Procedural Gothic

Regenerating Wellington's
19th Century Timber Churches

Sam Mclennan

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Figure 01. A small selection of Timber Gothic Churches generated by the procedural process described in this thesis

Abstract

This research looks at using the technique of procedural modelling to investigate the characteristic rules present within a loosely defined architectural style. The 19th-century timber Gothic churches built in the city of Wellington, New Zealand are examples of a particular interpretation of the Gothic style. Although they all share common aspects, there are no prescribed rules regulating how these churches were designed. This research explores a methodology for creating a procedural 'timber Gothic church generator' that is generated from an understanding and interpretation of the design of the buildings examined. Once developed, the procedural generator can be used to extrapolate, and produce other church designs as well as create hybrid designs. These outputs can be further refined through the creation of parametric rules. A key result of this methodology is to explicate better otherwise ambiguous design philosophies that are shared between the similar buildings. It shows how a design can be reverse-engineered and converted into procedural logic. The research establishes the process and logic to enable the creation of further rules to be explored.

Acknowledgements

Mum, Dad and Lucy; Without your Love and support this would not
have been possible, we've all come a long way since the
Gladstone days

Flatmates and regular mates; Thanks for the chats, the company and
overall pleasantness

Tane, Marc and Andre; Thank you for the amazing opportunities, your
guidance, and humour, this year has been absolutely outstanding

And Adam; Do your work

Contents

1. Introduction

1.1 Introduction and Motivation

The journey of this research began as an interest to grow my computational design skills. This lead me to the field of digital heritage reconstruction, more specifically ecclesiastical buildings, as the pseudo-formalised rules associated with such buildings represented a challenge to model procedurally. Looking at local examples to reconstruct in Wellington, I came across the lost design of St Mary's Cathedral. As I continued to research the building and others like it, it became clear that these designs shared many common characteristics and that they have developed in relation to one another. I also realised how unique these structures are, and how rare they have become due to the somewhat fragile nature of the building material. This led my focus for this research to become a matter of understanding these churches as well as communicating them. Many of these churches served an integral part of people's lives, and helped establish the city of Wellington. Yet today, for many of the lost churches, there is little trace of them. The application of the new digital technique of procedural modelling was something i believed could help in this situation. Looking at previous research, it became clear that procedural modelling offered a more efficient way of creating geometry than techniques previously used in digital heritage. Such a modelling method also enables the creation of systems that can be used to analyse the differing designs in a controlled and centralised location.
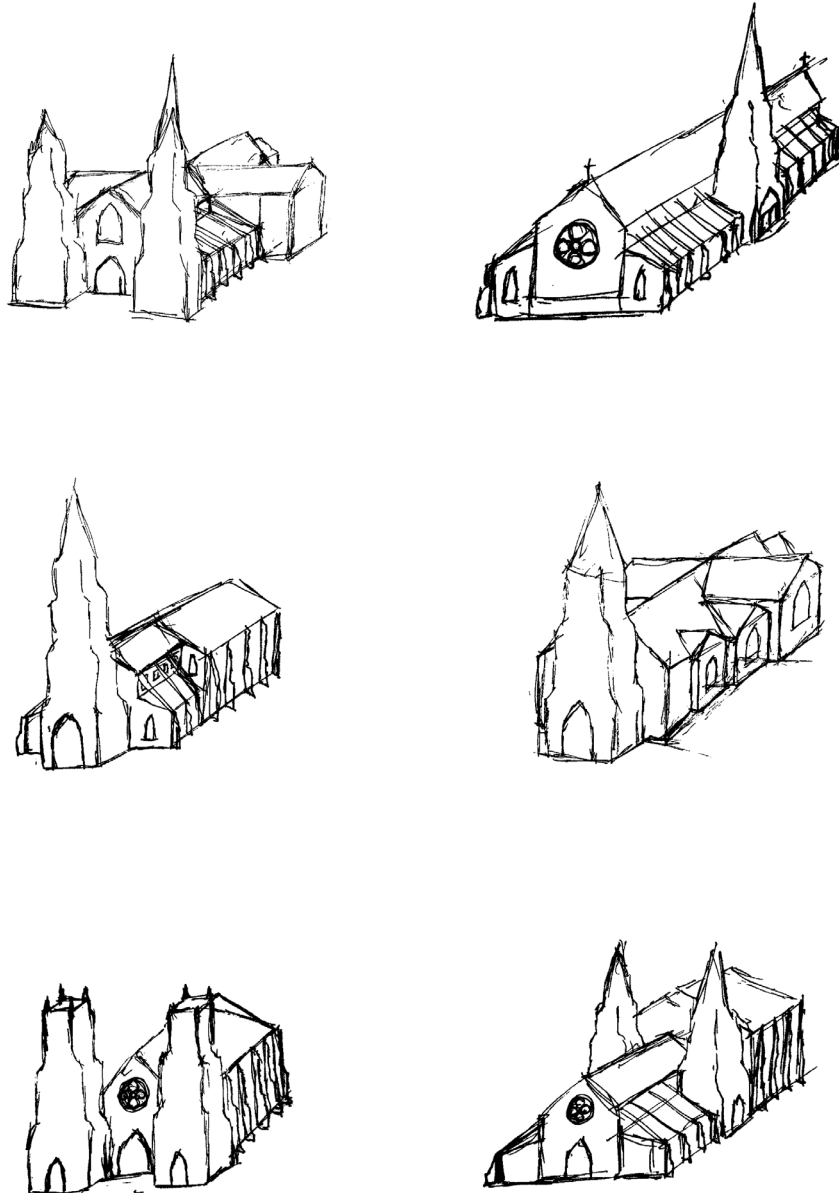
Figure 02. Initial sketches expressing the idea of creating speculative hybrid churches from the pieces of built churches

1.2 Research Scope

The scope of this research is centred around the use of procedural modelling and its application to the field of digital heritage. More specifically, this research will look at how procedural modelling can be used to enhance the critique and understanding of architectural heritage. To achieve this, two main objective were designated.

The first of these objectives is to attempt the creation of a procedural model that generates buildings of a particular architectural style; being in this case the Timber Gothic churches of Wellington. In order for this to be achieved, an understanding and formulation of the common rules between the differing designs needs to be established. Although the rules behind these churches will be investigated, the method for how these can be extracted is the main focus of this research.

The second objective of this research is to investigate how the process of objective 1 can be developed to both analyse and generate lost architectural heritage. The use of procedural modelling for the reconstruction of lost heritage offers a few key advantages over current practices in digital heritage. From the analysis of similar research in later sections of this thesis, there is still a lot of potential to push the use of procedural modelling, especially in regards to the specific type of software that will be utilized in this research

Overarching Research question

How can Procedural Modelling be used to enhance critique and understanding of architectural heritage?

Objective 1

Create a Procedural model that generates buildings of a particular architectural style: the timber Gothic Churches of Wellington

Objective 2

Investigate how the procedural modelling process of objective 1 can be developed to both analyse and generate lost architectural heritage

1.3 Thesis Structure

INTRODUCTION

This opening chapter covers the scope of the research and the motivation behind it

BACKGROUND

This section covers the core concepts that are relevent to this research, and explores other similar research that this thesis builds upon

HISTORIC BACKGROUND

This section looks at the history behind Wellington's Timber Gothic Churches by exploring the origin of the gothic style and its unique application in colonial territories

CONCEPT DESIGN

This chapter covers the initial process of creating a reconstruction of the a singular lost church. Through this process and initail procedural system was created, laying the foundation for the rest of the research

PRELIMINARY DESIGN

This chapter covers the adaptation and expansion of the procedure created in the concept design section. It explores its use to create speculative digital models of lost designs from the components of existing designs

DEVELOPED DESIGN

This section looks at the final adaptation of the procedure to create hybridised designs. It Illustrates how this system was created as well as what rules were utilised to produce completely automated results

CONCLUSION

This chapter summarises the results of the research as well as disscussing what aspects of the system could be pushed further

2. Background

2.1 | Digital Architectural Heritage

Cultural heritage is a finite resource that gives us insight into how the world of today has developed. Architecture plays a key role in this process, as the buildings we inhabit reflect the unique cultural processes of the time and place it is constructed in. The preservation of such architectural heritage has been a common objective for conservationists throughout history. In the past, written descriptions and/or illustrations were commonly employed to capture these buildings and the intangible heritage they carry with them.

In the digital age, 3D digital reconstructions for both existing and lost architectural heritage have become increasingly employed to enhance critique and understanding of aspects of cultural significance (Brown and Webb, 2010).

In certain building types with pseudo-formalised rules such as ecclesiastical buildings, interesting and useful findings can result from such analysis, as shown by Webb and Brown (2016). Such developments are closely intertwined with the increasing capability of the 3D modelling software used to create the reconstructions themselves.

Novitski's 'Rendering real and imagined buildings' is an early example of the digital reconstruction of heritage architecture, and shows how the techniques have developed over the years (1998)(figure. 04). Published in 1998, the book explores both heritage and fictional reconstructions that were created using simple Computer-aided design (CAD) software. These reconstructions consisted of basic geometries and textures that today look very dated. Despite this, the method of investigating and modelling a building in virtual 3D space that is explored in this work remains unchanged in following similar research.

As computing power grew, so did the detail of the reconstructions. This is reflected in the 'Rome Reborn' project, which is led by Prof. B. Frischer and is still being developed today (figure 05)(2008). Starting in the 1990's this project aimed at creating an interactive digital reconstruction of 4th century Rome.

Images Redacted for online
submission

Refer to print version for access
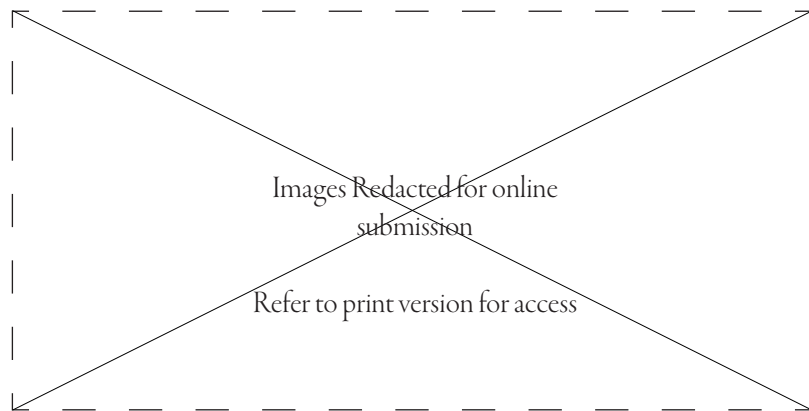
*Figure 03. Reconstruction by of the Temple of Jupiter in the Bay of Naples, Italy
(Sobiecki & Wrońska, 2018)*
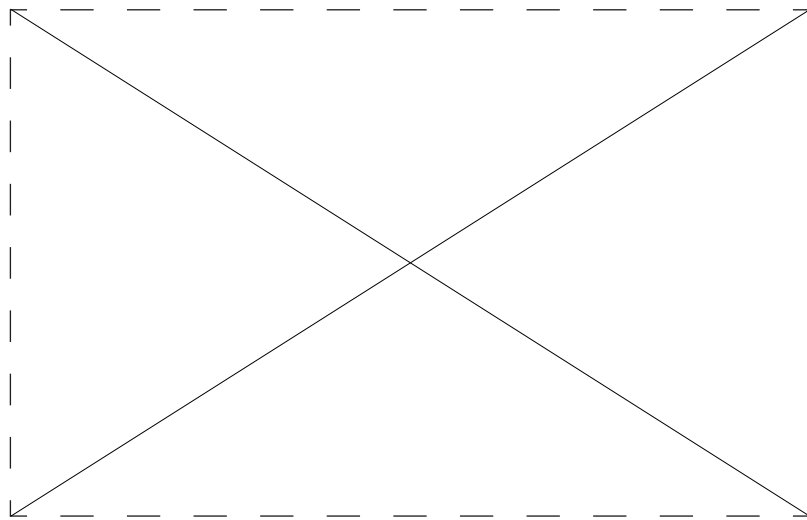
*Figure 04. Reconstruction of Frank Lloyd Wright's Larkin Building from the book
'Rendering real and Imagined buildings' (1998)*

"**Digital technologies** for surveying, modeling and representation have **produced important changes**. In particular, laser scanning, photogrammetry, advanced software for modeling and data analysis, and computer based visualisation have **moved the process of historical and critical knowledge toward the use of complex 3D models**"

Brusaporci, 'Digital Innovations in Architectural Heritage Conservation' (2017)
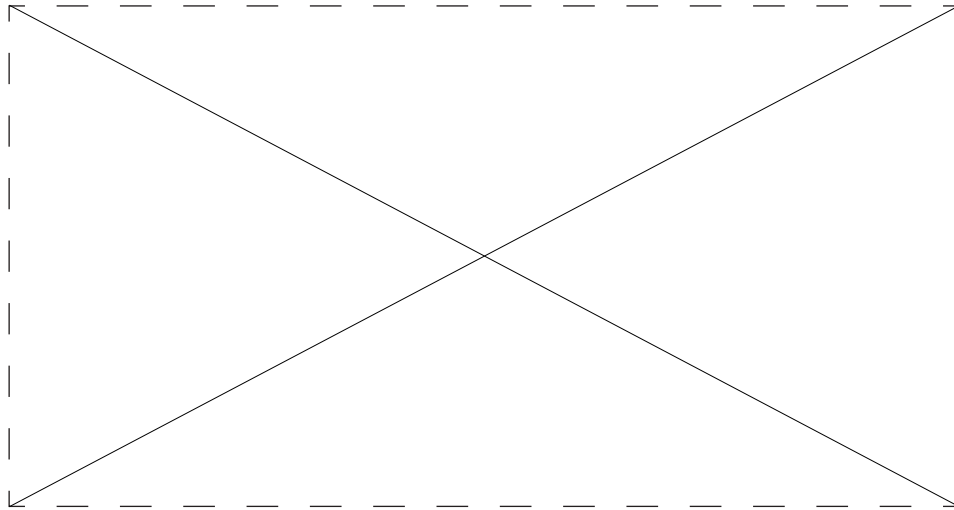
*Figure 05. View of the Rome Reborn project showing the manually create monuments
and procedurally generated surrounding buildings (Dylla et al., 2008)*

In the beginning, key landmarks and well-known buildings were modelled using much the same techniques as seen in 'Rendering real and Imagined buildings'. Buildings such as the colosseum were modelled in high detail according to archaeological data, taking many man hours of digital modelling to complete.

If this labour intensive approach was attempted for the remaining buildings in the city, the project would take an enormous amount of time to complete and the created digital model would be computationally hungry, and be difficult to adjust if new evidence were found. Such a problem required a more efficient approach to geometry creation.

The model was then augmented by researchers Muller and Van Gool, who used procedural modelling to populate the parts of the city that were yet to be modelled. The generated buildings are all visually similar despite each one being unique. This illustrates how recent computational techniques can model many variants of designs that have commonly defined principles, in an efficient manner.

2.2 Case Studies

2.2.1 Possible Palladian Villas

George Hersey, Richard Freedman | 1992

The project 'Possible Palladian Villas' is an early example of how procedural modelling can be applied to the context of architectural heritage. Procedural or 'generative' design within the field of architecture describes the creation of forms and relationships that respond to a common ruleset defined by the designer. Procedural and generative techniques are generally thought of as recent computational developments. However, in principle, some of the earliest and most prominent examples of such a design process include the work of Vitruvius and Palladio.

This simplistic research looks at the collection of villas designed by Palladio in the 16th century and attempts to establish the common rules that were used to create them (figure. 06). This was achieved by using a computer application to generate 2D floor plans and front elevations of designs that were based solely on computational logic (figure. 07). The created rules were based upon both Palladio's own description of his methods as well as analysis undertaken by previous researchers. What the researchers found however, is that many of these stated rules are not reflected in the collection of villas, with even Palladio's own rules being broken on many occasions. This created methodology of applying previously researched rules, seeing what the computer outputs, then adjusting the logic as needed. This iterative and investigative approach to the analysis of a collection of related buildings is something that this thesis will also continue to explore.

The main drawbacks of the process explored in this research however is the limitations in creating and adjusting procedural rules, and the limited visualisation capabilities. The applications that were created to both create and visualise the generated designs were coded manually alongside the rules themselves. This requirement of coding at a fundamental level is a barrier for some researchers, including myself. Therefore the research within this thesis utilises a different mode of software in order to create a procedural system. The software is much more capable than that employed in this 1992 example. The enhanced user interface means that more of the design relationships can be captured by 'authoring' rather than tediously writing code. This choice of software will also provide high quality 3-dimensional outputs that goes well beyond the 2D visuals as explored by Hersey and Freedman.

Figure 06. Example of a Palladian Villa, The Villa Rotunda (Villa Almerico-Capra)
(MCAD Library, 2001)
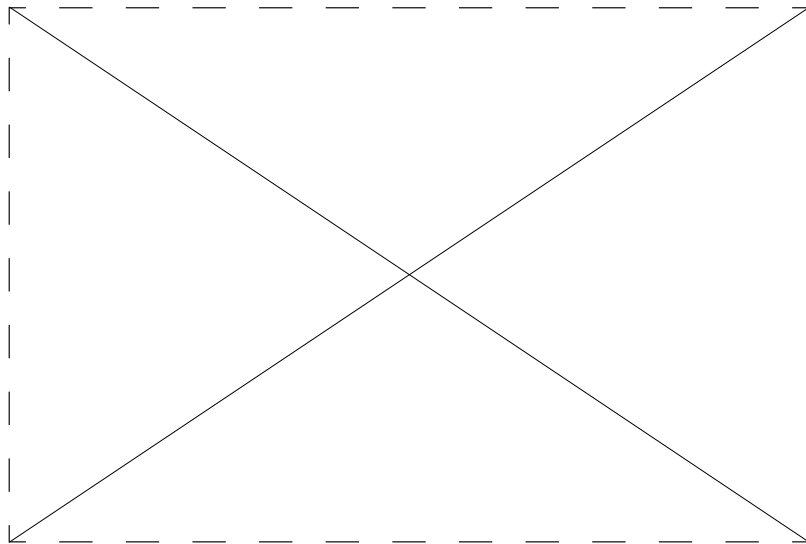
Figure 07. Screenshot of the developed application that creates facade elevations based
on the designs of Palladio (Hersey and Freedman, 1992)

2.2.2   Procedural Pompeii houses

Muller et al. | 2012

This research is an example of how procedural modelling can be used to populate a large area with architecture of a similar design. These roman houses of Pompeii were generated by a modified version of the software called 'CityEngine' developed firstly in 2001 by researchers Parish and Muller. The software takes in various GIS (Geographical Information Systems) data such as population density, land usage, street network and building footprints, and begins to assign types and styles to the buildings that would populate each plot. The software then calls upon the corresponding shape grammar for each type of building, with this being the ruleset that has been manually created and based on archaeological and historic data. The way it has been used in this research is to extrapolate a large scale visualisation of the city despite the lack of information of some portions. This is achieved through the analysis of the surveyed buildings being used to infill the areas where data is missing. Such an approach is something that this thesis will also explore, as creating reconstructions from incomplete data is a common problem within the field of digital architectural heritage.

One of the downsides of this software is the limited detail of the generated architecture. Because CityEngine was designed for large scale visualisations, the detail of the buildings are limited by the computer's hardware, needing to be kept as simple as possible for performance purposes.

In this thesis, the focus is a single building generated by rules extracted from designs of a single typology. The problem of computational power related to number of graphic elements is less of an issue in this work. Also, CityEngine has been developed for a customised purpose. The work in this thesis tackles a broad scope in a non-specific environment. This means it will take more work at the start of the modelling process, but the created procedural system will have more potential to be customized for whatever purpose that is desired
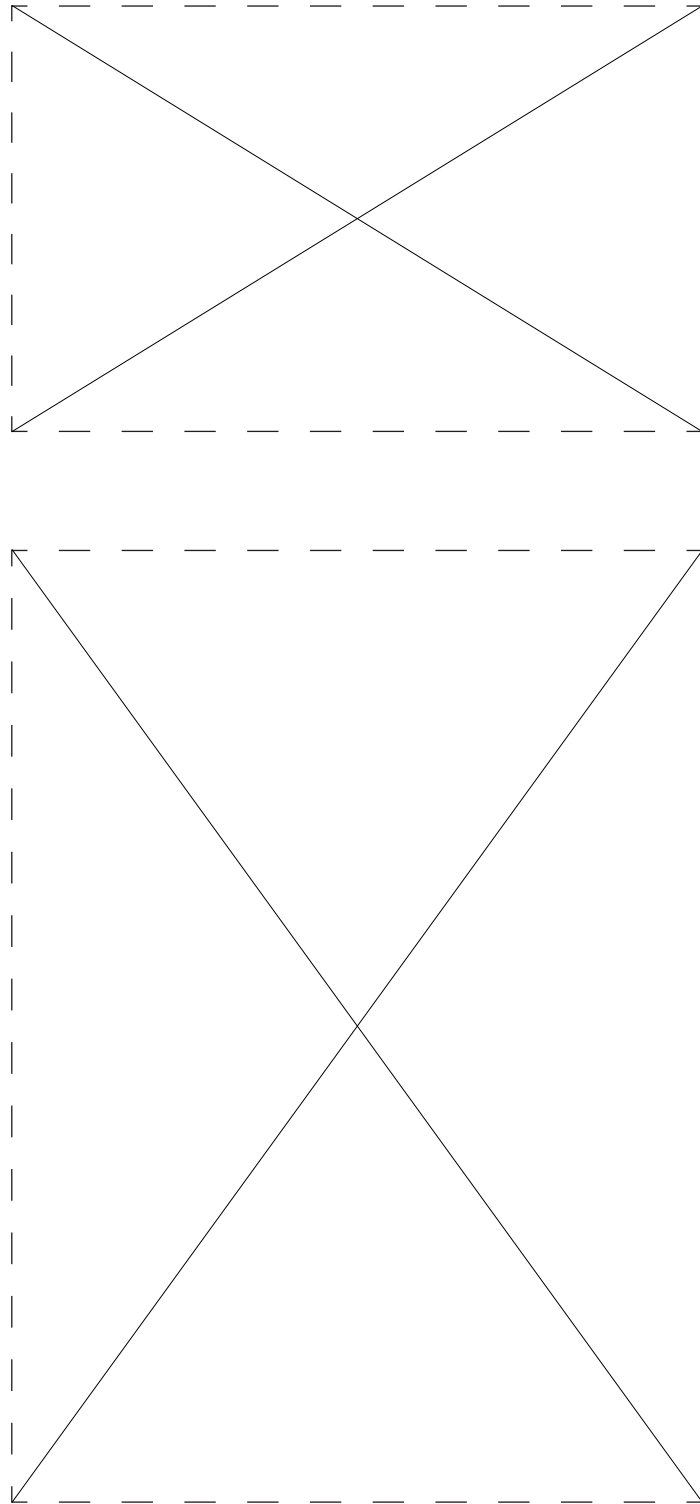
Figure 08. (top) Diaragram showing the portions of the city that were procedurally generated, (bottom) visualisations of the generated houses compared to a speculated illustration (Müller et al., 2012)
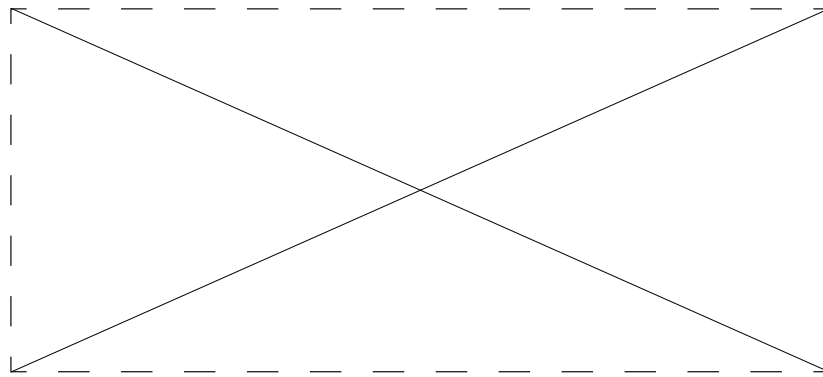
2.2.3 Shape Grammar Neo-Gothic chapels

Bojan Tepavčević, Vesna Stojaković | 2013

This research titled 'Procedural modelling in architecture based on statistical and fuzzy inference', shows how procedural modelling can be used with statistical analysis to form computational rules. Like the previous case study, these reconstructions use 'shape grammar' to generate the geometry. Figure 09 highlights the process of this technique, with it consisting of an iterative process where shapes are added based on where they sit in relation to other shapes. The overarching method employed within Tepavčević and Stojaković's research entails the selection of a group of similar buildings (local Neo-gothic chapels built between 1870 and 1930), the statistical analysis of such buildings, then the application of the findings into a shape grammar ruleset. The analysis phase breaks down the buildings into their constituent components while also keeping track of how many times these components appear in the varying designs. Percentages of the likelihood that any one component will be in a design can be calculated and help form the basis of the shape grammar. The result is a procedure that outputs historically accurate Neo-Gothic chapels very reliably. One of the potential uses that is explored in the research is the ability to speculate the unknown sections of a lost church from known sections, shown in figure 11. From the photo, only the front is shown well enough to be reconstructed. By entering this into the system, the shape grammar can then speculate many different possible reconstructions, all being based on historical data. The shape grammar also calculates the statistically most likely reconstruction, however guaranteeing the accuracy of a lost structure is very difficult.

The main downside to this form of procedural modelling is how much background knowledge of statistics and native coding is needed. As noted earlier, this research will use an alternate means of creating a procedural model. Also notable is that the scope and objectives explored by Tepavčević and Stojaković differ significantly to the proposed ones in this thesis. However, the initial analysis technique, using decomposition of the geometric elements was instructive, and informed the process that is adopted in this research

Figure 09. Diagram showing the iterative process of creating a Neo-Gothic church using shape grammar (Tepavčević & Stojaković, 2013)
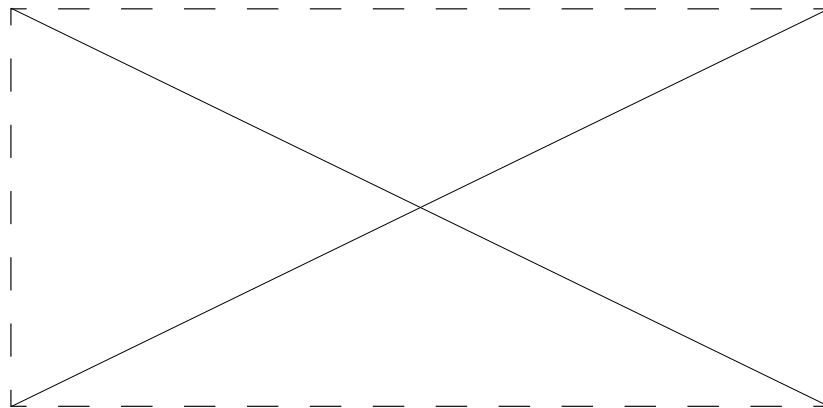
Figure 10. Generated designs based on the statistical analysis of Serbian Neo-Gothic Chapels built around the year 1900 (Tepavčević & Stojaković, 2013)
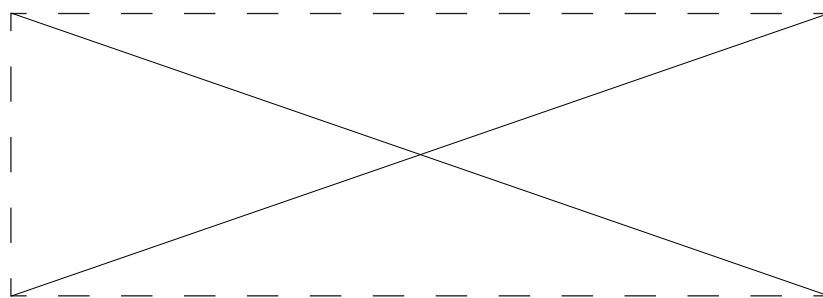
Figure 11. Diagram showing a lost chapel, the multitude of possible reconstructions created by the shape grammar, and the reconstruction that is statistically most likely to be the lost chapel (Tepavčević & Stojaković, 2013)
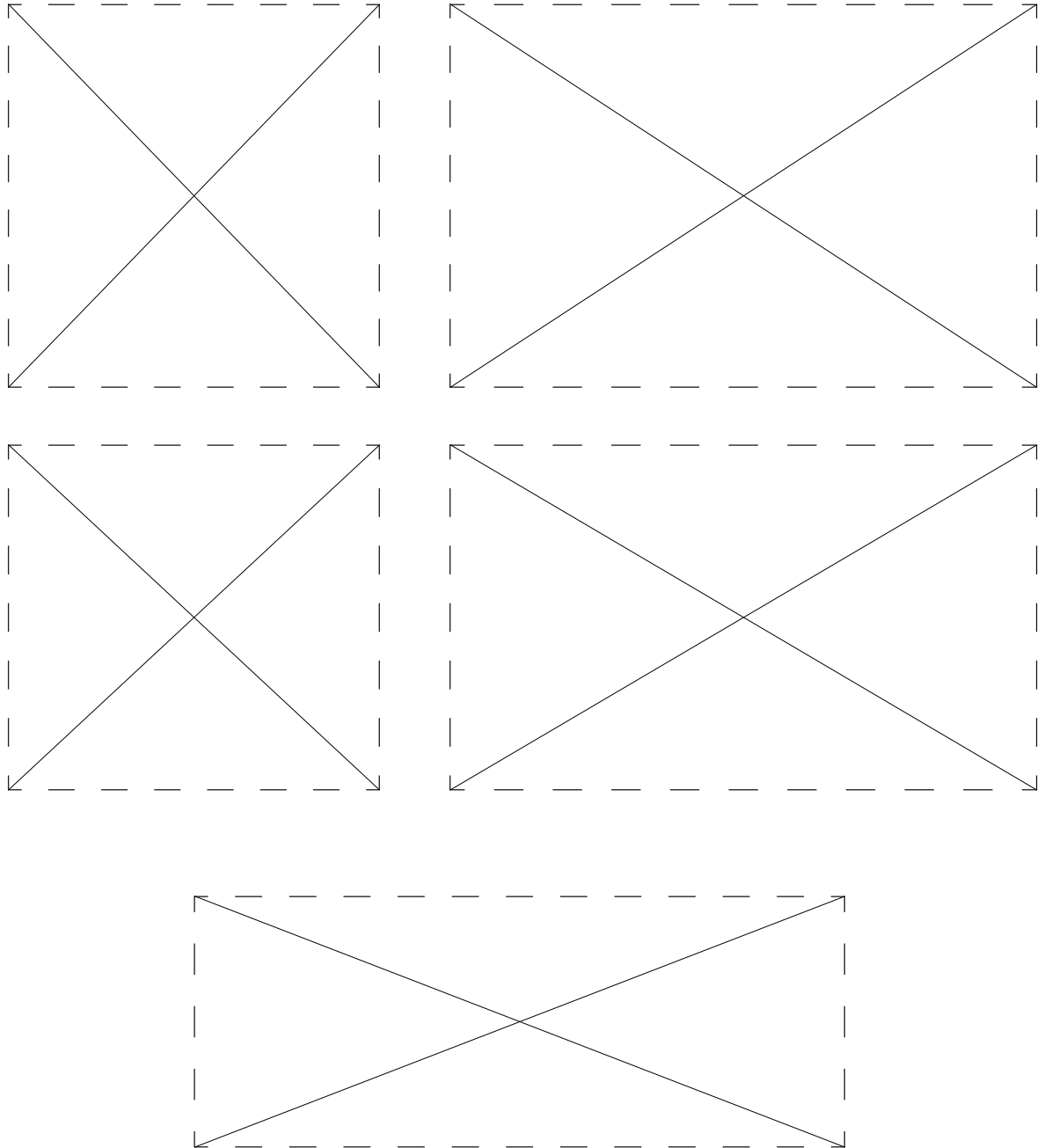
2.2.4   Procedural Second Empire Houses

Madison Kramer | 2019

This research looks at how new procedural modelling software's can be used to create detailed architectural heritage reconstructions. Kramer's research looks at the reconstruction of American second empire houses within the node based software called Houdini. Her process of researching and categorising the buildings into common components and rules is similar to other research discussed in this thesis however the level of detail is much greater. The motive behind her work centres on the ability to reconstruct both existing and lost designs efficiently, as the designs share many common characteristics. Such a function is something that will be explored within this thesis.

The reason behind the high level of detail of Kramers reconstructions is because Houdini is a software that has been designed for use in game and movie visual effects, and so has access to very high quality rendering capabilities. This detail is also an aspect that will be carried through into the work of this thesis.

Kramer's research however is not fully procedural like the other examples. Although the model uses procedural systems, new designs are created by adjusting parameters by hand. For it to be completely procedural, this process would need to be automated according to higher-level rules. A methodology for how to extract these higher level rules will be explored in the later section of this thesis

*Figure 12. Kramer's procedurally generated American Second Empire houses
(Kramer, 2019)*

2.3 Software - Houdini

This thesis will build on upon the reconstruction methods discussed in section 2.2. The latest procedural modelling software of Houdini will be used in this research, as from the case studies it was clear than the high level of visual fidelity was much further developed to that of other reconstruction case studies. The 'node-based' user interface was also a key reason why this software was chosen, as it requires no previous coding experience to use proficiently.

To give insight into what the practicalities of this research consisted of, a brief exploration of the software itself is needed. Houdini is a node based modelling software that focuses on the procedural generation of everything from particles, shader algorithms, animation and more importantly for this research, geometry.

'Node based' refers to how the user interface and workflow of the software has been designed, with these nodes being a form of visual programming. These nodes replace the standard coding interface with a selection of premade functions that would require many lines of code to replicate. These nodes also allow the user to adjust the function at any point within the parameters tab, highlighted in yellow in figure 14. The network editor (highlighted in red) is where the nodes are created and stringed together to create the procedural system. Whatever node is selected in this editor is what's available to be adjusted in the parameters tab. The output of the selected node can be seen in the Scene view.
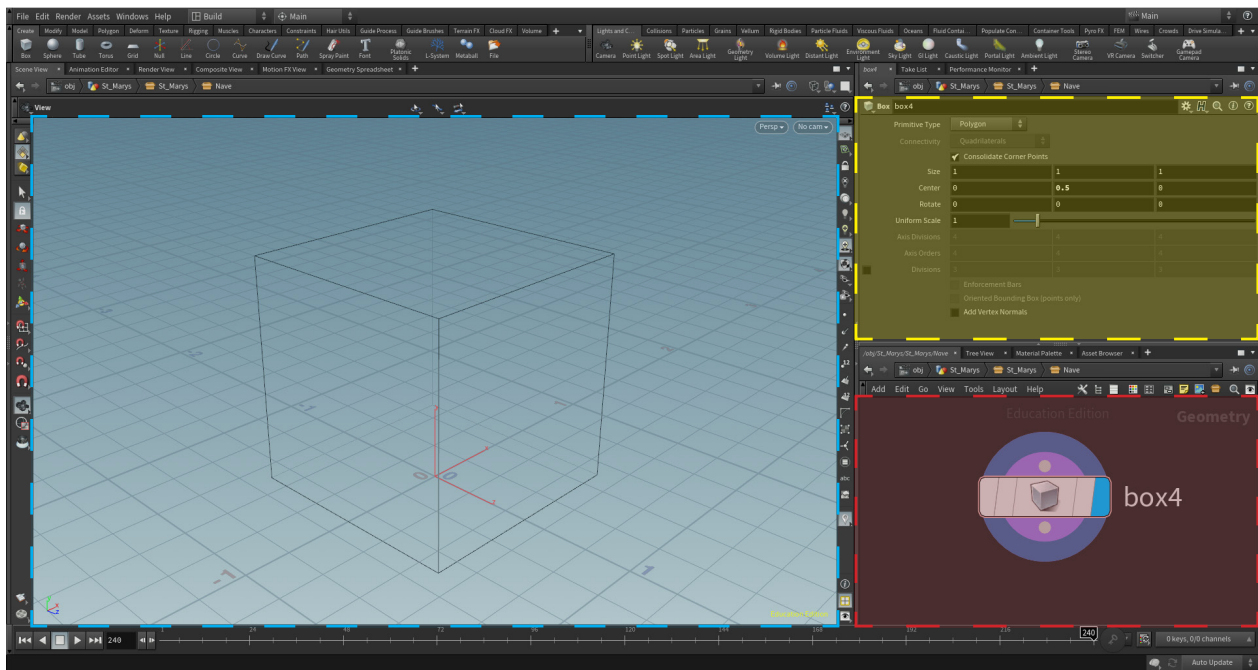
- Scene view

- Network editor

- Parameters tab

Figure 14. Diagram breaking down the Houdini user interface (authors image)

3. Historic Background

3.0 Timber Gothic

To understand how the Timber churches of Wellington were created and designed, an understanding of both the countries of Britain and New Zealand in the 19th century must be established. Looking at figure 15, two buildings from the middle of the 19th century can be seen, the top being built in Britain and the other being built in Wellington by the Anglican Church. Despite both examples being built at roughly the same time and in the Gothic style, these two designs are radically different.

