Acoustics in Catholic Churches of Nairobi
“Don’t only practice your art,  
But force your way into its secrets,  
For it and knowledge can  
Raise men to the divine.”

_Ludwig van Beethoven_
Declaration:

This thesis is my original work and to the best of my knowledge has not been presented for a degree in any other institution.

Author: ............................................................................................... Date.................................................................

Larry Matthew Siboe B02|35603|2010

This thesis is submitted in part fulfilment of the examination requirements for the award of the Bachelor of Architecture degree, Department of Architecture and Building Science, University of Nairobi.

Tutor: ...................................................................................... Date.................................................................

Arch. Norbert Musyoki

Year Master...............................................................................Date.................................................................

Dr. Tom Anyamba

Chairman: ..................................................................................Date.................................................................

Arch. Musau Kimeu
Acknowledgements

To God, the Greatest Architect of All.

To my family; my mother Inviolate Siboe for all her love, sacrifices and struggles all to give me and my brothers a better future and for being my source of strength. John Paul Siboe, Mark & Edel Siboe and Luke & Mercy Siboe thank you for your prayers, continual support, patience and confidence in me, throughout my academic pursuits.

To Willis Kabora, for all that you saw me through, God bless you.

Arch. Norbert Musyoki, my tutor, for his tireless efforts in guiding me through my academic endeavors; Dr. Tom Anyamba, for all the advice and dedication, Arch. Jarrett Odwallo, for your advice in matters architecture and beyond; Arch. Steve Nyamato, for all the advice you gave me and Mr Robert Otieno, for all your insights.

All lecturers, Department of Architecture and building science: Arch. Musau Kimeu, Prof. Robert Rukwaro, Arch. Adnan Mwakulomba, Arch. Eliud Liku, Arch. Yusuf Ebrahim, Arch. E. Oyaro, Arch. Allan Otieno and all others for all your guidance during my years in ADD.

My colleagues Dida, Keefs, Chalo, Oj, Vamtash, Kebz, Njeri, Rose, Manda, Georgie, Fatma and all my classmates for accompanying me in this six year journey of hard work.

My good friends Roy, Lloyd, Makeni, Stompie, Nelly, Mama Joe, Ivy, and Wasch for all the love and friendship.

To Arch. Murigu Muriithi and Arcs Africa Limited for taking me under their wing in my formative years and providing great support, time and insight into the world of Architecture.

The Management and staff at St. Austin’s Parish Church, St. Francis Xavier Catholic Church, Our Lady of Consolata Catholic Church and Our Lady of the Rosary Catholic Church for all their efforts in ensuring unlimited access to the buildings. Soweto Catholic Church, Nairobi for their permission to carry out detailed analyses of their building and church grounds.

Special thanks to Dr. Ahmed Pakar (and his staff at Aga Khan Hospital), whose timely intervention enabled me to see out the rest of this course when illness threatened to derail that. Your own pursuit of excellence in the field of Ophthalmology served as a source of inspiration during this long search for knowledge. Words cannot begin to express the debt of gratitude I owe you.

Thank you all and God bless you.
Dedication to Michael Kirk...

‘The littlest feet make the biggest footprints in our hearts’
TABLE OF CONTENTS.

CHAPTER 01: INTRODUCTION

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>1.1</td>
<td>Problem Statement</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>Research Questions</td>
<td>4</td>
</tr>
<tr>
<td>1.3</td>
<td>Objectives</td>
<td>4</td>
</tr>
<tr>
<td>1.4</td>
<td>Significance of Study</td>
<td>4</td>
</tr>
<tr>
<td>1.5</td>
<td>Scope</td>
<td>5</td>
</tr>
<tr>
<td>1.6</td>
<td>Limitations</td>
<td>5</td>
</tr>
<tr>
<td>1.7</td>
<td>Terminologies</td>
<td>6</td>
</tr>
<tr>
<td>1.8</td>
<td>Structure of Research Paper</td>
<td>7</td>
</tr>
</tbody>
</table>

