showers to promote use

The Toyota Motor Sales Headquarters' features for design incorporation:

- Space divided in two three-story office buildings with a total of five 'pods' or sections
- Floor plan of each pod consists of a central core with open floor plan around core to be modified to meet changing needs
- Each distinct section connected by two-story light-filled common lobby
- 8 acres of landscape including outdoor seating for eatery, break-out rooms, a jogging trail, and an outdoor stage
- Renewable resources that provide 20% of building's energy requirements
- Variety of materials all containing recycled content


fig.14 Courtyard area between pods


fig.15 Courtyard view from interior


fig.16 Courtyard between pods

Architectural Precedent 01 cont.

Sustainability & Human Connection with Nature

- Separate ventilation systems for hazardous air to avoid affecting the indoor air quality in the office areas
- Separate circulation loops for pedestrian and vehicular traffic
- Pedestrian circulation incorporated with the landscape to promote walking habits
- Landscape design incorporates a variety of outdoor spaces to promote typical indoor activities to move outside
- Heavily landscaped surface parking with trees to provide shading for pedestrians, help clean the air, and minimize heat islands
- Building mass responds to site's solar orientation to maximize interior day lighting and minimize heat gain
- All walls are constructed of concrete tilt-up walls in combination with low-E glass windows
- Elevators and lobby-based glass stairwells provide vertical circulation encouraging floor to floor interaction

fig. 17 Naturally lit stair-well

fig. 18 Paved walking paths in landscaping to encourage walking

Architectural Precedent 01 cont.

Sustainability & Human Connection with Nature

The Toyota Motor Sales Headquarters provides excellent examples of how to incorporate sustainable features into design. The combination of tilt-up concrete walls with horizontal bands of low-E windows not only promote energy efficiency, but visually break up the facade of the building with material variety. The building layout incorporates 'pods' that visually break up the floor plan and the elevation. The pods also create a more definite separation of spaces and their uses. The pod layout also gives opportunity for a unique connection between the intersection spaces of the pods. The open two-story, light-filled stairwells create connection that encourages mingling amongst the employees but mingles the employees with visual connection to the outdoors.

The intense use of landscaping throughout the entire master plan brings uniformity between the site and the structure. Landscaping adds to the functionality, sustainability, and aesthetics of the site. Promotion of outdoor activity with landscaping is a way to further interact the user with design. All of the design features listed about the Toyota Motor Sales Headquarters can be incorporated into the scope of this project.

fig.19 Exterior view of materials

fig.20 Day light stairwell

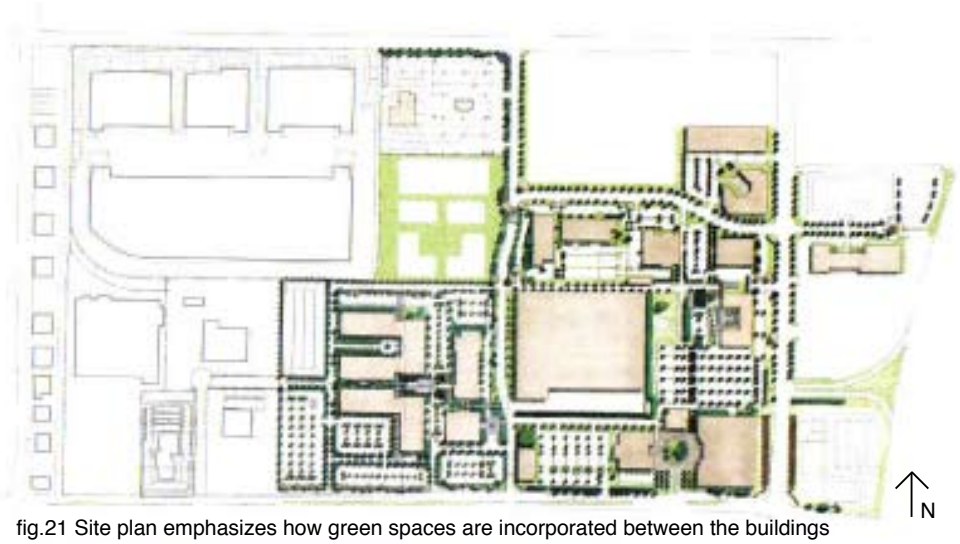

fig.21 Site plan emphasizes how green spaces are incorporated between the buildings