Although the scale and function of these buildings would logically dictate them to be very different, the choice of materials and geometric motifs are also very different. This clearly shows the divergence of a specific style of Gothic buildings that developed to suite the conditions of New Zealand.
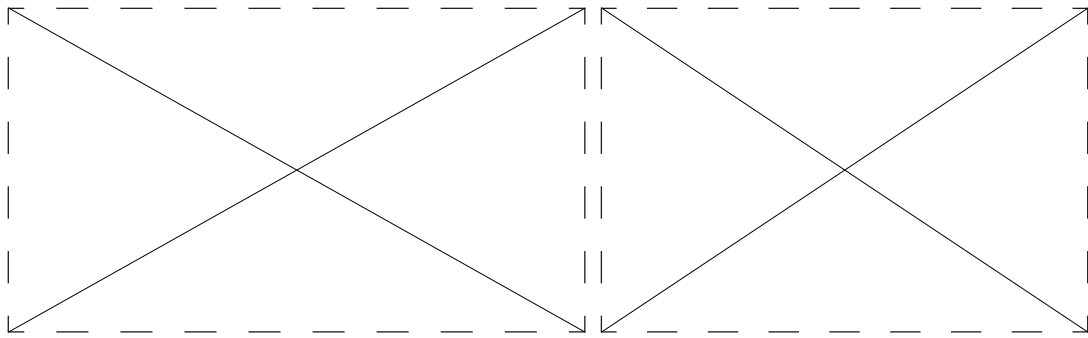
The Palace of Westminster, 1840-76
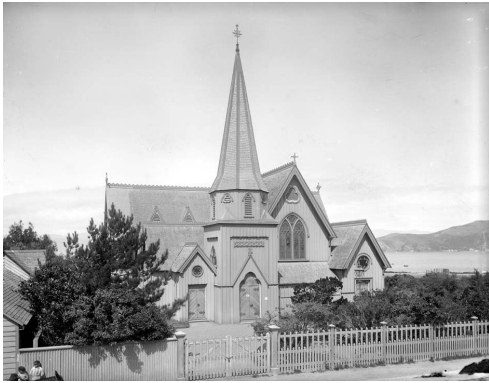
Old St Paul's, 1866

Figure 15. Photos comparing two Gothic designs that were built at around the same time in Britain (top) and New Zealand (bottom)

("Palace of Westminster," 2019) (Palace of Westminster interior, 2019)(Ref: 1/1-025547-G. Alexander Turnbull Library) (Tuten, 2011)

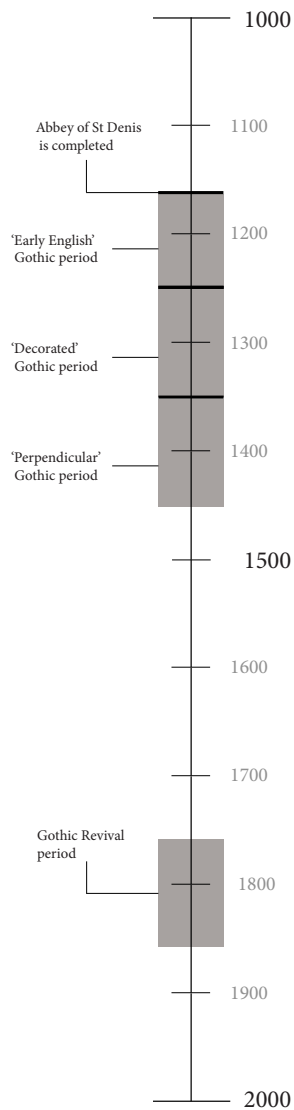The origins of the Gothic style is a topic of high debate, however it is generally agreed that the abbey of St Denis in France is one of the first examples where all of the defining characteristics of the Gothic style are seen in one holistic design. The style gained popularity across Europe, making its way to Britain at around the end of the 12th Century. The resulting English designs took great influence from French precedent, and marks the start of what is known as the 'Early English' period of Gothic design within the country. Over time Cathedrals and chapels grew more complex in their design as tastes changed and workers became more skilled. Gothic design remained the dominant style in Britain until Renaissance architecture began to spread across Europe in the 16th Century. During this span of ~400 years, the style developed from 'Early English', to the more ornamented 'Decorated', and finally to the 'Perpendicular' or 'Rectilinear' Gothic, which saw the highest level of ornamentation. After the Renaissance these styles then saw a resurgence in Britain during the 19th century. Britain's empire at that time was expanding vastly, and due to Gothic being the style of choice, Gothic structures were built across the globe in colonies such as those found in New Zealand. Due to the limited resources of these new territories however, some of these structures were built of timber rather than stone. This caused conflict amongst religious scholars, as the departure from using stone saw designs that were substantially different to the well-established British Gothic Styles they were attempting to replicate.

Figure 16. Timeline showing the development of the Gothic style in Britain
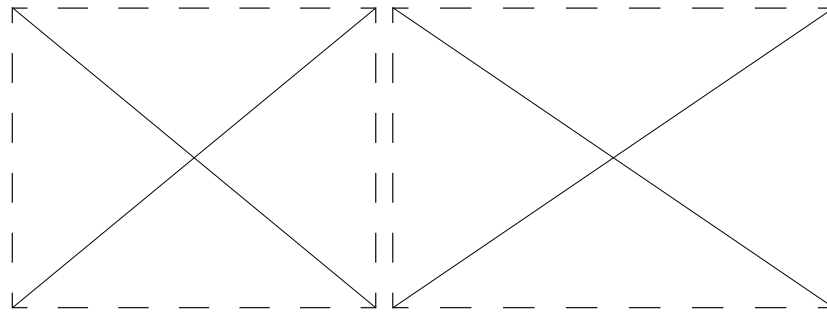
Salisbury Cathedral, 1220-1320
'Early English' Gothic
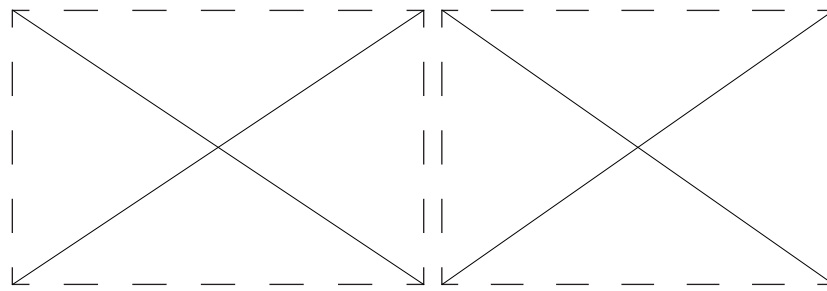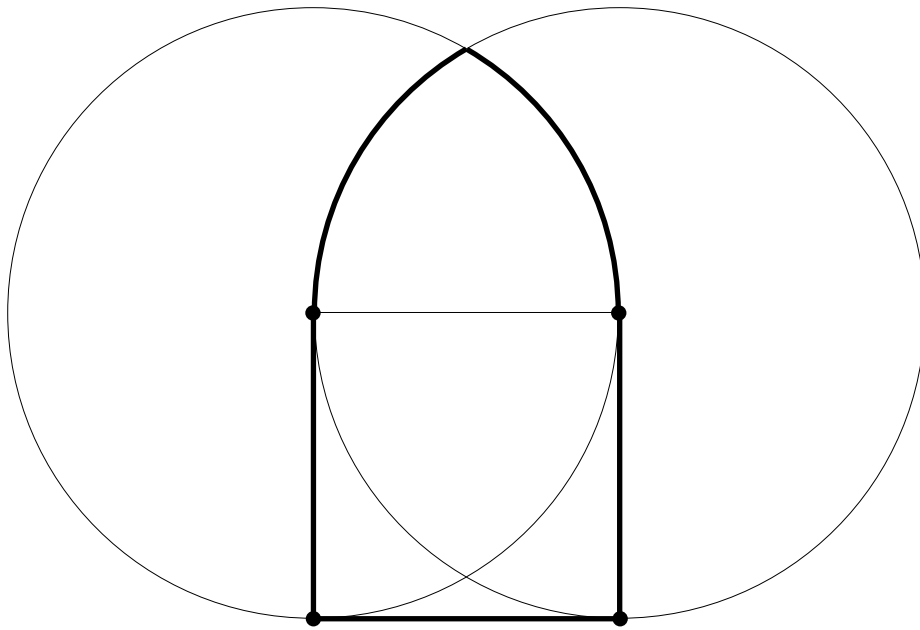
Henry VII Chapel, Westminster Abbey, 1509
'Perpendicular' Gothic
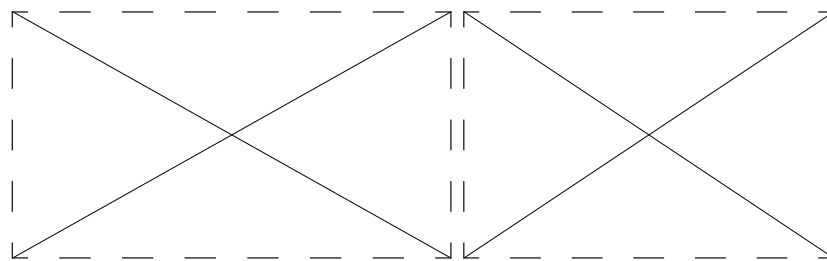
The Palace of Westminster, 1840-76
Gothic Revival

Figure 17. Examples of some of the different styles of British Gothic Architecture

*("Salisbury Cathedral," 2019) (barnyz, 2007) (Henry VII Chapel, Westminster Abbey, n.d.) (Encircle
Photos, n.d.) ("Palace of Westminster," 2020) (Palace of Westminster interior, 2020)*

Figure 18. Geometric definition of the Gothic Pointed arch

One of the key characteristics of the Gothic style is the use of the pointed arch (figure 18). The reason for this is because of how the shape performs structurally. When compared to traditional semi-circular arches as found in the prevailing Roman inspired architecture, they allow the weight of the spanning members to fall more downwards and less outwards. This means less supporting structure such as buttresses and thicker walls are needed to support the weight of the roof, allowing designs to be taller and more slender to let more light in. But this is only true when using stone or concrete as a building material. In a material such as timber where sizes of members are limited by the size of the tree, replicating the structure exactly would be extremely impractical. This is why Gothic designs built of timber are so different to from those of stone, because their structure dictates it (figure. 19). These differences caused English religious scholars to initially reject such timber structures, stating in the article "Wooden Churches' that was published in the Journal 'The Ecclesiologist' in 1845, "We do not think these churches are in any respects good models of construction." (Turner, 2014)

"We do not think these churches are in any respects good models of construction"

From the article 'Wooden Churches' published in 'The Ecclesiologist' in 1845
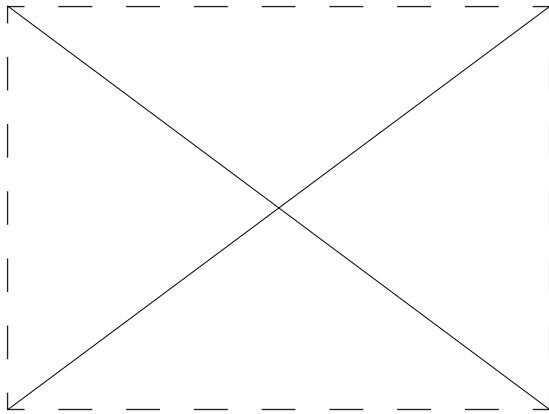
St John's College Chapel, 1847
Auckland, New Zealand
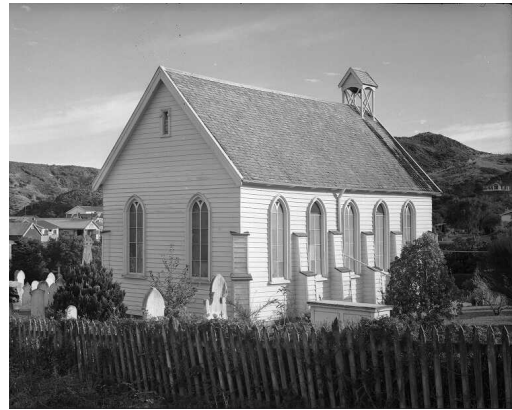
Christ Church, 1836
Russell, New Zealand
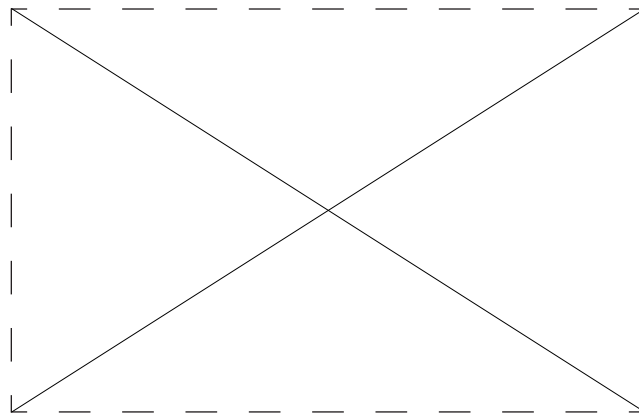
St Luke's Episcopal Church, 1854
United States

Figure 19. Examples of colonial Gothic churches that were built of timber

(Bremner, 2012) (Ref: 1/2-008800-F. Alexander Turnbull Library) (St. Luke's Episcopal Church, 2019)

This distain for timber churches aligns with the architectural rhetoric that was popular at the time of the gothic Revival. One of John Ruskin's 'Seven lamps of Architecture' was Truth, referring to the honesty of the material and its use. He states as an example "if the intermediate shell were made of wood instead of stone, and whitewashed to look like the rest,—this would, of course, be direct deceit, and altogether unpardonable".

But this rejection of timber did little to stop settlers from building with it, and only fuelled the differences between Gothic churches built of stone to that of timber. Perhaps realising the lack of choice some settlers had, in 1848 the paper "On Wooden Churches" was published in the same journal. This paper venerated the material for church construction and justified that "The very first Spiritual Church was the ark, made of 'gopher wood'" (Turner, 2014). The article also goes on to give guidelines and precedents for the construction of timber churches, however in practice these guides were not followed to any significant degree

"The very first Spiritual Church was the ark, made of 'gopher wood'"

From the article 'On Wooden Churches' published in 'The Ecclesiologist' in 1848
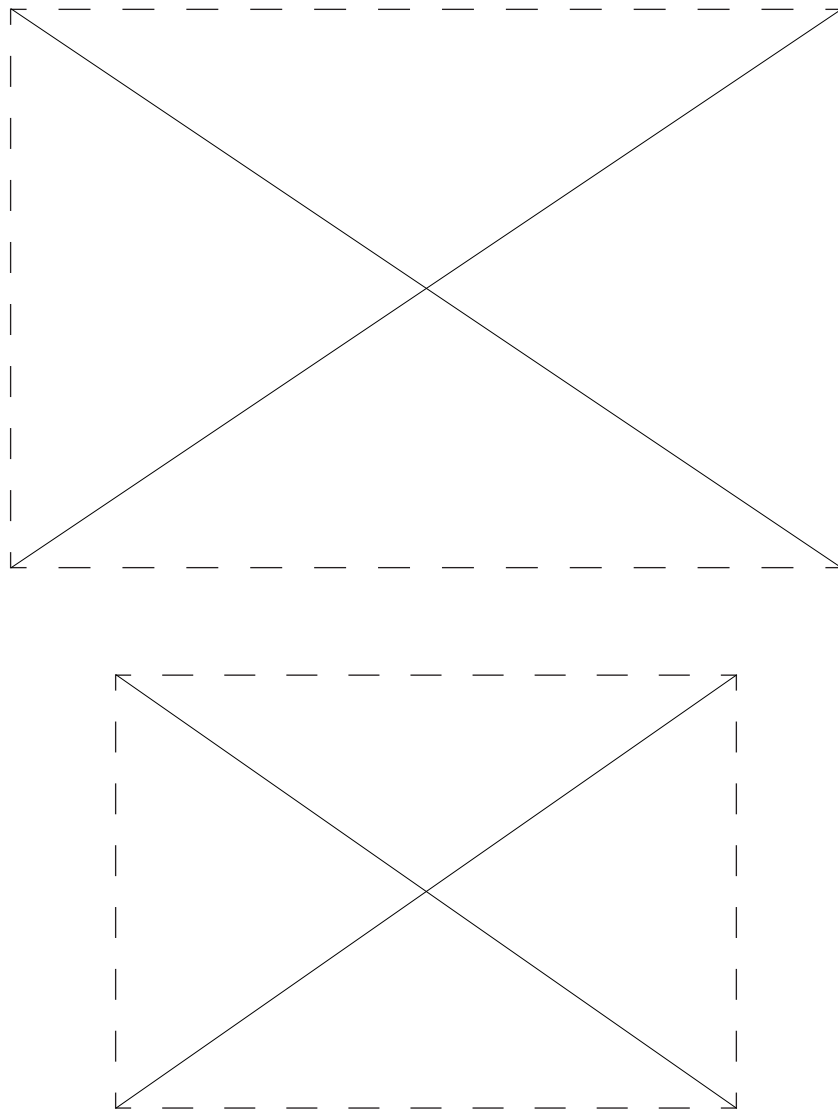
Figure 20. Illustrations of the churches described as being of good precedent, from the 1848 article 'Wooden Churches' (Turner, 2014)

3.1 Wellington Churches

3.1.1 1840 - 1865

In 1840 the Aurora lands in Wellington, bringing settlers from Britain to the newly established colony. In these early years, negotiations with the occupying Maori people for their land kept the development of the settlement at bay until 1844 (The Making of Wellington, 1800-1914, 1990). After this, many small scale churches were built, with the dominant style being Gothic. No good quality stone could be sourced in the area, so local timbers such as Totara, Kauri and Rimu were used. The denomination of these early churches were predominantly Anglican, however Roman Catholic, Wesleyan and Presbyterian churches were also established

The common characteristics of these early churches include their simple central Nave design that is typically extended upon as the congregation grew, high roof pitches, and pointed arch windows. Their typical cladding consists of either rusticated or overlapping horizontal weatherboards on the walls, with the roof being wooden shingles. Very little of these original churches still stand as they were mostly replaced by bigger churches in later years.

Original St Mary's

1851

The first St Paul's

1844

Old St John's

1854

Old St Peter's

1848
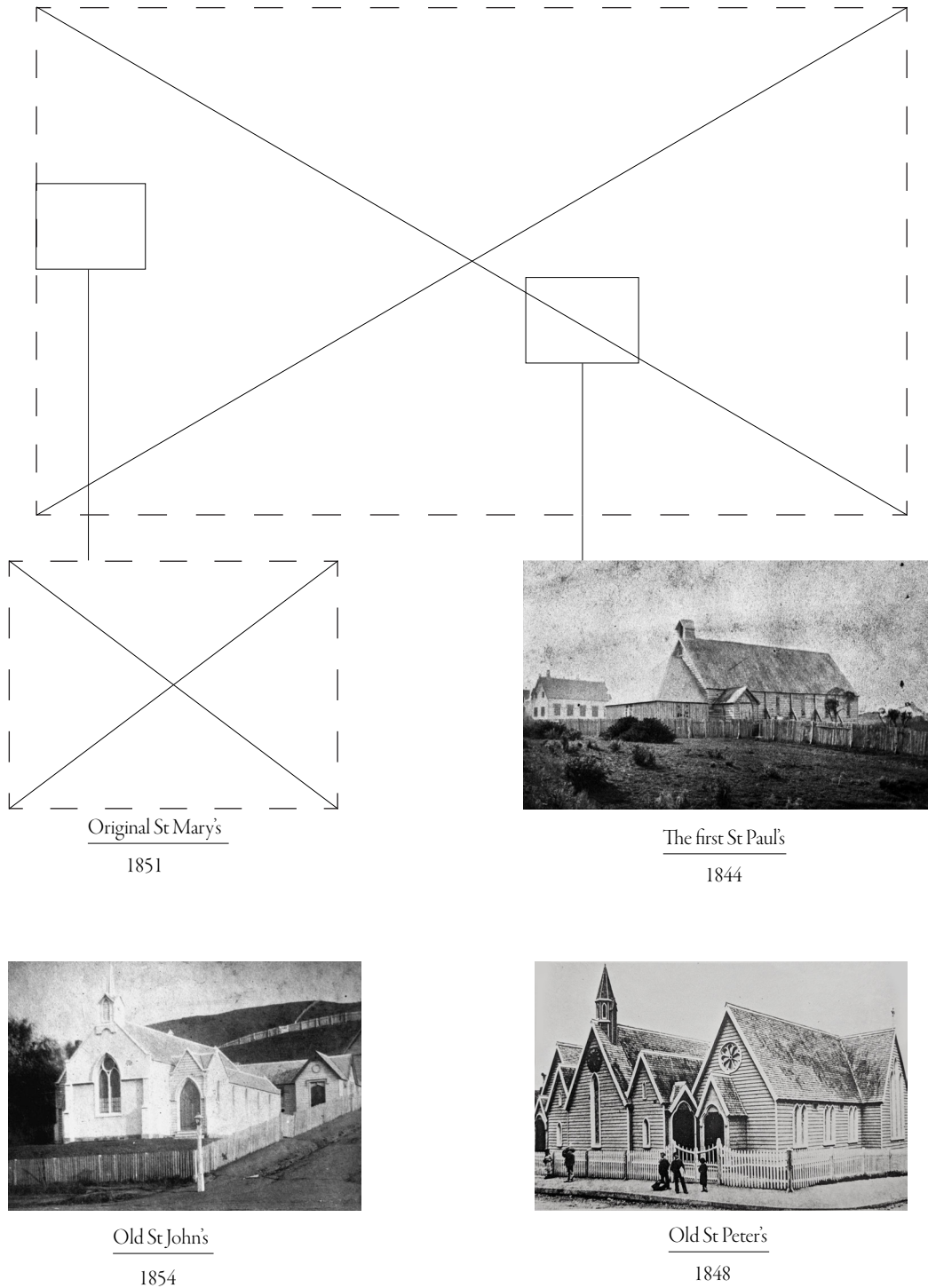
Figure 21. A range of some of the first churches built in Wellington

(Mew & Humphris, 2014) (1/4-009967-F. Alexander Turnbull Library) (Ref: PAColl-6114-02. Alexander Turnbull Library)(1/2-003790-F. Alexander Turnbull Library)

3.1.2   1865 - 1900

In 1865 the capital city of New Zealand was changed from Auckland to Wellington, bringing with it more money and more people to the region. Stone was still unable to be sourced in the area, and so timber remained the material of choice. The growing skill of both designers and carpenters within the settlement allowed designs to be larger and more ornate than the churches of previous years. The dominant style also remained Gothic, however some congregations such as the Presbyterians of St Andrew's bucked this trend, deciding upon a Romanesque design.

The characteristics of these timber churches from this time vary between each design, as many different architects and denominations created their own interpretations of a Gothic church. Multiple different trends began to develop during this time however, with common aspects such as the use of buttresses, larger and more ornate stained windows, and tall towers being seen throughout. Typical claddings remained horizontal weatherboards, however vertical board and batten cladding appear in some designs.

St Peter's

1879

Old St Paul's

1866
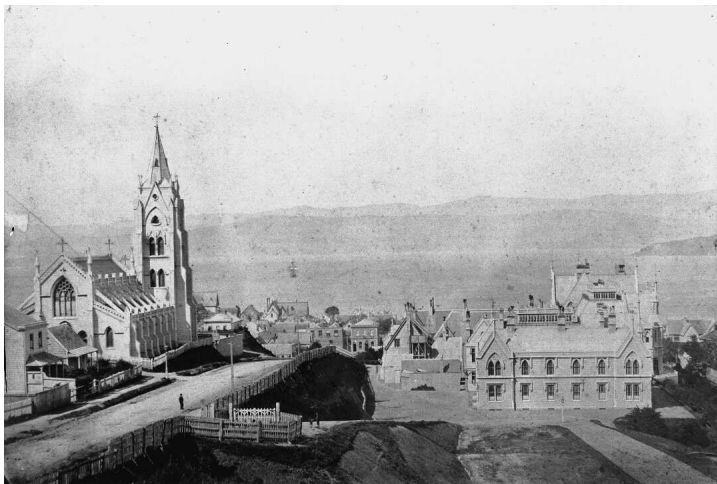
St Mary's Cathedral

1867
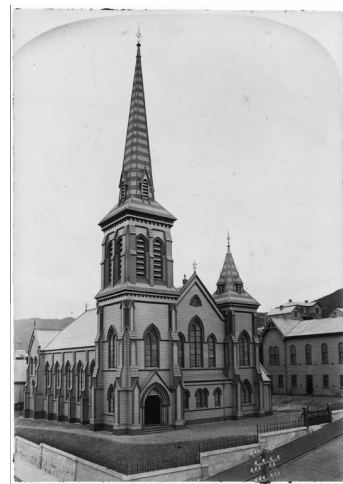
St John's

1885

Figure 22. A range of some of the larger timber churches built during the late 19th Century in Wellington

(Ref: 1/1-019972-G. Alexander Turnbull Library) (Ref: 1/1-025547-G. Alexander Turnbull Library)
(Ref: 1/2-021261-F Alexander Turnbull Library) (Ref: 1/2-036459-F Alexander Turnbull Library)

3.1.3   1900 - 1939

At the turn of the 20th century cement and concrete was beginning to be produced in the north island, prompting its use for new construction. This is reflected in the churches built in Wellington during this time, as concrete and bricks have been used to create some of the city's most iconic landmarks. These designs followed very closely to what was developed during the 19th century, with Gothic and classically inspired churches being most prominent

The designs from this time also vary greatly as the new material prompted many new possibilities. The layout of these structures however remain true to the designs seen in the 19th century. Much like that seen in section 3.1.2, these traditional church layouts typically consist of a central nave flanked by aisles and a either 1 or 2 towers.
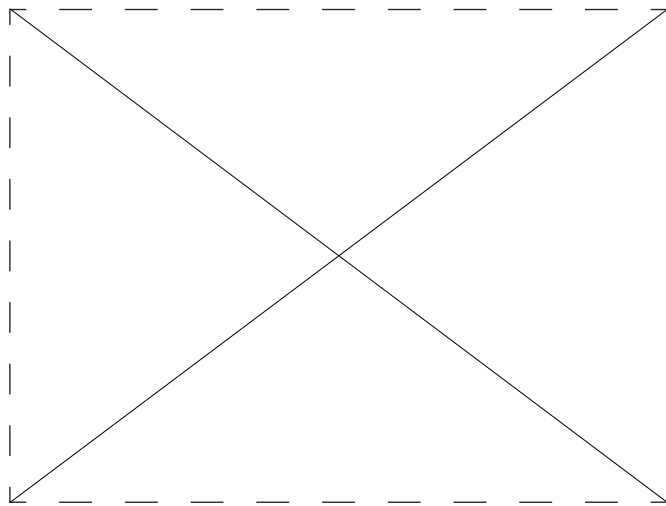
St Gerard's Church and Monastery

1908
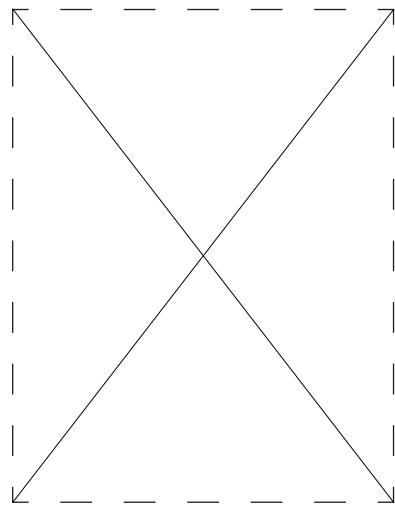
St Mary of the Angels

1922
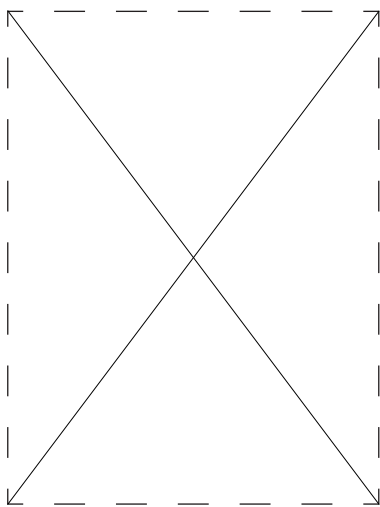
St Andrew's

1922
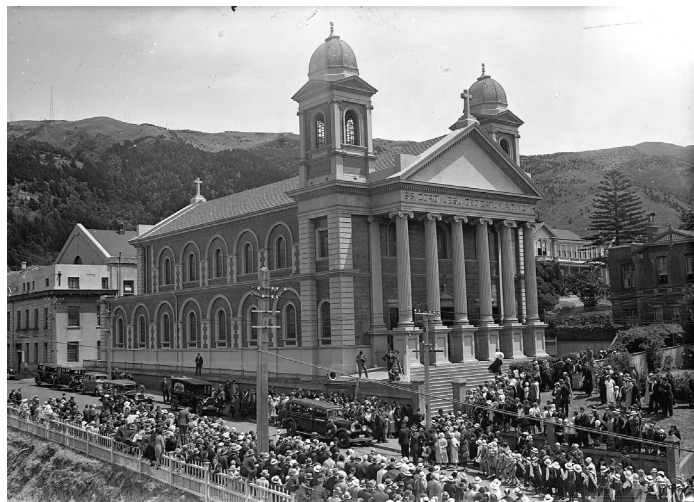
Sacred Heart Cathedral (Replaced St Mary's)

1901

Figure 23. Some of the churches built in Wellington after the turn of the Century

("St Gerard's Church and Monastery," 2019) (Ref: DW-4412-F Alexander Turnbull Library) (St Andrew's on the Terrace, n.d.) (Ref: 1/2-047641-G, Alexander Turnbull Library)

3.1.4   1939 - Onwards

After World War II, the amount of new churches being built in Wellington were very little. However, Wellington's largest church (St Paul's) was being constructed during this time, taking 61 years to complete. Although WWII held back construction, difficultly in deciding what the style of the church would be caused much delay. This aspect is also reflected in other churches built during this time period, as choices of materials and style saw a departure from tradition in favour of creating new and modern designs

Yet again the characteristics of the churches built in this time period vary greatly, however some trends do appear. Almost all of them have been designed using basic geometries such as tringles, squares and circles, a common trait of contemporary modernist design. Towers appear much less in these designs and greater focus is put on the Nave space, which has also departed from the traditional rectangular shape to more experimental forms as seen in the Futuna Chapel

St Paul's Cathedral

1937-1998

St Mark's Church

1963

Futuna Chapel

1961

St Joseph's

2005

Figure 24. A selection of the churches built after world war II

(Wellington Cathedral of St Paul, 2019) (Ref: DW-1722-F Alexander Turnbull Library) (Futuna Chapel, 2020) (St Joseph's Church | Studio Pacific Architecture, 2019)

Timber Gothic Period

Kent Terrace Presbytarian
Architect: Thomas Turnbull
Construction: Timber
Builder: Clark and Thomas
Capacity: 520

Ward Memorial Methodist Church
Architect: William Fielding
Construction: Brick

Timber St James', Lower Hutt
Architect: ???
Construction: Timber
Builder: ???
Capacity: ~300

Second Wesleyan Church
Architect: Robert Stokes
Construction: Timber
Builder: ???
Capacity: 130

Holy Trinity Church
Architect: George Kilsby
Construction: Timber
Builder: George Kilsby
Capacity: ~100

St David's Petone
Architect: ???
Construction: Timber
Builder: ???
Capacity: ~300

St Thomas'
Architect: Clere, Fitzgerald and Richmond
Construction: Timber
Builder: E. Gray
Capacity: 350

St Michael's Kelburn
Architect: ???
Construction: Brick, Timber

Original St Mary's Cathedral
Architect: Thomas Fitzgerald
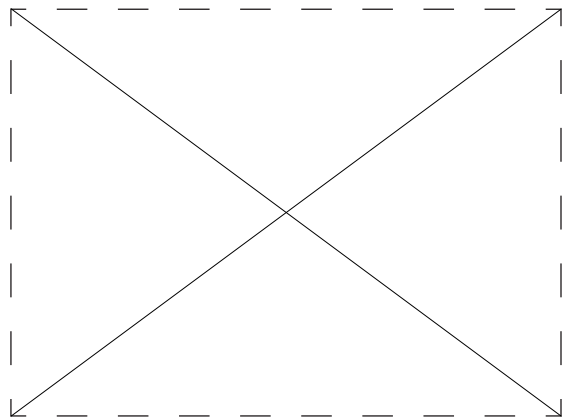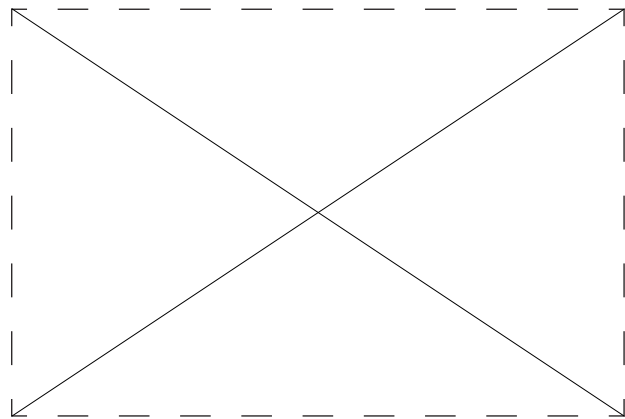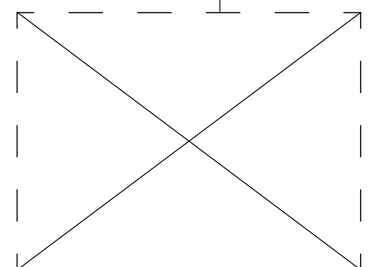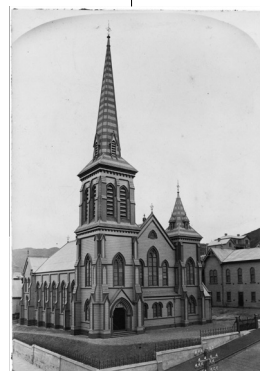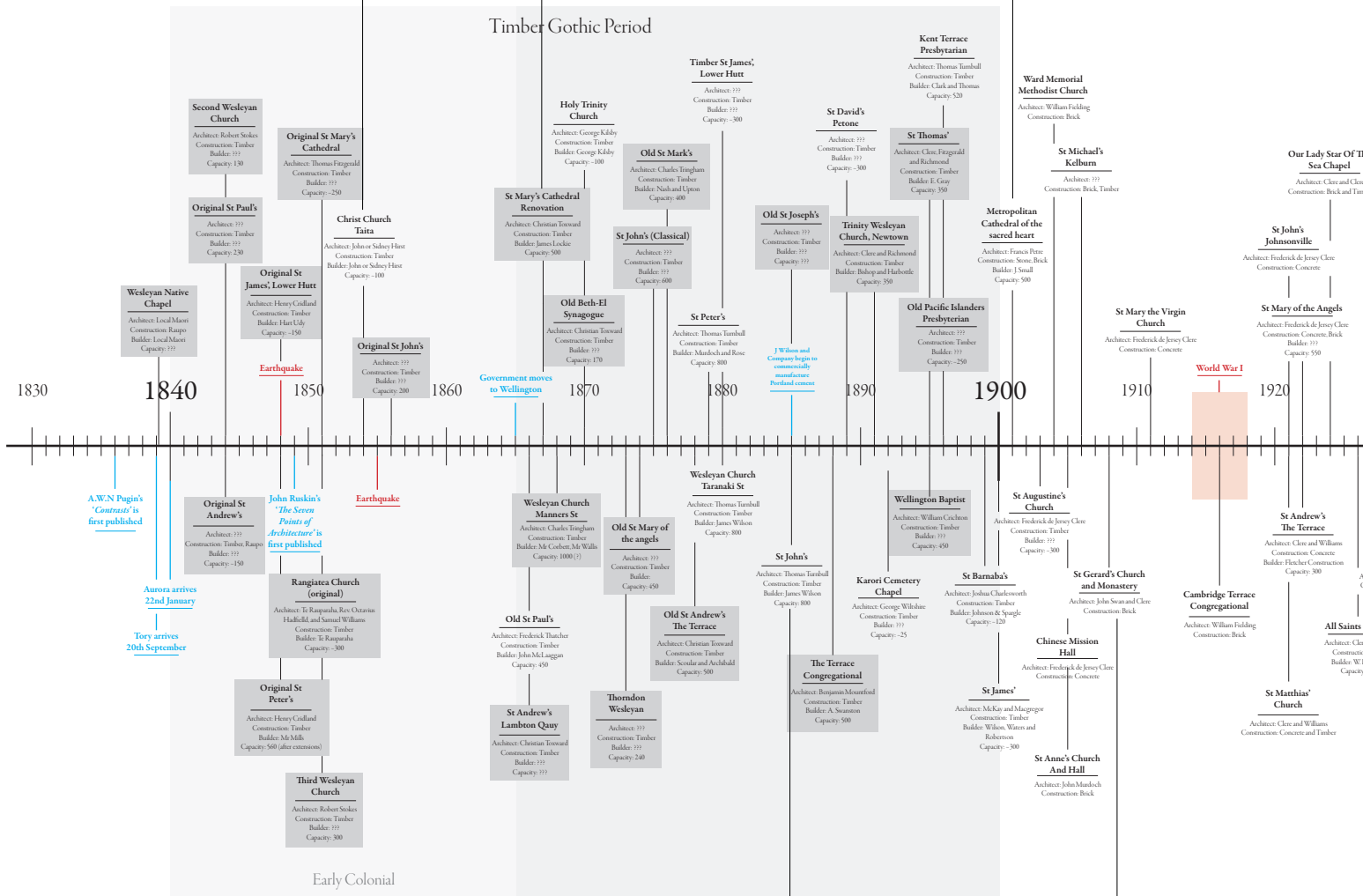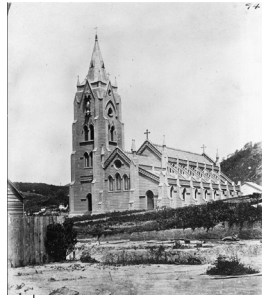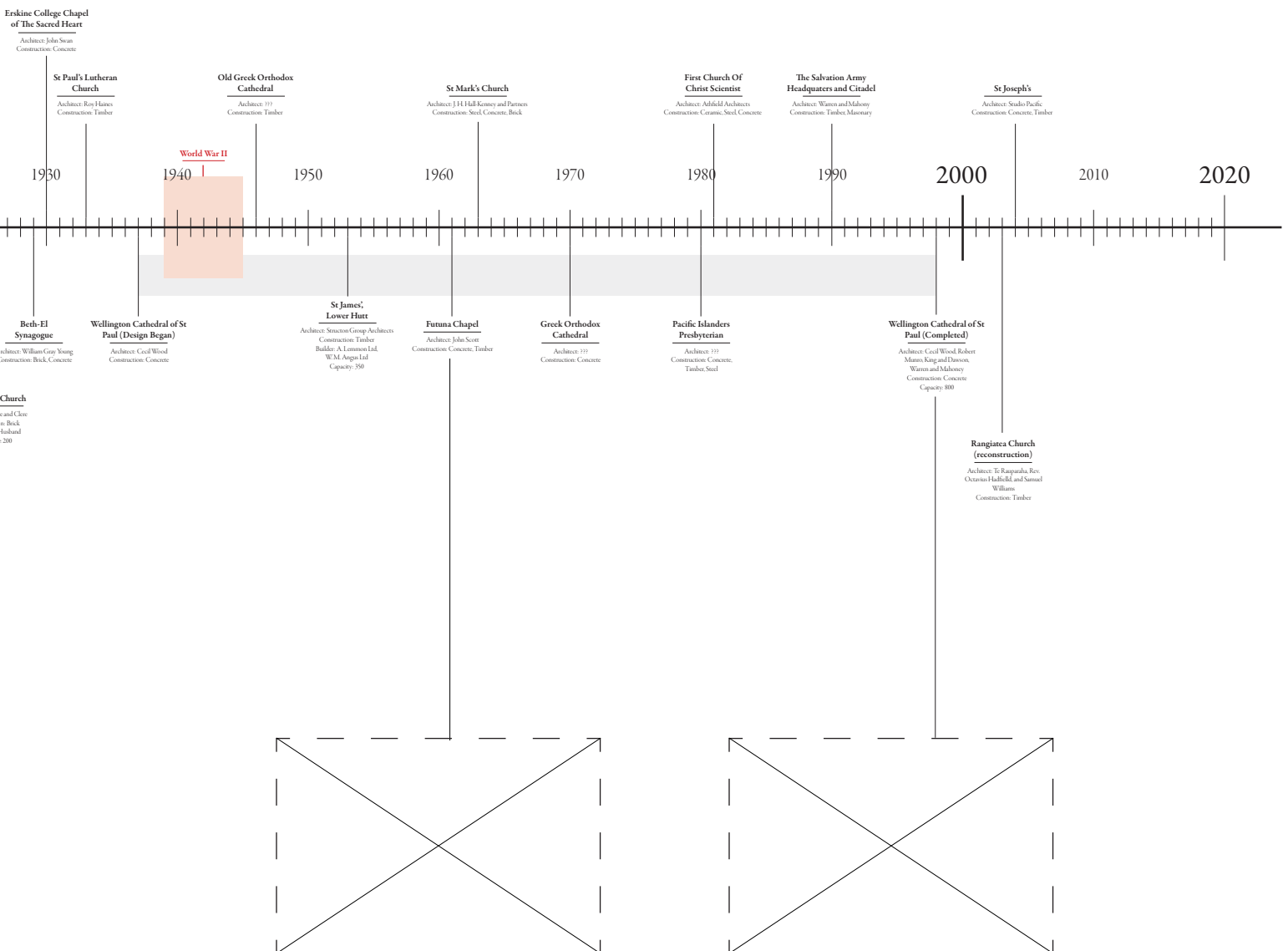Construction: Timber
Builder: ???
Capacity: ~250

Original St Paul's
Architect: ???
Construction: Timber
Builder: ???
Capacity: 230

St Mary's Cathedral Renovation
Architect: Christian Toxward
Construction: Timber
Builder: James Leckie
Capacity: 500

Old St Mark's
Architect: Charles Tringham
Construction: Timber
Builder: Nash and Upton
Capacity: 400

Old St Joseph's
Architect: ???
Construction: Timber
Builder: ???
Capacity: ???

