Associative Design Methodology:
Performative Design for a Modern Work-Teach-Learn Unitec

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Abstract

This research project focuses on displaying the advantages of using the computer as a design tool through the redesign and reuse of a series of five joined buildings, Unitec’s existing buildings 111-115. This divided into two parts.

In the first part the question is, how can the advantages of using the computer as a design tool be shown? This is explored by understanding the design method terminologies, discovering what the computer is being used for and how it is being used, and finding out what digital tools are available to implement these methods and processes.

The second part covers the reuse of Unitec’s existing buildings 111-115 and updating them through renovation. It reviews Unitec’s needs as an institution essentially as a client to the project (unofficially). It investigates office design and spatial planning as it is identified as a programmatic asset. It reviews the sustainability of materials both as a possible design factor and as sustainability is found to be a key issue for the project. Precedents with building typologies and purposes relevant to the findings of the previous topics are reviewed.

The site is predefined by the current location of the buildings and the future plans for Unitec as a campus. It was identified purposefully as a good foundation to apply the digital design methodologies to. The site not only is the defined plot of land and its context, but the five joined buildings themselves. The buildings were investigated in their current state of use to identify existing problems that could be resolved and bettered. Physical characteristics of height, structure, and floor area were analysed.

The design combines lessons learnt through the research and is informed by Unitec’s needs and the three major driving factors that parallel Unitec’s views which are: flexibility, encouraging interaction, and reducing environmental impact. These ideas are to work in parallel with using the computer as a design tool in a performative associative manner to design a work-learn-teach complex as a reuse through the redesign buildings.
Acknowledgements

Thanks to my supervisors, especially to Jeanette for all the hard work at the end!

Thanks to my family for supporting me throughout my architectural study, I could not have made it without your help.

Thanks to my Dad for ‘ringing me’ and getting me back into this project to see it through to the end.

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Introduction
1. RESEARCH QUESTION
How can a digital associative design methodology inform the redesign of a series of modern work-teach-learn buildings?

2. BACKGROUND OF THE PROJECT
The computer is a powerful tool. It has evolved into both a pencil and a pen within the field of architecture industry. Its primary functions are to convey visualisation of the design and give the ability to make live changes to it. This is where the average New Zealand architect's use of the computer reaches the 'barrier of essentials' and ends. Since the beginning when the computer was first implemented into architectural practice, the computer was used as a tool for furthering design, not just displaying it. Now with modern advances, computers in the field of architecture can assist in drawing complex geometries, generate a design of any scale from a series of rules, optimise a design, and perform computer simulations.

Unitec’s building 111-115 consists of the following programmes: admin, education, civil engineering and construction, communication studies, and natural sciences buildings.

3. PROJECT OUTLINE
Unitec is in the midst of mass change. It is taking its large Mount Albert campus and compacting that into a tightly knit core composed of renovated existing buildings and new buildings, and green spaces. To put that in perspective, that is reducing its campus of 55 hectares to 8 hectares, which is 14.5% the size of the original.

Unitec also aims to have state-of-the-art facilities and support best practice pedagogies. It is also proposing to expand its business park and have business park/tertiary partnerships.

The project is a redesign of a series of five existing buildings 111-115 will allow for a comparison versus what this project aims to design thus being able to display the advantages the computer as a tool has to offer.

The tertiary institution Unitec currently involved in changing itself both in image and physically by downsizing as a campus proved to be a design opportunity to apply the above design logic and methodology to. The redesign of the existing series of buildings 111-115 will allow for a comparison versus what this project aims to design thus being able to display the advantages the computer as a tool has to offer.

1 Visualisation, in this case referring to the array of architectural drawings able to be produced: orthographic, perspective, and axonometric drawings and the 3d digital model.
3 See chapter X.X The Computer a Design Tool
5 D-1-Summary-Unitec-Property-Strategy (Unitec Institute of Technology, 2015), 6.
4. AIMS/OBJECTIVES

This project has two distinct aims, each with a series of objectives. This project aims to display advantages of using the computer as a design tool:

- Using the computer for high performance (performative architecture) design
- Using the computer to use a variety of tools created by others to extend the design
- Using the computer for algorithmic design – graphically scripting tools for specific needs and a compilation of both this and the previous
- Using a variety of software as a learning process

This project aims to reuse the existing buildings and update them through renovation:

- Explore the potential in reusing the existing buildings, how the architecture can further Unitec’s core values and its ideas for the future
- Improve their performance in a number of ways: re-plan for flexibility, improve environmental performance, and encourage user interaction.