CHAPTER 02: LITERATURE REVIEW

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Introduction</td>
<td>9</td>
</tr>
<tr>
<td>2.1</td>
<td>Introduction to Acoustics</td>
<td>10</td>
</tr>
<tr>
<td>2.1.1</td>
<td>Properties of Sound</td>
<td>10</td>
</tr>
<tr>
<td>2.1.2</td>
<td>Behaviour of Sound in Enclosed Spaces</td>
<td>12</td>
</tr>
<tr>
<td>2.1.3</td>
<td>Design Considerations for Multi-Purpose Spaces</td>
<td>12</td>
</tr>
<tr>
<td>2.2</td>
<td>History of the Church</td>
<td>17</td>
</tr>
<tr>
<td>2.2.1</td>
<td>The Origins of Christian Worship</td>
<td>17</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Legalization of Christianity</td>
<td>18</td>
</tr>
<tr>
<td>2.2.3</td>
<td>The Middle Ages</td>
<td>19</td>
</tr>
<tr>
<td>2.2.4</td>
<td>The East-West Schism, The Reformation And The Counter-Reformation</td>
<td>23</td>
</tr>
<tr>
<td>2.2.5</td>
<td>From Enlightenment to the Second Vatican Council</td>
<td>25</td>
</tr>
<tr>
<td>2.3</td>
<td>The Catholic Church in Kenya</td>
<td>27</td>
</tr>
<tr>
<td>2.3.1</td>
<td>The Foundation of Nairobi Mission, 1889</td>
<td>28</td>
</tr>
<tr>
<td>2.4</td>
<td>The Second Vatican Council</td>
<td>29</td>
</tr>
<tr>
<td>2.5</td>
<td>Summary</td>
<td>31</td>
</tr>
</tbody>
</table>
## CHAPTER 03: RESEARCH METHODOLOGY

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 Introduction</td>
</tr>
<tr>
<td>3.1 Research Purpose</td>
</tr>
<tr>
<td>3.2 Research Design</td>
</tr>
<tr>
<td>3.3 Time Horizon</td>
</tr>
<tr>
<td>3.4 Population, Population Frame and Sampling</td>
</tr>
<tr>
<td>3.5 Sampling Design</td>
</tr>
<tr>
<td>3.5 Data Collection Methods</td>
</tr>
<tr>
<td>3.6 Data Analysis</td>
</tr>
<tr>
<td>3.7 Data Presentation Techniques</td>
</tr>
</tbody>
</table>

## CHAPTER 04: RESEARCH FINDINGS

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 Introduction</td>
</tr>
<tr>
<td>4.1 St. Austin’s Parish Church</td>
</tr>
<tr>
<td>4.1.1 Background Information</td>
</tr>
<tr>
<td>4.1.2 Architectural Analysis</td>
</tr>
<tr>
<td>4.2 St. Francis Xavier Catholic Church</td>
</tr>
<tr>
<td>4.2.1 Background Information</td>
</tr>
<tr>
<td>4.2.2 Architectural Analysis</td>
</tr>
<tr>
<td>4.3 Our Lady Consolata Catholic Church, Consolata Shrine Parish</td>
</tr>
<tr>
<td>4.3.1 Background Information</td>
</tr>
<tr>
<td>4.3.2 Architectural Analysis</td>
</tr>
<tr>
<td>4.4 Our Lady of the Rosary Catholic Church</td>
</tr>
<tr>
<td>4.4.1 Background Information</td>
</tr>
<tr>
<td>4.4.2 Architectural Analysis</td>
</tr>
</tbody>
</table>

## CHAPTER 05: CONCLUSIONS AND RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0 Introduction</td>
</tr>
<tr>
<td>5.1 Summary of Findings and Conclusions</td>
</tr>
<tr>
<td>5.2 Recommendations</td>
</tr>
<tr>
<td>5.3 Future Recommendations for Research</td>
</tr>
</tbody>
</table>

## CHAPTER 06: REFERENCES

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
</tr>
</tbody>
</table>

## CHAPTER 07: APENDICE

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
</tr>
</tbody>
</table>
List of Figures

Chapter 01:

Fig 1.01: Map showing position of Nairobi in Kenya; Pg. 5

Chapter 02:

Fig. 2.01: Image illustrating how sound vibrations reach the ear from the source; Pg.10
Fig. 2.02: Image showing the directionality of sound with the human voice as an example; Pg.10
Fig. 2.03: Image illustrating sound loudness; Pg.11
Fig. 2.04: Image illustrating sound intensity; Pg.11
Fig. 2.05: Image illustrating the Behavior of Sound in an Enclosed Space; Pg.12
Fig. 2.06: Image showing sound reflection from a convex surface; Pg.14
Fig. 2.07: Image illustrating sound reflection from a concave surface; Pg.14
Fig. 2.08: Image showing audience absorption of direct sound in when seating is level (A) and when raked (B), Pg.15
Fig. 2.09: Image showing seating dimensions for effective sound absorption in a raked seating layout, Pg.15
Fig 2.10: Image showing interior view of St. Austin’s Catholic Church, Muthangari, Pg16
Fig 2.11: Image showing Audio-Visual devices at the Chancel in St. Austin’s Catholic Church, Muthangari, Pg16
Fig 2.12: Image showing a plan of the domestic church in Doura Europos, Syria, Pg.18
Fig 2.13: Image showing a section of the domestic church in Doura Europos, Syria, Pg.18
Fig 2.14: Image showing a plan of the Basilica of Sant’Apollinare in Classe, Pg.19
Fig 2.15: Image a section of the Basilica of Sant’Apollinare in Classe, Pg.19
Fig 2.16: Image showing a plan of St. Mark’s Basilica, Venice, Pg.21
Fig 2.17: Image showing a section of St. Mark’s Basilica, Venice, Pg.21
Fig 2.18: Image showing a plan of Duomo of Orvieto Abbey Church of Casamari, Pg.22
Fig 2.19: Image showing a section of Duomo of Orvieto Abbey Church of Casamari, Pg.22

Chapter 03:

Fig 3.01: Image showing main entrance into St. Francis Xavier Catholic Church, Parklands, Pg.33
Fig 3.02: Image showing main entrance into Our Lady of Consolata Catholic Church, Westlands, Pg.33
Fig 3.03: Map showing Catholic Churches in Kenya, Pg.34
Fig 3.04: Map showing Catholic Churches in Nairobi County, Pg.34
Fig 3.05: Image showing a traditional tape measure, Pg.35
Fig 3.06: Image showing a long distance tape measure, Pg.35

Chapter 04:

Fig 4.01: Image showing main entrance into St. Austin’s Parish Church, Muthangari, Pg.40
Fig 4.02: Image showing location of St. Austin’s Parish Church, Muthangari, Pg.41
Fig 4.03: Image showing interior view of St. Austin’s Parish Church, Muthangari, Pg.41
Fig 4.04: Image showing Foundation Stone of St. Austin’s Parish Church, Muthangari, Pg.42
Fig 4.05: Image showing side entrance into St. Austin’s Parish Church, Muthangari, Pg.42
Fig 4.06: Image showing Ground Floor Plan of St. Austin’s Parish Church, Muthangari, Pg.45
Fig 4.07: Image showing Balcony Plan of St. Austin’s Parish Church, Muthangari, Pg.45
Fig 4.08: Image showing Section A-A of St. Austin’s Parish Church, Muthangari, Pg.46
Fig 4.09: Image showing Elevation of South facing Facade of St. Austin’s Parish Church, Muthangari, Pg.46
Fig 4.10: Image showing main entrance into St. Francis Xavier Catholic Church, Parklands, Pg.48
Fig 4.11: Image showing main entrance into St. Francis Xavier Catholic Church, Parklands, Pg.48
Fig 4.12: Image showing location of St. Francis Xavier Catholic Church, Parklands, Pg.49
Fig 4.13: Image showing interior of St. Francis Xavier Catholic Church, Parklands, Pg.49
Fig 4.14: Image showing Ground Floor Plan of St. Francis Xavier Catholic Church, Parklands, Pg.52
Fig 4.15: Image showing Balcony Plan of St. Francis Xavier Catholic Church, Parklands, Pg.52
Fig 4.16: Image showing Elevation of South facade of St. Francis Xavier Catholic Church, Parklands, Pg.53
Fig 4.17: Image showing Section A-A of St. Francis Xavier Catholic Church, Parklands, Pg.53
Fig 4.18: Image showing main entrance into Our Lady of Consolata Catholic Church, Westlands, Pg.55
Fig 4.19: Image showing the Rosary Garden at Our Lady of Consolata Catholic Church, Westlands, Pg.55
Fig 4.20: Image showing location of Our Lady of Consolata Catholic Church, Westlands, Pg.56
Fig 4.21: Image showing the altar at Our Lady of Consolata Catholic Church, Westlands, Pg.56
Fig 4.22: Image showing Ground Floor Plan of Consolata Church, Westlands, Pg.59
Fig 4.23: Image showing Section A-A of Consolata Church, Westlands, Pg.59
Fig 4.24: Image showing North and West Elevations of Our Lady of Consolata Catholic Church, Westlands, Pg.60
Fig 4.25: Image showing 3Ds of Our Lady of Consolata Catholic Church, Westlands, Pg.60
Fig 4.26: Image showing main entrance into Our Lady of the Rosary Catholic Church, Ridgeways, Pg.62
Fig 4.27: Image showing main entrance into Our Lady of the Rosary Catholic Church, Ridgeways, Pg.62
Fig 4.28: Image showing the location of Our Lady of the Rosary Catholic Church, Ridgeways, Pg.63
Fig 4.29: Image showing interior of Our Lady of the Rosary Catholic Church, Ridgeways, Pg.63
Fig 4.30: Image showing Ground Floor Plan of Our Lady of the Rosary, Ridgeways, Pg.66
Fig 4.31: Image showing Section A-A of Our Lady of the Rosary, Ridgeways, Pg.66
Fig 4.32: Image showing Elevation E-01 of Our Lady of the Rosary, Ridgeways, Pg.67
Fig 4.33: Image showing Elevation E-02 of Our Lady of the Rosary, Ridgeways, Pg.67