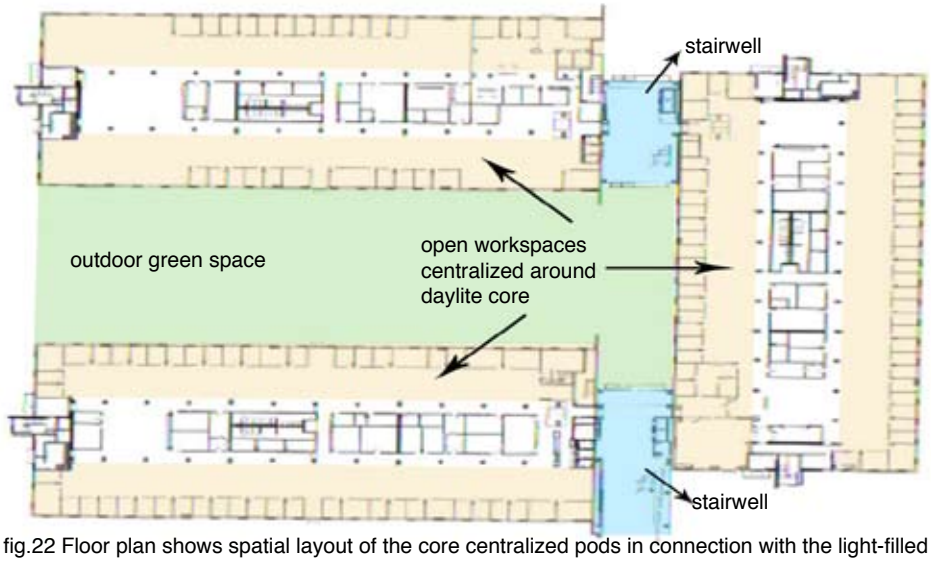

fig.22 Floor plan shows spatial layout of the core centralized pods in connection with the light-filled stairwells, and outdoor green spaces

Architectural Precedent 02

Project. Northampton Academy

Architect. Feiden Clegg Bradley Architects
Location. Northampton, Massachusetts
Size. 134,333 square feet
Completion Date. December 2005

The Northhampton Academy offers an example to each of the theoretical issues of building envelope, materials, circulation, human connection with nature. The most important feature of the Northampton Academy is the attention the design team used to focus on connecting the building with its natural context. The connection that the user makes with the outside is the focal point not only in the views but in the circulation. The layout is organized around a large, centralized, sloping courtyard. From within this courtyard, a user can orient themselves within the campus. The spatial plans are laid out in a series of sections surrounding the central courtyard all connected by outdoor corridors on the ground level and naturally lit corridors on the first floor. Multiple smaller courtyard spaces are layout within the different section further enhancing the visual connection with the natural outdoor context.

fig.23 Sloping, central courtyard

fig.24 Outdoor corridors around courtyard

fig.25 Naturally lit transition spaces

Architectural Precedent 02 cont.

Sustainability & Human Connection with Nature

The sloping site provides an opportunity for natural elevation changes to break up the floor plans. The flowing connection of spaces combined with the benefits of natural light and connection to nature creates a wonderful learning atmosphere. "The design illustrates the manifold benefits of clear, organized thinking, and the effectiveness of the flow of internal and landscaped spaces is evident to anyone watching the students use the building."[1]

From a sustainable standpoint, materials, day lighting, ventilation, low environmental impact, and water harvesting were the main concepts on the minds of the design team. Natural and vernacular material choices were used to softly flow into the site. Methodical attention was paid to the details of material connections as well as the connection of the ventilation system with the materials. The ventilation system uses aluminum double-glazed fixed and open windows, acoustical vent panels, acoustical louvers, and ground level intake fans and roof-mounted extract vent fans. The use of day light corridors and Corbusian ribbon windows on the facades make the need for artificial light obsolete during the day time hours. Water drainage from the sloping site is captured to prevent run-off into the street and used for watering the landscaped spaces.

1 Hyams, Richard. "The Effectiveness of the Landscape Spaces is Evident to Anyone Watching Students Use the Building." Architect's Journal. 15 June 2006: 36-47.

