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Research Article

The Architectural Design and Development of Northwestern University

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About Article

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ABSTRACT

This project aims to design a sustainable campus for Northwestern University, which serves as a model for other universities seeking to reduce their environmental impact. The project design will be guided by principles of sustainability, including energy efficiency, water conservation, waste reduction, and healthy indoor environments. The design incorporates renewable energy sources, such as solar panels and wind turbines, as well as innovative technologies for reducing energy and water use. The project team includes students, faculty, and staff from various departments, Including architecture, engineering, and environmental science. The design process is highly collaborative, with regular feedback and input from stakeholders. The final design is informed by research on sustainable campus design, best practices in green building, and input from stakeholders. The project includes specifications, as well as 3D renderings. The outcome of this project is a comprehensive design proposal for a sustainable campus, which can be used to secure funding and support from the university administration. This project also has a significant impact on the university community, demonstrating the university's commitment to sustainability and providing a healthier and more sustainable environment for students, faculty, and staff.

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1. INTRODUCTION

A university is a key driver of societal progress and economic development. Nations with well-developed higher education systems tend to have a more skilled and innovative workforce, contributing to overall prosperity and competitiveness in the global market. It plays a crucial role in shaping the future of individuals and society, empowering learners to become responsible and contributing members of their communities.

Figure 1. Official website University of Zambia, Lusaka, Zambia

"Education is for improving the lives of others and for leaving your community and world better than you found it."
- Marian Wright Edelman

Education enables us to think deeply about primary concerns in life, especially pollution. Protection of the earth and its environment has never been at such a focus ever in the history of humanity. As educated people, we know and realize our responsibilities in protecting the earth and its atmosphere. Higher educational thinking also fosters a desire for improvement in the quality of life of individuals. It has been proven by studies that people who are highly educated have better access to health, from increased awareness of dietary practices and resultantly better and healthier lifestyle. In nations where education activities are on the rise, the youth are more mature and level headed. This improves the entire scenario of the nation as a whole as there is reduced criminal activities. Therefore, the design of a modern public university is to create a campus that is innovative, and sustainable, which also reflects the unique identity and values of the university. We believe that the physical environment plays a critical role in shaping the experiences of students. This shall bring about effective growth to the country through the following;

(i) A greater supply of human capital; universities are producers of human capital and skilled workers are more productive than unskilled workers

(ii) Support for democratic values. Universities could promote strong institutions directly by providing a platform for democratic dialogue and sharing of ideas, through events, publications, or reports to policy makers

(iii) Demand effects. Increased consumption from students and staff and the universities' purchase of local goods and services could have a material impact on GDP.

Figure 2. College times, Copperbelt University (CBU), Kitwe, Zambia

1.1. Scope of work

The Northwestern university shall focus on provision of the following services as its scope of the research. The facility shall be a double story structure and shall have various facilities and the design shall be limited to the scope outlined below.

- School of Mines
- School business
- School of belt Environment
- School of Engineering
- Study parks
- Car park
- Water bodies
- Walkways and drive ways
- Science labs
- Arena
- Tutorial rooms
- Lecture theaters
- Sports facilities

1.2. Objectives

(i) Increasing access to higher education: The Country often has limited access to higher education, which can limit opportunities for individuals to pursue advanced degrees and careers.

(ii) Addressing workforce needs: Developing a university in a country can help to address workforce needs by providing training and education in fields that are in high demand locally and internationally.

(iii) Encouraging Development: Universities can be catalysts for development, attracting businesses, research facilities, and other institutions to the area.

(iv) Providing high-quality education: One of the primary objectives of a university is to provide students with a high-quality education that prepares them for their future careers and personal growth.

(v) Serving the community: Many universities have a commitment to serving their communities through outreach programs, civic engagement, and public service.

2. LITERATURE REVIEW

2.1. Overview

This reviews the literature on the Northwestern University.

Universities typically offer a wide range of disciplines, including but not limited to, business, engineering, arts, social sciences, natural sciences, law, medicine, and education. In addition to academic programs, universities often provide a range of resources and services to support the academic and personal development of students, including libraries, research centers, student organizations, and health services. Universities also often have a strong focus on research and scholarship, with faculty and students conducting research in a wide range of fields. Overall, universities play a vital role in the education and development of individuals, as well as in the advancement of knowledge and research.