Trinity Wesleyan Church, Newtown
Architect: Clere and Richmond
Construction: Timber
Builder: Bishop and Harbottle
Capacity: 350

Metropolitan Cathedral of the sacred heart
Architect: Francis Petre
Construction: Stone, Brick
Builder: J. Small
Capacity: 500

Our Lady Star Of The Sea Chapel
Architect: Clere and Clere
Construction: Brick and Tim

Christ Church Taita
Architect: John or Sidney Hirst
Construction: Timber
Builder: John or Sidney Hirst
Capacity: ~100

St John's (Classical)
Architect: ???
Construction: Timber
Builder: ???
Capacity: 600

St Peter's
Architect: Thomas Turnbull
Construction: Timber
Builder: Murdoch and Rose
Capacity: 800

Old Pacific Islanders Presbyterian
Architect: ???
Construction: Timber
Builder: ???
Capacity: ~250

St John's Johnsonville
Architect: Frederick de Jersey Clere
Construction: Concrete

Original St James', Lower Hutt
Architect: Henry Cridland
Construction: Timber
Builder: Hart Udy
Capacity: ~150

Old Beth-El Synagogue
Architect: Christian Toxward
Construction: Timber
Builder: ???
Capacity: 170

St Mary the Virgin Church
Architect: Frederick de Jersey Clere
Construction: Concrete

St Mary of the Angels
Architect: Frederick de Jersey Clere
Construction: Concrete, Brick
Builder: ???
Capacity: 550

Wesleyan Native Chapel
Architect: Local Maori
Construction: Raupo
Builder: Local Maori
Capacity: ???

Original St John's
Architect: ???
Construction: Timber
Builder: ???
Capacity: 200

J Wilson and Company begin to commercially manufacture Portland cement

1830   **1840**   1850   1860   Government moves to Wellington   1870   1880   1890   **1900**   1910   World War I   1920

A.W.N Pugin's "Contrasts" is first published

Original St Andrew's
Architect: ???
Construction: Timber, Raupo
Builder: ???
Capacity: ~150

John Ruskin's "The Seven Points of Architecture" is first published

Earthquake

Wesleyan Church Manners St
Architect: Charles Tringham
Construction: Timber
Builder: Mr Corbett, Mr Wallis
Capacity: 1000 (?)

Wesleyan Church Taranaki St
Architect: Thomas Turnbull
Construction: Timber
Builder: James Wilson
Capacity: 800

Wellington Baptist
Architect: William Crichton
Construction: Timber
Builder: ???
Capacity: 450

St Augustine's Church
Architect: Frederick de Jersey Clere
Construction: Timber
Builder: ???
Capacity: ~300

St Andrew's The Terrace
Architect: Clere and Williams
Construction: Concrete
Capacity: 300

Aurora arrives 22nd January

Tory arrives 20th September

Rangiatea Church (original)
Architect: Te Rauparaha, Rev Octavius Hadfield, and Samuel Williams
Construction: Timber
Builder: Te Rauparaha
Capacity: ~300

Old St Mary of the angels
Architect: ???
Construction: Timber
Builder: ???
Capacity: 450

St John's
Architect: Thomas Turnbull
Construction: Timber
Builder: James Wilson
Capacity: 800

Karori Cemetery Chapel
Architect: George Wiltshire
Construction: Timber
Builder: ???
Capacity: ~25

St Barnaba's
Architect: Joshua Charlesworth
Construction: Timber
Builder: Johnson & Spargle
Capacity: ~120

St Gerard's Church and Monastery
Architect: John Swan and Clere
Construction: Brick

Cambridge Terrace Congregational
Architect: William Fielding
Construction: Brick

All Saints
Architect: Clere
Construction:
Builder: W.
Capacity:

Original St Peter's
Architect: Henry Cridland
Construction: Timber
Builder: Mr Mills
Capacity: 560 (after extensions)

Old St Paul's
Architect: Frederick Thatcher
Construction: Timber
Builder: John McLaggan
Capacity: 450

Old St Andrew's The Terrace
Architect: Christian Toxward
Construction: Timber
Builder: Scoular and Archibald
Capacity: 500

The Terrace Congregational
Architect: Benjamin Mountford
Construction: Timber
Builder: A. Swanston
Capacity: 500

Chinese Mission Hall
Architect: Frederick de Jersey Clere
Construction: Concrete

St James'
Architect: McKay and Macgregor
Construction: Timber
Builder: Wilson, Waters and Robertson
Capacity: ~300

St Anne's Church And Hall
Architect: John Murdoch
Construction: Brick

St Matthias' Church
Architect: Clere and Williams
Construction: Concrete and Timb

Original St Andrew's
Architect: ???
Construction: Timber, Raupo
Builder: ???
Capacity: ~150

Third Wesleyan Church
Architect: Robert Stokes
Construction: Timber
Builder: ???
Capacity: 300

St Andrew's Lambton Quay
Architect: Christian Toxward
Construction: Timber
Builder: ???
Capacity: ???

Thorndon Wesleyan
Architect: ???
Construction: Timber
Builder: ???
Capacity: 240

Early Colonial

3.2 Timeline

This timeline plots all of the churches between 1840 to present that have been researched for this thesis. This is by no means comprehensive, but it does provide a detailed overview of the development of the churches of Wellington. The information found in this timeline started as a reinterpretation of the research found in Charles Fearnley's 'Early Wellington Churches', and was then progressively added to (Fearnly, 1977). Observing the timeline it can be seen how the events such as the Government moving to Wellington, concrete being produced in the north island, and the world wars have had an impact on both the amount and design of the city's unique churches.

Erskine College Chapel of The Sacred Heart
Architect: John Swan
Construction: Concrete

St Paul's Lutheran Church
Architect: Roy Haines
Construction: Timber

Old Greek Orthodox Cathedral
Architect: ???
Construction: Timber

St Mark's Church
Architect: J. H. Hall-Kenney and Partners
Construction: Steel, Concrete, Brick

First Church Of Christ Scientist
Architect: Ashfield Architects
Construction: Ceramic, Steel, Concrete

The Salvation Army Headquaters and Citadel
Architect: Warren and Mahony
Construction: Timber, Masonary

St Joseph's
Architect: Studio Pacific
Construction: Concrete, Timber

World War II

1930   1940   1950   1960   1970   1980   1990   **2000**   2010   **2020**

Beth-El Synagogue
Architect: William Gray Young
Construction: Brick, Concrete

Wellington Cathedral of St Paul (Design Began)
Architect: Cecil Wood
Construction: Concrete

St James', Lower Hutt
Architect: Structon Group Architects
Construction: Timber
Builder: A. Lemmon Ltd
W.M Angus Ltd
Capacity: 350

Futuna Chapel
Architect: John Scott
Construction: Concrete, Timber

Greek Orthodox Cathedral
Architect: ???
Construction: Concrete

Pacific Islanders Presbyterian
Architect: ???
Construction: Concrete, Timber, Steel

Wellington Cathedral of St Paul (Completed)
Architect: Cecil Wood, Robert Munro, King and Dawson, Warren and Mahoney
Construction: Concrete
Capacity: 800

Church
e and Clere
n: Brick
Husband
200

Rangiatea Church (reconstruction)
Architect: Te Rauparaha, Rev. Octavius Hadfield, and Samuel Williams
Construction: Timber

43

4. Concept Design

4.1 | Reconstructing St Mary's

This thesis began with the idea of digitally reconstructing the lost Wellington church of St Mary's Cathedral, as seen in figure 26. The thought behind this was to use procedural modelling to create a reconstruction that could still be adjusted to account for new evidence. But this adjustability was just the start of what procedural modelling had to offer the field of Architectural Heritage.

The method behind this initial reconstruction follows closely to that explored in the research by Nick Webb and Andre Brown (2016). This process, seen diagrammed in figure 25, entails firstly researching a selected case study, speculating and creating digital representations of the case study, then finally analysing the created representation against the research.
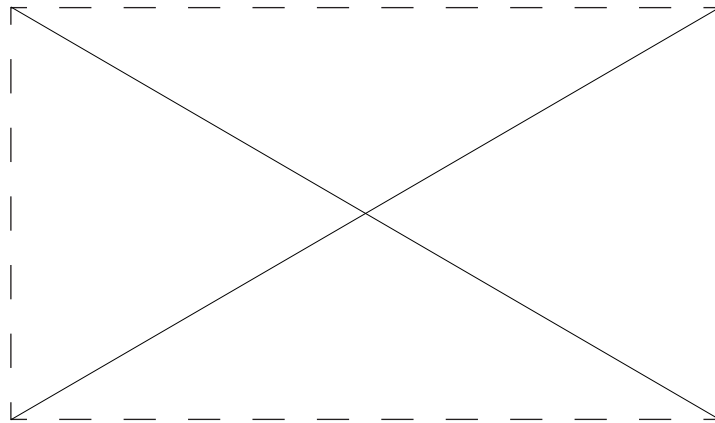
Figure 25. Methodology diagram proposed by Webb and Brown (2016) for the reconstruction of lost architectural heritage

Figure 26. A photo of the east side of St Mary's Cathedral (Te Papa collections D.000019)

4.1.1   Research

Figure 27. A photo showing the what remained of St Mary's after the 1898 fire
(Te Papa collections O.003726)

One of the first things that was revealed about St Mary's during this research is that it went through multiple design iterations. The first structure was built on the Molesworth street site in 1851 by surveyor and architect Thomas Fitzgerald. The Cathedral was then extended and heavily added to in 1867 by architect Christian Toxward. The last changes were made in 1880, consisting of finishing the interior (which had stayed unfinished from the 1867 upgrades) and replacing the heavy lead spire with 4 wooden turrets.

The cathedral caught fire in 1898 while it was being repainted. It destroyed the building beyond repair, prompting the Basilica that sits on the site at present to be constructed (shown in section 3.1.3).

1851
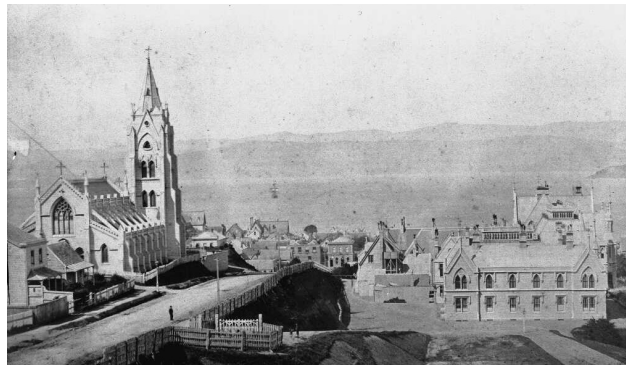
1867

1880

Figure 28. Three pictures showing how St Mary's Cathedral changed over the years

(WCC archives 00138:0:12060) (Ref: 1/2-021261-F Alexander Turnbull Library) (WCC archives 00155:0:50)

THE ROMAN CATHOLIC CATHE-DRAL.

THE exterior of St. Mary's Cathedral, at Thorndon, has now been completed, and the internal fittings and decorations are now rapidly progressing, so that it is anticipated the building can be opened for Divine Worship on Christmas Day. A description of it may therefore be interesting to our readers.

The old building, for which the present cathedral is intended as a substitute, was erected about fifteen years ago on a brick and rubble foundation. It stood the lapse of time remarkably well, and the timber used in its framing was found upon examination at the time when the work of building the new cathedral was begun, to be perfectly sound, and as good as new. Some two years ago the designs were ordered from a well-known architect in Dunedin, who proposed to build gables to the sides of the existing church, in order to strengthen the clear story walls, and also to extend the west end, but it was found that no room would be gained by the side gables, and that the cost would exceed the sum estimated. Some time afterwards the drawings were given to another professional gentleman, for him to make such alterations as he deemed best, but nothing seemed to result from his endeavors, and the matter was then referred to Mr Toxward, who proposed to lengthen the building by 33 feet, and to support the whole of the clear story by flying buttresses, to strip the old shingle roof, take down the covering of the walls, demolish the tower, and build a new one on a larger base with buttresses, stating that this course was essentially necessary in order that the tower might be of sufficiently firm construction and well tied to resist the strong winds to which it is exposed. Mr Toxward, in his design, adopted the early English Gothic, or rather the style which prevailed during the reigns of the first three Edwards, and usually termed the decorative, though the term geometrical middle-pointed style has likewise been applied to it. His design was ultimately adopted, and tenders were invited. Mr Lockie's was the lowest—£2645, and was accordingly accepted.

The cathedral stands on a commanding position at Thorndon, and lies due east and west. It is in the form of a parallelogram, with a lofty and imposing tower in the south-east corner. It measures 108 feet in length from foot of buttress to buttress, and 58 feet in width. The whole of the outside walls are double framed and two feet thick, carrying out the old walls. The walls of the tower are twelve inches thick. The main entrance is at the west end, and consists of two triple three-quarter cylindrical shafts, with caps and bases, supporting moulded archways over three Gothic traceried and pannelled doors. In the centre and over the doors is a beautifully designed geometrical pointed tracery window, glazed with colored glass, with a bold label mould carried horizontally to the spring of the arch, forming a string course, and terminating at the top in a finial, under which is a trefoil leaf. At the same end are two pointed windows, with label or hood mouldings, with deep hollows continued between the buttresses as string courses. These windows will give light to the aisles. The buttresses of both ends of the building have three weatherings, finished at the first and third weatherings by small gables, above which rise octagonal turrets, terminating with gilded gothic finials; the octagonal parts standing clear and free above the coping of the parapets of the gables. The parapets are all perforated and quatre-foiled, the coping on the top being crockets, and they are capped by a five feet high gilded Latin cross. The whole gives the structure a light and graceful appearance. Each of the sides is supported by eight buttresses, each having two weatherings, surmounted by gables extending above the parapet of the aisles. The face is ornamented by pointed sunk panels. Between each of the buttresses is a pointed window, provided with similar hood moulds and string courses as those of the west end. On the sides of the clear story and immediately above the lower windows, are double and pointed windows, finished similar to those of the aisles. These are separated by flat buttresses, which have no intermediate weatherings, but terminate by gables over a perforated parapet, similar to those of the nave. Flying buttresses are introduced to support the clear storey wall; and the roof is slightly arched towards the wall. There are two gables at the east end, of which that covering the sanctuary is lower than the other, which belongs to the nave. Both have similar perforated parapets, turrets, crockets, and gilded crosses to those of the west end; but the lighting is provided for by a triple window with a smaller one of a circular form. Both have label moulds and string courses. There are two entrances into the building from this end, one to the robing room, the other to the sacristy. The roofs are all slated; and the ridges of the nave and sanctuary are provided with a neat cresting.

The tower stands at the south-east corner of the building. It is 16 feet square at the base, and rises to a height of 106 feet, the measurement being taken from the surface of the ground to the top of the cross. It is supported to a height of 68 feet by buttresses, with 6 feet bases. Above are octagonal turrets, finished in a similar manner to those of the gables, the top standing clear above the parapet on each corner of the square part of the tower. At a height of 26 feet from the ground is a frieze; three feet above which are three double windows lighting the second floor. About one foot above the third floor are four double pointed arched openings, fitted with moveable Louvres. It is intended to place a peal of bells in this floor. The tower contains four floors in all. At a height of 54 feet, facing east, in a niche, surmounted by a canopy, with pedimental gables and pinnacles, stands, upon a half-globe, a beautiful gilded statue of the Madonna, 7 feet 3 inches in height. The figure is of iron, and was made in France. Upon the globe is engraved in Gothic letters :—
"This statue was presented and blessed by the Right Reverend Philip Joseph Viard, Bishop of Wellington, on the eighth day of September, 1867. *Virgo Immaculata. Ora pro Nobis.*
Translated—Virgin Immaculate, pray for us. On each of the other three sides of the tower, on the same level as the statue, is a triangular window, finished similarly to those already described. The walls of the tower terminate in four pediments, having deep hollow moulds and coping. The east gable is surmounted by a five pointed star indicating the star seen in the east at the Nativity. On the west gable are the initials interwoven, A. M., "*Ave Maria.*" Facing north and south is a gilded cross. From the top of the parapet rises the spire, crowned by a gilded wrought iron Latin cross, six feet in height.

The whole of the building stands on a brick foundation, and is built mainly of New Zealand timber, such as totara and red pine. The outside boarding is totara, rebated (or, as it is here wrongly called, "rusticated"; the woodwork is painted and sanded, which has, we believe, been found to be the best mode of protecting wood in these colonies. It is widely adopted in Australia in wooden buildings, with this object, and is not applied for the purpose of imitating stone as is generally supposed. The roof of the cathedral is covered with countless slates, but for the spire of the tower 6lb lead has been used and all the gutters are laid with 6lb lead; all the sashes throughout have leaden lights.

The interior of the building next claims attention. On entering at the west end the visitor will see before him a lofty nave 70 feet in length, 20 feet wide, and 40 feet high in the centre, the height from the floor to the beginning of the roof being 27 feet. On each side of the nave and divided from it by six piers is an aisle of similar length, by 13 feet in width, and 13 feet in height from the floor to the lower side of the roof. The decorations of the nave and aisles are not to be gone on with at present; but it is intended to form the ceiling of the nave into cross vaults, the piers to be formed by four three-quarter clustered columns. The ceiling of each aisle will form an arch. At the end of the nave is the sanctuary 25 feet long and 20 feet wide, and 30 feet high to the crown of the ceiling. The interior is at present in the hands of the workmen, and will be completed by the beginning of this month. The ceiling is to be executed in plaster and in the form of a pointed arch divided into panels by round and hollow diagonal mouldings. At each intersection is a boll flower. The ceiling springs from a cornice and frieze ornamented with leaves and quatrefoils. The walls are plastered to within 6 feet from the floor, and are supported by 14 three quarter columns with ornamented caps and bases. The dado round the walls is 6 feet high of figured varnished red pine gothic panels. At each side is an open archway leading to St. Mary's and St. Joseph's chapels, which adjoin, while a doorway leads to the Sacristy's robing-room. The triple windows in the sanctuary will be furnished with hood mouldings and ball flowers at the spring; colored and stained glass will be alone used. It is intended to place the figures of two Apostles in the arch between the nave and sanctuary, one on each side and also one against each wall in the sanctuary. On the northern side of the sanctuary is the sacristy and St. Mary's chapel, opposite St. Joseph's chapel; both chapels are vaulted, each having two open arches with clustered columns. A temporary gallery for the choir has been erected at the west end but for this will be substituted, at some future time, a handsome gallery, decorated with pedimental labels and finials, two arches being left for statues. The cathedral will afford accommodation for about five hundred worshippers.

The building, taken as a whole, is one of the finest, if not the finest, ecclesiastical structure in the colony; and does infinite credit to its architect, who has succeeded in producing a work at once elegant and durable Its site has also been singularly well chosen as it can be seen from all parts of the town and the harbor.

Total length: 108 feet
Total width: 58 feet
Wall thickness: 2 feet
Tower wall thickness: 1 foot
Tower base area: 16 foot square
Tower height: 106 feet
Tower buttress height: 68 feet
Tower buttress base: 6 feet
Nave length: 70 feet
Nave width: 20 feet
Nave height (centre): 40 feet
Nave height (sides): 27 feet
Aisle width: 13 feet
Aisle height (side): 13 feet
Sanctuary length: 25 feet
Sanctuary width: 20 feet
Sanctuary height: 30 feet

Other details on tower and interior decoration are also included

Figure 29. The 1867 article describing St Mary's and the dimensions mentioned in it
(The Roman Catholic Cathedral, 1867, National Library of New Zealand)

One of the most useful discoveries that helped the reconstruction of St Mary's was its description in a paper article from 1867. The article describes the Cathedral just as the additions made by Toxward were being completed. The description details the basic dimensions of the church and provides an overview of the design's key features. Plans for the cathedral could not be found during this research, making these measurements crucial for its reconstruction
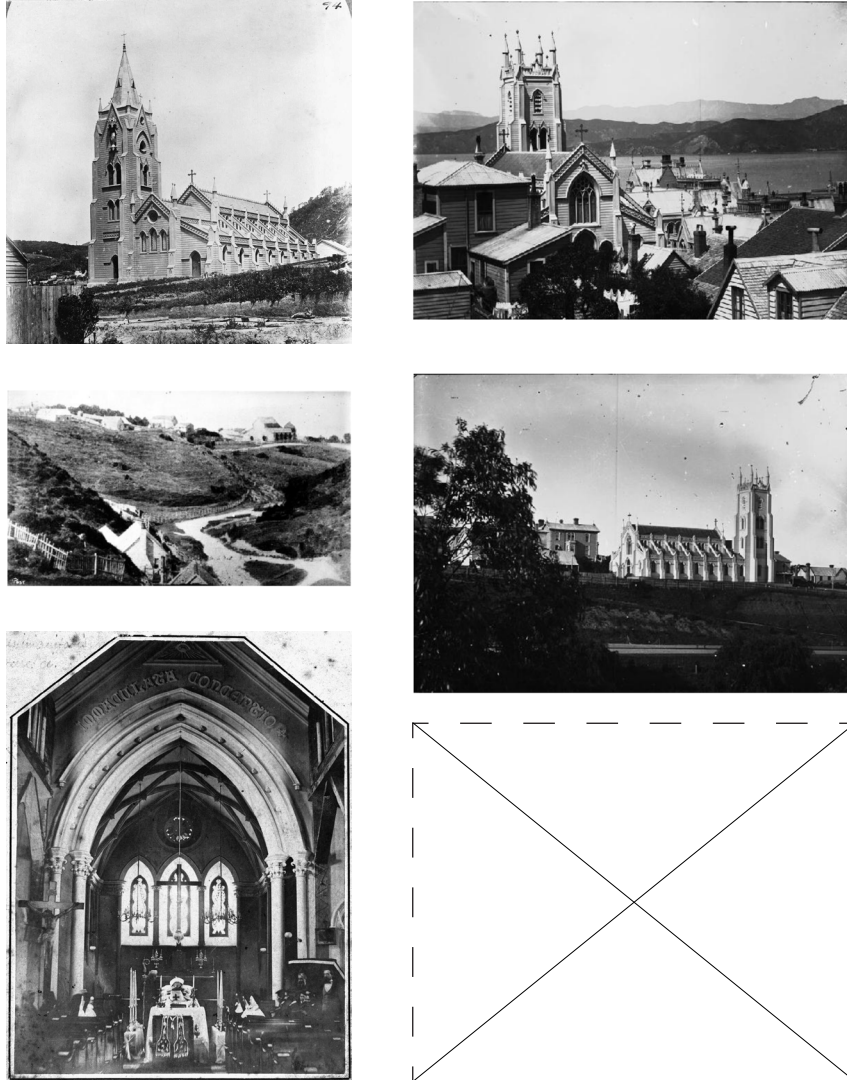
Figure 30. A collection of photos of the Cathedral that were found while researching

(Ref: 1/2-002467-F Alexander Turnbull Library) (WCC archives 00155:0:1) (WCC archives 00138:0:12060) (WCC archives 00155:0:50) (Ref: PAColl-3334 Alexander Turnbull Library)(Archdiocese of Wellington archives)

Many photos of the exterior of St Mary's could be found, however only a couple of the interior. Most of the exterior shots of the cathedral are from a long distance away so gauging the small details proved difficult. This was until the discovery of the high resolution photo seen on figure 26. This immense detail of this photo was a key contributor to the reconstruction

Through the analysis of the photos and descriptions of St Mary's the general layout can be speculated, and broken down into the main areas of the Cathedral, as seen in figure 32. Although St Mary's is a complex church in terms of its ornamentation, the basic layout of the design is very simple, consisting of just 4 different areas. These areas all connect to the central nave, with the tower interestingly being located at the back of the church.

Figure 31. Picture of the west side of St Mary's and the old Government Buildings
(Ref: 1/2-021261-F Alexander Turnbull Library)

1. - Nave   3. - Tower

2. - Sanctuary   4. - Aisles
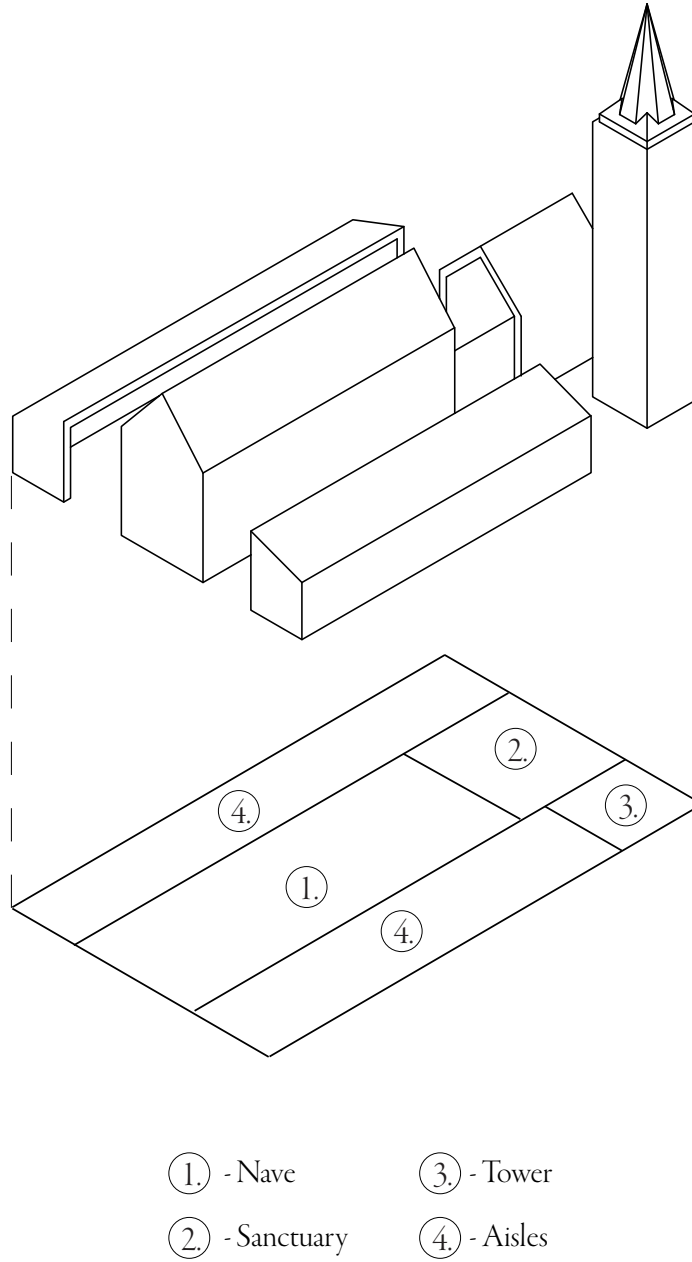
Figure 32. Diagram Breaking down the main areas of St Mary's

4.1.2 Digital Modelling

These speculated main areas where then modelled in the software Houdini. The details of how this is done will be explained later in this chapter, but the overarching method will be discussed here. Using the dimensions found in the 1867 article, basic geometric representations could be made to start the reconstruction

Total length: 108 feet
Total width: 58 feet
Wall thickness: 2 feet
Tower wall thickness: 1 foot
Tower base area: 16 foot square
Tower height: 106 feet
Tower buttress height: 68 feet
Tower buttress base: 6 feet
Nave length: 70 feet
Nave width: 20 feet
Nave height (centre): 40 feet
Nave height (sides): 27 feet
Aisle width: 13 feet
Aisle height (side): 13 feet
Sanctuary length: 25 feet
Sanctuary width: 20 feet
Sanctuary height: 30 feet

Figure 33. 1867 article highlighting the dimensions of the areas being built in figure 34
(The Roman Catholic Cathedral, 1867, National Library of New Zealand)

Nave
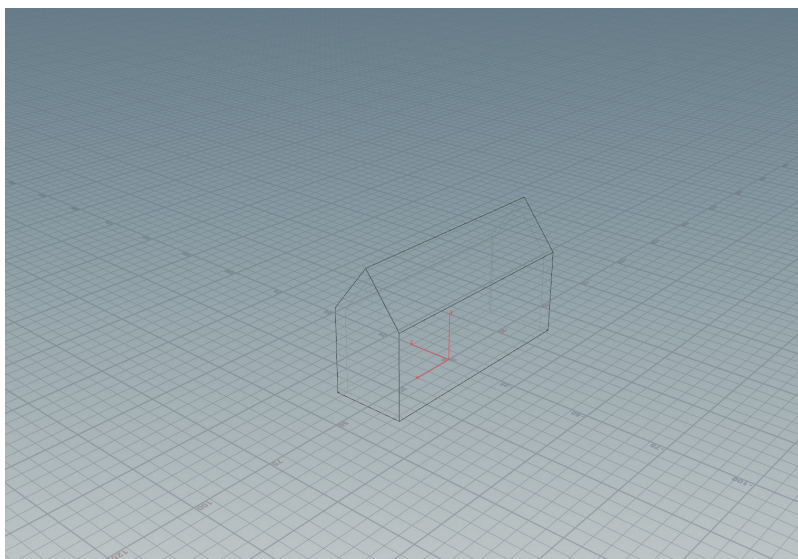
Sanctuary
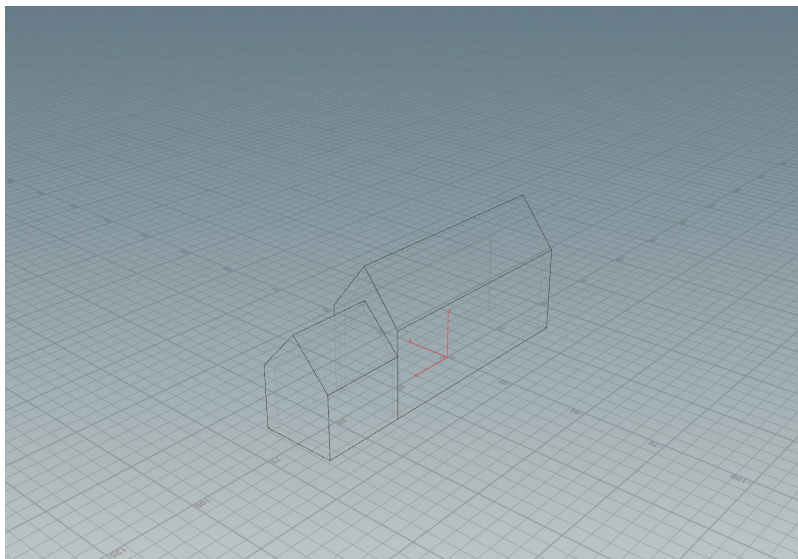
Figure 34. Screenshots of Houdini's scene view, showing the created areas based on the dimensions in figure 33

THE ROMAN CATHOLIC CATHEDRAL.

THE exterior of St. Mary's Cathedral, at Thorndon, has now been completed, and the internal fittings and decorations are now rapidly progressing, so that it is anticipated the building can be opened for Divine Worship on Christmas Day. A description of it may therefore be interesting to our readers.

The old building, for which the present cathedral is intended as a substitute, was erected about fifteen years ago on a brick and rubble foundation. It stood the lapse of time remarkably well, and the timber used in its framing was found upon examination at the time when the work of building the new cathedral was begun, to be perfectly sound, and as good as new. Some two years ago the designs were ordered from a well-known architect in Dunedin, who proposed to build gables to the sides of the existing church, in order to strengthen the clear story walls, and also to extend the west end, but it was found that no room would be gained by the side gables, and that the cost would exceed the sum estimated. Some time afterwards the drawings were given to another professional gentleman, for him to make such alterations as he deemed best, but nothing seemed to result from his endeavors, and the matter was then referred to Mr Toxward, who proposed to lengthen the building by 33 feet, and to support the whole of the clear story by flying buttresses, to strip the old shingle roof, take down the covering of the walls, demolish the tower, and build a new one on a larger base with buttresses, stating that this course was essentially necessary in order that the tower might be of sufficiently firm construction and well tied to resist the strong winds to which it is exposed. Mr Toxward, in his design, adopted the early English Gothic, or rather the style which prevailed during the reigns of the first three Edwards, and usually termed the decorative, though the term geometrical middle-pointed style has likewise been applied to it. His design was ultimately adopted, and tenders were invited. Mr Lockie's was the lowest—£2945, and was accordingly accepted.

The cathedral stands on a commanding position at Thorndon, and lies due east and west. It is in the form of a parallelogram, with a lofty and imposing tower in the south-east corner. It measures 108 feet in length from foot of buttress to buttress, and 58 feet in width. The whole of the outside walls are double framed and two feet thick, carrying out the old walls. The walls of the tower are twelve inches thick. The main entrance is at the west end, and consists of two triple three-quarter cylindrical shafts, with caps and bases, supporting moulded archways over three Gothic traceried and pannelled doors. In the centre and over the doors is a beautifully designed geometrical pointed tracery window, glazed with colored glass, with a bold label mould carried horizontally to the spring of the arch, forming a string course, and terminating at the top in a finial, under which is a trefoil leaf. At the same end are two pointed windows, with label or hood mouldings, with deep hollows continued between the buttresses as string courses. These windows will give light to the aisles. The buttresses of both ends of

the building have three weatherings, finished at the first and third weatherings by small gables, above which rise octagonal turrets, terminating with gilded gothic finials; the octagonal parts standing clear and free above the coping of the parapets of the gables. The parapets are all perforated and quatrefoiled, the coping on the top being crockets, and they are capped by a five feet high gilded Latin cross. The whole gives the structure a light and graceful appearance. Each of the sides is supported by eight buttresses, each having two weatherings, surmounted by gables extending above the parapet of the aisles. The face is ornamented by pointed sunk panels. Between each of the buttresses is a pointed window, provided with similar hood moulds and string courses as those of the west end. At the top of the aisle walls runs a bold cornice and perforated quatrefoil parapet. On the sides of the clear story and immediately above the lower windows, are double and pointed windows, finished similar to those of the aisles. These are separated by flat buttresses, which have no intermediate weatherings, but terminate by gables over a perforated parapet, similar to those of the aisles. Flying buttresses are introduced to support the clear storey wall; and the roof is slightly arched towards the wall. There are two gables at the east end, of which that covering the sanctuary is lower than the other, which belongs to the nave. Both have similar perforated parapets, turrets, crockets, and gilded crosses to those of the west end; but the lighting is provided for by a triple window with a smaller one of a circular form. Both have label moulds and string courses. There are two entrances into the building from this end, one to the robing room, the other to the sacristy. The roofs are all slated; and the ridges of the nave and sanctuary are provided with a neat cresting.

The tower stands at the south-east corner of the building. It is 16 feet square at the base, and rises to a height of 106 feet, the measurement being taken from the surface of the ground to the top of the cross. It is supported to a height of 68 feet by buttresses, with 6 feet bases. Above are octagonal turrets, finished in a similar manner to those of the gables, the top standing clear above the parapet on each corner of the square part of the tower. At a height of 24 feet from the ground is a frieze; three feet above which are three double windows lighting the second floor. About one foot above the third floor are four double pointed arched openings, fitted with moveable Louvres. It is intended to place a peal of bells in this floor. The tower contains four floors in all. At a height of 54 feet, facing east, in a niche, surmounted by a canopy, with pedimental gables and pinnacles, stands, upon a half-globe, a beautiful gilded statue of the Madonna, 7 feet 3 inches in height. The figure is of iron, and was made in France. Upon the globe is engraved in Gothic letters :—

" This statue was presented and blessed by the Right Reverend Philip Joseph Viard, Bishop of Wellington, on the eighth day of September, 1867. *Virgo Immaculata. Ora pro Nobis.*

Translated—Virgin Immaculate, pray for us.

On each of the other three sides of the tower, on the same level as the statue, is a triangular window, finished similarly to those

already described. The walls of the tower terminate in four pediments, having deep hollow moulds and coping. The east gable is surmounted by a five pointed star indicating the star seen in the east at the Nativity. On the west gable are the initials interwoven, A. M., "*Ave Maria.*" Facing north and south is a gilded cross. From the top of the parapet rises the spire, crowned by a gilded wrought iron Latin cross, six feet in height.

The whole of the building stands on a brick foundation, and is built mainly of New Zealand timber, such as totara and red pine. The outside boarding is totara, rebated (or, as it is here wrongly called, "rusticated"; the woodwork is painted and sanded, which has, we believe, been found to be the best mode of protecting wood in these colonies. It is widely adopted in Australia in wooden buildings, with this object, and is not applied for the purpose of imitating stone as is generally supposed. The roof of the cathedral is covered with countess slates, but for the spire of the tower 6lb lead has been used and all the gutters are laid with 6lb lead; all the sashes throughout have leaden lights.