This project is also limited to the amount of available information about Unitec’s existing buildings 111-115 as well as their future plans for them.

5. SCOPE AND LIMITATIONS

The project is about assessing and understanding computer design software. It is about using these software to their full potential in a digital environment in a performative manner. It is about being able to associate these digital tools so that they can create a live feedback loop of design decisions and changes, hence allowing the user to adjust a model and view results as opposed to creating a brand new model to view results.

This project is limited to the architecture related software that Unitec has access to. Again, the aim is to use the computer to its full potential within the available realm.

The project is also limited by my own ability to ‘control’ computer and software: in this case I’m referring to my minimal ability to do written coding/scripting as I primarily work with visual scripting. Scripting as written code has proven to be a more definite form of control. On the reverse this can be seen as a positive as most architects and designers in New Zealand will not have much if any coding/scripting experience whatsoever. This research project can display how visual scripting and pre-made digital tools are accessible and learnable to them.

This project is also limited to the amount of available information about Unitec’s existing buildings 111-115 as well as their future plans for them.

6. METHODS

1. Researching texts about digital theory, digital design, and digital methods in architecture as a grounding and later revisiting this once these ideas have been implemented in the design of this research project.
2. Researching design texts on activities for the research project relative to Unitec’s existing building and its future plan.
3. Understanding the existing buildings: structure, material, programme, functionality, environmental performance, and relationship to context and evaluating whether they are suitable to be kept for this research project or demolished to create a tabula rasa.
4. Location plans and images of the existing local site to the proposed future masterplan.
5. An analysis of the problems with the existing buildings and the problems with Unitec’s proposal.
6. Diagramming available information about Unitec’s proposed design and diagramming floor area calculations for both the existing buildings and Unitec’s proposed design as standards for this research project to meet or expand on.
7. Context analysis - steps 3-7 fall under site analysis but are better described as individual parts diagramming important context factors at different scales and showing important changes coming with the future plan.
Literature Review
Introduction
The computer is an everyday tool of the modern architecture office. It is used for communication, planning, budgeting, calculating, financials, filing, and of course architectural drafting, drawing, and other visuals. It is a powerful and vital tool that people in any industry could not do without. Architecture in New Zealand tends to overlook the power of this complex yet simple machine, and essentially misses design opportunities with the edge that this tool could provide. Using the computer as a design tool opens architecture to a wide possibility of formal and informed possibilities, such as: complex geometries, assemblies, and surfaces; analysis tools for quantitative data like daylight illuminance, structural stress forces, structural fire design, air quality, acoustic performance, aero dynamics/wind forces, and building evacuation simulations; and optimisation of design costs, materials, structure, form, or buildability.

Any of the prior listed possibilities can be used as an input to inform the design by creating simple rules or relationships between elements (element: could be as simple as a point or a line, or as complex as doubly curved surface, detailed assembly, a building as a whole).
Digital Design Terms

Parametric Design
A range of disciplines from mathematics to design use the term parametric - “working with parameters of a defined range.” Parametric design is not something new, the new thing is that it is being done on a computer and the way it is being done - “the actual use of the term "parametric" as an "associative" mode of designing is a recent development.” Parametric design is not only about making better formal considerations (although it performs well at solving curvilinear-parametric design being the original applied digital design technique and being used as the face of a new style, people tend to get misled by the meanings, even when clarified from the definitions above. In a lot of cases both techniques are being used in association with one another, given that parametric techniques are based on the manipulation of form versus algorithmic which are based on the use of code. So to conclude, via both the methodology and intent for this project, both techniques will be used; both in association and as “associative design.”

Algorithmic Design
An algorithm is “a procedure or set of rules used in calculation and problem-solving, (in later use spec.) a precisely defined set of mathematical or logical operations for the performance of a particular task.” In digital design the user is able to reach outside the limits of the design software with the use of scripting languages. Visual scripting is also a simpler option with tools available such as generative components, grasshopper, and dynamo. It explains the capacity of the computer to operate as a search engine and perform tasks that would otherwise consume inordinate time (this leads to optimisation).

Parametric or Algorithmic
Both techniques involve parameters that are adjusted to alter the outcomes and both techniques can produce similar formal outcomes. Parametric design being the original applied digital design technique and being used as the face of a new style, people tend to get misled by the meanings, even when clarified from the definitions above. In a lot of cases both techniques are being used in association with one another, given that parametric techniques are based on the manipulation of form versus algorithmic which are based on the use of code. So to conclude, via both the methodology and intent for this project, both techniques will be used; both in association and as “associative design.”