3.2. Scope of review

This literature review aims to evaluate the information about the Northwestern University, an
institution of higher education that provides academic and professional programs leading to undergraduate and graduate degrees. It also aims to discuss the importance of universities in a country by providing training and education to individuals who want to gain educational skills as well as further their studies.

3.4. Gaps in literature

Distinguishing gaps in the literature is vital for advancing the research, design and development of Northwestern university. By addressing these gaps, researchers can create more effective, user-friendly designs. Here are some key gaps in the literature on the design and development of the University.

(i) Disconnect between research and practice. McDaniels (2018) highlighted that educational research alone does not automatically lead to changes in practice. Boser and McDaniels (2018) suggest this disconnect could be due to lack of trust in experts by practitioners.

(ii) Bridges (2015) noted that many studies do not account for specific contexts in which educational interventions occur.

This research may not address the specific needs and challenges faced by diverse communities, languages or cultures.

3. METHODOLOGY

The following are the software's that will facilitate good presentation in terms of providing both visual and audio output.

(i) AutoCAD
(ii) Autodesk Revit
(iii) Microsoft word
(iv) Lumion

3.1. Conceptual Design (Fish Gills)

Gills are respiratory organs found in various aquatic organisms that enable them to extract oxygen from water. They are specialized structures adapted for underwater breathing. Fish and some other aquatic animals, such as amphibians and certain invertebrates, possess gills.

Gills are composed of thin, highly vascularized tissues that are located on either side of the fish's head, protected by gill covers or opercula. These tissues have a large surface area, allowing for efficient oxygen exchange. As water flows over the gills', dissolved oxygen is extracted from the water and diffuses into the bloodstream while carbon dioxide, a waste product, is released back into the water.

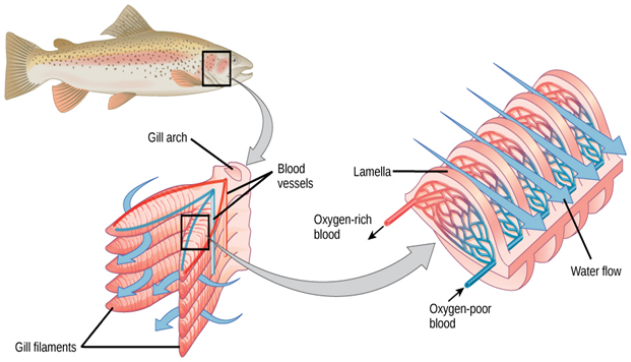

Figure 3. NOAA by Duane Raver

3.2. Concept Definition

The structure of gills consists of gill filaments, which are thin projections or finger-like structures lined with tiny structures called lamellae.

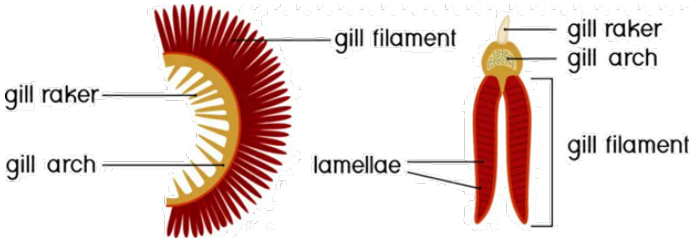

Figure 4. Fish gill diagram, fisharticle by Sayed

The lamellae further increase the surface area available for oxygen exchange. Blood vessels run through the lamellae, facilitating the exchange of gases between the water and the bloodstream.

3.3. Concept Application

Incorporating porous or perforated architectural elements, such as decorative screens, lattices, or slatted facades, can create a network of air passages within the building. These structures can promote airflow, allowing for natural ventilation and the exchange of fresh air.