LIST OF TABLES

Table 4.1: Showing reverberation time calculations for St. Austin’s Parish Church, Pg.47
Table 4.2: Showing reverberation time calculations for St. Francis Xavier Catholic Church; Pg.54
Table 4.3: Showing reverberation time calculations for Our Lady Consolata Catholic Church; Pg.61
Table 4.4: Showing reverberation time calculations for Our Lady of the Rosary Catholic Church; Pg.68
Table 4.5: Showing summary of comparative analysis of the acoustic parameters of selected case studies; Pg.69

Table 5.1: Showing summary of comparative analysis of the acoustic parameters of selected case studies and Recommendations; Pg.72
1.0 Introduction

For centuries, churches were designed with emphasis on aesthetics as well as gathering as many of the congregation as possible to listen to the Word and the architecture of the day was dominated by the aspiration to span wide spaces. Before natural acoustics were supplemented by artificial sound systems in the late 19th century, consideration of good natural acoustics was not essential as there was a segregation between the congregation and clergy during celebrations. This segregation was brought about mainly by: the use of the Latin language by clergymen to celebrate mass, despite the fact that the language was not understood by many at the time, as well as the choir doing most of the singing during celebrations, leaving the congregation feeling left out. As such, acoustics did not play a major role in considerations for church design. In the mid-20th-century, after the Second Vatican Council (1963 – 1965) was convoked and disbanded, changes were made to the Catholic Church that forced the aspect of acoustics to be considered in the process of design from the beginning and, fortunately, during the last quarter of the 20th century and early years of this century, architects and designers have recognized the importance and value of designing for natural acoustics in spaces for worship.

In advocating good acoustics for worship and presenting ways to achieve them, this research addresses three primary audiences: (1) pastors and church leaders involved in or considering a building project; (2) church building committees investigating and making decisions for a building project; (3) architects, sound contractors, and other design professionals who will work with pastors and committees and, ultimately, be responsible for incorporating acoustical elements in the design and construction process.
1.1 Problem Statement

Speech and music, in the form of prayer and songs, relates to the main services of Catholic Churches. For that, their buildings require good room acoustical quality.

The Catholic Rites changed with the Second Vatican Council (1963 – 1965), influencing directly speech and music during its services. Among these changes were the use of local language and the active participation of congregation during the celebrations. Thus, the acoustic characteristics and requirements also changed, especially when the emphasis on speech intelligibility increased. In this case, church buildings designed before the changes introduced by the Council are still used for services today. Often the long reverberation times, characteristic of ancient churches, are not suitable for those celebrations.

Understanding of speech is difficult due to the distance between the sound source at the front of the church and the congregation, especially those seated at the rear. Moreover, due to the growth of urban noise, it’s increasingly difficult for the human voice to compete with these external sounds. In order to aid understanding of the word, audio-visual enhancements in the form of artificial sound systems and television screens are commonly used as a support for speech intelligibility and clarity of music in these rooms both in ancient and modern churches. However, the misuse of these equipment, as well as a poor acoustical design of the space, prevents these devices from meeting their goal. Good equipment installed in a building that has a poor acoustics, may not be as helpful to the users perception of sound. The degree of success of these equipment varies from church to church and testing of the acoustic performances of selected case studies, those built before and after Vatican II, will form part of this research.