The interior of the building next claims attention. On entering at the west end the visitor will see before him a lofty nave 70 feet in length, 20 feet wide, and 40 feet high in the centre, the height from the floor to the beginning of the roof being 27 feet. On each side of the nave and divided from it by six piers is an aisle of similar length, by 13 feet in width, and 13 feet in height from the floor to the lower side of the roof. The decorations of the nave and aisles are not to be gone on with at present; but it is intended to form the ceiling of the nave into cross vaults, the piers to be formed by four three-quarter clustered columns. The ceiling of each aisle will form an arch. At the end of the nave is the sanctuary 25 feet long and 20 feet wide, and 30 feet high to the crown of the ceiling. The interior is at present in the hands of the workmen, and will be completed by the beginning of this month. The ceiling is to be executed in plaster and in the form of a pointed arch divided into panels by round and hollow diagonal mouldings. At each intersection is a ball flower. The ceiling springs from a cornice and frieze ornamented with leaves and quatrefoils. The walls are plastered to within 6 feet from the floor, and are supported by 14 three-quarter columns with ornamented caps and bases. The dado round the walls is 6 feet high of figured varnished red pine gothic panels. At each side is an open archway leading to St. Mary's and St. Joseph's chapels, which adjoin, while a doorway leads to the Sacristy's robing-room. The triple windows in the sanctuary will be furnished with hood mouldings and ball flowers at the spring; colored and stained glass will be alone used. It is intended to place the figures of two Apostles in the arch between the nave and sanctuary, one on each side, and also one against each wall in the sanctuary. On the northern side of the sanctuary is the sacristy and St. Mary's chapel, opposite St. Joseph's chapel; both chapels are vaulted, each having two open arches with clustered columns. A temporary gallery for the choir has been erected at the west end but for this will be substituted, at some future time, a handsome gallery, decorated with pedimental labels and finials, two arches being left for statues. The cathedral will afford accommodation for about five hundred worshippers.

The building, taken as a whole, is one of the finest, if not the finest, ecclesiastical structure in the colony ; and does infinite credit to its architect, who has succeeded in producing a work at once elegant and durable Its site has also been singularly well chosen as it can be seen from all parts of the town and the harbor.

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Sanctuary length: 25 feet
Sanctuary width: 20 feet
Sanctuary height: 30 feet

Figure 35. 1867 article highlighting the dimensions of the areas being built in figure 36
(The Roman Catholic Cathedral, 1867, National Library of New Zealand)

Tower
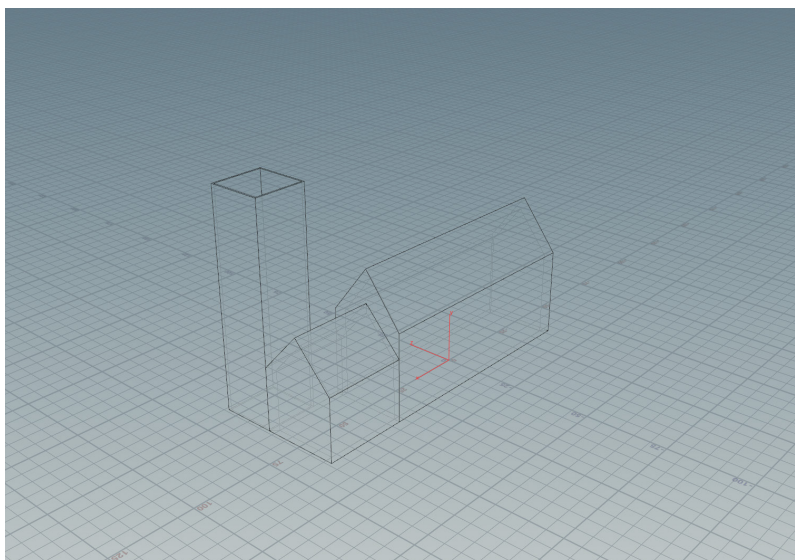
Spire
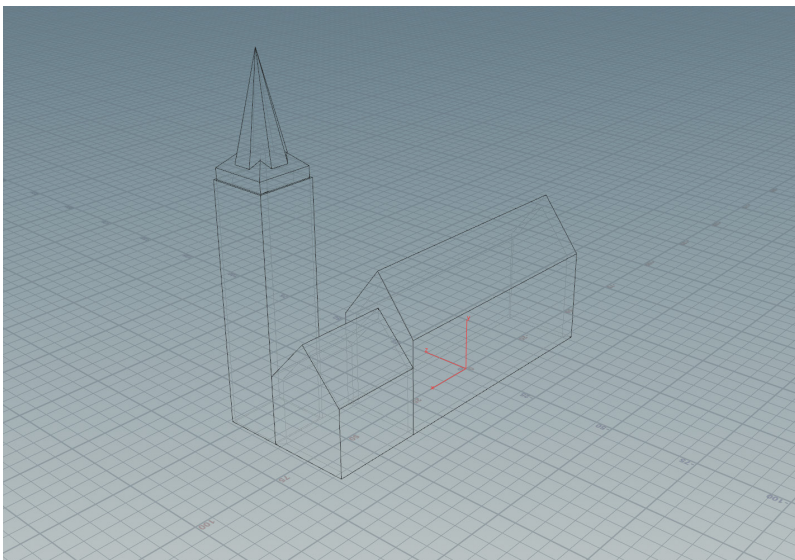
Figure 36. Screenshots of the Houdini's scene view, showing the created areas based on the dimensions in figure 35

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Nave height (sides): 27 feet
Aisle width: 13 feet
Aisle height (side): 13 feet
Sanctuary length: 25 feet
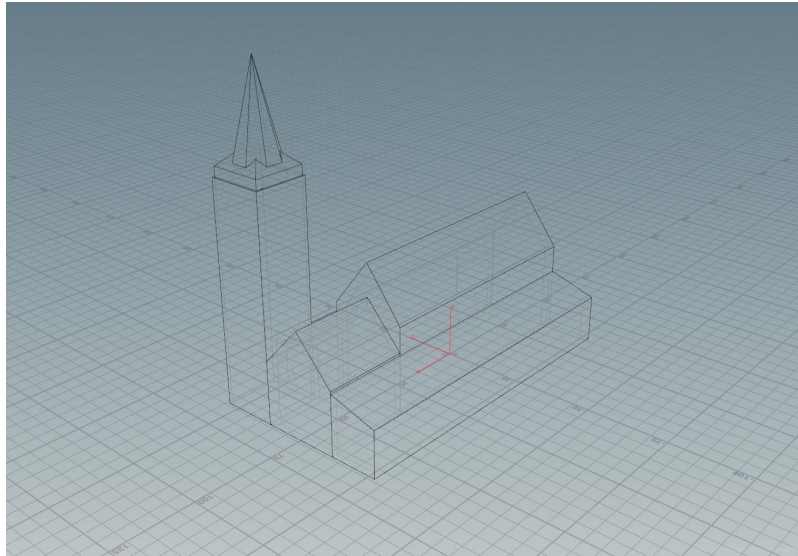Sanctuary width: 20 feet
Sanctuary height: 30 feet

Figure 37. 1867 article highlighting the dimensions of the areas being built in figure 38
(The Roman Catholic Cathedral, 1867, National Library of New Zealand)

Aisles

Tower
buttressing
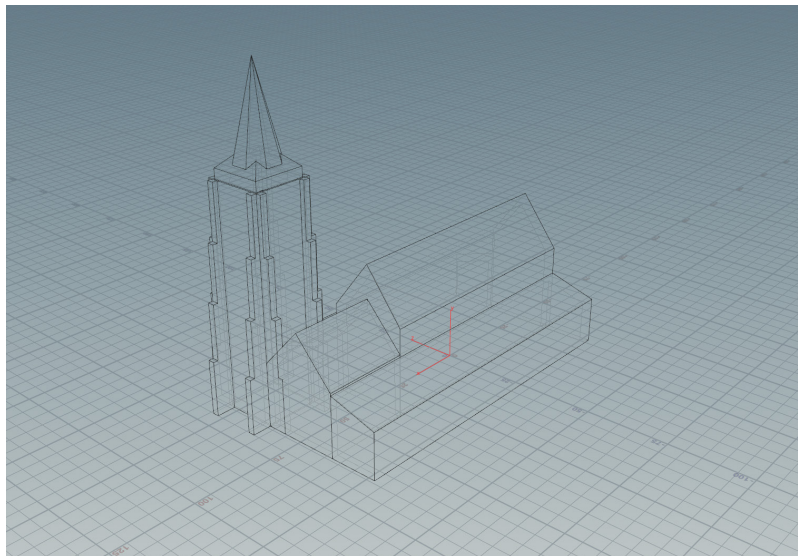
Figure 38. Screenshots of the Houdini's scene view, showing the created areas based on the dimensions in figure 37

4.1.3   Analyse and Review

The digital model created from the measurements of the 1867 were then compared to the photographic evidence, as seen in figure 39. The proportions of the model appeared to align very closely to that seen in the 19th century photos, and so the reconstruction continued. From this point it became a matter of adding more detail by modelling the other architectural components of the design. This proved to be a challenge as the article does not give dimensions for these more intricate details. Methods in extracting detail from the researched photos then became a crucial part of this reconstruction

Developing further from these main shapes, the architectural details present in these areas were further categorised into additive and subtractive components. Additive components consisted of the various buttresses, parapets and eave details that are simply added on top of the basic shape; whereas subtractive components consisted of details that carve into the shape such as the windows and doors (figure. 40).
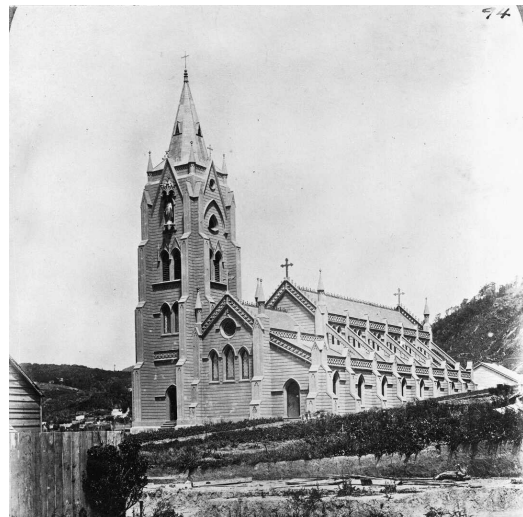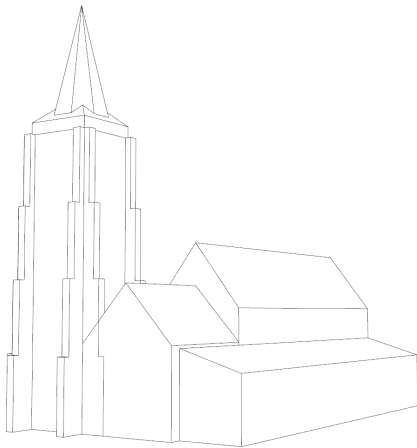
Figure 39. Created digital model of St Mary's compared to a 1879 photo
(Ref: 1/2-002467-F Alexander Turnbull Library)

| Parapet | Buttressing | Nave | Windows | Feature Window | Clerestory | Doors |

| Parapet | Buttressing | Aisles | Windows | Doors |

| Parapet | Buttressing | Sanctuary | Windows | Feature Window |

| Spire | Buttressing | Tower | Windows | Doors |

- Section of the Church

- Additive components

- Subtractive components
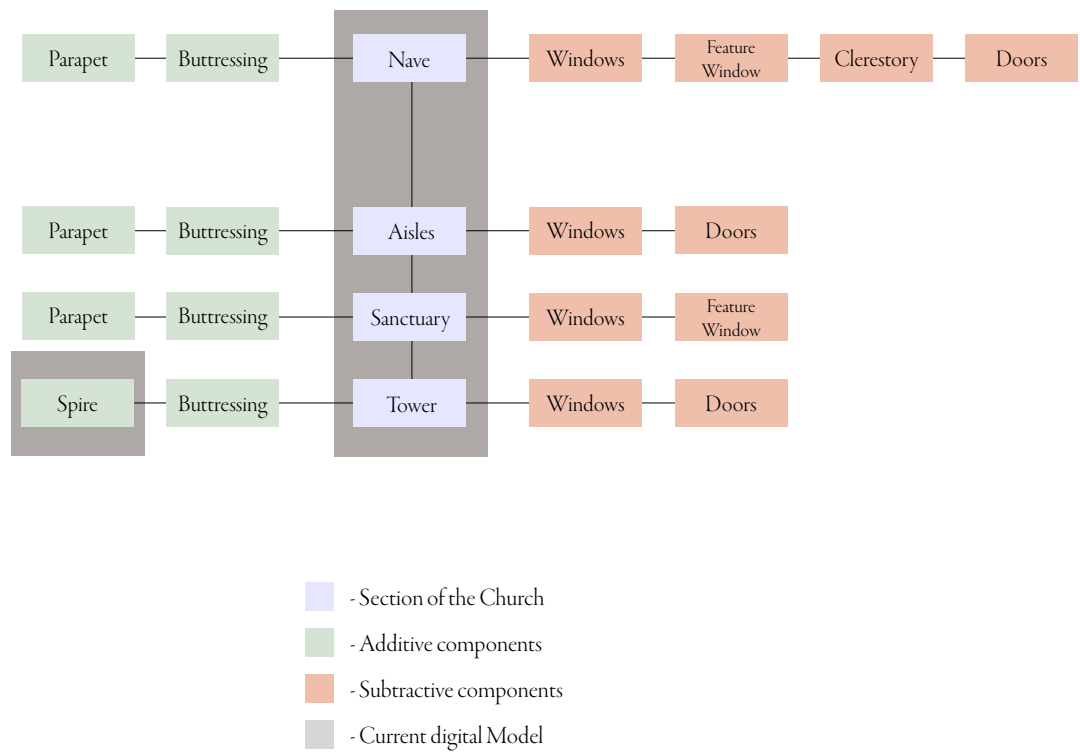
- Current digital Model

Figure 40. Diagram of the further catagorisation of architectural components within St Mary's

4.2 | Extracting Detail

4.2.1 Buttresses

For the more detailed components of St Mary's, photographic analysis was the main source evidence guiding the reconstruction. One of the only detail components where specific mention of their dimensions are made in the 1867 article however is the tower buttresses. As seen in figure 41, the height and base length of the tower buttresses are stated. No mention of the thickness of the buttresses are made, however it is assumed in this research that this thickness matches the thickness of the walls.

Total length: 108 feet
Total width: 58 feet
Wall thickness: 2 feet
Tower wall thickness: 1 foot
Tower base area: 16 foot square
Tower height: 106 feet
Tower buttress height: 68 feet
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Nave length: 70 feet
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Sanctuary length: 25 feet
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Figure 41. 1867 article where the dimensions of the tower buttress are stated
(The Roman Catholic Cathedral, 1867, National Library of New Zealand)
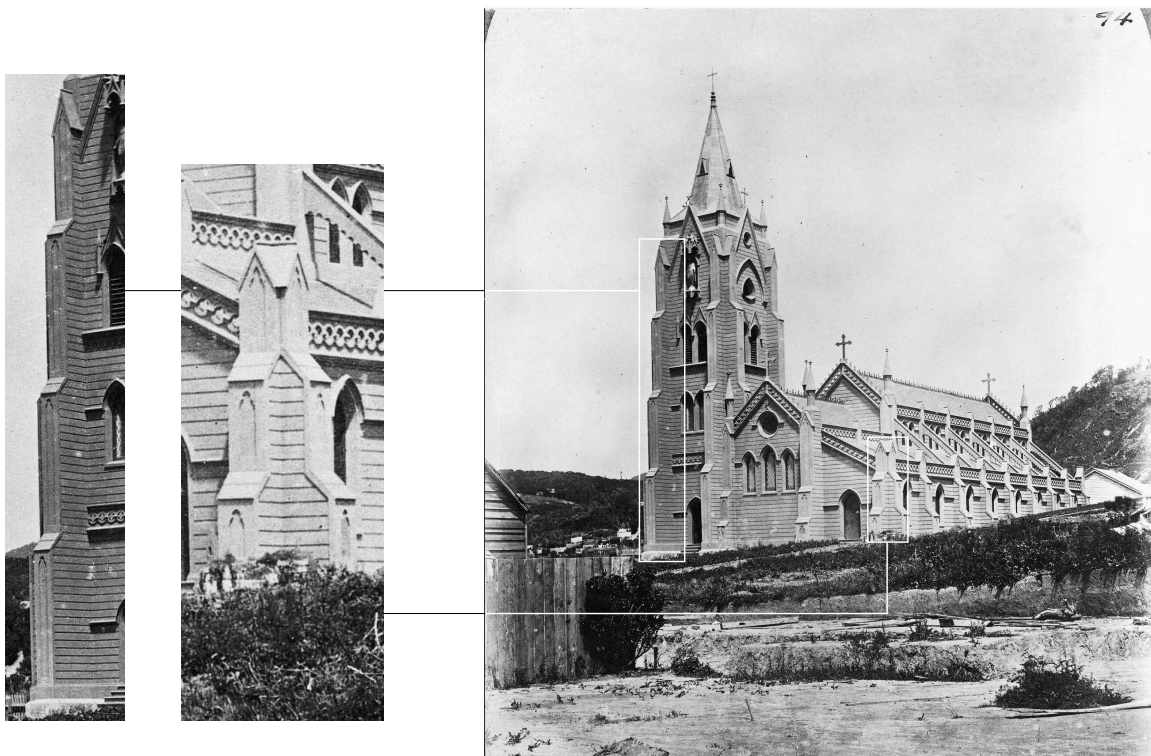
*Figure 42. Diagram showing the tower buttresses and aisle buttresses that are assumed
to be the same thickness as the wall they adjoin to
(Ref: 1/2-002467-F Alexander Turnbull Library)*

Aisle	Sanctuary	Nave	Tower
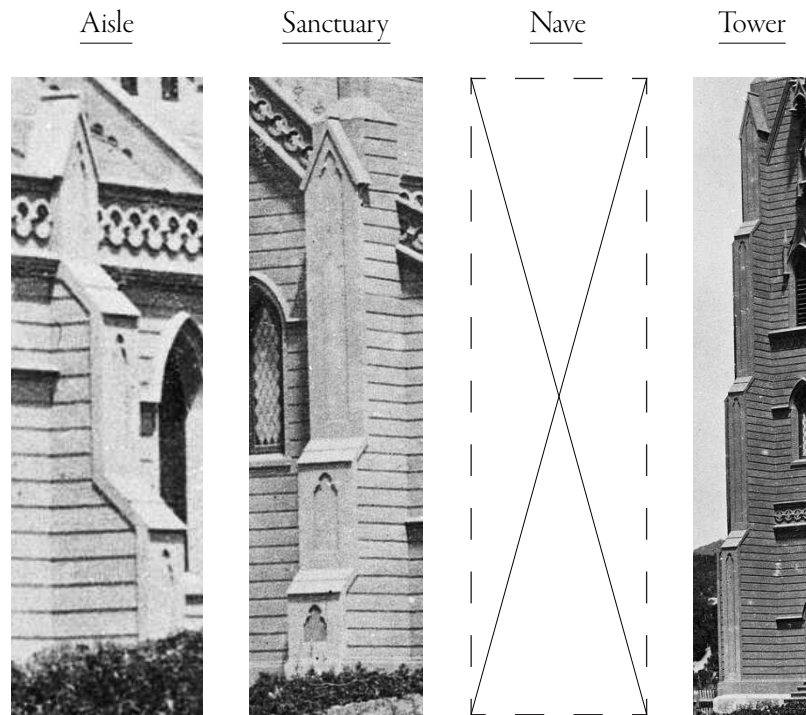
Figure 43. Photos of all the different buttresses present in St Mary's
(Ref: 1/2-002467-F Alexander Turnbull Library) (Front of St Mary's Cathedral, 2019)

As seen in section 4.1.2, a speculative reconstruction of the tower buttresses was attempted. Because St Mary's makes prominent use of buttressing, with there being four different types in just the one design, the tower buttresses were adapted into a procedural model could the dimension could be adjusted to create the varying designs. The height, width, length, number of divisions, and adjoining buttress gable are all available to be adjusted, as seen in figure 44. The protective panelling on the buttresses were also added, building upon the simple tower buttress model of section 4.1.2. The buttresses were then applied to the digital reconstruction and checked against archival evidence, as seen in figure 45 on the following page.

Select amount of divisions

Gable addition Yes/No

Aisle Buttress   Sancuary Buttress   Nave Buttress   Tower Buttress
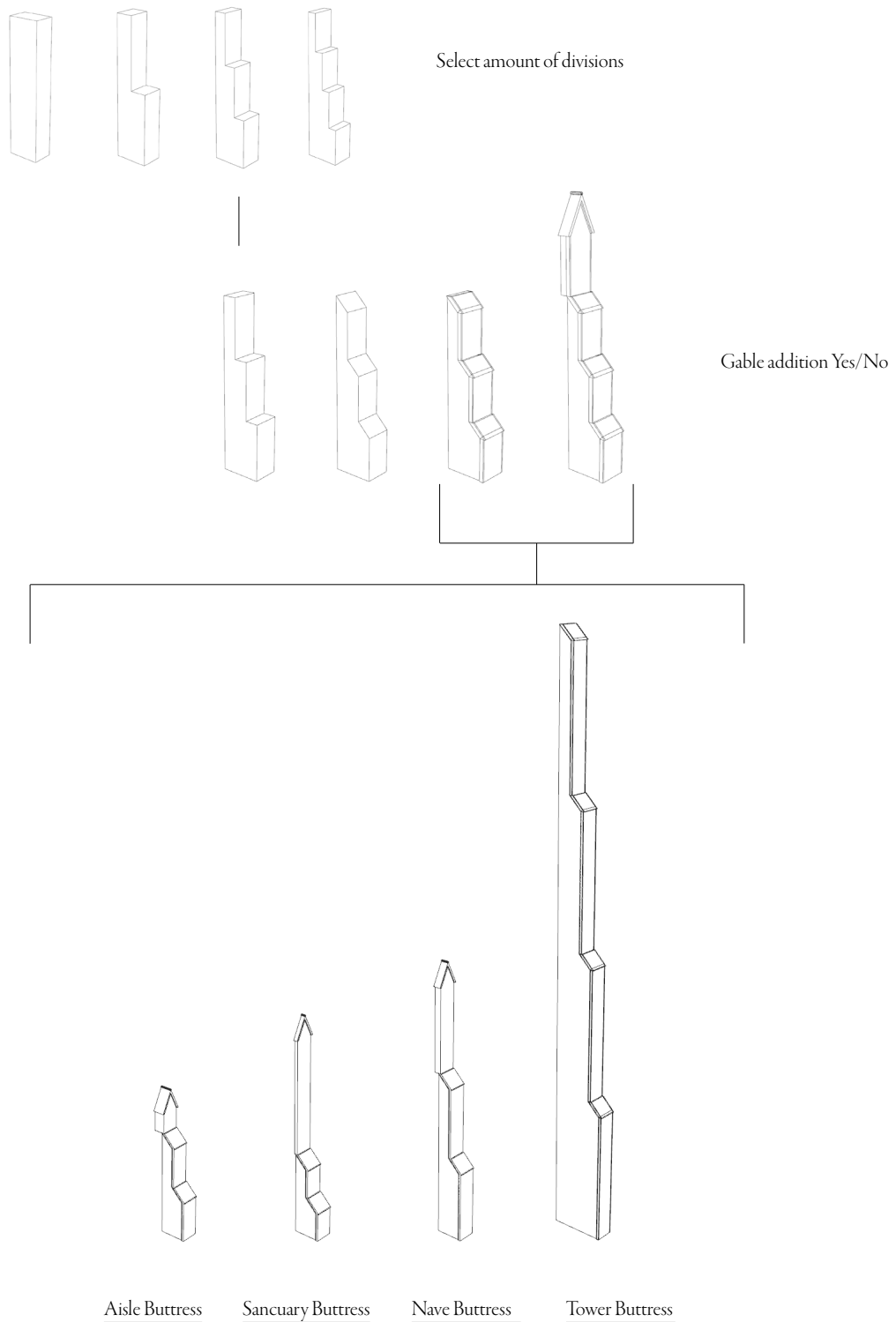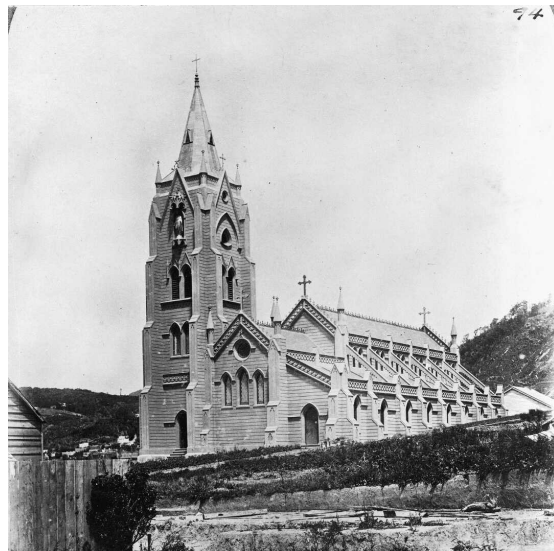
*Figure 44. Diagram showing the different designs the procedural buttress component
can create*
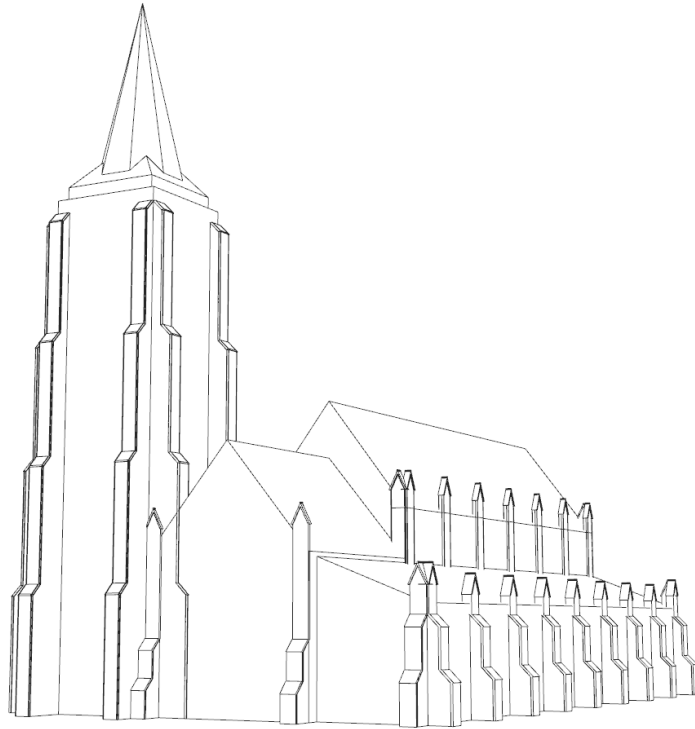
Figure 45. Created digital model of St Mary's compared to a 1879 photo
(Ref: 1/2-002467-F Alexander Turnbull Library)

Parapet	Buttressing	Nave	Windows	Feature Window	Clerestory	Doors
Parapet	Buttressing	Aisles	Windows	Doors		
Parapet	Buttressing	Sanctuary	Windows	Feature Window		
Spire	Buttressing	Tower	Windows	Doors		

- Section of the Church
- Additive components
- Subtractive components
- Current digital Model

Figure 46. Diagram of the current components of the St Mary's Reconstruction

4.2.2   Rosette Window

Figure 47. Close up of the photo that was the main influence for the windows'
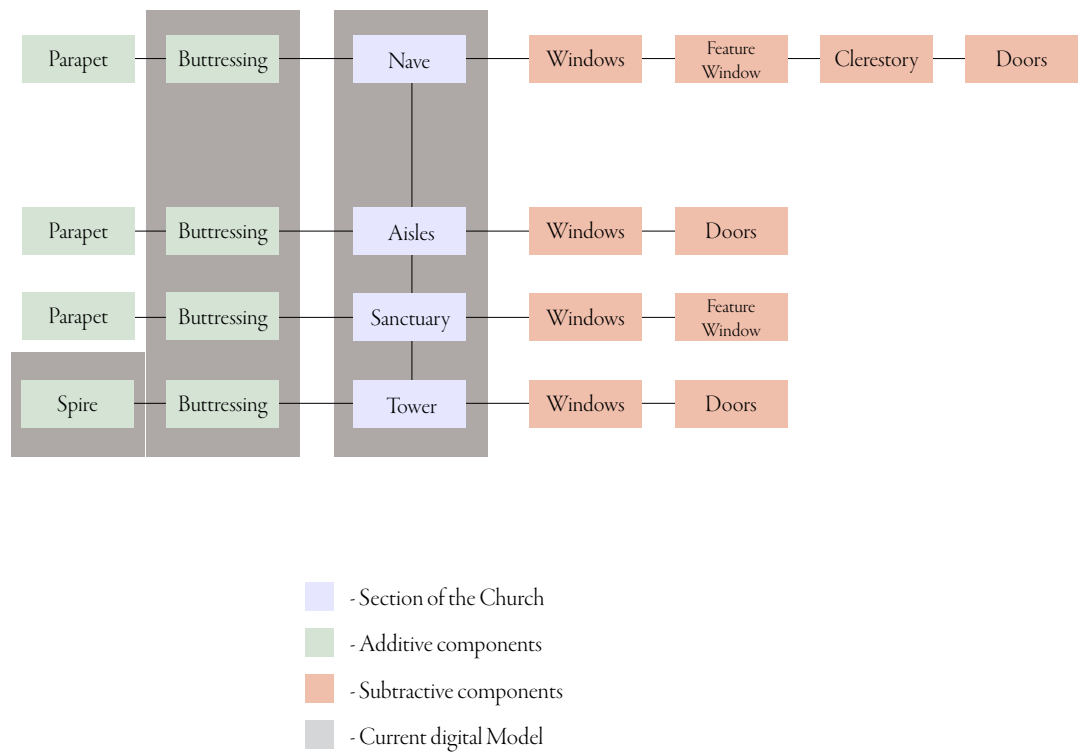*reconstruction*
(Ref: 1/2-021261-F Alexander Turnbull Library)
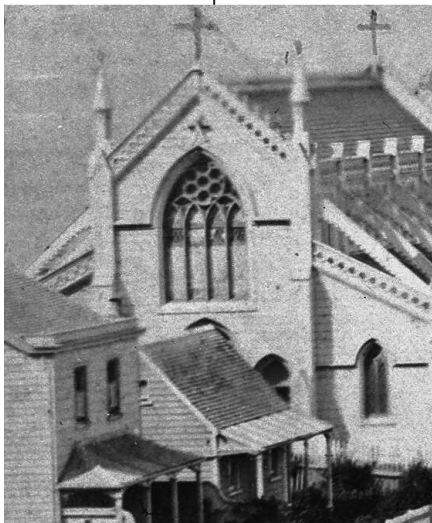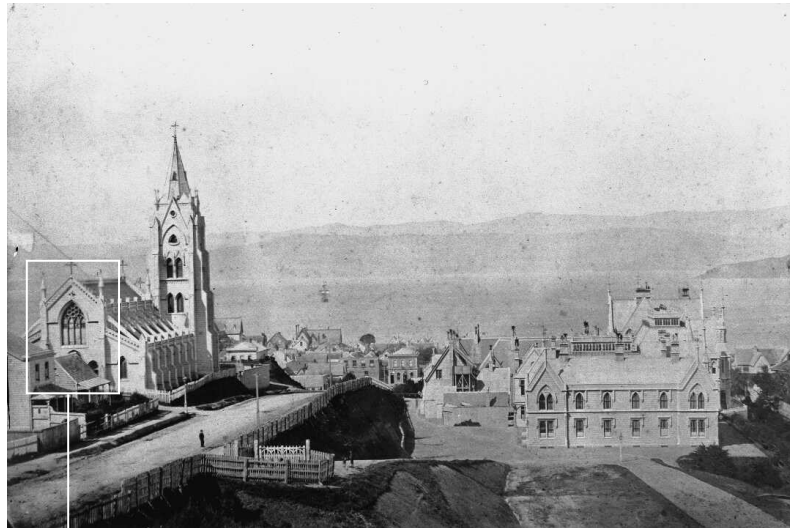
There is no mention of the dimensions of the Rosette window that sits on the west side of the Cathedral. The main driver of the window's reconstruction was also photo analysis, however one photo, seen in figure 47, was especially helpful.

Other supplementary photos of the window were also found during the research within section 4.1.1. The quality of these photos, seen in figure 48, were quite low however, with the only useful information that could be gathered from them being a closer view of the timber profile that outlines the window in the top photograph

Figure 48. Other photos of St Mary's showing the Rossete window
(Front of St Mary's Cathedral, 2019) (Archdiocese of Wellington archives)
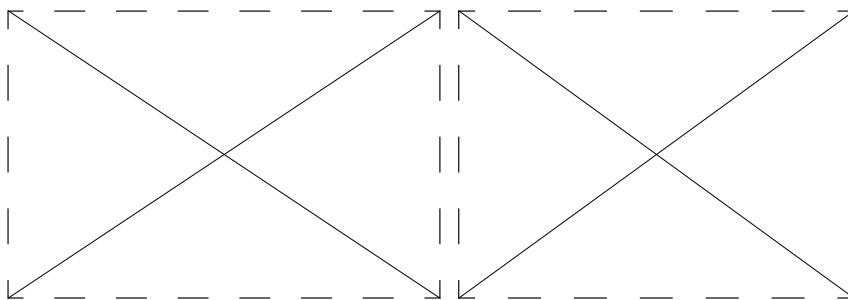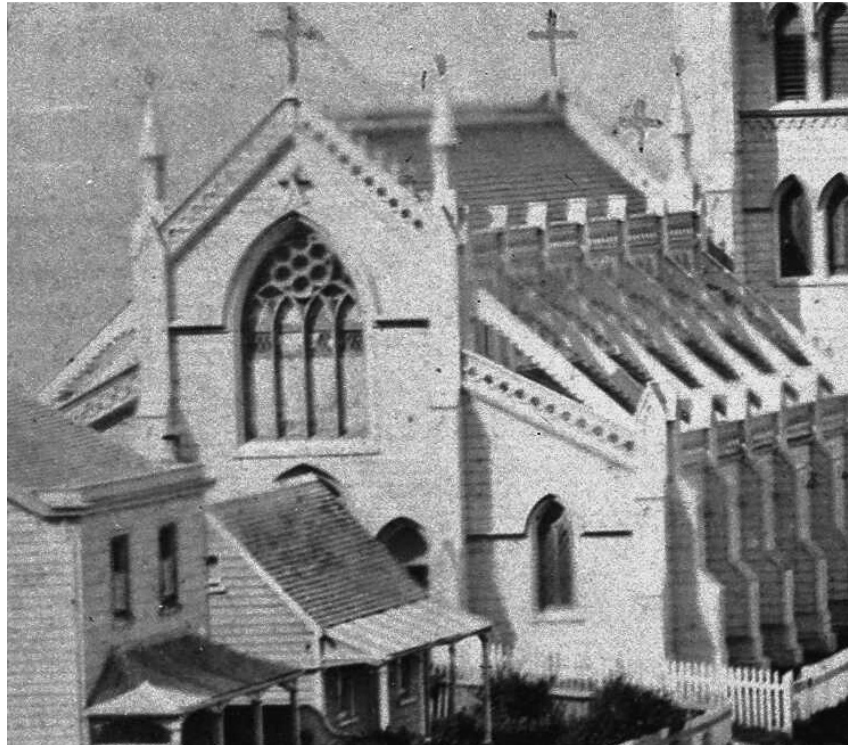
Figure 49. Key photos used for the reconstruction of the Rosette window
(Ref: 1/2-021261-F Alexander Turnbull Library) (Front of St Mary's Cathedral, n.d.) (Archdiocese of Wellington archives)

To create the window, firstly a simple pointed arch much the same that is diagrammed in section 4.0, is created. Then by a process of trial and error, the rest of the tracery design is reverse engineered by only using segments of circles and lines. The modelled lines were then checked against the photographic evidence until a close match was created. A profile was then extruded along these lines to create the 3D reconstruction.
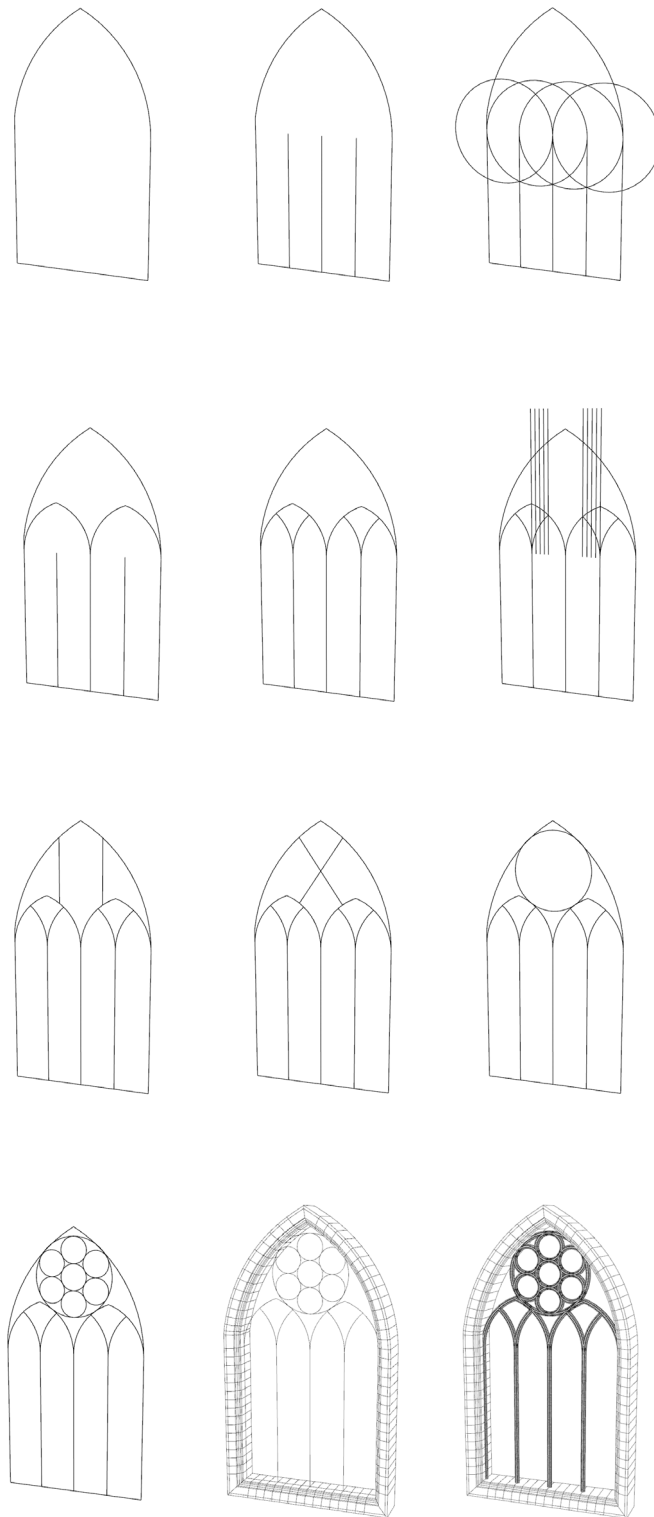
Figure 50. Diagram showing how the lines of the window were created and converted into a 3D model