Definition:
Optimization - an act, process, or methodology of making some-thing (such as a design, system, or decision) as fully perfect, functional, or effective as possible; specifically: the mathematical procedures (such as finding the maximum of a function) involved in this.16

15 Ibid.
12 Ibid.
13 Ibid.
What can be taken from this is that there is a very involved process with digital tools allowing the manipulation of geometry to create a variety of early conceptual variations of a design within one system. This same founding geometry can then be used to continue the design in developments all the way to the final as-built configuration, also generating variations that can then be tested and compared on a performance level such as wind and daylight.

Throughout the process, parts may be optimized and different configurations investigated, giving all parties involved a deeper understanding of possibilities and their impact on the overall design.

The case study on the tower “The Pinnacle” in London is a built example of an associative design [built with “Bentley’s Generative Components parametric modelling software”]. The reasoning behind using an interactive associative digital system is of a need for high-performance, interactivity, and flexibility.

The tower's geometry was constructed and thus built from a lines and arcs. The case study mainly talks about the design journey from softening a triangular floor plate design, to the iterations of designing the double skin façade envelope, to how the envelope henceforth affects the column placement, to the optimization of the envelope.

Designing for the impact on the London skyline seemed to be the main concern mentioned as a design driver, with planning constraints, aesthetic considerations and commercial demands being some of the other influencing design factors. Images of studies of the double skin façade, wind pressure analysis, and daylight analysis are included but their use in the performance of the design is not described (figures 2, 6, 7). It can be supposed that they were just a sample of studies taken of various configurations.

The Pinnacle
2008-unbuilt
London, England
Kohn Pedersen Fox Associates

Tools used:
- associative software
- wind pressure analysis
- daylight illuminance analysis
- optimisation

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Throughout the process, parts may be optimized and different configurations investigated, giving all parties involved a deeper understanding of possibilities and their impact on the overall design.

18 Ibid.
19 Ibid.
20 Ibid., 7-11.
21 Ibid., 6.
The Daylight-Optimised Façade ‘Broadcasting Place’
2009
Leeds, United Kingdom
Faldon Clegg Bradley Studios

Tools used:
• associative software
• daylight illuminance analysis
• external contractor: daylight illuminance analysis
• external contractor: solar gain analysis
• optimisation

The design for “The Daylight-Optimised Façade” uses digital design for both early and end stages of the design. The design strategy for the façade was to be applied to two landmark buildings in a new academic complex for Leeds Metropolitan University, one of which would be a 23-storey tower. It is shown in the first figure that both buildings were multi-storey, one of which includes the tower, and both were treated as one development. The choice of the corten steel rainscreen façade mimics the colour of the redbrick from the local context. The programmes included 240 student bed-rooms, a key public space, and four different tertiary departments. The teaching and office space was treated as “shell-and-core only” for the design development.

During the early stages of the façade design the concept of overshadowing lead to having a larger glazing percentage on the lower levels and a lesser glazing percentage (higher opaque percentage) as the tower height increases. This was derived from the intuitive logic of upper stories having greater access to daylight thus less transparent surfaces were needed. This was then tested by a daylight illuminance analysis with an objective of achieving a three percent daylight factor and it was found that the used logic of overshadowing only applied to areas of the façade that were close to other buildings. To continue with the concept, a detailed overshadowing data analysis was appointed to a building research contractor. From the results of glassing percentages for a three percent daylight factor (daylight illuminance analysis) and maximum glazing percentages possible without overheating (solar gain analysis), a combined result of the two analyses was derived, and from that, a computer-generated façade was produced, also incorporating different type of solar glass. Finally from the results, manual adjustments could be made to allow for cores, entrances, plant areas, and fixing of the panels.

Firstly, what can be taken from this firstly is the design programme is treated as a flexible open space for offices and teaching. The only effect internal activities had on the design of the façade was designing for a desired daylight factor. The materiality and the style of the façade being transparent and opaque is to fit into the neighbouring context. A random layout with random width for the panels was initially used and then a specific 1.5m wide option was chosen for ease of design and construction. The daylight illuminance and overheating analyses had to be done at a specialised level, above the architects’ abilities, to allow for reliable and accurate data that could then be manipulated into the desired design concept. In the end it is the designer who has the final say by choosing the final layout and manipulating it to allow for other factors, including aesthetic ones.