Through this study, the author hopes to establish how modern churches can be designed so as to fully harness and utilize natural acoustics to join the faithful not only in heart but also in voice.
1.2 Research Questions
I. What acoustic variables are assessed when designing for worship spaces?
II. How did designers in the past deal with the acoustic requirements of the different periods in the Church’s history?
III. How do Catholic churches in Nairobi built before Vatican II perform acoustically compared to those built after Vatican II after the changes brought about by this council?

1.3 Objectives
I. To establish the history of the church with focus on the different acoustic needs of different times and how they were addressed
II. To establish the acoustic parameters assessed when designing a church
III. To analyse the acoustic performances of Catholic Churches in Nairobi built in the pre and post Vatican II era

1.4 Significance of Study
There is need to highlight the importance acoustics play in churches. Throughout its history, the Church has undergone several changes that have resulted in different acoustic requirements. In order to understand the present situation, it is necessary to trace the history of the Catholic Church, the evolution of church acoustics and how different designers responded to the different acoustic requirements of their time.

This study seeks to investigate how ancient and modern churches have responded to the current requirements by carrying out acoustic studies within selected case studies so as to help designers to better design for natural acoustics while ensuring that the constants in church design are maintained.
1.5 Scope

Acoustic performance of contemporary churches in Kenya has been documented in previous studies: Otieno, R. J. in 2013.

Otieno (2013) documented the acoustic performance of contemporary churches with a focus on Christ is the Answer Ministries (CITAM).

The research will focus on acoustics in Catholic Church buildings. Physical investigation will be limited to within Nairobi city (Fig 1.01). The reason the author chose to settle for the metropolitan urban centre is because it is the largest city in Kenya thus has diversity in Catholic Church buildings. It is also the oldest ecclesiastical province of Kenya hence it’s importance in the history of the Catholic Church in Kenya.

1.6 Limitations

During the study, limitations were realized in the following areas:

I. Time: - The time allocated for the study was not sufficient enough to carry out a comprehensive study of the vast history of the Catholic Church and therefore only specific areas focusing on different acoustic requirements of different times and how they were addressed were covered in order to give the research context.

II. Finances: - The lack of adequate finances to travel to all the areas necessary for establishing the history of the church in Nairobi at a more exploratory state.

III. Security: - The country is under constant terrorist attacks therefore buildings and documents relating to planning, design and detail drawings of their structure were not easily accessible.
1.7 Terminologies

Catechetical: relating to religious instructions given to a person in preparation for Christian baptism or confirmation.

Schism: a division between people, usually belonging to an organization, movement or religious denomination.

Doctrines: a set of beliefs held and taught by a church, political party or other group.

Reverberation: a sound that echoes.

Reverberation Time: the time required for the level of a steady sound to decay by 60DB after the sound has stopped.

Jesuits: members of the society of Jesus, a Catholic Order of priests founded by St. Ignatius Layola, St. Francis Xavier and others in 1534, to do missionary work.

Canon Law: law governing the affairs of a Christian Church, especially the law created or recognized by the papal authority in the Catholic Church.

Liturgy: form according to which public religious worship, especially Christian worship, is conducted.

Aggiornamento: renewing the Church and bringing it up-to-date.

Ressourcement: maintaining its eternal truth and continuity with the past.
1.8 Structure of the Research Paper

Chapter one explains, in an introductory capacity, the intended area of study giving a brief context to the problem statement. The research questions and the objectives are stated by the author as well as justification on the necessity of the study. The scope of the study is outlined as well as the limitations that will be encountered.

Within chapter two, the research engages a brief introduction on church acoustics and the parameters assessed when designing for worship spaces. The author also establishes the history on the Catholic Church and how the different acoustic needs of different times were addressed as well as establishing the changes the Second Vatican Council made to the church with a focus on those that affected church acoustics.

Chapter three consists of data collection and analysis of findings to answer the research questions posed in chapter one. The methods employed are explained in detail and include the research design, the research strategy, the time horizon, the population, the sample, the data sources and finally the data presentation and analysis techniques.

Chapter four will analyse the parameters identified in chapter two based on four case studies identified to facilitate this study.

Chapter five of this thesis will outline conclusions derived from the study and recommendations that can be implemented in future projects.