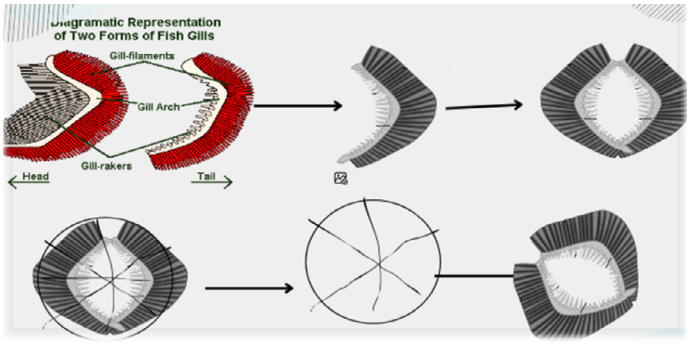

Figure 5. Sketch concept, Author

3.3.1. Airflow Channels

Gills have well-defined channels that direct the flow of water over their surface. In building design, considering the layout and arrangement of spaces to create airflow channels can enhance ventilation. Strategically placing windows, vents, and ducts to facilitate the movement of air through the building can help maintain a comfortable indoor environment. Water-to-Air Transition: Gills efficiently extract oxygen from water and release carbon dioxide.

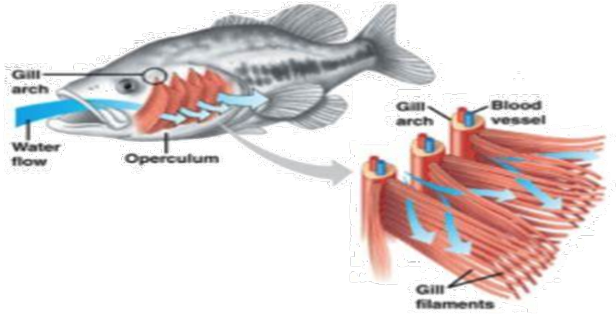

Figure 6. Official website Louisiana State University

3.3.2. In building design

This concept can be applied to the transition between outdoor and indoor spaces. Designing transitional zones, such as vestibules or atriums, can act as buffers between the exterior and interior, allowing for gradual adjustments in temperature and air quality.

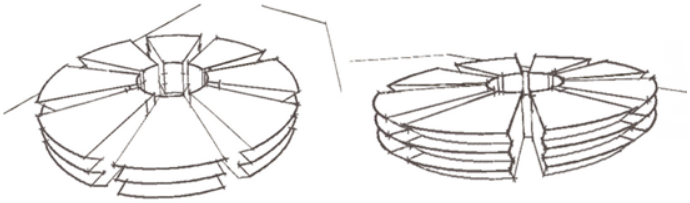

Figure 7. Sketch concept, Author

3.3.3. Efficiency and Sustainability

Gills are highly efficient in extracting oxygen. Applying principles of efficiency and sustainability in building design can help reduce energy consumption. Incorporating energy-efficient systems like natural ventilation, passive cooling strategies, and heat recovery systems can minimize the building's ecological footprint and promote a healthier indoor environment.

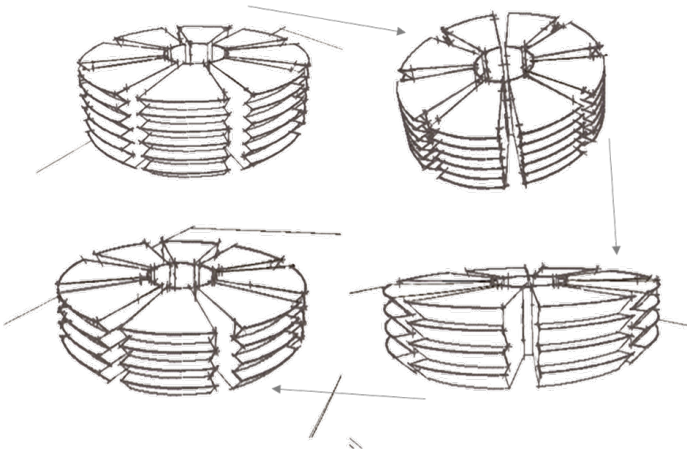

Figure 8. Sketch concept, Author

4. RESULTS AND DISCUSSION

4.1. Design Sensitivity

4.1.1. Environmental impact

The structure was well planned and designed with considerations of factors like weather conditions, terrain, soil type, temperature, humidity, rain, wind, and wind direction. The rooms and environment were designed to be more efficient and pleasant by taking into consideration the particular environmental circumstances of the location