Total length: 108 feet
Total width: 58 feet
Wall thickness: 2 feet
Tower wall thickness: 1 foot
Tower base area: 16 foot square
Tower height: 106 feet
Tower buttress height: 68 feet
Tower buttress base: 6 feet
Nave length: 70 feet
Nave width: 20 feet
Nave height (centre): 40 feet
Nave height (sides): 27 feet
Aisle width: 13 feet
Aisle height (side): 13 feet
Sanctuary length: 25 feet
Sanctuary width: 20 feet
Sanctuary height: 30 feet

Figure 51. Dimensions used to size the Rosette window
(The Roman Catholic Cathedral, 1867, National Library of New Zealand)

Being a procedural model, the size of the window could be adjusted. Seeing as there is no dimensions of the window within the article, it was sized in proportion to a value that is known, the width of the nave. In figure 52, the method for how this was achieved is diagrammed. The width of the nave is 24 feet including the 2 foot thick walls either side of the span. Judging from the photo in figure 52, the width of the window is around 2/5ths that of the nave, meaning the size of the Rosette window would be around 10 feet. The window model was adjusted according as can be seen in figure 53
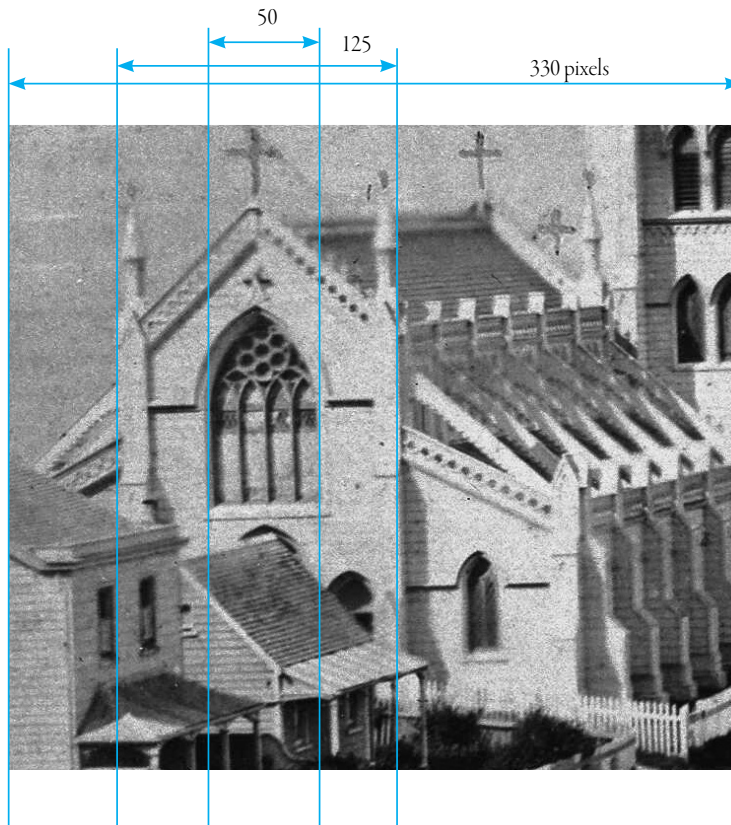
125 = 20 feet wide Nave + 2 wall widths
    = 24 feet

50 = 2/5 of 125 pixels
    = 2/5 of 24 feet

    = 9.6 feet

Figure 52. Diagram showing the process of sizing the window according to the known dimensions of the Nave
(Ref: 1/2-021261-F Alexander Turnbull Library)

Figure 53. Diagram of the windows' ability to change size
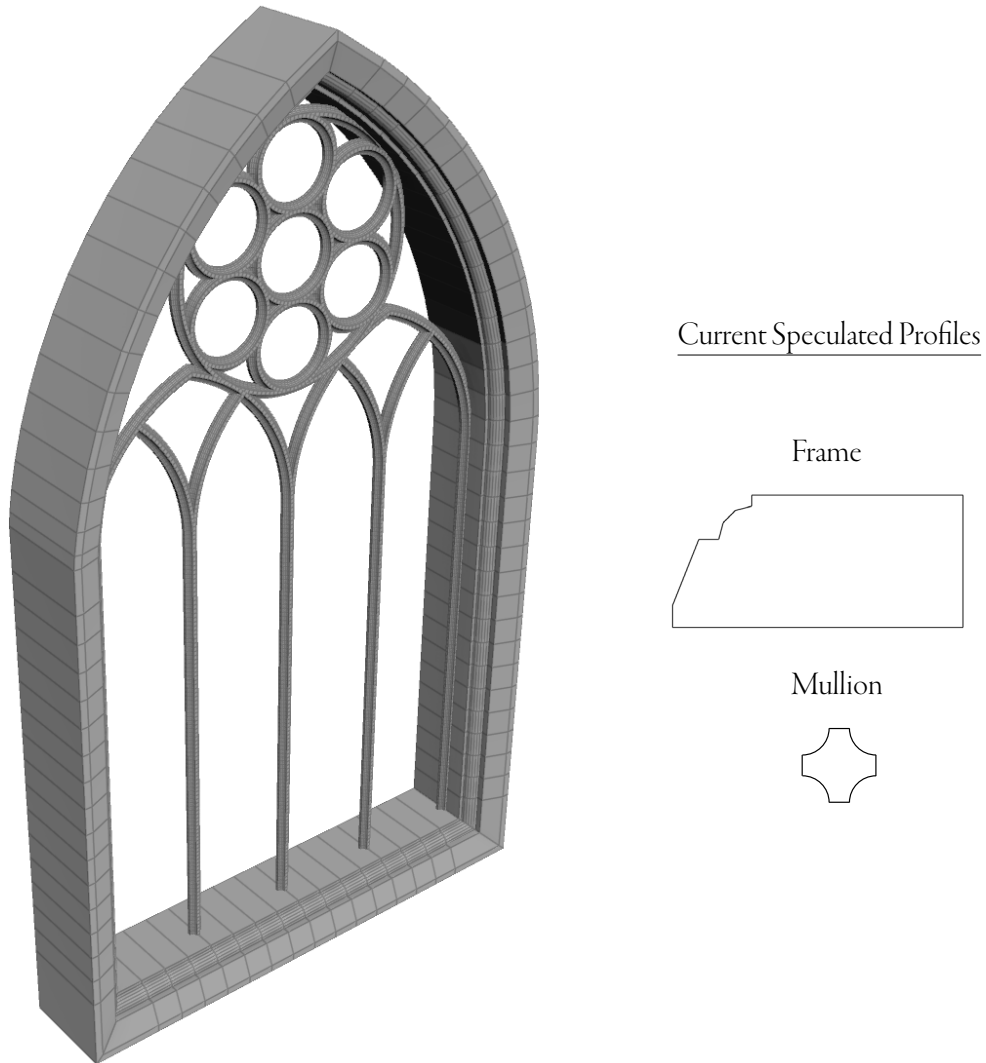
Figure 54. Diagram showing the current speculated window profiles

The current profiles that of the Rosette window are placeholders, as the highest quality photo of the window that could be found (figure 55) is off insufficient detail. The current profiles have been based on the observations of both photos of St Mary's and other similar churches that still exist today. This approximation of such detail is something that can be changed later, as switching inputs in a procedural system is able to be achieved easily. The Rosette window was then applied to the digital reconstruction and checked against archival evidence, as seen in figure 57
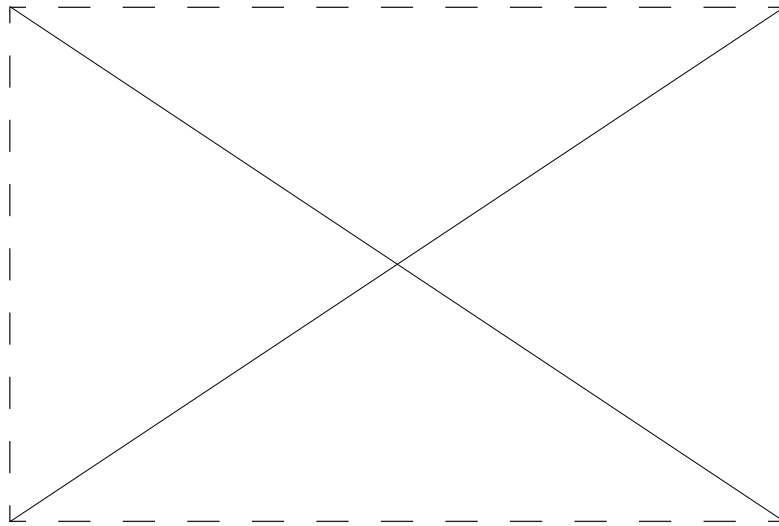
Figure 55. Close up view of St Mary's Showing the Rosette window frame profile
(Front of St Mary's Cathedral, n.d.)

Figure 56. Windows and frames from the still-existing Timber Gothic Churches of St Peter's and St John's (authors photos)
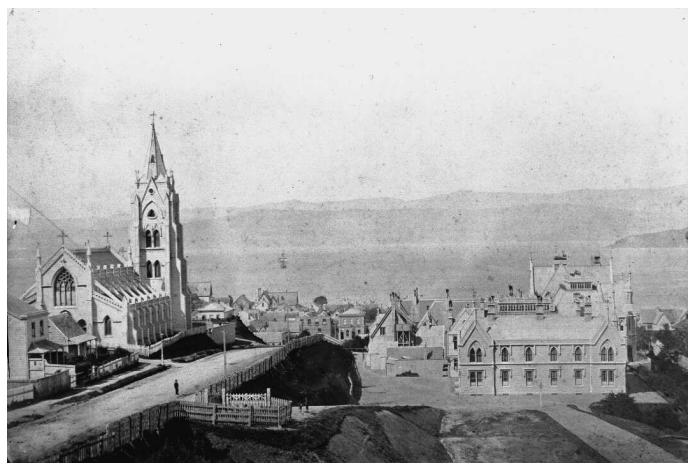
Figure 57. Created digital model of St Mary's compared to a 1879 photo
(Ref: 1/2-021261-F Alexander Turnbull Library)
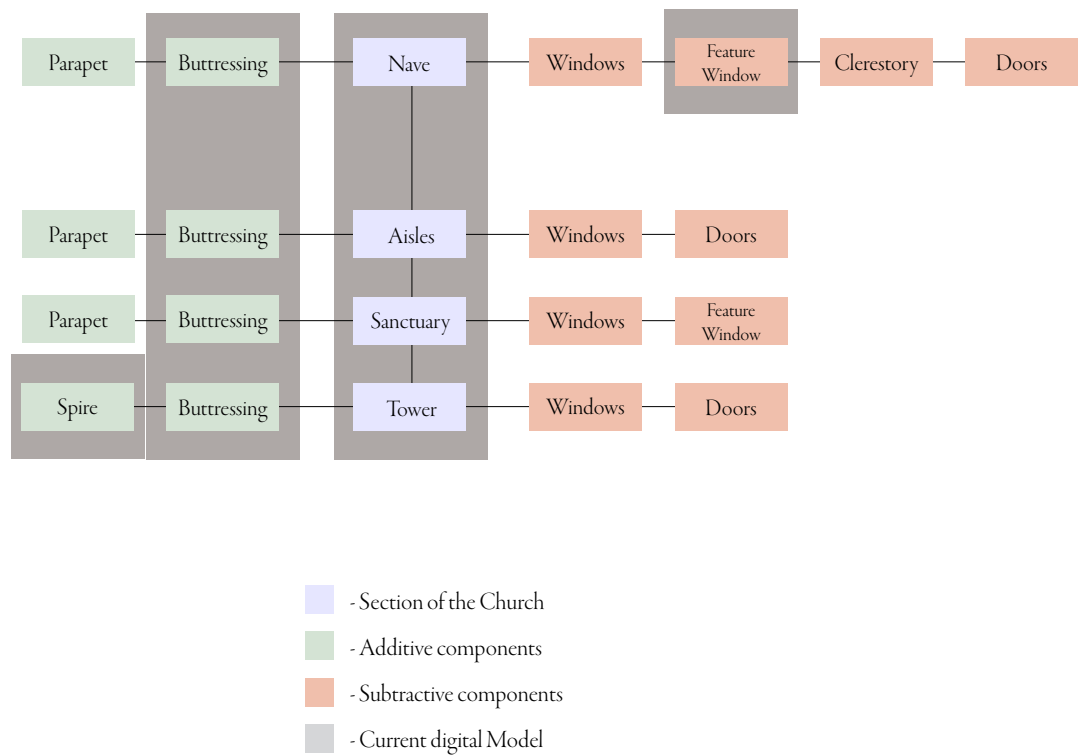
Figure 58. Diagram of the current components of the St Mary's Reconstruction

4.2.3   Parapets
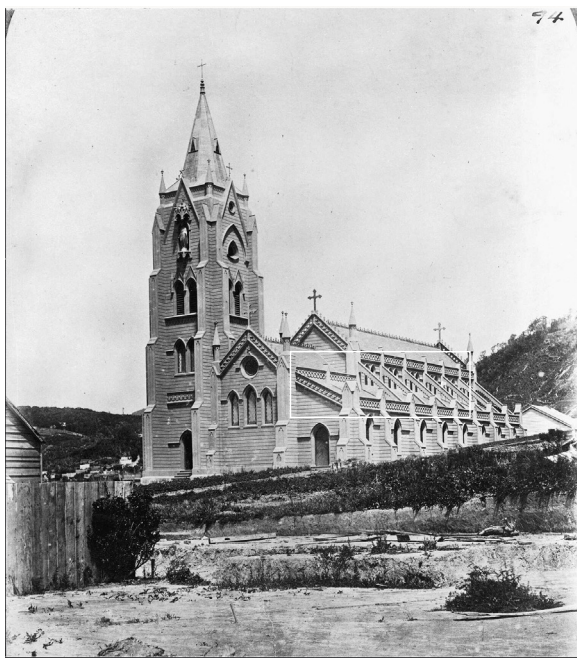
Figure 59. Key photos used for the reconstruction of the parapet
(Ref: 1/2-002467-F Alexander Turnbull Library) (Te Papa collections O.003726)

The parapets of St Mary's were difficult to model as the low quality of the researched photos did not clearly show how they were constructed. The photos that were the most useful are shown in figure 59, with close up views being shown in figure 60. Parapets are seen on the aisles, sanctuary and nave of St Mary's Cathedral. There is also a similarly patterned strip that runs across the side of the tower, seen in the left photo of figure 59. This was not modelled however as the level of detail for this reconstruction was not as much of a focus as creating the main component groups for further development.

Figure 60. Close up views of the photos used to reconstruct the parapet
(Ref: 1/2-002467-F Alexander Turnbull Library) (Te Papa collections O.003726)

Figure 61. Diagram of the creation of a quatrefoil shape

From the photos it was simple to recognise that the shape of the holes in the parapets were quatrefoils, a shape seen in many other Gothic Structures. This form was then constructed from the use of four connected circles, as seen in figure 61. The 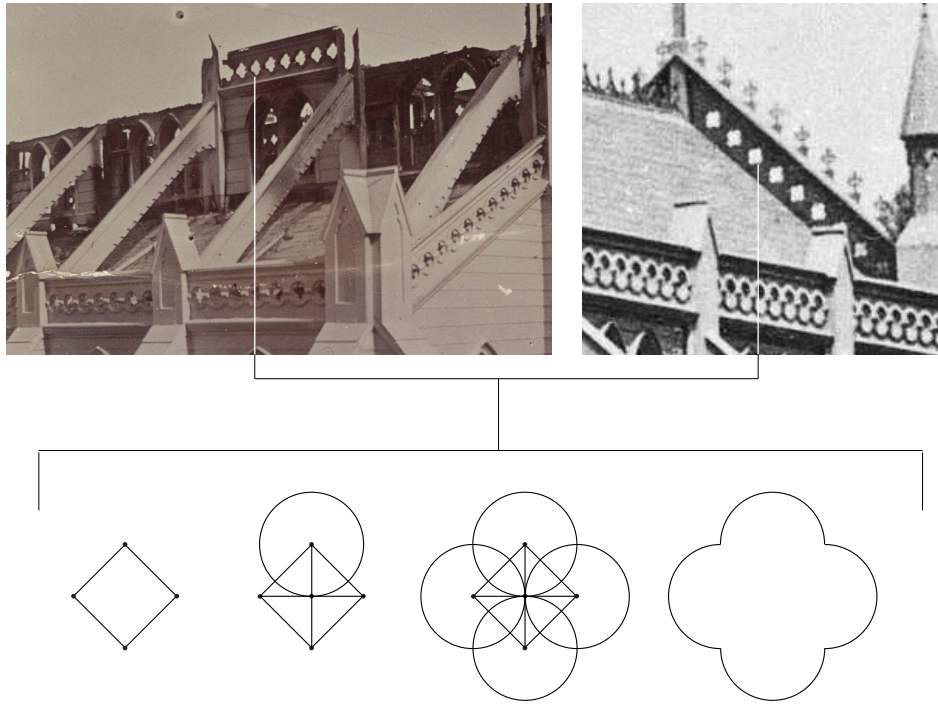construction of the parapet was also assumed to be an intricate and large timber profile that is penetrated by these quatrefoil forms. This was modelled in Houdini by highlighting the edges where the parapet is, sweeping a profile along it, and subtracting the quatrefoils, as seen in figure 62.
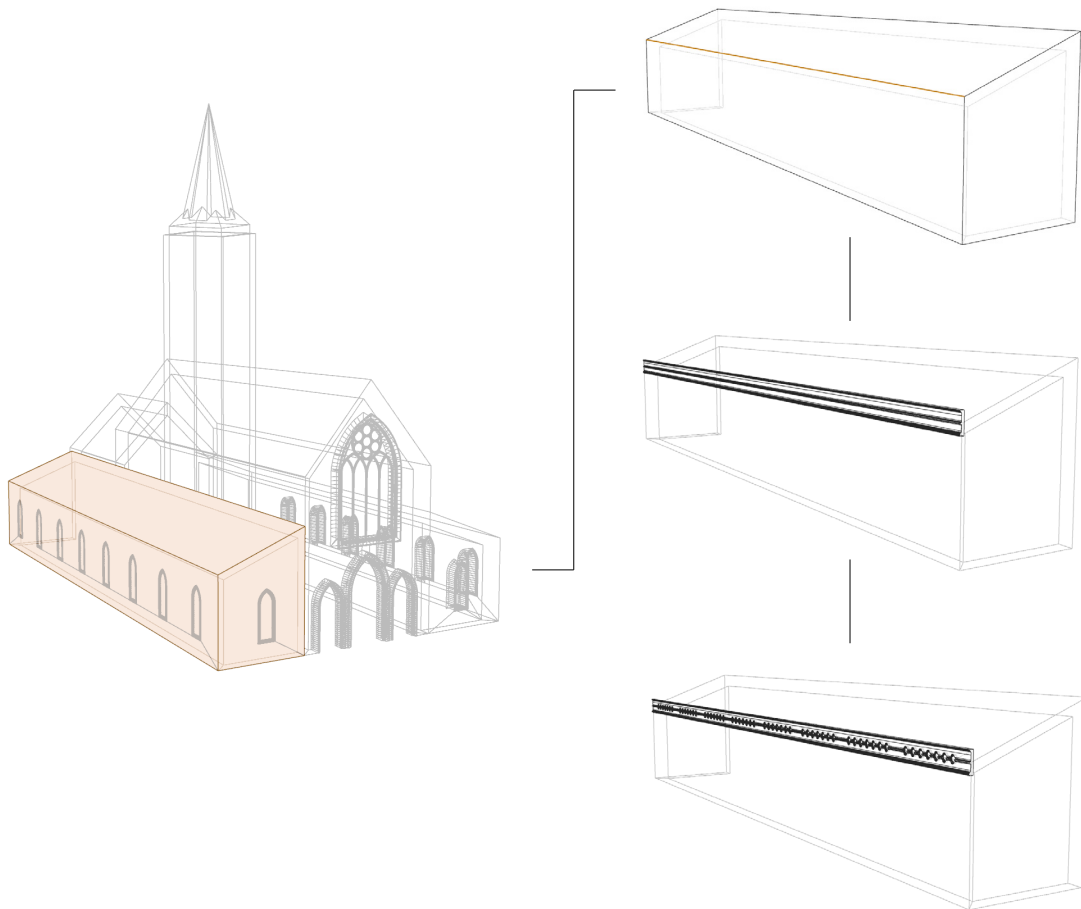
Figure 62. Diagram of how the parapet is applied to the side of the aisle
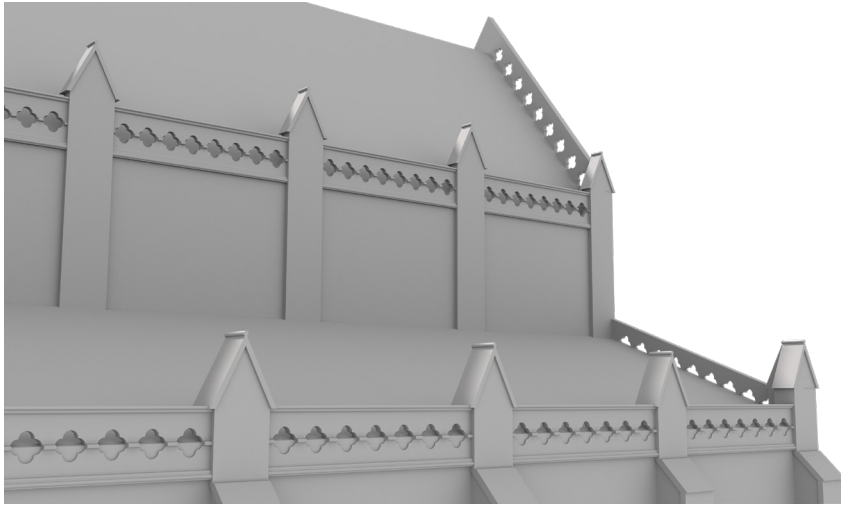
Current Speculated Profile

Figure 63. Render showing the resulting parapet from the speculated profile diagrammed below

Just as the Rosette window, the profile of the parapet is a placeholder. It has been based off of what could be gauged from the photos, however its accuracy is questionable and would need to be changed at a later date. The use of the quatrefoil parapet is not seen very much in similar designs, except for 2. One of them is the lost Wesleyan Church that used to be on Manners St, and from the photo seen in figure 65, it appears to be very similar. This is the only high quality photo of this church however, and so the awkward angle gives little indication to how these were constructed. The other appearance of these parapets is in the existing design of St Peter's. Although containing the repetition of the quatrefoil motif, the design of it is quite different to the ones seen in St Mary's (figure 64). This means more evidence would need to be found in order to establish an accurate reconstruction. The parapets were then applied to the digital reconstruction and checked against archival evidence, as seen in figure 66.

Figure 64. Photos of the qautrefoil parapet design seen on the existing St Peter's (author's photos)
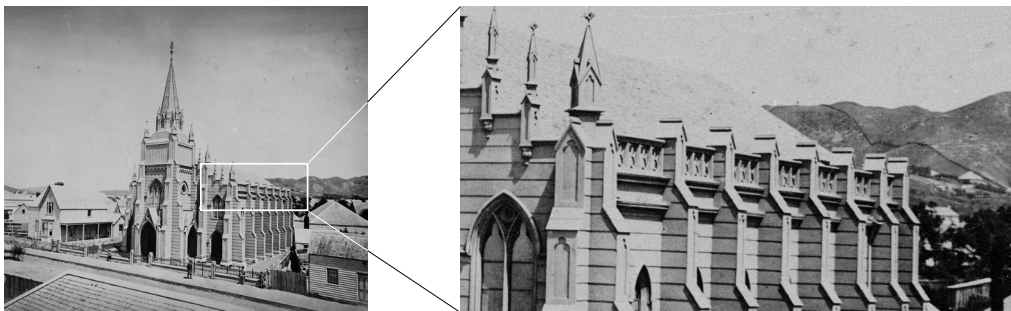
Figure 65. A close up on the quatrefoil parapet design on the lost Manners St Wesleyan Church
(Ref: 1/2-002324-A-G Alexander Turnbull Library)
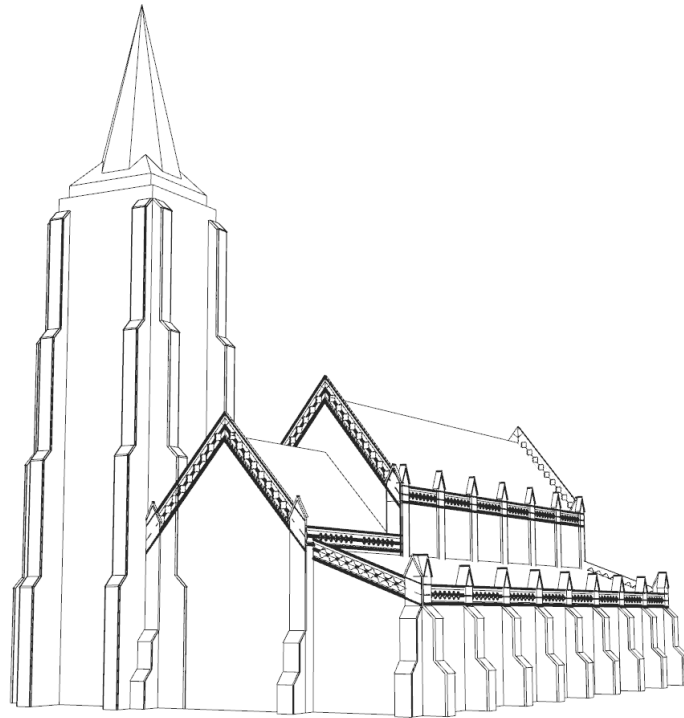
Figure 66. Created digital model of St Mary's compared to a 1879 photo
(Ref: 1/2-002467-F Alexander Turnbull Library)

Parapet	Buttressing		Nave		Windows	Feature Window	Clerestory	Doors

Parapet — Buttressing — Nave — Windows — Feature Window — Clerestory — Doors

Parapet — Buttressing — Aisles — Windows — Doors

Parapet — Buttressing — Sanctuary — Windows — Feature Window

Spire — Buttressing — Tower — Windows — Doors

- Section of the Church

- Additive components

- Subtractive components

- Current digital Model
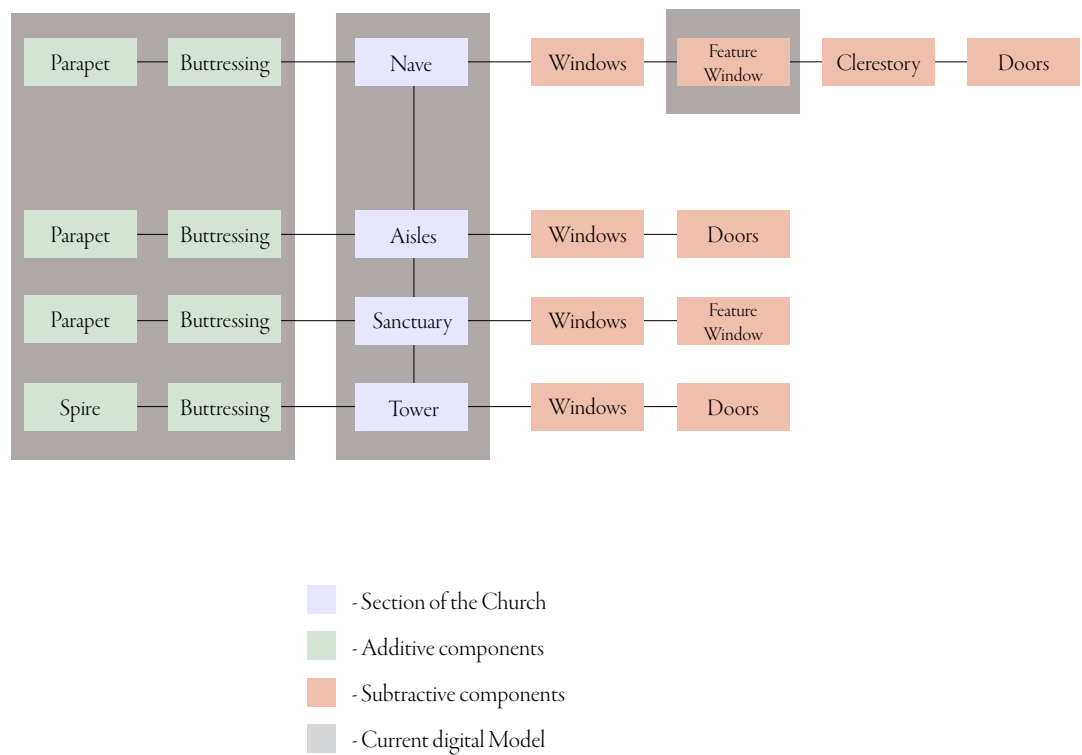
Figure 67. Diagram of the current components of the St Mary's Reconstruction

4.2.4   Doors and Windows

Figure 68. Key photos used for the reconstruction of the Doors and window of St Mary's
(Te Papa collections O.003726) (Te Papa collections D.000019)

The final addition to this reconstruction of St Mary's is the doors and windows. The way these components were created is very similar to the Rosette window, as they are constructed of lines that are then extruded along with a profile. The dimensions were also gauged in much the same way, being calculated from the known dimension of the nave, as seen in figure 69.
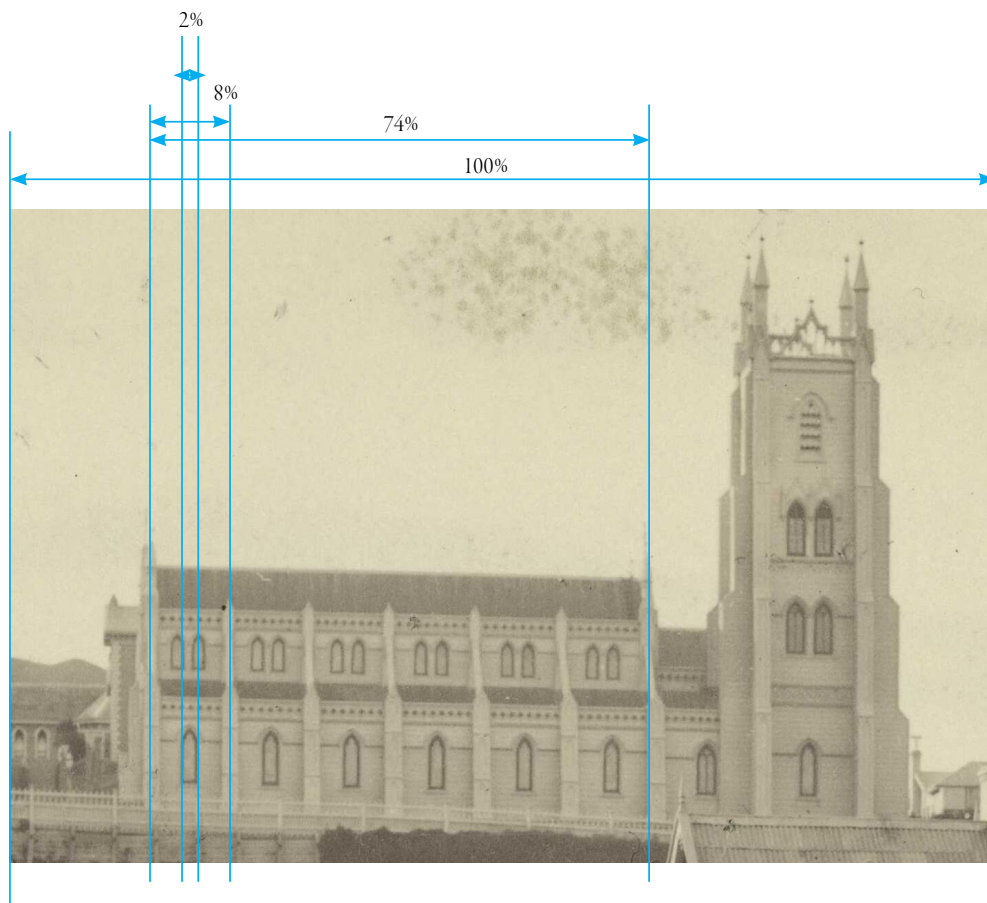
74% = 74 feet
2% = 2 foot
Aisle window = ~2 foot wide

Figure 69. Diagram showing how the size of the windows were calculated from the
known size of the nave
(Ref: PAColl-8651 Alexander Turnbull Library)
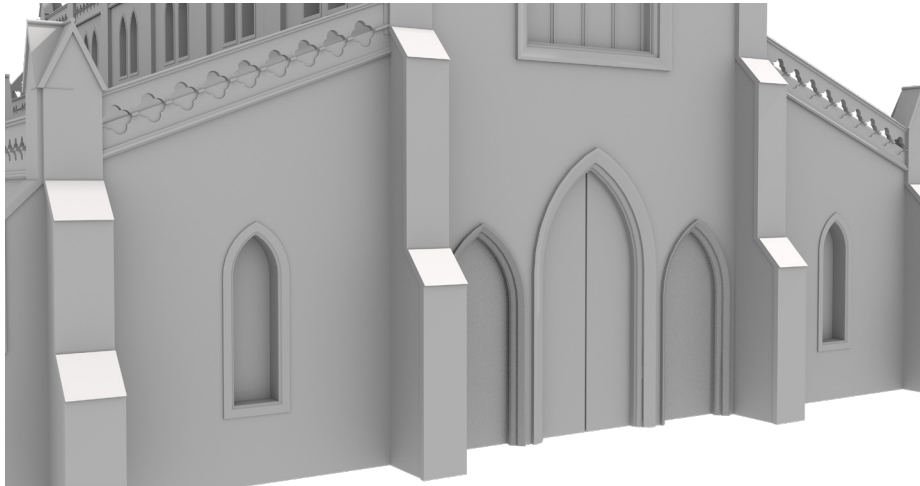
Current Speculated Window Profile
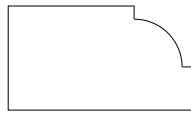
Figure 70. Render showing the resulting windows and doors from the Rosette frame profile and the window profile diagrammed below

The profile of the windows are all the same, being the speculated profile seen in figure 70. Seeing as there is little information on the frame profiles of St Mary's, this profile has been speculated to be very similar to that found in the windows of St Peter's seen in figure 56 of the Rosette window reconstruction. The width, height, and profile thickness can all be adjusted to create the various window designs present in St Mary's, as seen in figure 71. The thickness of the window is also predetermined by the wall thickness of whichever area of the church it is being applied to.

The frame of the doors is assumed to be the same as the Rosette window, as from the photo of the burnt wreckage in figure 68 it can be seen that both frame are equally detailed. The window and doors were then applied to the digital reconstruction and checked against archival evidence, as seen in figure 72
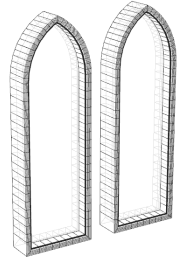
Tower windows
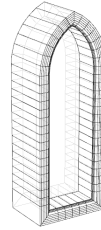
Aisle windows
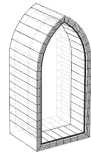
Clerestory windows
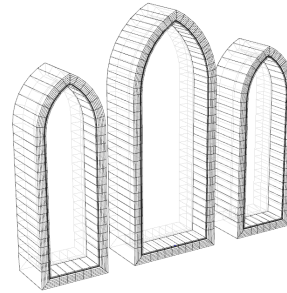
Sanctuary windows
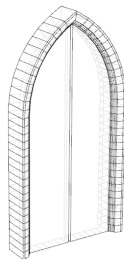
Tower Door
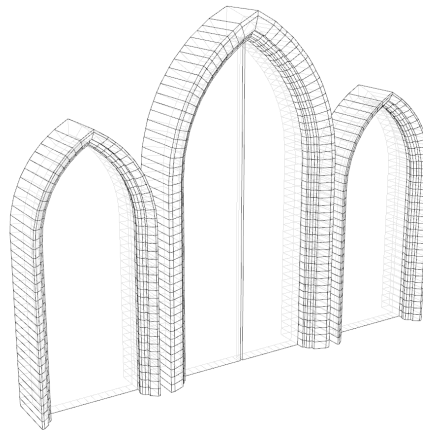
Nave Door

Figure 71. Diagram showing the different doors and windows present in the St Mary's Reconstruction
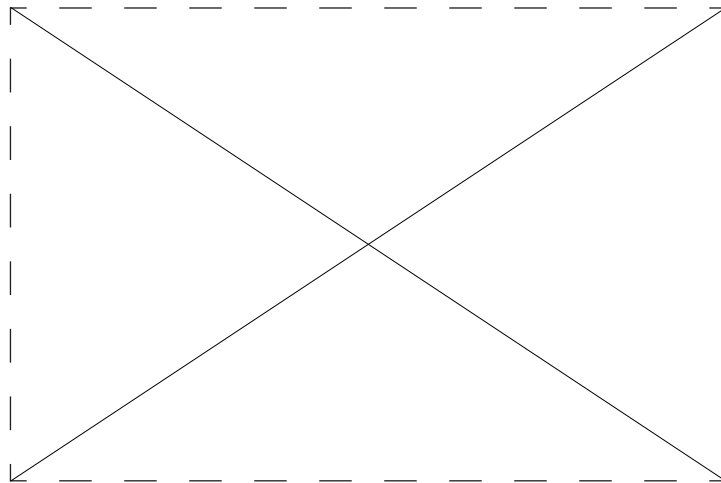
*Figure 72. Created digital model of St Mary's compared to an 1882 photo (minus the
1880's spire change)*
(Front of St Mary's Cathedral, n.d.)