fig.26 Smaller courtyard

fig.27 Light-well corridor on first floor

fig.28 Stair-well

fig.29 Cafeteria with view to courtyard

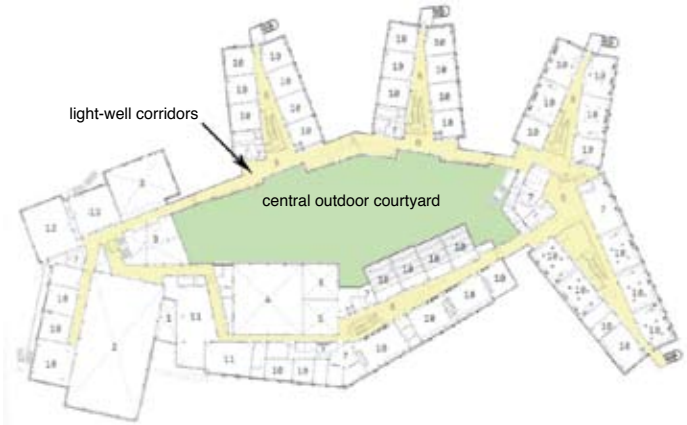

fig.30 First floor plan

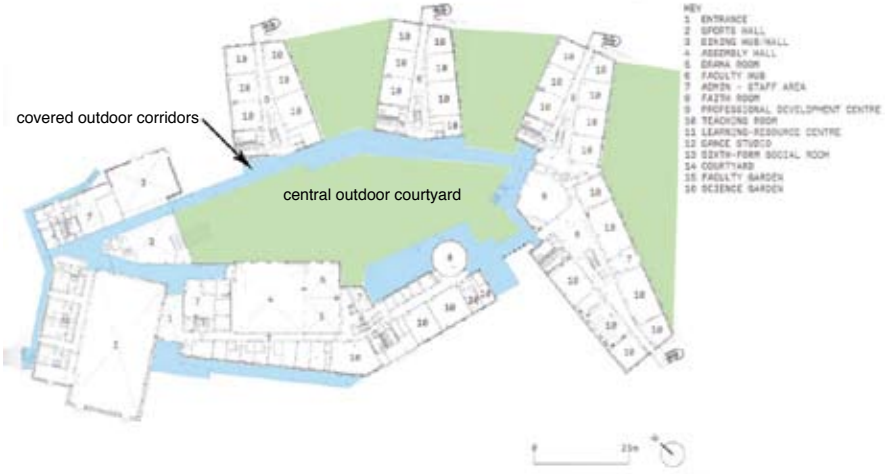

fig.31 Ground floor plan

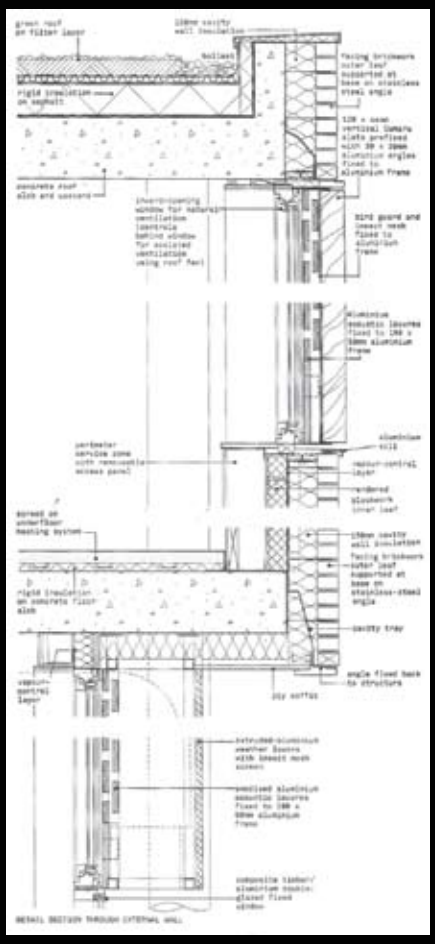

fig.32 Example of carefully articulated exterior wall detail encompassing sustainability features

Project. Protestant Comprehensive School

Architect. Peter Hubner of plus+bauplanung, Neckartenzlingen
Location. Gelsenkirchen, Bismark
Size. 205,700 square feet

The entire focus for the design of the Protestant Comprehensive School is energy efficiency. "The energy concept is based on a premise that includes the following strategies: minimizing the use of fossil fuels; minimizing the investment costs for technical equipment for building systems; minimizing potential cooling loads; minimizing transmissio and ventilation losses; optimizing thermal and visual comfort; and minimizing the energy and material consumption."[1] The strategies started with the design of the building envelope. High thermal insulation standards were a must in order to deal with seasonal climatic fluctuation. Shading devices and shading plants are also used to improve indoor climate. The sun is used as a natural heat source, the soil and night air are used as a natural cooling source, and accessible storage spaces are used as thermal buffers. A central, covered outdoor circulation corridor can be used as a space for relaxation, to study, or to experience nature. The covered 'market square' is used as a central location for the complex and is located in the corridor.


fig.33 Aerial image of complex


fig.34 Exterior View


fig. 35 Covered 'market square'

1 Gonzalo, Roberto and Karl J. Habermann. Energy Efficient Architecture: Basics for Planning and Construction. Boston: Birkhauser-Publisher for Architecture, 2006.

Architectural Precedent 03 cont.

Sustainability & Human Connection with Nature

The key elements for the natural ventilation system are the geothermal tunnel and the exhaust shaft. The air enters through the cross ventilation path and flows through the geothermal tunnel where it is conditioned and blown to heat or cool the spaces and exits. Tis concept works for both the winter and summer conditions. A comfortable level of natural day lighting is achieved with an abundance of clerestories. Clerestories are also used to light the gymnasium which increases energy efficiency. Shading devices used on windows add to the aesthetics of the building.

fig.36 Site plan illustrates central corridor of complex

fig.37 Example of sun shading devices

fig.38 Naturally lit basketball court

fig.39 Exterior view

Bibliography

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Gonzalo, Roberto and Karl J. Habermann. Energy Efficient Architecture: Basics for Planning and Construction. Boston: Birkhauser-Publisher for Architecture, 2006.

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Ed. Watson, Donald. Time Saver Standards for Building Materials & Systems. New York: McGraw-Hill, 2000

www.usgbc.org

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