4.1.2. Architecture and environment

Architecture in the design of Northwestern University is heavily influenced by the environment in which it is built. The climate, natural landscape, and available building materials are just a few factors that have influenced the design of a building. For example, the buildings have been designed to stay cool in a hot and dry climate by incorporating features such as large overhangs and courtyards to shade windows and walls from the sun. during cold season, the buildings have been designed to retain heat by using thick insulation and orienting windows to take advantage of the sun's warmth. The natural landscape has been designed to influence the design of a building.

The building has been designed to keep the inside cool during hot season. This has been achieved by Utilizing materials that reflect heat or give shade from the sun. During cold season, the building has been designed to control heat loss from the inside. This has been achieved by using passive solar heating techniques and creating a well-insulated exterior.

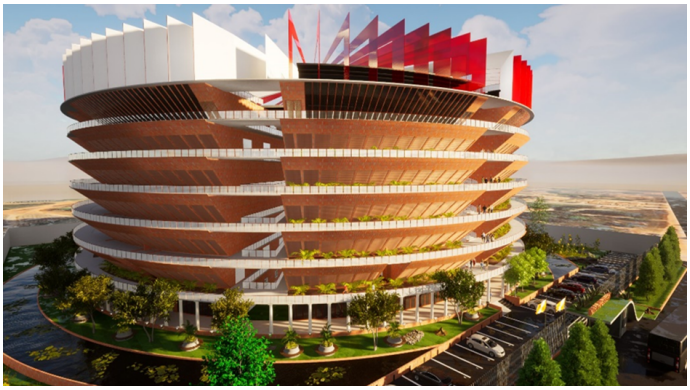

Figure 9. Northwestern University 3D perspective render, Author

Figure 10. Northwestern University Top view 3D perspective render, Author

4.2. Technical Appraisal

4.2.1. Structural Analysis

The building to be supported on structural columns, beams, slabs and Structural walls to be in external walls and other partition areas.

Figure 11. Northwestern University Side view 3D perspective render, Author

4.2.2. Foundations

The site is mostly sandy, loamy and Clay soil which is bad for high rise buildings for the foundation's columns supporting the structure, there will be combination of pad with a deep concrete thick footing to evenly distribute the load.

Figure 12. Northwestern University Front view main entrance 3D perspective render, Author

4.2.3. Load bearing walls

All structural walls as they form the cores are constructed of 300mm glass fiber reinforced concrete (GFRC).

4.2.4. Non load bearing partition walls

Non load bearing partition walls comprise of wooden or steel frames fixed to floor beam studs with wood and glass panel inserts.

4.2.5. Curtain walls

Curtain walls are used throughout the buildings and constitute a combination of gypsum boards and low UV glass panels and solar control toughened glass curtain walling for the social heart building.

4.2.6. Roof

The research is supported on hollow steel sections connected to the building frame at columns and the cores. It is covered by aluminum profiled roofing, while the education and administration block use a flat roof made of pre-casted concrete

4.3. Special Study

Site Micro climate control using natural vegetation and water

This special study focuses on the integration of natural vegetation and water elements in the university design to influence micro elements. Such elements are known to have a significant impact on temperature regulations, air quality and the overall wellbeing of students and faculty.

Numerous studies highlight the advantages of incorporating natural vegetation and water features in architectural design (Pickard, 2018; Aldegeily *et al.*, 2018).

Figure 13. Northwestern University side view main entrance 3D perspective render, Author.

Vegetation, such as trees and green roofs, contributes to cooling through shade and evapotranspiration, reducing the heat island effect (Neufert, 2002). Similarly, water bodies, including ponds and fountains, have a cooling effect on their surroundings through the process of evaporative cooling (Adler, 1999). Integrating these elements in the university campus can lead to improved outdoor comfort, especially during hot and humid seasons. The positive effects on micro climate control and overall sustainability are evident, making it a feasible and cost-effective approach.

Furthermore, the integration of these elements aligns with broader ecological and environmental goals, contributing to the creation of green and resilient University campus.