Parapet	Buttressing		Nave		Windows	Feature Window		Clerestory	Doors

Parapet	Buttressing		Aisles		Windows	Doors

Parapet	Buttressing		Sanctuary		Windows	Feature Window

Spire	Buttressing		Tower		Windows	Doors

- Section of the Church

- Additive components

- Subtractive components

- Current digital Model
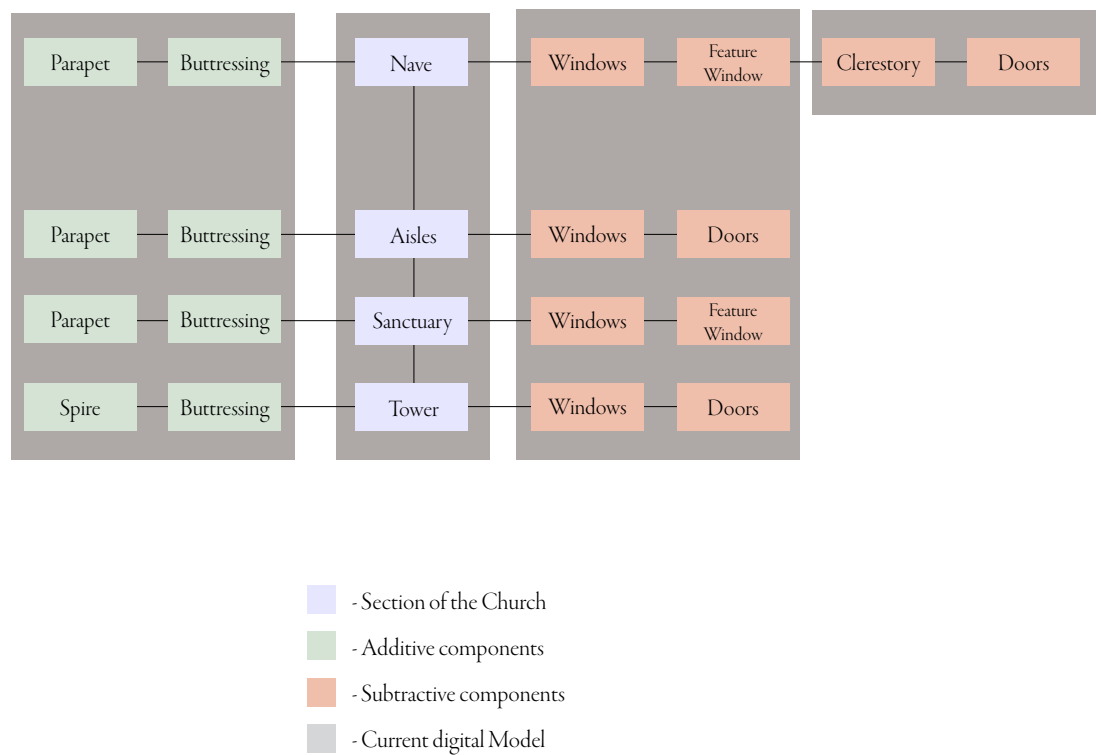
Figure 73. Diagram of the current components of the St Mary's Reconstruction

4.2.5   Final Touches

The last additions to the digital reconstruction of St Mary's was the flying buttresses and cladding. The cladding was achieved by subtracting the grooves that the overlapping rusticated weatherboards would make from the exterior walls. Another way of achieving such an effect would be to apply a bitmap texture however this is not the focus of this research. The flying buttresses were created by a simple extrusion from the top of the aisle buttresses to the side of the nave. From the photos it can be seen that these flying buttresses are curved on the bottom side however this is not included in this reconstruction for the sake of simplicity

Figure 74. Clay Render of the completed St Mary's Cathedral Reconstruction

4.3   Created System

The initial process of creating this reconstruction saw many rearrangements of the procedural node system as seen in figure 75. This current system separates the different church areas and applies the subtractive components before bringing all these segments together along with the additive components. The difficulty in applying the subtractive components was that the hole for the window had to be cut into the basic shape. This is what the Boolean functions are for. The Boolean shape is created alongside the window itself so that their sizes match. This is done within the subtractive component node, with the Boolean shape then being linked in the layer above so that it can be connected to a Boolean function with the shape it cuts into.

- Basic Church shapes/areas

- Subtractive Components

- Additive Components

- Subtractive Components Boolean
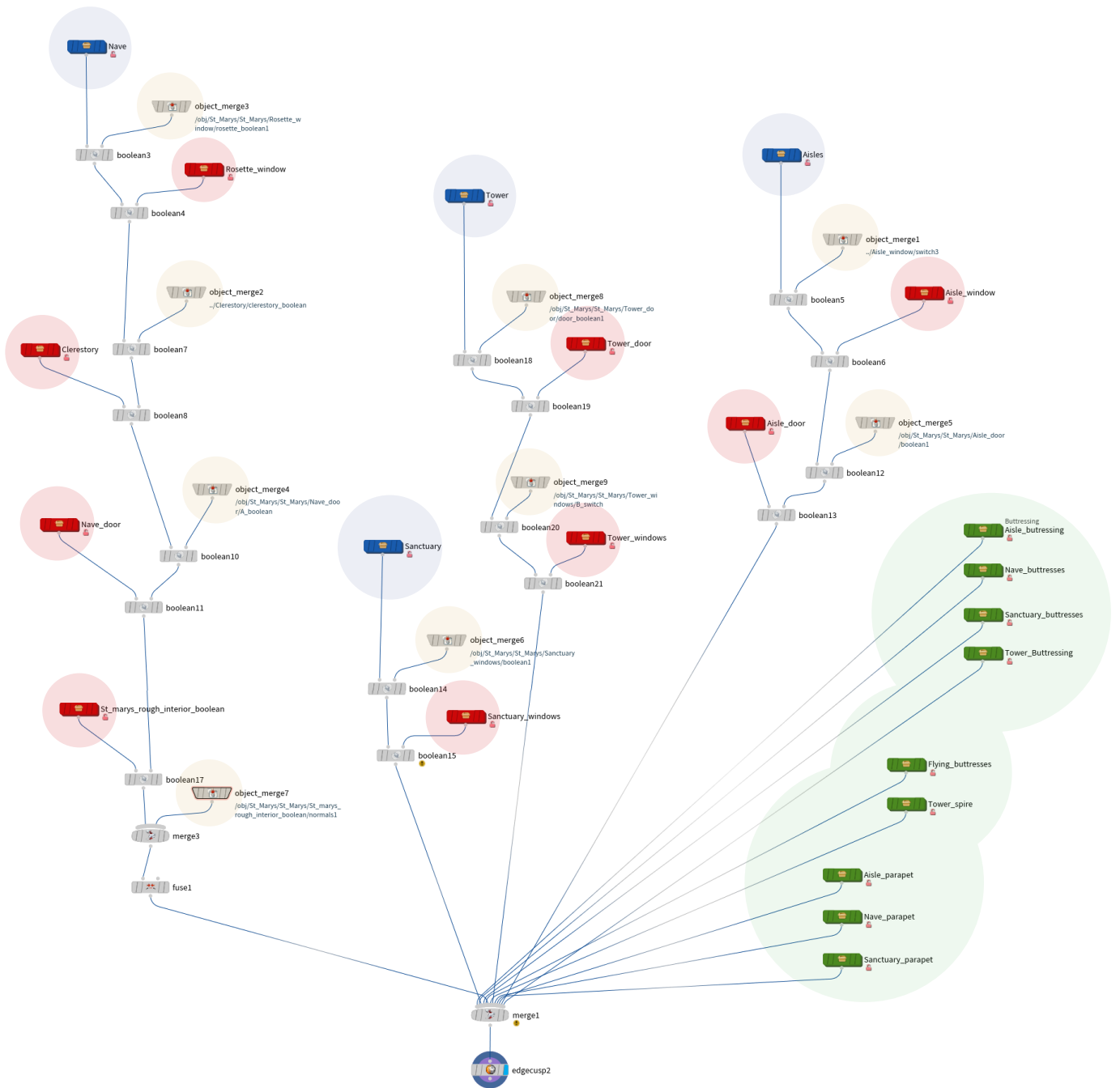
Figure 75. The created node system for the reconstruction of St Mary's
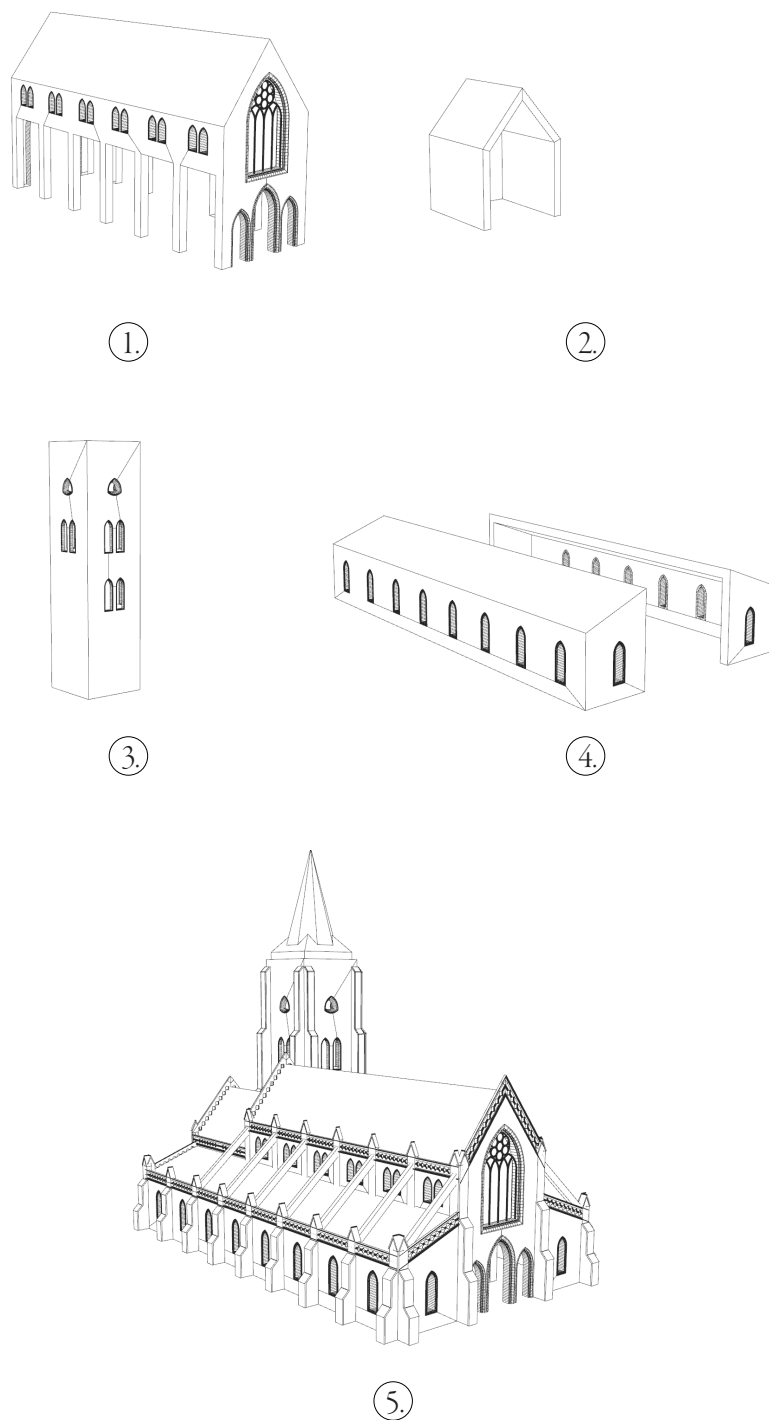
Figure 76. Diagram showing what's happening at various points in the procedural system

Nave

object_merge3
/obj/St_Marys/St_Marys/Rosette_w
indow/rosette_boolean1

boolean3

Rosette_window

boolean4

object_merge2
../Clerestory/clerestory_boolean

Clerestory

boolean7

boolean8

object_merge4
/obj/St_Marys/St_Marys/Nave_doo
r/A_boolean

Nave_door

boolean10

boolean11

St_marys_rough_interior_boolean

boolean17

object_merge7
/obj/St_Marys/St_Marys/St_marys_
rough_interior_boolean/normals1

merge3

1. fuse1

Tower

object_merge8
/obj/St_Marys/St_Marys/Tower_do
or/door_boolean1

boolean18

Tower_door

boolean19

object_merge9
/obj/St_Marys/St_Marys/Tower_wi
ndows/B_switch

Sanctuary

boolean20

Tower_windows

3. boolean21

object_merge6
/St_Marys/St_Marys/Sanctuary
_windows/boolean1

boolean14

Sanctuary_windows

2. boolean15

Aisles

object_merge1
../Aisle_window/switch3

boolean5

Aisle_window

boolean6

Aisle_door

object_merge5
/obj/St_Marys/St_Marys/Aisle_door
/boolean1

boolean12

4. boolean13

Buttressing
Aisle_butressing

Nave_buttresses

Sanctuary_buttresses

Tower_Buttressing

Flying_buttresses

Tower_spire

Aisle_parapet

Nave_parapet

Sanctuary_parapet

5. merge1

edgecusp2

- Basic Church shapes/areas

- Subtractive Components

- Additive Components

- Subtractive Components Boolean

97

Figure 77. Diagram showing the nodes that are used to create the nave, and how these nodes are grouped within a singular node
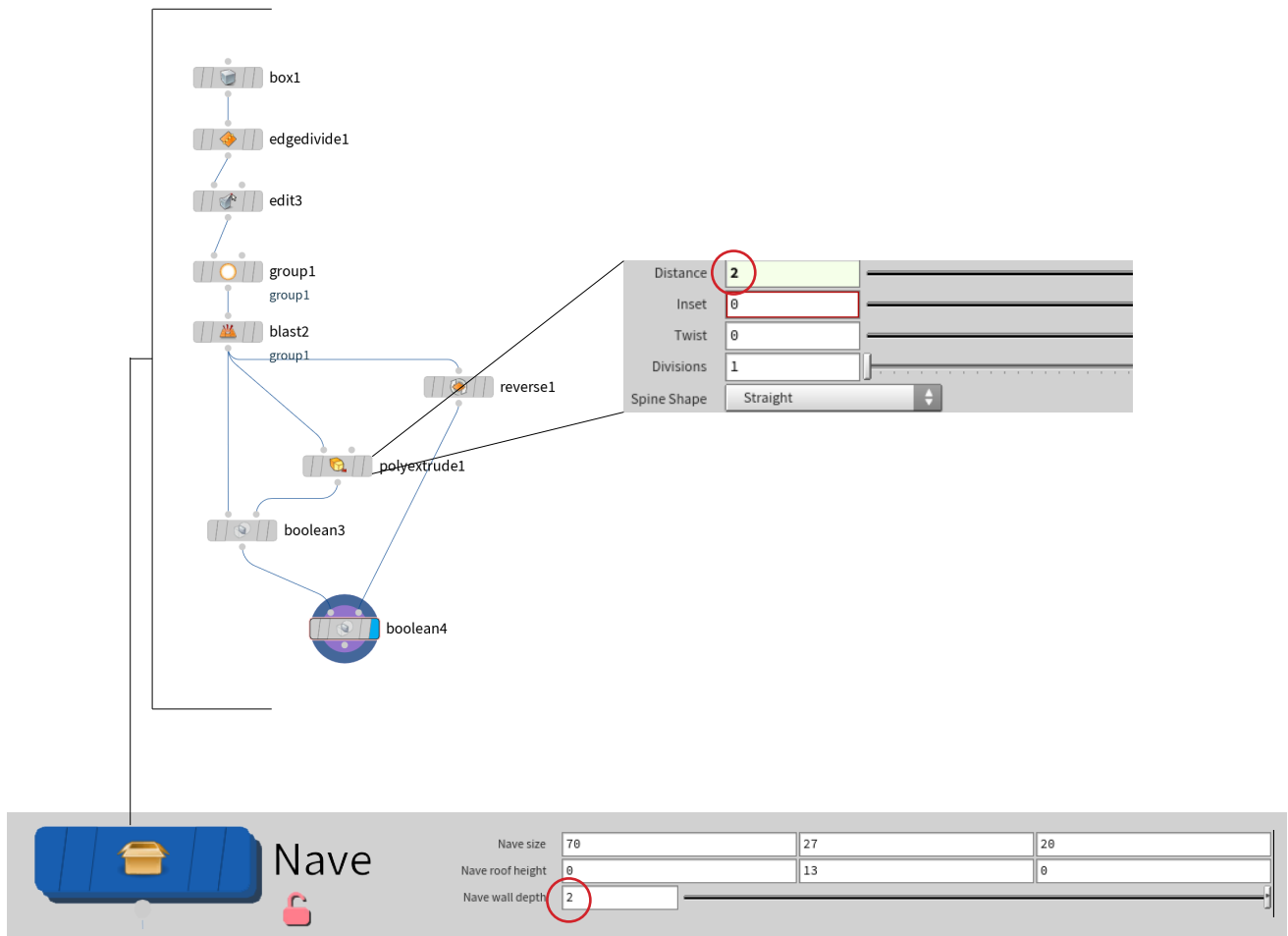
Figure 78. Diagram showing how the custom parameters of the Nave node are simply links to the functions inside the node

Each component is able to be adjusted. This is done in the parameters tab when the node of the component is selected, seen in figure 78. These are custom parameters, and are merely links to the functions within the node that actually alter the geometry. The result is 22 component nodes with around 3-8 parameters each.

4.4 Reflection

The initial process of creating this reconstruction was very labour intensive and would have been comparable, if not more complicated than a traditional CAD reconstruction. However one the main advantages of procedural modelling over CAD is being able to create the system for a component without having to know the full dimensions of it. This means you can create a rough reconstruction and then make it more historically accurate later on.

The other advantage to using procedural modelling for this reconstruction is that many of the components such as the buttresses, doors and windows could be adapted to create the different variations of the component within the design. This saved a lot of time in the modelling process

One of the negatives of the system that was found was that adjusting the custom parameters. Because the adjustable parameters of the components can only be changed while the node is selected, the process of applying the same change to different components (such as moving the buttresses and fitting the windows between them) can become tedious. One solution to this would be to interlink these parameters together, or collect all the parameters into one node.
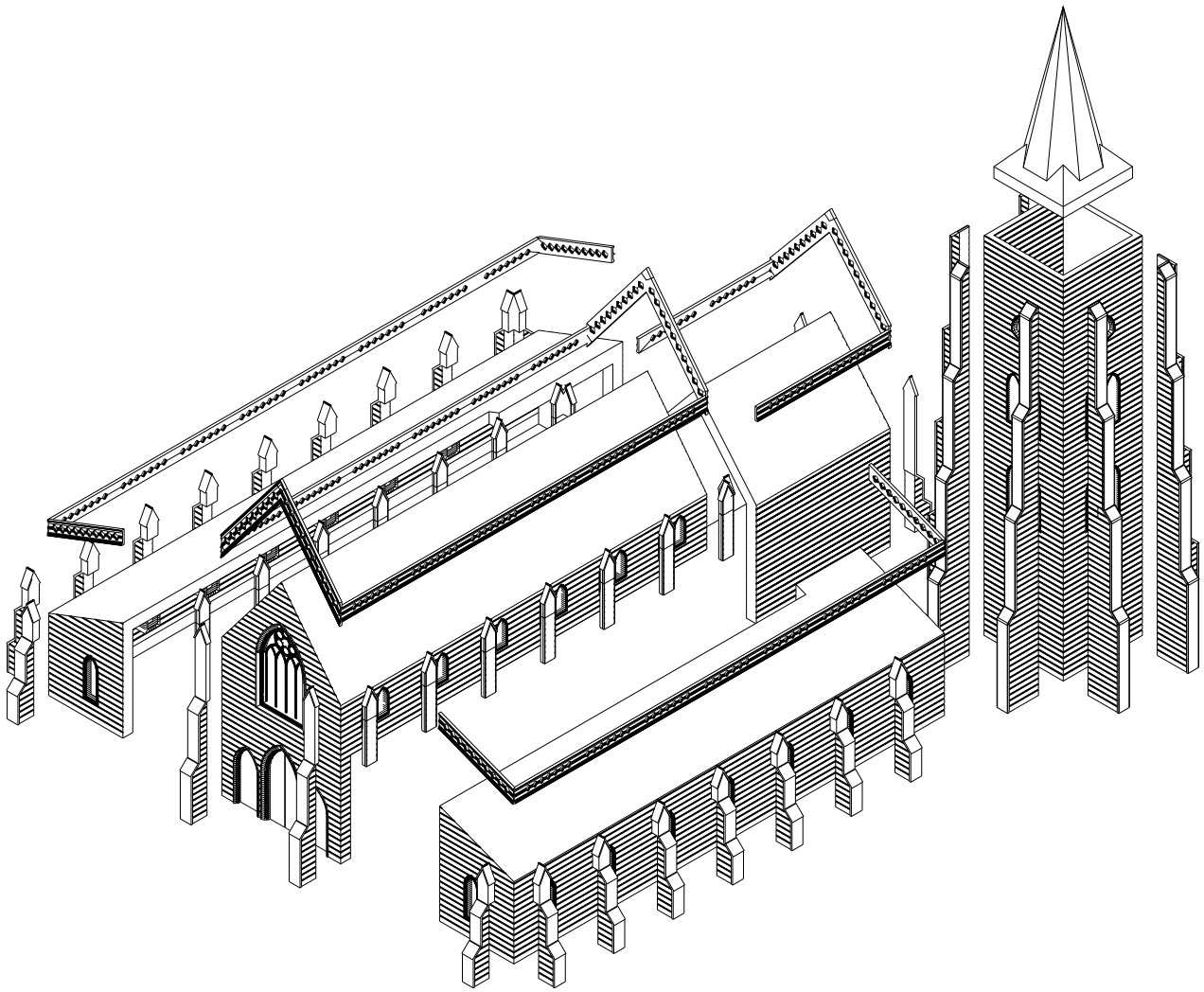
Figure 79. Exploded view of the St Mary's Cathedral reconstruction

5. Preliminary Design

5.1   Adapting the Procedure

Now that an initial procedural church system is in place, the focus of the research turned to the exploration of what else could be made.

Figure 80 shows three different timber church designs built in Wellington, being the already reconstructed St Mary's, Old St Paul's, and St Peter's. What is clear from the diagram is that these designs all consist of very different layouts and basic dimensions. Although these designs share many architectural components, new components would have to be added to the procedural system in order for these designs to be created. This is what is explored in this chapter.

What is also explored in this chapter is the analysis of lost church designs. This relates to the second objective of this research and looks at how similar designs may be descended from one another. This is achieved through the analysis and comparison of the constituent components of each design.
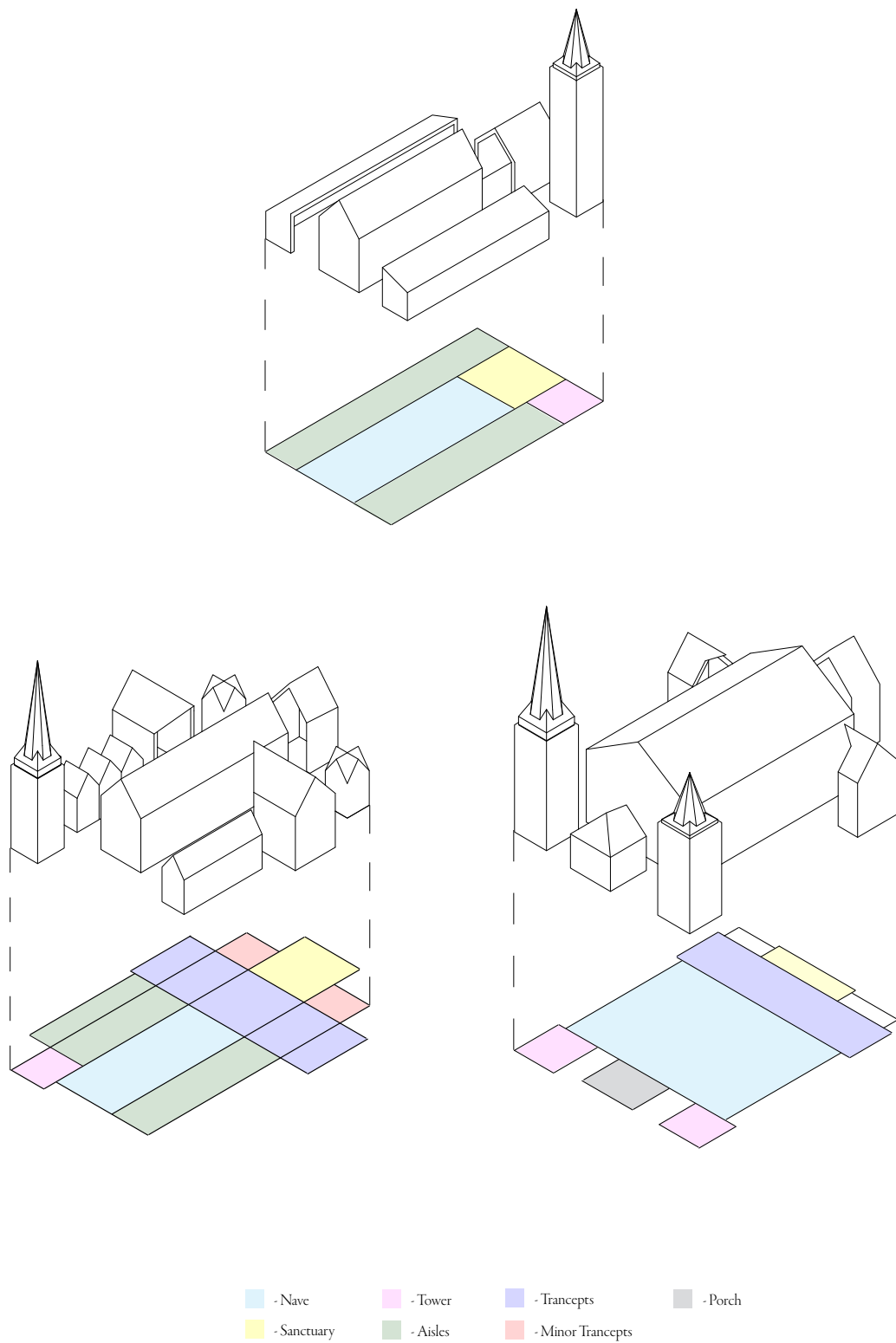
Figure 80. Spacial breakdown of St Mary's (top) compared to Old St Paul's (left) and St John's (right)

Select and research case study

First hand data

- Plans
- Photos
- Written descriptions

Second hand data

- Similar buildings by architect
- 'Style' geometry

Break down case study into architectural components and underlying rules

Procedural Component Library

Create or adjust procedural architectural components

Digital reconstruction

Repeat process for similar
case studies to build up
the component library

Figure 81. Diagram for the proposed methodology of creating a component library that would inform speculative reconstructions of lost designs

Developing from the method proposed by Webb (mentioned in section 4.1), a methodology for the reconstruction of lost architectural heritage was created, as seen in figure 81. This methodology reflects how different designs can consist of very similar architectural components (figure 82). The sharabilty and adjustability of the procedural components within Houdini allow reconstructions for one design to be the basis for another. The components from St Mary's become part of the library of procedural items that can be adjusted to create other designs. In order to grow this library, some existing designs were then reconstructed using the same system used to generate St Mary's

St Peter's
1879

St Mary's Cathedral
1867

Manners St Wesleyan Church
1868

Figure 82. Diagram comparing how the design of the buttresses has changed between the different churches

(Ref: 1/1-019972-G. Alexander Turnbull Library) (Ref: 1/2-002467-F Alexander Turnbull Library)
(Ref: 1/2-002324-A-G Alexander Turnbull Library)

5.1.1   Old St Paul's

Old St Paul's was built in 1866, just 1 year before St Mary's Cathedral. It was originally designed by Frederick Thatcher, however as the size of the congregation grew, other architects were brought in to design extensions for the church. This included a transept and aisle extension design by Christian Toxward, the architect of St Mary's. This was the key motive for the reconstruction of this design. Old St Paul's was one of the first existing designs that was reconstructed in this research. This was because it was thought that many of its components could be taken from St Mary's, as it was built at almost the same time and was one of the only examples of Toxward's architecture that still survives. However this was not the case. The design of Old St Paul's proved to be very different and added many new categories to the procedural system. These included the addition of a transept, minor transept, 3 new feature windows, eaves, porch/baptistery, and a host of aisle extensions. This Anglican Church also used horizontal board and batten cladding rather than rusticated weatherboards as seen on St Mary's Cathedral
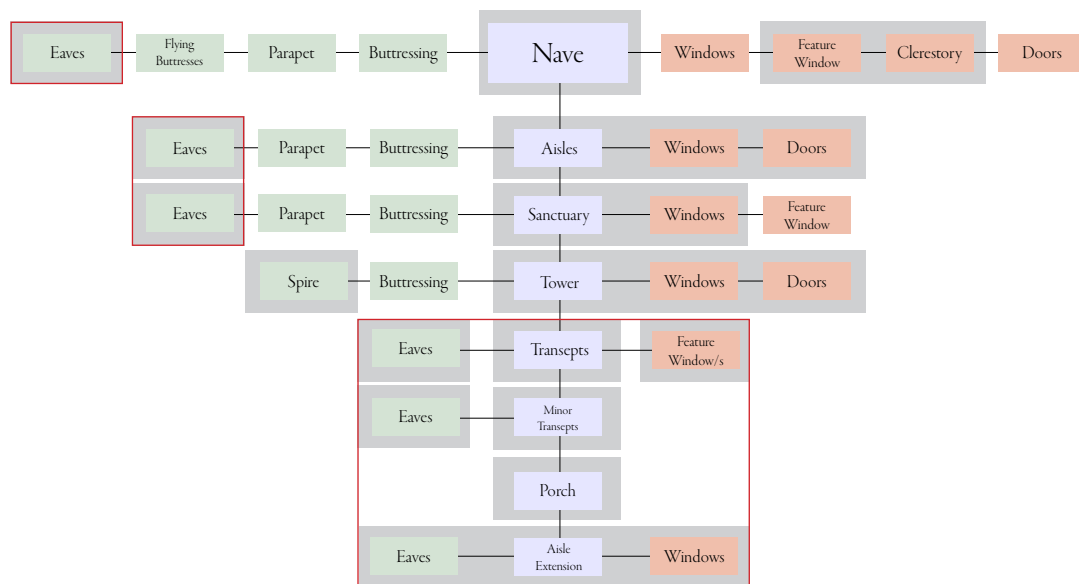
Figure 83. 1868 photo of Old St Paul's (top), and a diagram of the constituent components of Old St Paul's, with the red highlighting the new component categories added (Ref: 1/1-025547-G. Alexander Turnbull Library)
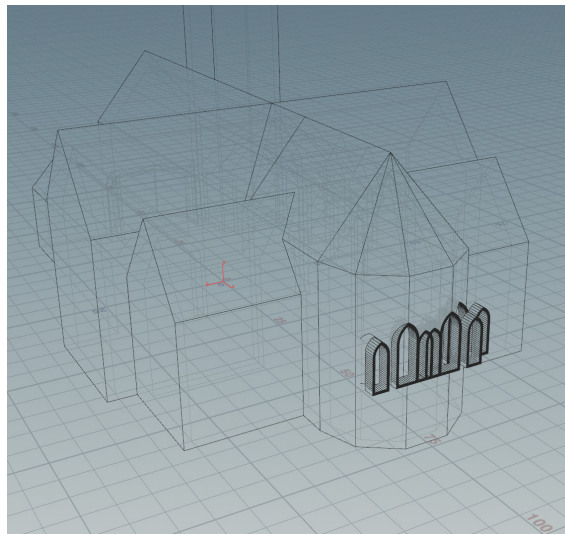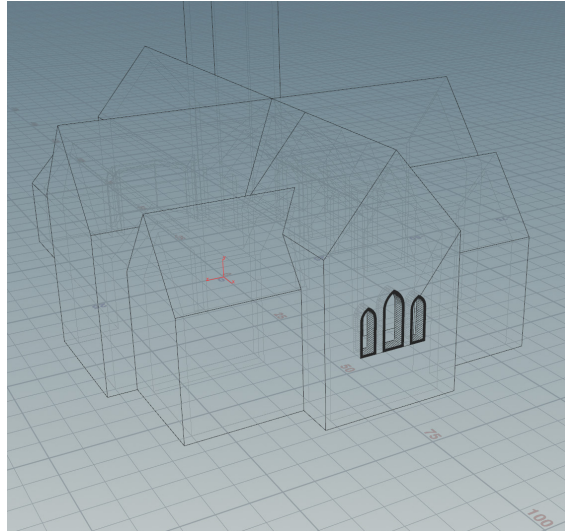
Figure 84. Houdini's scene view showing how the windows malfunction when applied to the Old St Paul's sanctuary design
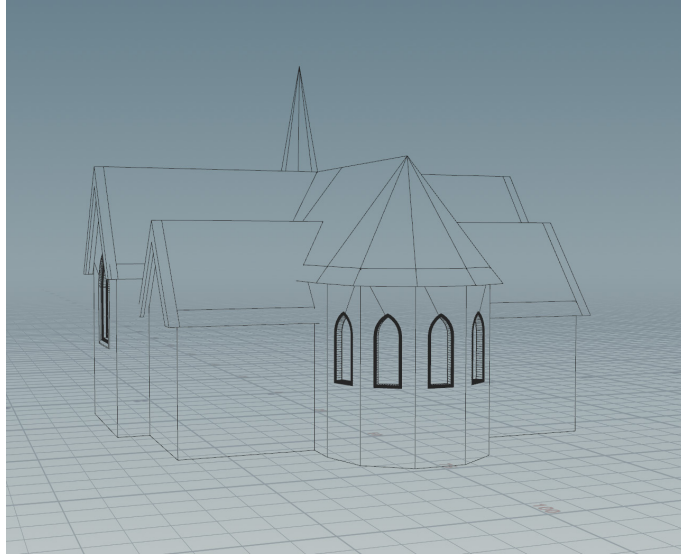
*Figure 85. Houdini's scene view showing the adapted window component applied to
the Old St Paul's Sanctuary design*

As well as new components being added to the procedural system, existing components were
also adjusted. One such example is the sanctuary. The design of St Mary's sanctuary was a
simple rectangular shape with a gabled roof. The design of Old St Paul's is the same however the
end is chamfered, consisting of 5 equal sides. As seen in figure 84, when the sanctuary windows
that were originally designed for St Mary's are applied to the chamfered sanctuary, the resulting
multiple windows are oriented incorrectly and clip each other. This required a redesign of the
sanctuary window component so that when the chamfered sanctuary is selected, windows like
the ones seen in figure 85 are generated.

Figure 86. Render of the front elevation containing Thatcher's oddly divided windows

An interesting outcome of this reconstruction was the ability to compare the architectural components that were designed by Thatcher, to those by Toxward. Through the reconstruction of the feature windows that are seen in figure 88, it was found that Toxward's windows are enclosed in a traditional Gothic arch, while Thatcher's use a less angular 'drop' arch. A drop arch is created by bringing the centre of the circle that creates the top arch closer to the centre, seen in figure 87. The drop arch seen in Thatcher's designs is created by bringing the centre of the circles in by a third. This division by an odd number is continued in the tracery, as 5 sided cinquefoil's can be seen in the front window. The reason this is significant is because almost all of Toxward's tracery is created using even divisions, with quatrefoils being and divisions of 4 being very common in his window designs. The significance of this finding is minor, however it was something that was very obvious during the process of reconstruction
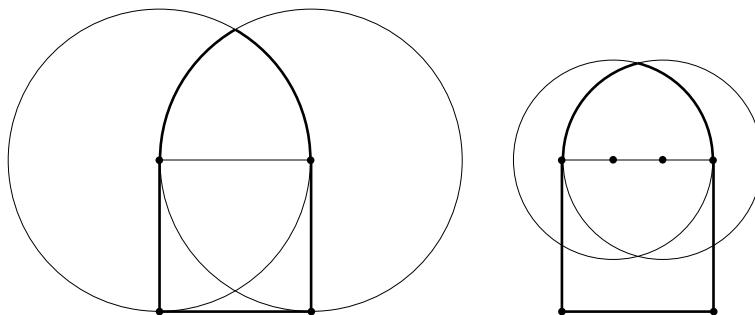
Figure 87. Diagram showing the difference between and traditional Gothic arch (left)
to a drop Gothic arch (right)

St Mary's Front Window

Christian Toxward

Old St Paul's Front Window

Frederick Thatcher

Old St Paul's North Transept window

Christian Toxward

Old St Paul's South Transept window

Frederick Thatcher

Old St Paul's Aisle window

Frederick Thatcher

Figure 88. Renders comparing the new window components that were added through the reconstruction of Old St Paul's to the Rosette window of St Mary's

5.1.2   Christ Church Taita
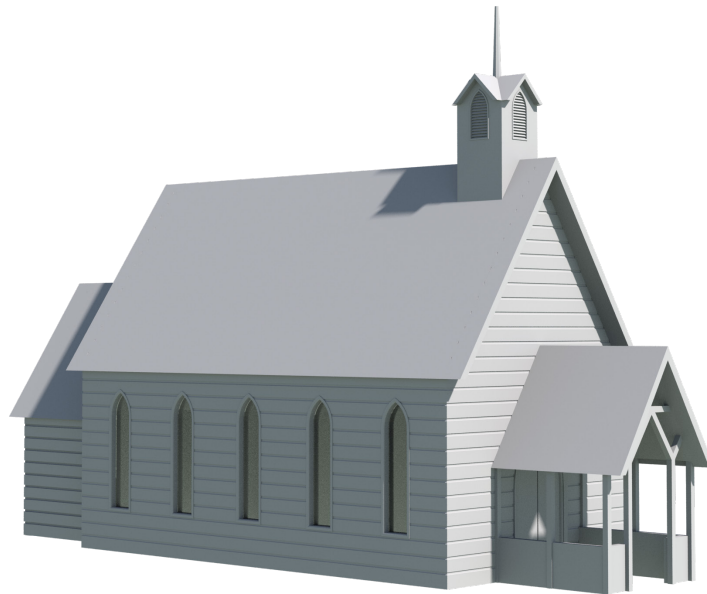
Christ Church in Taita was built in 1854 and stands as Wellington's oldest church that still exists today. This simple church was designed and constructed by John and Sidney Hirst. The reason this church was reconstructed was to see if the procedural system could create timber gothic church designs that are similar to ones built by early settlers before the government moved to Wellington in 1865. The simplicity of the design meant that very few architectural components needed to be added to the procedural system, with the only new additions being the small steeple located on the top of the nave, and a custom design for the porch to expose its framing. The clerestory component was also adapted to become the windows for the nave. This would mean it would no longer be classified as a clear story however as they are both windows applied to the side of the nave, no new component category was added

Steeple	Eaves	Flying Buttresses	Parapet	Buttressing	Nave	Windows	Feature Window	Clerestory	Doors
Eaves	Parapet	Buttressing	Aisles	Windows	Doors
Eaves	Parapet	Buttressing	Sanctuary	Windows	Feature Window
Spire	Buttressing	Tower	Windows	Doors
Eaves	Transepts	Feature Window/s
Eaves	Minor Transepts
Eaves	Porch	Exposed Framing
Eaves	Aisle Extension	Windows

Figure 89. 1951 photo of Christ Church in Taita (top), and a diagram of its constitu-
ent components, with the red highlighting the new component catagories added
(Ref: PAColl-6303-06 Alexander Turnbull Library)
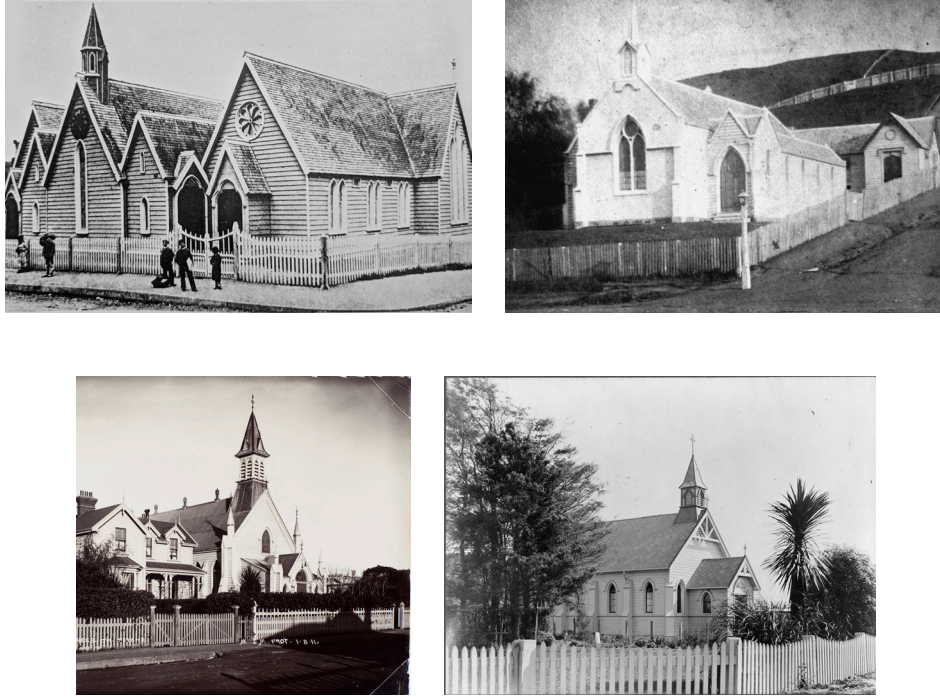
Figure 90. Collection of Wellington's timber Gothic Churches that also include a nave steeple.