4.4. Final Scheme

4.4.1. Elevation

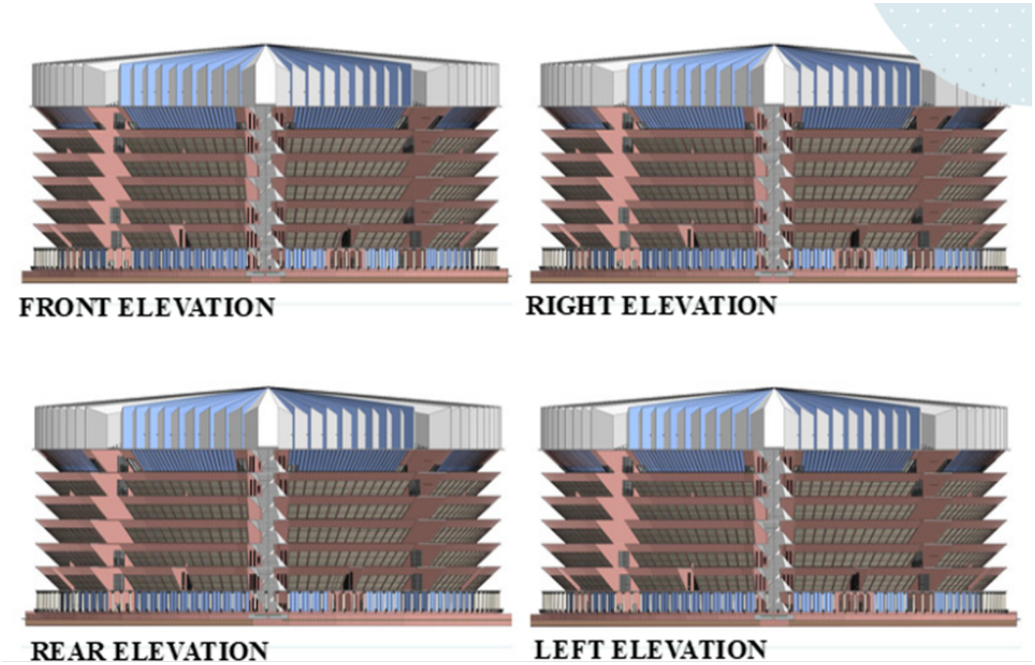

Figure 14. Final scheme Elevations, Author.

4.4.2. Floor Plans

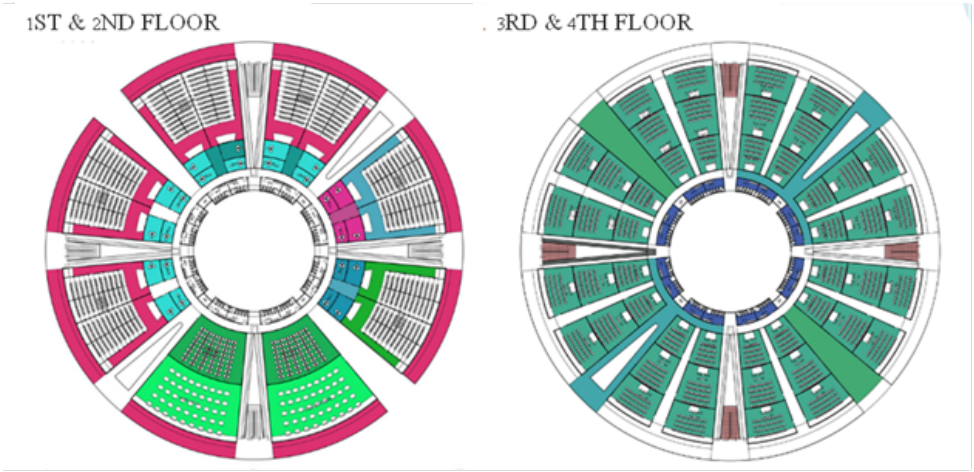

Figure 15. Final scheme floor plans, Author.