(Ref: PAColl-6114-02. Alexander Turnbull Library)(Ref: 1/2-044658. Alexander Turnbull Library) (Te Papa Collections O.001745) (Ref: 1/2-107532-F Alexander Turnbull Library)

By looking at the churches researched for this thesis, it can be seen that the inclusion of a nave steeple is something that is very common in early designs, but seldom seen in designs of the second half of the 19th century. Although later examples such as St David's and St Hilda's (as seen in the lower left and right of figure 90) do make use of the nave steeple, a tower is more often included in the larger more complex designs

Figure 91. Render of the digital reconstruction of Christ Church Taita

5.1.3   St Peter's

St Peter's was built in 1879 by architect Thomas Turnbull. This church shares significant
similarities with St Marys in terms of its use of buttressing and cladding type, however the
layout and proportions are radically different when compared to the churches that have been
reconstructed so far. This was the main reason such a church was chosen for reconstruction.
Looking at the researched examples of Wellington's Gothic Churches, it can be observed that
there are various churches with similar proportions to St Peter's (figure 93). In order for the
components to be adaptable enough to create these designs, the procedural model will have to
be able to be adjusted to handle such large proportions; and so St Peter's was chosen for
reconstruction

| Steeple | Eaves | Flying Buttresses | Parapet | Buttressing | **Nave** | Windows | Feature Window | Clerestory | Doors |

| | Eaves | Parapet | Buttressing | Aisles | Windows | Doors |

| | Eaves | Parapet | Buttressing | Sanctuary | Windows | Feature Window |

| | Spire | Buttressing | Tower | Windows | Doors | Bell Vents |

| | Eaves | Transepts | Feature Window/s |

| | Eaves | Minor Transepts |

| | Eaves | Porch | Exposed Framing | Doors |

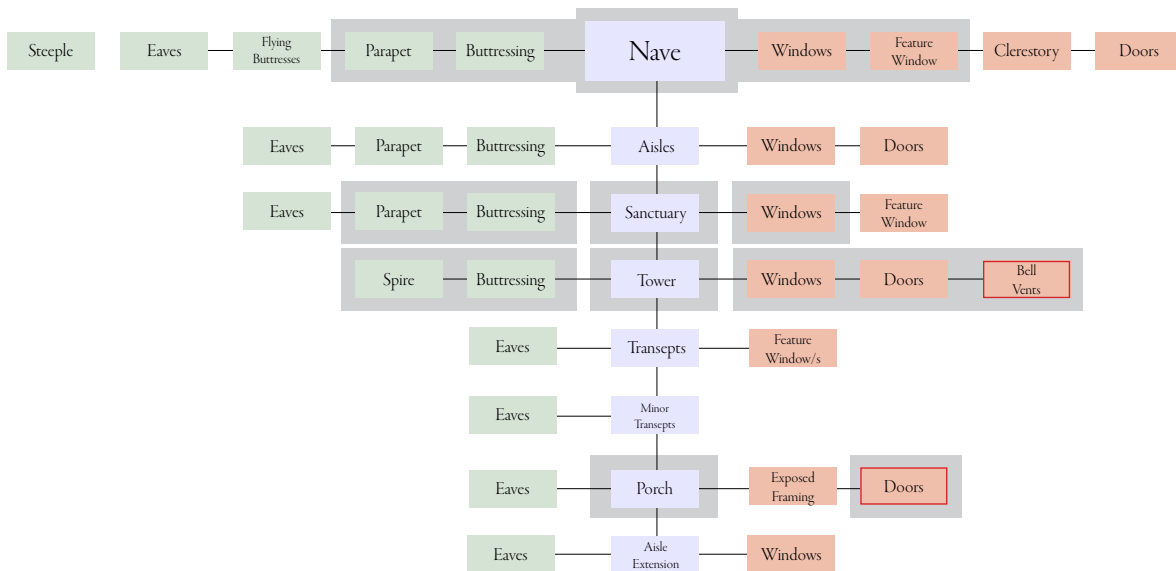| | Eaves | Aisle Extension | Windows |

Figure 92. 1920's photo of St Peter's (top), and a diagram of its constituent compo-
nents, with the red highlighting the new component catagories added
(Ref: 1/2-036459-F Alexander Turnbull Library)

*Figure 93. Photo's of churches with a similar design to St Peter's; being the Wesleyan
Church Taranaki St (left) and St John's
(author's photo) (Ref: 1/1-019972-G. Alexander Turnbull Library)*

Although St Peter's is a very different design to that of the previously explored churches, very little new components had to be added to the procedural model in order for its reconstruction to be created. The only truly new component categories was the porch door and the bell vents. Other key changes to the system were seen in the buttress and tower components. The tower of St Peter's tapers inwards as it reaches the top, and as can be seen in figure 94. This is where the bell vents are housed. The buttresses also needed to be adapted to have gables at the top of each division. The choice between gabled or angled buttresses then became another custom parameter alongside the amount of divisions and basic dimensions of the buttress. Other changes were made to the windows of the nave. New front windows were added, alongside a new feature window design. This new window was very simple, consisting of 3 pointed arches of different sizes.

Figure 94. Render of the reconstruction of St Peter's, showing the gabled buttresses that were added to the procedural model

5.2 | Speculative Reconstructions

5.2.1 Manners St Wesleyan Church

Once the procedural model was adapted to create the designs of Old St Paul's, Christ Church Taita, and St Peter's, testing what the updated system could create became a key focus. The first lost church that was attempted to be reconstructed was the Wesleyan Church that used to be on Manners St. This church was built in 1869 by Architect Charles Tringham, and tragically burnt down in 1879. From this research, only 1 close-up photo could be found, seen in figure 95. This photo only shows the front façade and gives little insight to both the side and rear of the church. Despite this lack of information however, a simple digital reconstruction was able to be created by the system using the existing procedural components.

| Steeple | Eaves | Flying Buttresses | Parapet | Buttressing | **Nave** | Windows | Feature Window | Clerestory | Doors |

| Eaves | Parapet | Buttressing | Aisles | Windows | Doors |

| Eaves | Parapet | Buttressing | Sanctuary | Windows | Feature Window |

| Spire | Buttressing | Tower | Windows | Doors | Bell Vents |

| Eaves | Transepts | Feature Window/s |

| Eaves | Minor Transepts |

| Eaves | Porch | Exposed Framing | Doors |

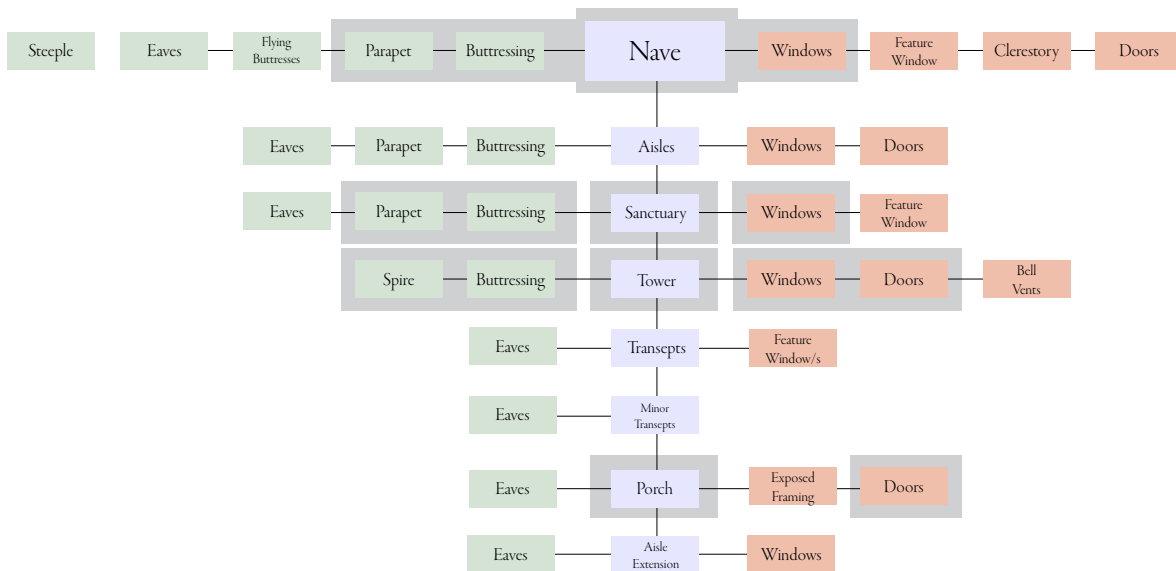| Eaves | Aisle Extension | Windows |

*Figure 95. Photo of the Manners St Wesleyan Church (top), and a diagram
of its constituent components
(Ref: 1/2-002324-A-G Alexander Turnbull Library)*

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Figure 96. Renders comparing the St Peter's (left) and the Manners St Wesleyan Church (right) reconstructions

The reason why this speculative reconstruction was able to be created in such detail is due to the clear similarities the lost design has to St Peter's. This is by design, as the speculative reconstruction started out as St Peter's, but was then adjusted accordingly. As seen in figure 97, the constituent components of each design is almost the same, with only the feature window and bell vents not being included in both designs. The only other differences that were modelled between these reconstructions was that the buttress divisions were increased and changed from gabled to angled, the tower moved to the front, the tower windows were adjusted, and the porch was extended to protrude from the tower.

St Peter's

Steeple	Eaves	Flying Buttresses	Parapet	Buttressing	Nave	Windows	Feature Window	Clerestory	Doors

	Eaves	Parapet	Buttressing	Aisles	Windows	Doors

	Eaves	Parapet	Buttressing	Sanctuary	Windows	Feature Window

	Spire	Buttressing	Tower	Windows	Doors	Bell Vents

	Eaves	Transepts	Feature Window/s

	Eaves	Minor Transepts

	Eaves	Porch	Exposed Framing	Doors

	Eaves	Aisle Extension	Windows

Manners St Wesleyan Church

Steeple	Eaves	Flying Buttresses	Parapet	Buttressing	Nave	Windows	Feature Window	Clerestory	Doors

	Eaves	Parapet	Buttressing	Aisles	Windows	Doors

	Eaves	Parapet	Buttressing	Sanctuary	Windows	Feature Window

	Spire	Buttressing	Tower	Windows	Doors	Bell Vents

	Eaves	Transepts	Feature Window/s

	Eaves	Minor Transepts

	Eaves	Porch	Exposed Framing	Doors

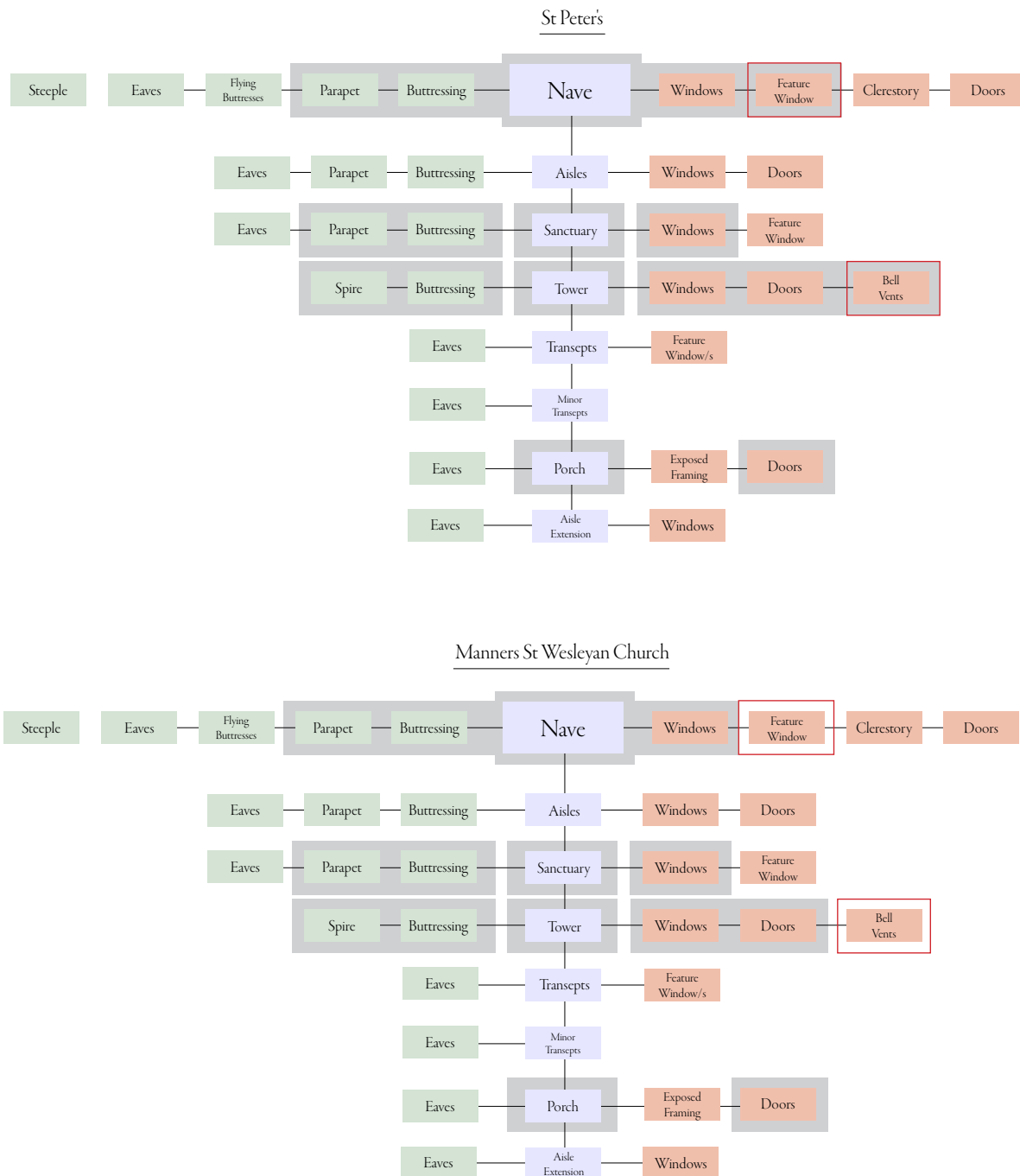|	Eaves	Aisle Extension	Windows

Figure 97. Diagrams of the constituent components of both St Peter's and the Manners St Wesleyan Church (red highlights the differing components between the two designs)

As previously mentioned in section 5.1.3, there are a number of church designs in Wellington that follow closely to that of St Peter's. Looking closer at these designs, it can be seen that 3 out of the 4 similar designs have been created by the architect Thomas Turnbull. These churches were all built within a span of 6 years, consisting of an enlarged, buttressed nave space with no aisles, and either 1 or 2 large towers. Although this trend is characteristic of Turnbull, the first of these large nave designs was not created by him, but by another architect Charles Tringham. This design preceded Turnbull's by a decade. This combined with the fact that Turnbull was also the architect behind the new Wesleyan church on Taranaki St, it is plausible to assume that the Manners St Church was a key influence on how Turnbull designed his churches in Wellington. Whether intentional or unintentional, the process of reconstructing the Manners St Wesleyan Church clearly showed the designs are related. It could be speculated that the later designs of St Peter's, the Taranaki St Wesleyan Church, and St John's were all descended from the original Tringham design of 1868, as diagrammed in figure 98.
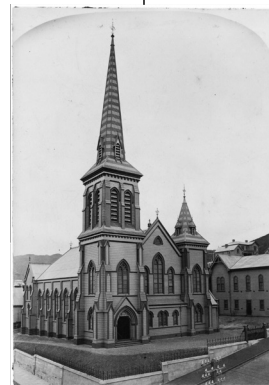
1868
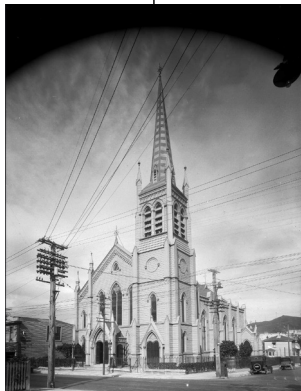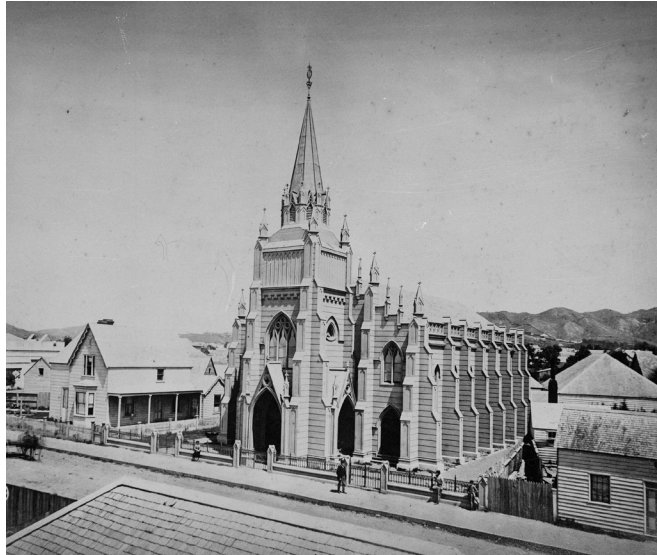
1879

1880

1885

Figure 98. Diagram proposing that the design of the later churches stemmed from the principles used in the Manners St Wesleyan Church

(Ref: 1/2-002324-A-G Alexander Turnbull Library) (Ref: 1/2-036459-F Alexander Turnbull Library) (Author's photo) (Ref: 1/1-019972-G. Alexander Turnbull Library)

5.2.2   St James', Lower Hutt

For some of the Wellingtons churches, the people responsible for designing and building them are not recorded, leaving it open for speculation. One such design is the lost church of St James' in Lower Hutt. St James' was built in 1880 and features a simple nave and transept design with a tower located on the south side of the nave. One of the interesting features of this church when compared to other Wellington Churches of the same era is the distinctive bell vents. In this research, the bell vent component was added to the procedural model while it was being adapted to create St Peter's. By simply adjusting the height and width, St James' bell vents were also reconstructed. These vents are also seen in the design for St John's. As mentioned in the previous section of 5.2.1, both St Peter's and St John's were designed by Thomas Turnbull, leading to the speculation that St James' could also be a design of his.
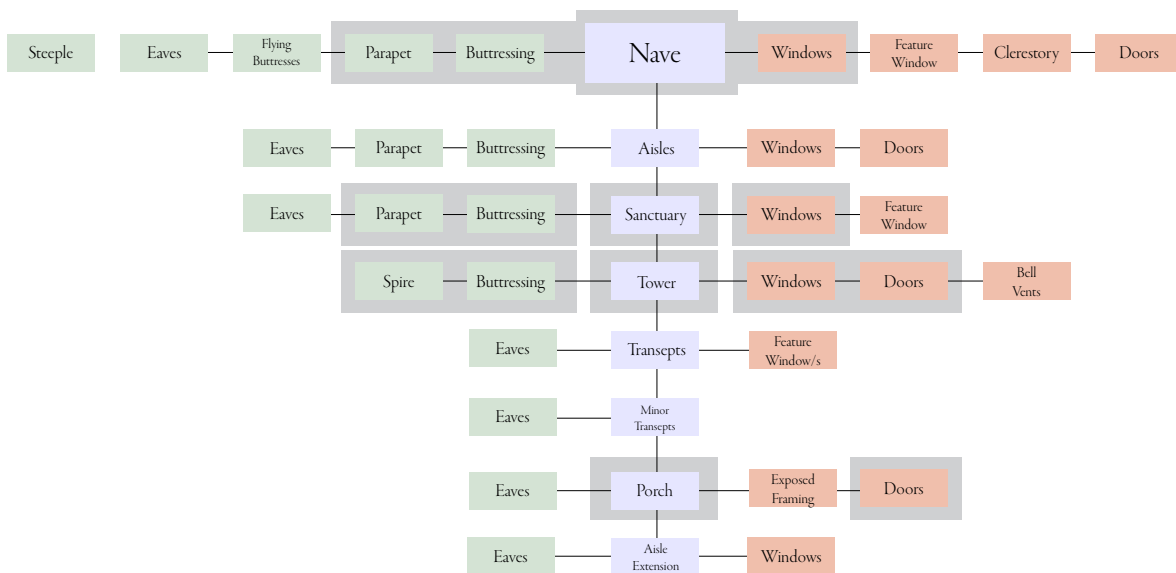
| Steeple | Eaves | Flying Buttresses | Parapet | Buttressing | **Nave** | Windows | Feature Window | Clerestory | Doors |

| | | Eaves | Parapet | Buttressing | Aisles | Windows | Doors |

| | | Eaves | Parapet | Buttressing | Sanctuary | Windows | Feature Window |

| | | Spire | Buttressing | Tower | Windows | Doors | Bell Vents |

| | Eaves | Transepts | Feature Window/s |

| | Eaves | Minor Transepts |

| | Eaves | Porch | Exposed Framing | Doors |

| | Eaves | Aisle Extension | Windows |

Figure 99. A photo of St James' (top), and a diagram of its constituent components
(Ref: 1/2-140330-G Alexander Turnbull Library)
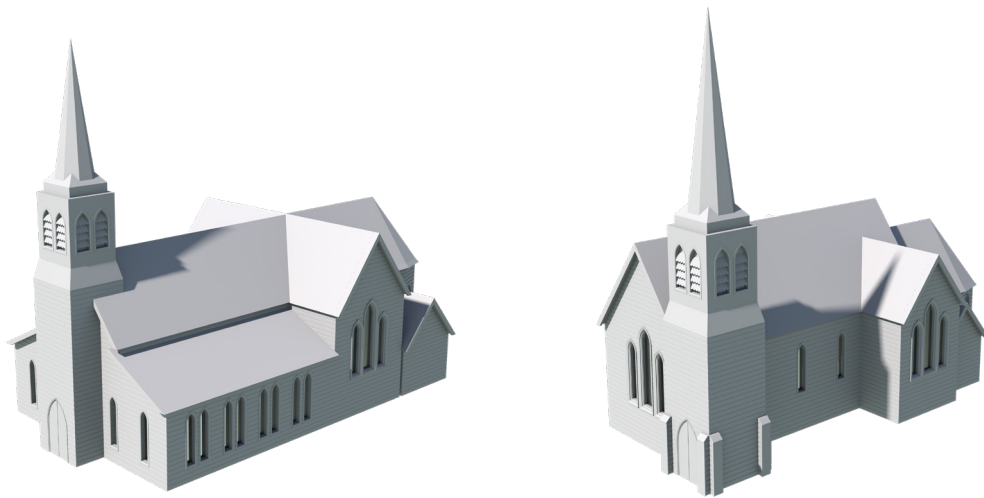
Figure 100. Renders comparing the St James' reconstruction to the St Patrick's Masterton reconstruction

Researching further into the designs of Turnbull, St Patrick's church in Masterton was found upon. St Patrick's was built in 1879 and features a similar nave and transept design, except with the addition of aisles and the tower being located at the front of the nave. Using the pre-existing procedural components, a reconstruction of St Patrick's was created so that direct comparison in a controlled environment could be conducted. Through this process the similarities between these designs became very clear (figure. 100,101). The bell vents of each design are almost exactly the same, being housed in the taper portion of each of the towers. The feature windows for the transepts are also exactly the same, consisting of three different sized pointed arch windows. From the investigation of the constituent components of St James' and the church designs of Thomas Turnbull, it is plausible to suggest that St James' was a design that was either heavily inspired by the design of Turnbull, or Turnbull himself

St James'

St Patrick's Masterton
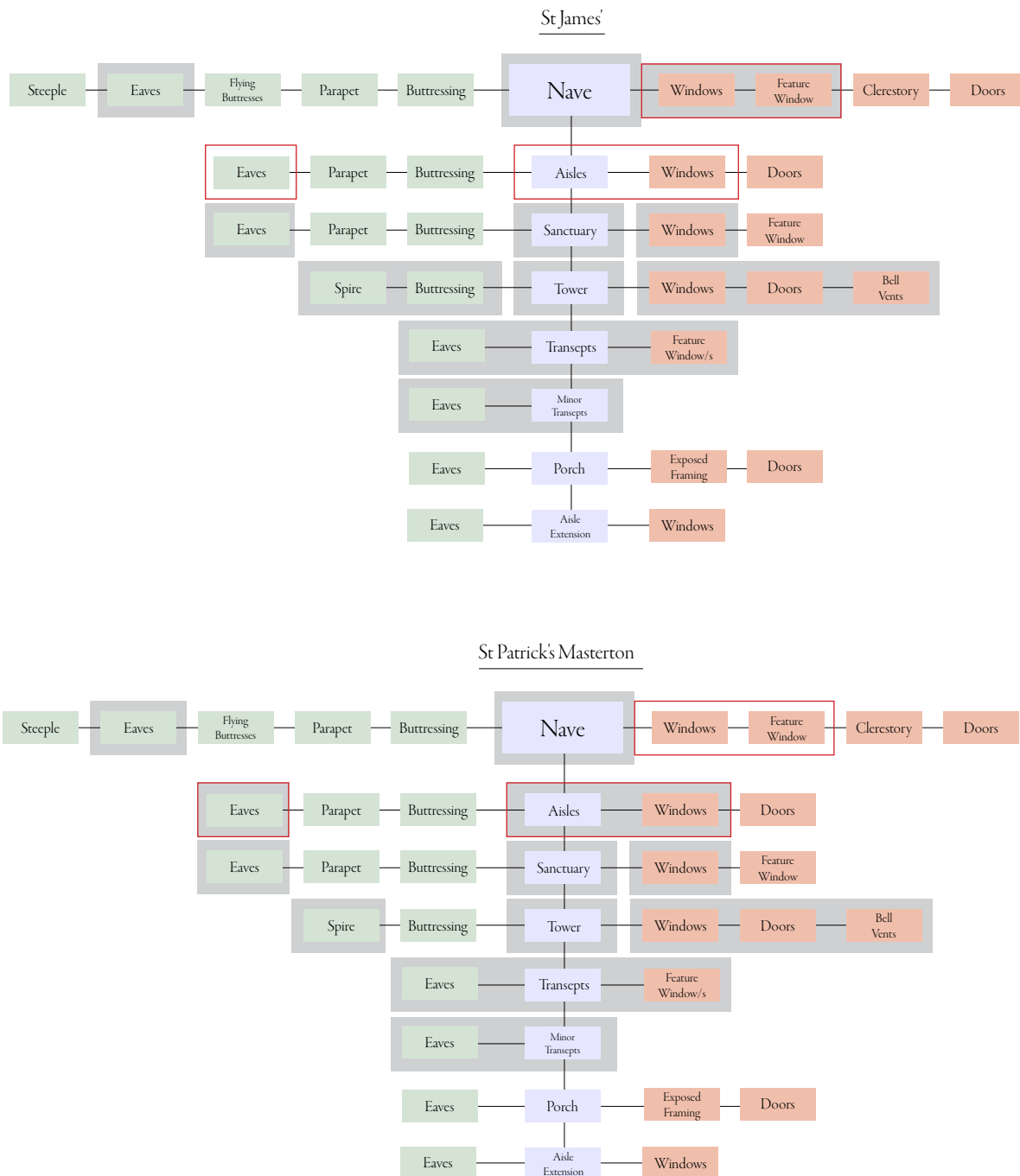
Figure 101. Diagrams of the constituent components of both St James' and St Patrick's Masterton (red highlighting the differing components between each design)

6. Developed Design

6.1 System Overview

Through the process of creating the reconstructions mentioned in chapter 5, many changes had to be made to the procedural system in order for it to function properly and produce clean geometry. This was because an additional 17 component categories were incorporated into the procedural model. The main change within the organisation of the system was the complete rearrangement of the order in which the different component groups were added and subtracted from one another. As seen in figure 103 and figure 104 on the following page, the adapted system merges the components together according to its category type, eg. additive, subtractive, and basic church shape. This greatly reduces the amount of Boolean functions needed as each component is no longer being handled individually. This also made adding new component groups easier, as they can simply connected to the existing merge nodes that collected the components together. Coming to this node organisation took many attempts as the system would often work for one design and not others.

- Basic Church shapes/areas

- Subtractive Components

- Additive Components

- Basic Church shapes/areas interior boolean
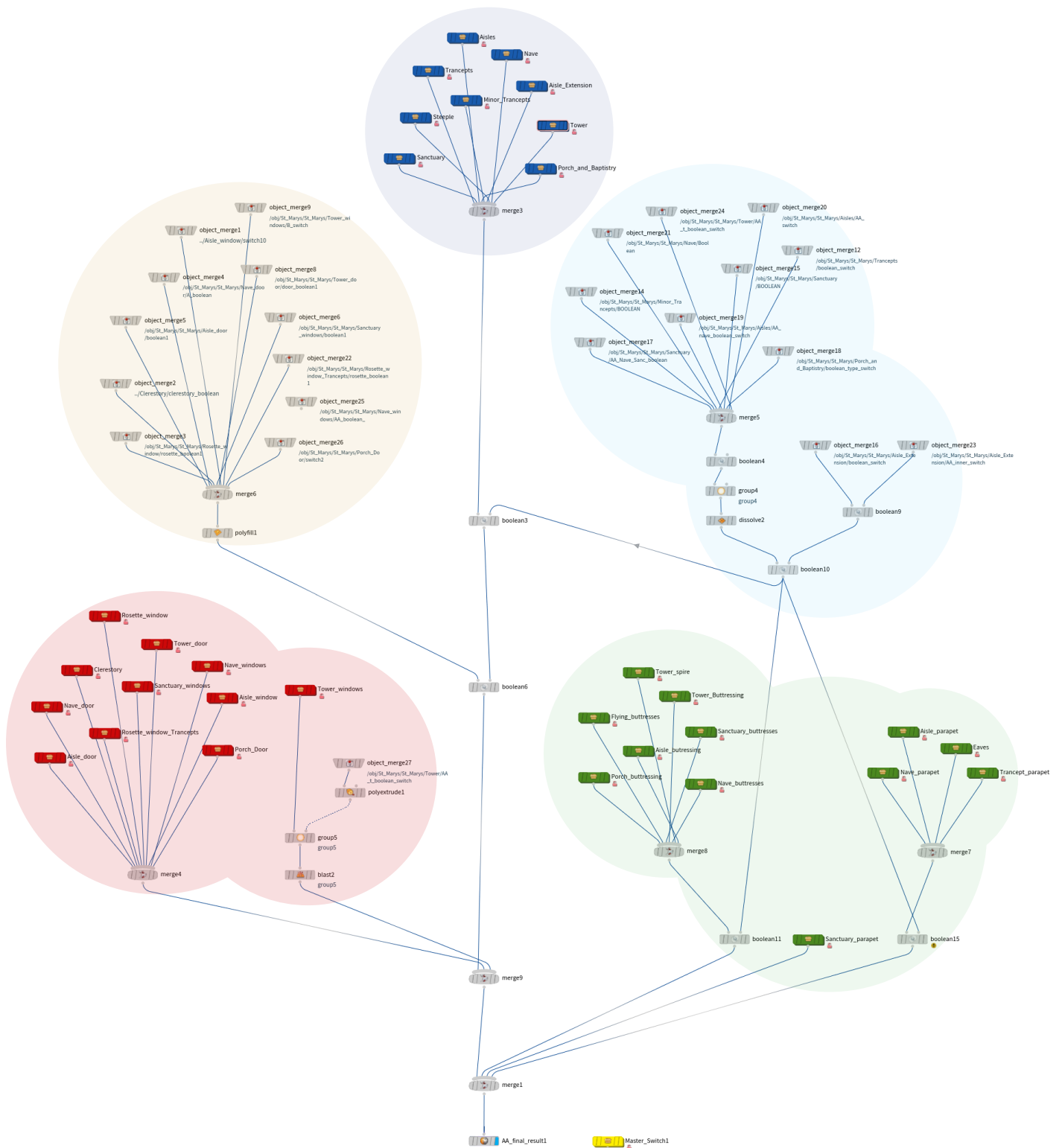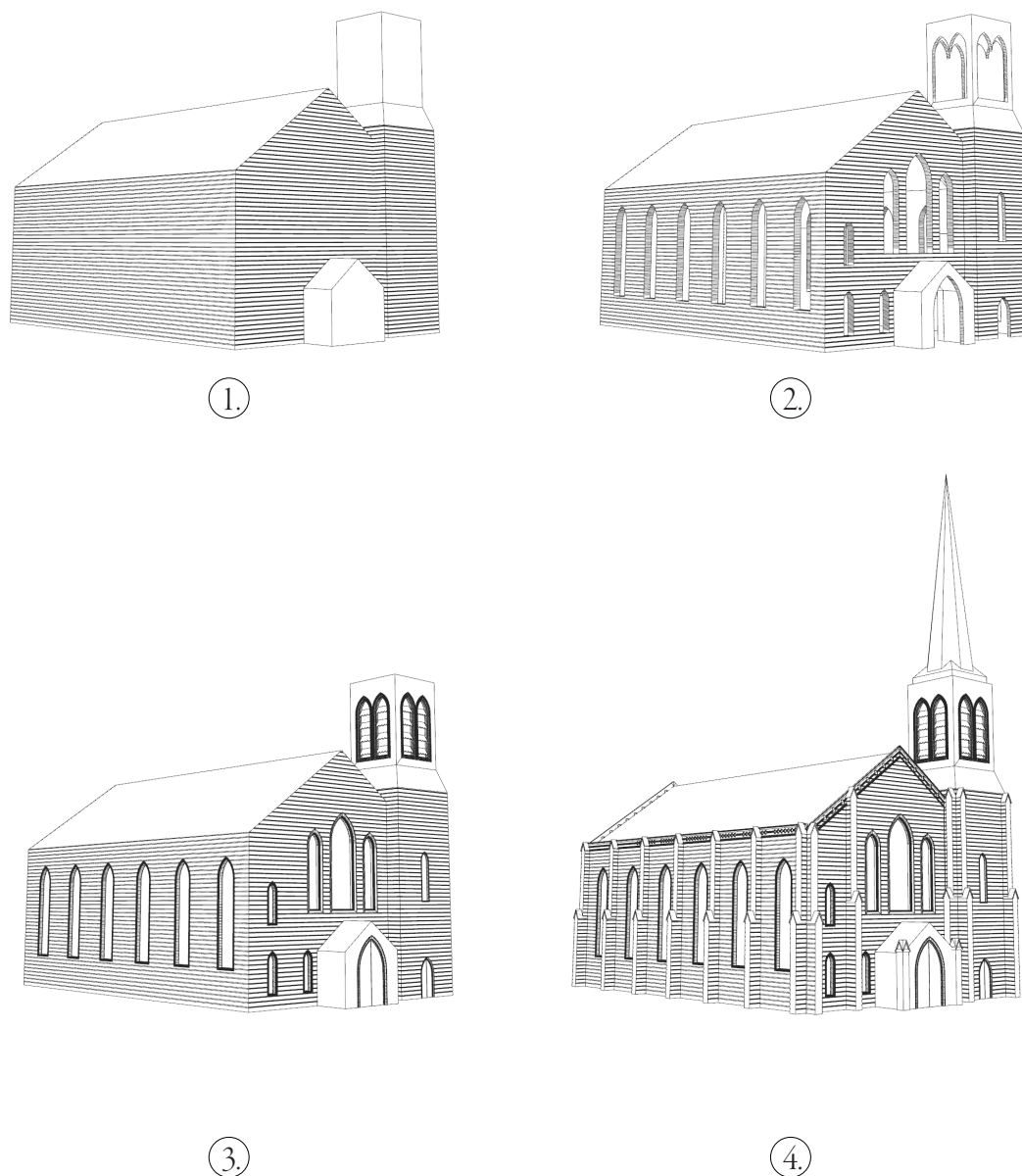
- Subtractive Components boolean