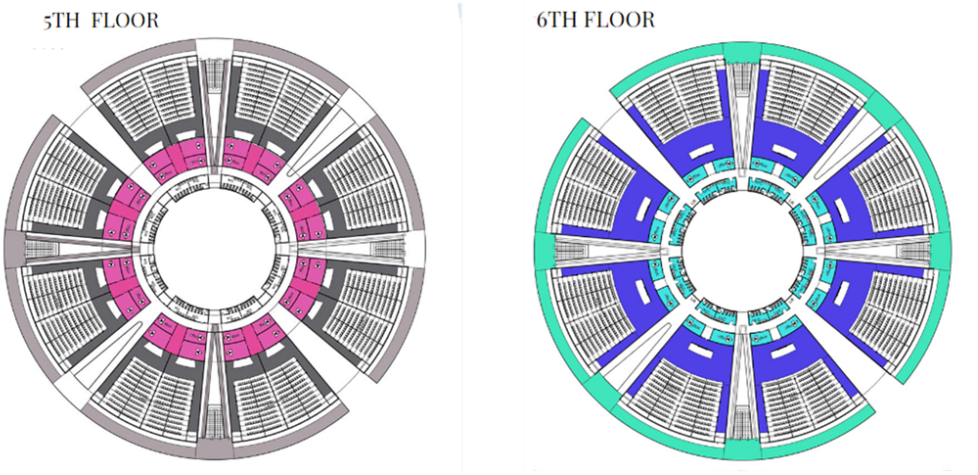

Figure 16. Final scheme floor plans, Author.

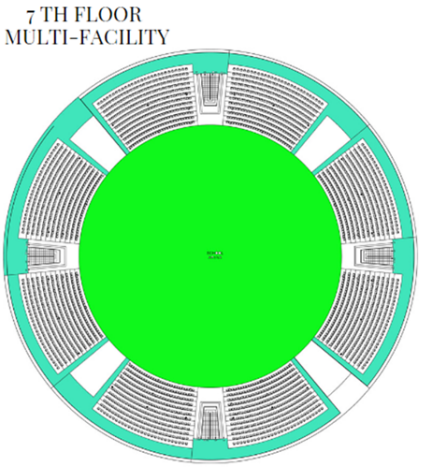

Figure 17. Final scheme floor plans, Author.

Figure 18. Northwestern University aerial views main entrance 3D perspective render Author.

Figure 19. Northwestern University side views main entrance 3D perspective render Author.

4.5. Research Findings

Based on the findings and insights gained from this research project, the main objective of the Northwestern University is to facilitate student learning, development of skills, knowledge and preparation for future success. Hence, this research reveals the following

4.5.1. The university enhances economic growth

When an entire society is educated, productivity increases, average income increases, and unemployment decreases. This leads to the economic growth and stability of a society as a whole. It starts with education.

4.5.2. Promotes Equality and Empowerment

Education provides everyone with a sense of empowerment, the idea that they have the choice to change their own lives and choose their path.

Gender-based violence is lower in communities with high education rates for all genders. Educated persons are more likely to support gender equality and are more likely to make efforts to stop and prevent gender-based or domestic violence.

4.5.3. Connecting Across Borders

The new world of digital education is helping those who get an education to connect across the globe with people from other cultures. Students can collaborate across borders, increasing the cultural awareness and worldliness of the individuals. Education offers a global perspective on the world that is not possible to attain elsewhere.

4.5.4. Research and Innovation

Universities are hubs of research and innovation. Encouraging students and faculty to engage in research contributes to advancing knowledge, technological breakthroughs, and developing solutions to real-world problems.

4.5.5. Specialization

Universities allow students to specialize in specific fields of study, enabling them to acquire advanced knowledge and expertise in their areas of interest. The specialization prepares individuals for specialized careers and positions in their respective industries.

5. CONCLUSIONS

In essence, the purpose of universities extends beyond acquiring degrees and credentials. It seeks to cultivate well-rounded individuals who are intellectually curious, socially responsible, and equipped to contribute meaningfully to their communities and the broader global society. Universities serve as a transformative journey that prepares individuals for the challenges and opportunities of the future. Designing and developing a university will have significant impact on the university community, demonstrating the university's commitment to sustainability and providing a healthier and more sustainable environment for students, faculty, and staff.

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