*Figure 103. The node system used for the reconstructions of chapter 5, being adapted
from the initial system seen in section 4.3*

Figure 104. Diagram showing the changed organistation of the component catagories,
and the created geometry at key steps within the procedural system

- Basic Church shapes/areas

- Subtractive Components

- Additive Components

- Basic Church shapes/areas interior boolean

- Subtractive Components boolean
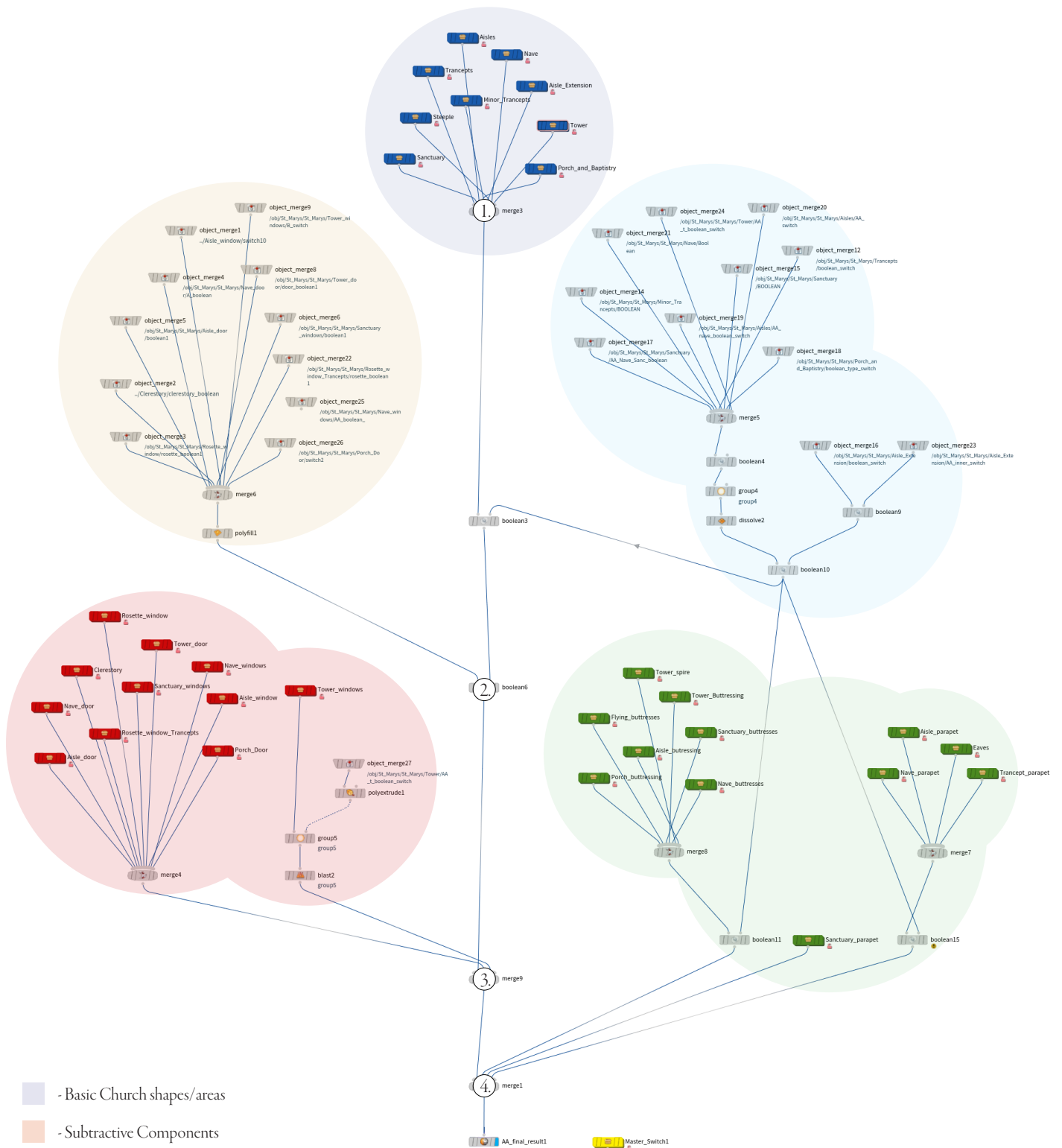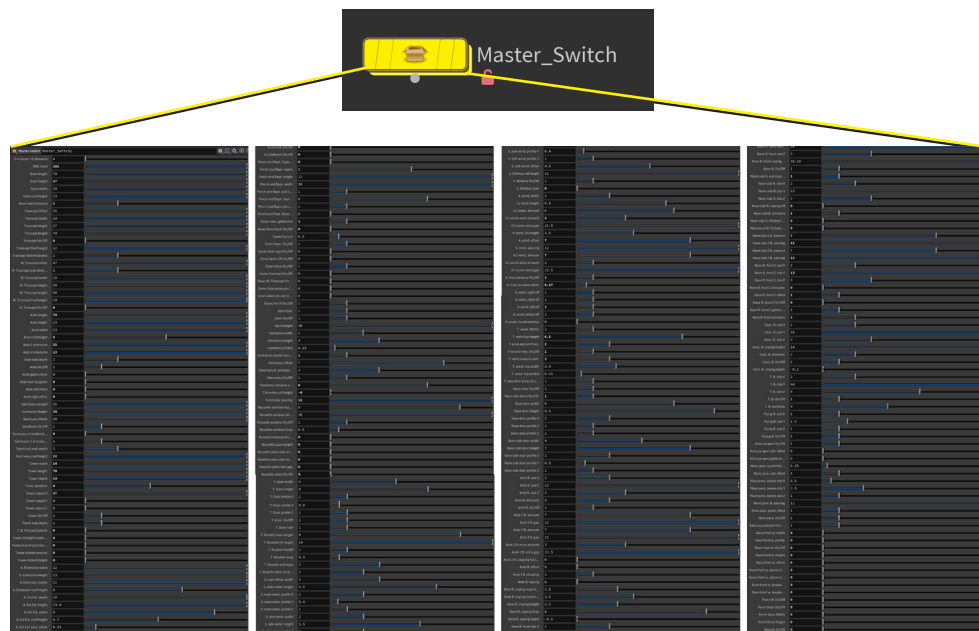
Figure 105. Diagram showing all the parameters of the procedural system and how they have been collected into a single node

The other major change to the procedural system was the creation of a 'Master switch' node. As mentioned in the reflection of section 4.4, the large amount of parameters for each component made adjusting them an overcomplicated process. A speculated solution to this was to collect all the parameters into one place. This was implemented while creating the reconstructions in section 5 and is shown is figure 105 above. The total amount of parameters is over 240. A key advantage of such a rearrangement is that different configurations of these parameters can be saved and made into presets. These presets were what was used to save the different church reconstructions seen in figure 106.
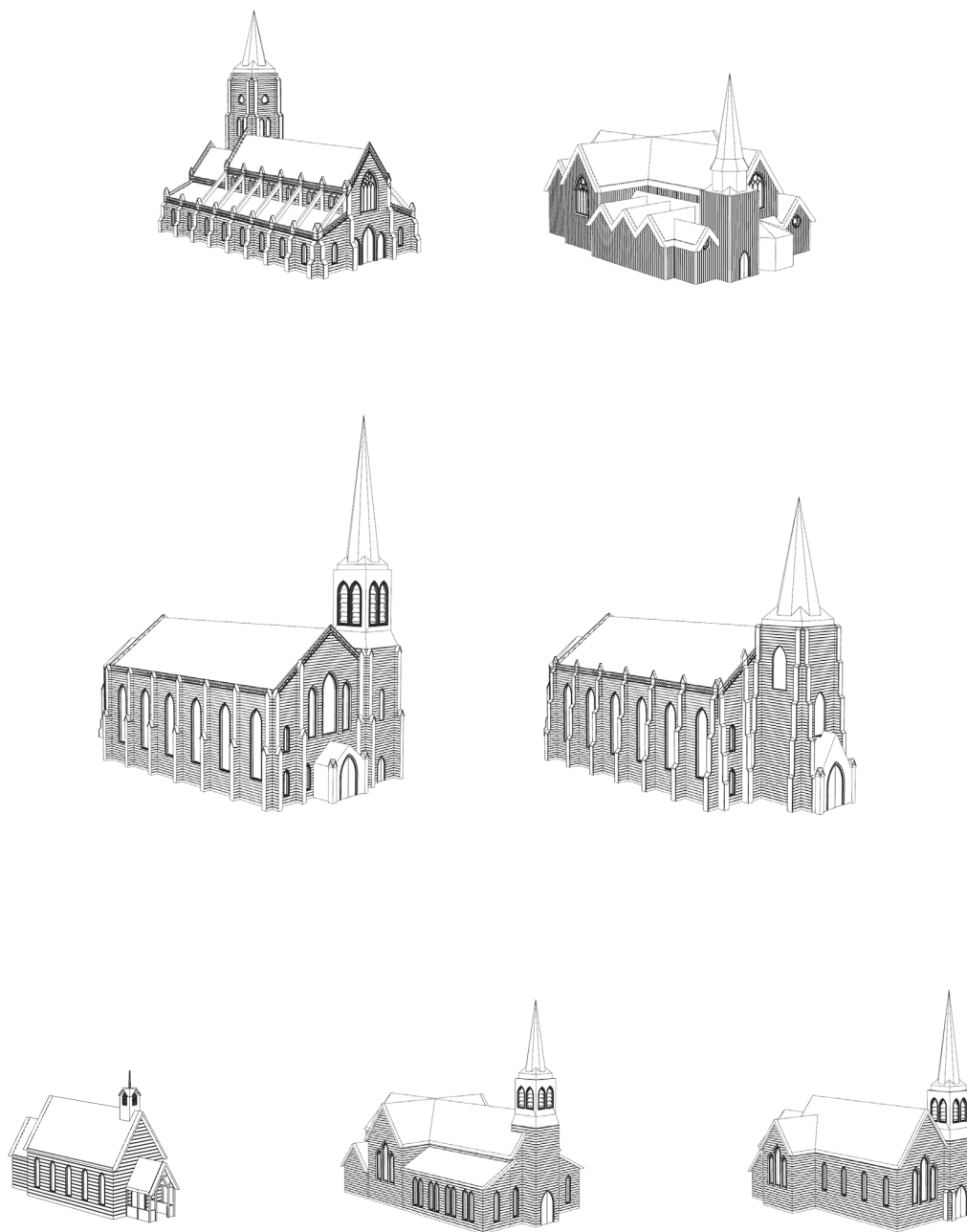
Figure 106. Views of the various church reconstruction presets that were created in sections 4 and 5,

6.2 Church Generator

6.2.1 System

For a fully procedural system to be made, the parameters of the components need to be controlled by the computer. It was also the intention of this research to maintain the ability to control the procedural model by hand, as well as access the saved presets of the reconstructions mentioned in sections 4 and 5. To achieve this, the ability to switch between having the parameters dictated by hand and by the computer needed to be devised.

The solution to this came from experimenting with the 'switch' node within Houdini. Each parameter found in the parameters tab of the master switch node is dictated by the switch system seen in figure 108. As mentioned in section 6.1, the 240+ parameters can be adjusted by hand to create custom designs. However instead of these values being linked directly to the components themselves they are instead linked inside the master switch node to the switch system of figure 108. This results in over 240 versions of this switch system being housed within the master switch node, as seen in figure 111 on the following page.

The user entered value is linked to a transform node (ladled 'User_Entered_Value' in figure 108), which moves a generated point in the amount that is entered. This is simply to store the value. The node is then connected to a switch which is controlled outside the master switch node, being shown in figure 107. The other node connected to this switch also moves the generated point. Ladled 'Set_Value_or_value_within_set_range' in figure 108, this node is able to generate random values within a set range, store predetermined values, and even be linked to other component values to form relationships. This is where the rule making and testing is created. The resulting value decided by the switch is connected to a node that reads the value and links it to the corresponding component parameter.
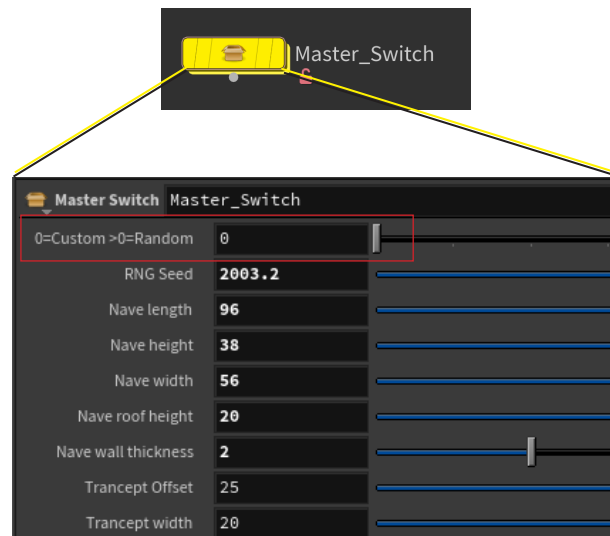
Figure 107. Parameters tab of the master switch node, showing the top parameter which is connected to the switch shown in figure 108 below
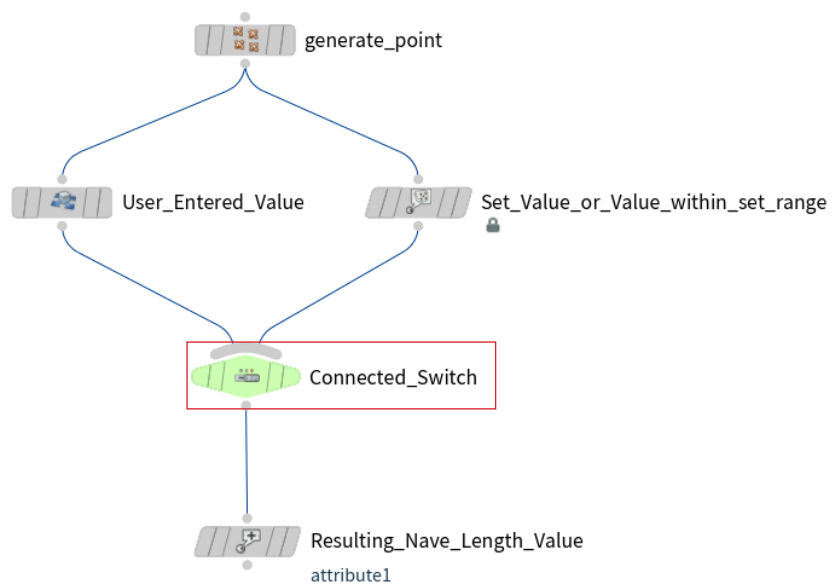

Figure 108. The switch system that is applied to each individual parameter within the master switch node. This enables the output to be switched from a user controlled design, to a rule based design
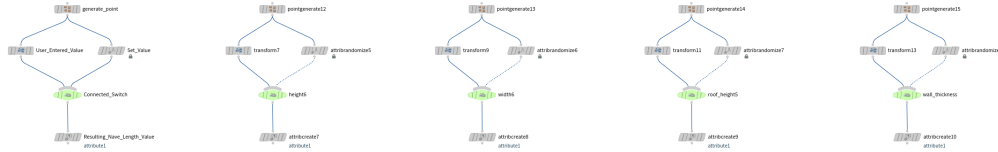
141

Figure 109. The 5 switch systems that enable the Nave Length, Height, Width, Roof Height, and Wall thickness to be switch from user controlled to computer controlled values

To begin the process of creating fully procedural church designs, the values of the computer controlled nodes needed to be defined. This was achieved by using the data from the churches already reconstructed in this thesis. The majority of the dimensions for the components have been defined by the highest and lowest values of each parameter. For example, the narrowest nave found in the reconstructed churches is Christ Church, being only 18 feet wide. The widest nave of the churches that were reconstructed was St Peter's at 56 feet. This meant that the generated value of the computer controlled nave width was defined to fall somewhere between 18 and 56 feet.
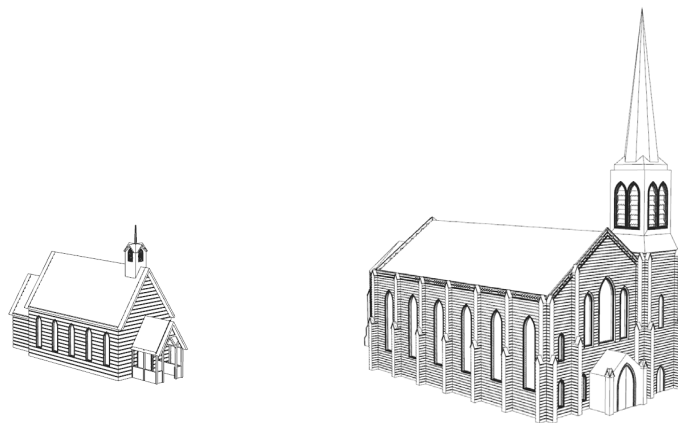

Figure 110. The smallest and largest nave of the churches that were reconstructed. These were used to define the minimum and maximum values of the randomly generated nave sizes for the fully procedural system
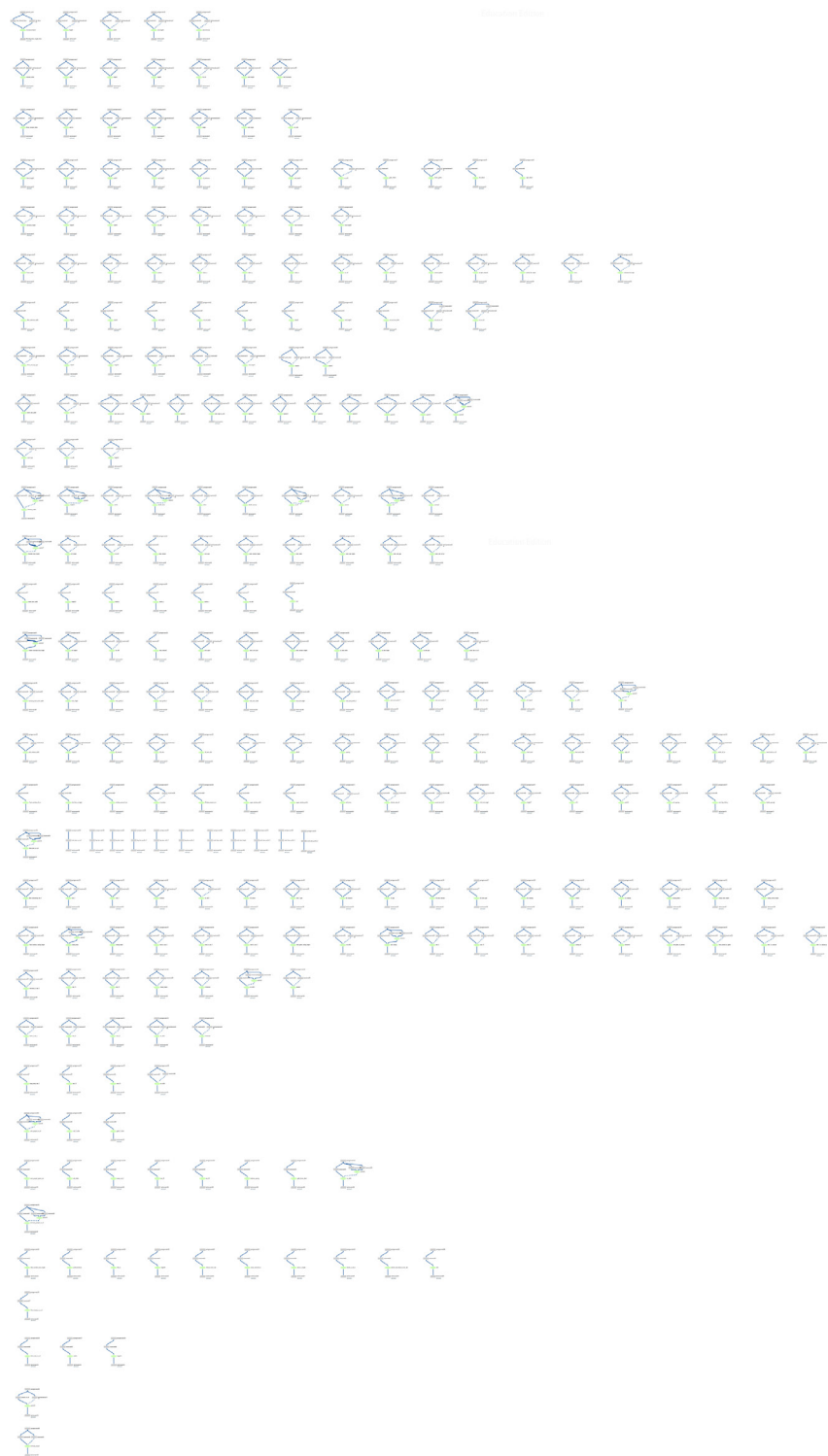
Figure 111. The 240+ switch systems that are housed within the master switch node

The initial goal while creating this fully procedural system was to simply get it to produce random-ly generated designs reliably. This involved a lot of bug fixing within the components, making sure things like windows and doors weren't passing through roofs, and that buttresses were the same height as the section of the church they were attached to. Despite this, even the further developed procedural system still produced distorted geometry, as seen in figure 114.

At first, only a few parameters were controlled by the computer, with the rest of them being filled in by the last preset that was selected before switching the system to create random designs. These outputs, seen in figure 113, interestingly mimicked the designs of the previous reconstructions, with parameters such as the nave, transept and aisle dimensions being selected randomly between the ranges defined by the previously reconstructed churches.

The way that this system was refined was through the process of rulemaking. What is meant by this, is that the dimensions of the components are related proportionally to other components. For example, the dimensions of the aisle windows are generated in the current fully procedural system so that they are 0.7x the height of the wall, and 2 feet wide, as all the aisle windows in the previous reconstructions followed this trend.

Another example of this rule making is utilised in the nave buttresses, seen in figure 112. When a church is generated, the number of buttresses on the nave is set between 4 and 8, as that was the range defined by the previously reconstructed examples. The spacing between these buttresses are then predetermined by the length of Nave divided by the number of buttresses, automating the process which in the past would've required the adjustment of 2-3 individual parameters. This rule making was applied to as many of the component categories as possible until the outputs of the system became sufficiently refined.
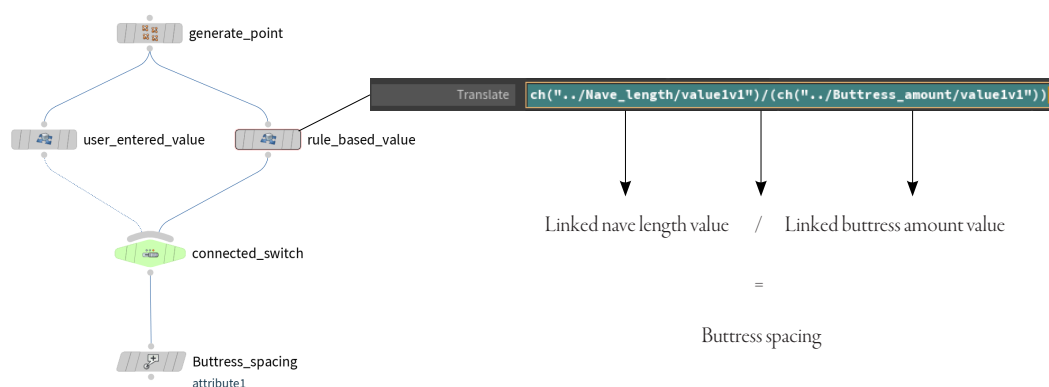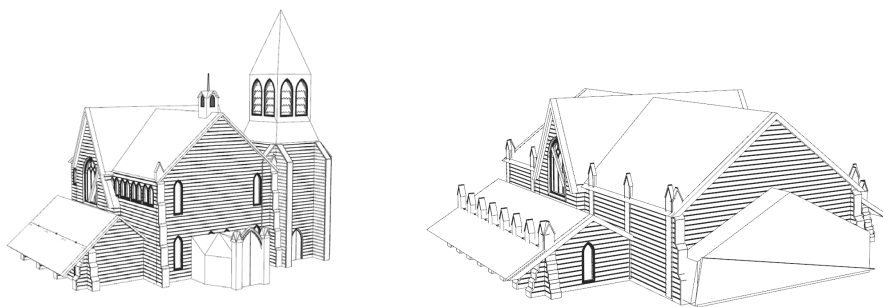

Figure 112. Diagram breaking down how component values were linked together in Houdini to create proportional relationships

*Figure 113. Some of the first attempts at producing procedural churches*

Figure 114. Two developed procedurally generated churches. These examples show how the components are still prone to malfunctioning despite the adaptations added in section 5

6.2.2 Outputs

Figure 115. A plausible church design created solely by the procedural system

Here is a random selection of the church designs that were generated form the final iteration of the procedural system. Overall, most of the outputted churches are highly implausible however some, such as that seen in figure 115, are somewhat realistic in their proportions and layout. One of the most successful aspects of these random designs are the windows and feature windows. This means the relationships between the placement of the windows and the section of the church it is appending to are comprehensive enough to work with a wide range of designs.
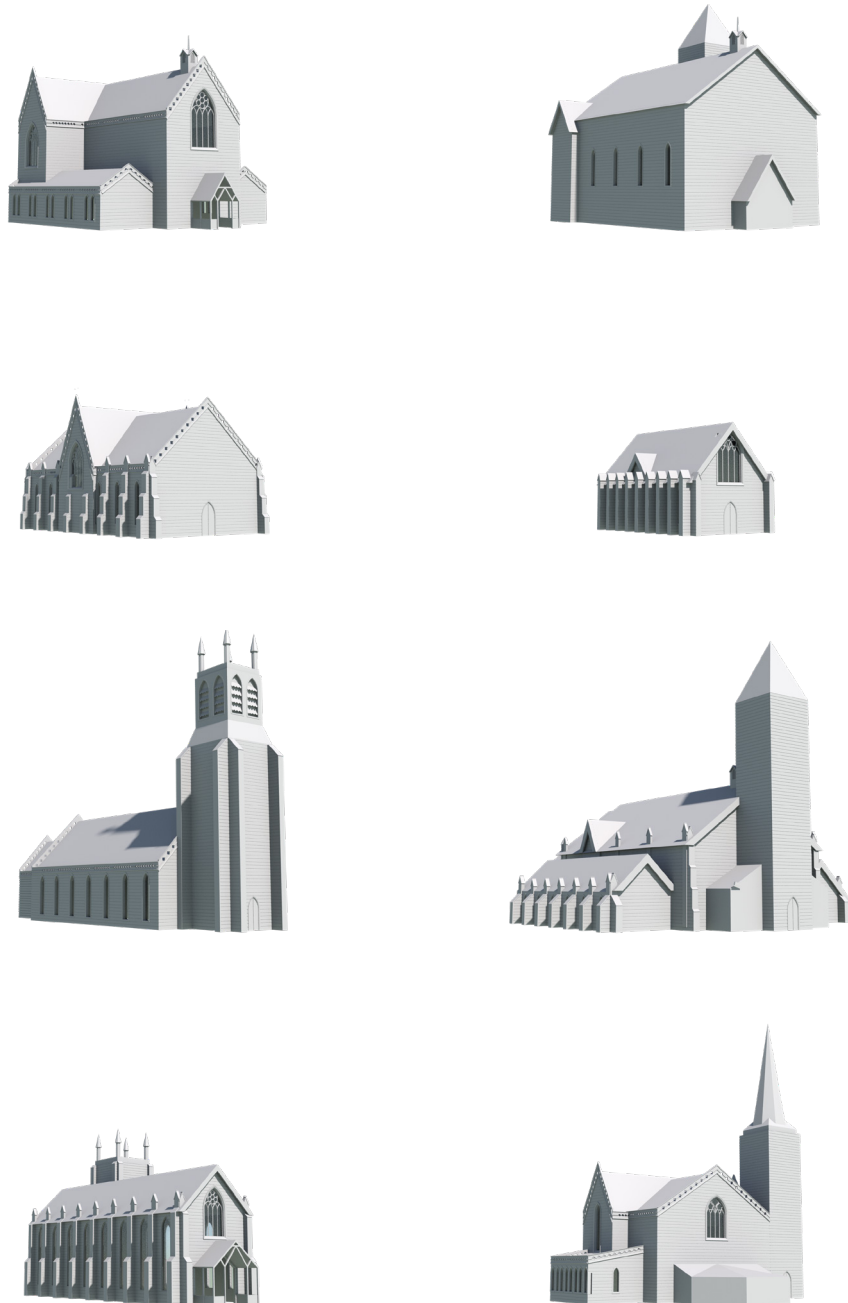
Figure 116. A random selection of generated churches from the procedural system
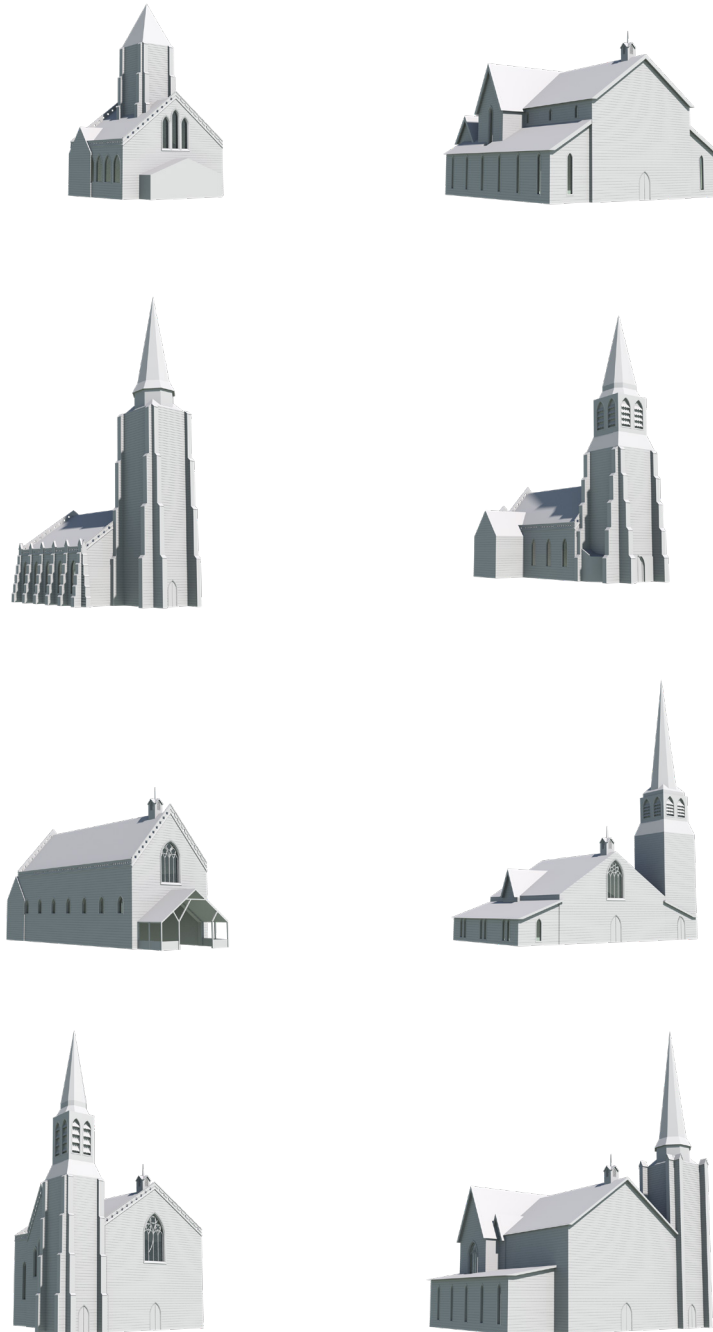
Figure 117. A random selection of generated churches from the procedural system

Figure 118. One of the many bespoke church designs created by the developed procedural system

Seen in figure 118 is an example of one of the bespoke designs that the procedural system produces. Although very unique, such a church design still bears some resemblance to the original churches they have been constructed from. This shows that even though the architectural components of the researched churches have been shared and adapted for many built designs, the different combinations of these components could produce a limitless variety of designs.

7. Conclusion

7.1 Conclusion

This research has shown that procedural modelling, when applied to the field of digital architectural heritage, offers many potential applications. The software Houdini proved to be very efficient at creating geometry as well as rendering high quality visualisations of the churches that were generated. The process of creating the developed procedural model also enabled detailed analysis and comparison of these reconstructions to be undertaken.

One of the significant findings of this research is the ability to store all the historical data of the reconstructed churches in one centralised place. This feature is why such detailed comparison, as explored in section 5, can be undertaken.

Another key finding of this research is the developed methodology for the creation of a procedural system that outputs buildings of a specific style. Being the first objective of this research, the resulting procedural model is able to generate designs that resemble the designs they are based on. However, these generated design are often very unrealistic in terms of their proportions and layout. Further refinement of the underlying rules of the procedural components would need to be made in order for plausible hybrid designs to be created reliably.

Many lost timber Gothic Church designs were also reconstructed in this research. These reconstruction, such as the Manners St Wesleyan Church, St Mary's Cathedral, and St James' were very successful in replicating the dimensions and appearance of the churches seen in the archival photos. This aspect combined with the comprehensive analysis found within section 5, meets the second objective of this research: Investigate how the procedural modelling process of objective 1 can be developed to both analyse and generate lost architectural heritage
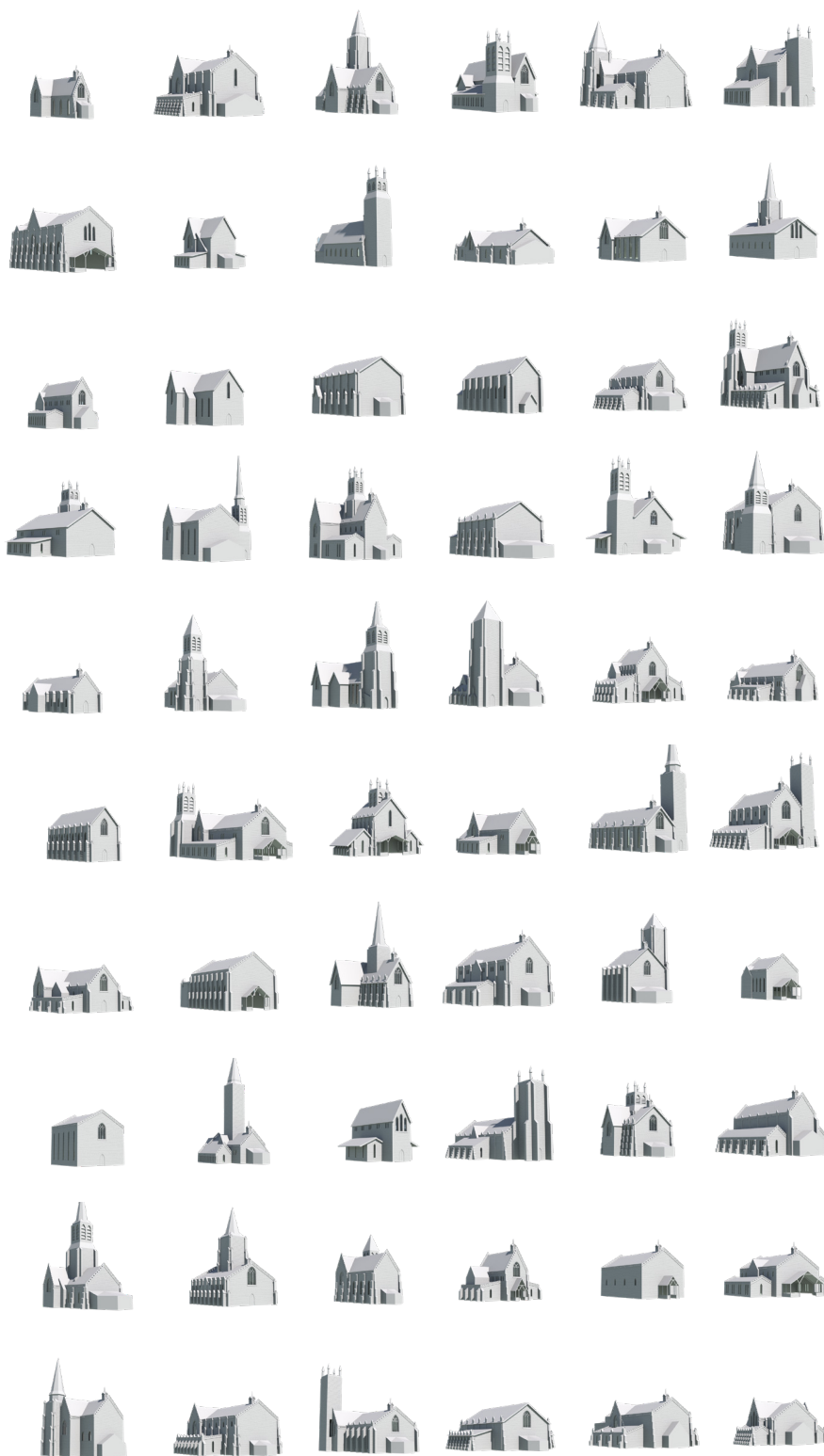
7.2   Future Work

The main aspect of this research that could benefit from further work would be the refinement of the procedural system. One of the ways this system could be improved would be to simply add more complex and comprehensive rules to the current system. Another way would to further categorise the churches into subtypes. One of the key reasons the outputs of the developed procedural system produce such oddly proportioned churches, is because both large and small church designs are included in the sample. If the designs were further separated into 'small/early churches' and 'big/late 19th century churches', the created procedural systems would produce more specific designs.

The application of textures could also be explored in future work. Textures where explored minorly throughout this research as a transparent glass texture was used for the window panes. Further colourisation of the church reconstructions could be explored, however finding the colours of some of the lost churches would prove difficult.

As what has been done in this thesis, other future work could include the addition of more lost and existing timber Gothic Churches. There are still many designs in Wellington that could be modelled very easily from the existing components. This is also true for designs outside of Wellington. From looking at archival photos of the timber Gothic churches in other towns and cities across New Zealand, it is clear that these unique buildings are not just a product of Wellington. To whatever degree, the expansion and adaptation of the procedural system is a key area that could be worked on in the future.

7.3 References

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8. Addendum

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8.1 On-Site Examination

Additional content was created for the required on-site examination. This content included 3D prints of the churches that were generated in this thesis, and minor additional graphics that were displayed both physically and digitally. The designs that were selected for 3D printing included the lost churches of St Mary's Cathedral, St James', and the Manners St Wesleyan Church; alongside a selection of randomly generated churches at a smaller scale