Figure 8: The Daylight-Optimised Façade A
Figure 9: The Daylight-Optimised Façade B
Figure 10: The Daylight-Optimised Façade C

23  Ibid.
24  Ibid.
25  Ibid.
26  Ibid.
27  Ibid., 149-150.
28  Ibid.
model was then analysed under an acoustic and illumination simulation. Finally the panels could be separated and unfolded into their individual developable surfaces for fabrication tests and then actual construction.

The hall louvered façade was designed as an associative system that had a control surface linked to the louvre rotation angles. The angles were aligned with programmatic requirements such as the architect’s desired line of sights from within the building. An Excel spreadsheet was linked to the rotation values so they could then be used by the contractor for construction.

What can be taken from these examples is that both had a desired formal concept and the associative system was used in order to formalise the geometry. Consequently, in the case of the circular gallery, the geometry could be analysed and manipulated to achieve an optimum result as decided by the architect/designer. In the case of the louvered façade of the hall, it could be manipulated precisely and thus able to give an organised and accurate output of that to the contractors for construction. Interactive associative digital systems are being used and can be used not only as a design tool but as a communication tool at all stages of the design process.

Tools used:
- associative software
- external contractor: structural analysis
- external contractor: daylight illuminance analysis
- external contractor: acoustic analysis
- optimisation
- digital fabrication

The design for the “Museo Del Acero” project is an adaptive reuse of an old steel foundry with a new extension including the programmes of a gallery, a series of exhibition spaces, a workshop, and educational spaces. The associative digital processes were used on the circular gallery and the cladding design of the large hall. They generate the design, refine the geometry (optimise and simplify), and link to construction fabrication processes.

For the gallery the objective was to create a folded steel roof, and the design of this was yielded from the base geometry of concentric and offset circles. These were further manipulated and subdivided, and the surfaces become panels were created from the nodes. These were then tested “under a structural finite element analysis program to determine structural and material requirements.”

The model was able to be adjusted as it was an associative system and created a feedback loop between architects and engineers. The

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“Museo Del Acero: Workflow Case Study”

2007

Monterrey, Mexico

Grimshaw Architects

Tools used:
- associative software
- external contractor: structural analysis
- external contractor: daylight illuminance analysis
- external contractor: acoustic analysis
- optimisation
- digital fabrication

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29 Ibid.
30 Ibid.
31 Ibid.
32 Ibid.
33 Ibid., 141.
Summarised Conclusion

All projects mentioned use an interactive associative digital system, in which a design can be adjusted at will within the bounds of the input parameters. Some architects use tools together with and/or within these systems, and others use them externally through specialist contractors. The significance is that, in the present, there is a high availability of these tools for architects/designers. It takes some investment in time, training, and practice, but they are then able to integrate these performative tools into their processes. The question of whether or not to approach external specialists for these performative tools of analysis depends on the level of accuracy and detailed data desired to inform the final result. Again, even if a highly accurate result is desired, the architect/designer has the ability themselves to test it early on and make decisions before reaching out to achieve the detailed design results. On the other hand, some architects/designers are able to form close partnerships with these specialists, such as the teams that worked on “The Pinnacle” and “Museo Del Acero”; “The interesting fact is that with evolving design technologies, the loop can be far more close-coupled; structural analysis really can adapt form in a visible manner and in a fashion that enhances architectural concepts.”

Digital tools can be used at different levels to prove or make a concept, test for a sufficient result, or to form a finite result. The advantage of having them integrated into a digital system allows for a streamlined workflow with fast real-time feedback generating results.

35 Ibid., 57.
36 Ibid., 58.
37 Ibid., 59.
38 Ibid., 60.
39 Ibid., 50.

Figure 17: Toni Stabile Student Center A
Figure 18: Toni Stabile Student Center C
Figure 19: Toni Stabile Student Center D
Figure 20: Toni Stabile Student Center E
Figure 21: Toni Stabile Student Center F
Figure 22: Toni Stabile Student Center B
I have chosen to focus on ArchiCAD as the primary BIM System due to the development and subsequent release of ‘Grasshopper – ARCHICAD Live Connection’ at the end of April in 2016. This coupled the well supported Grasshopper to ArchiCAD with a tool that allows an interactive live two-way update, as well as better importability of geometry from either system interface. If this workflow is found to have flaws or obvious limitations to my design intent, then it will be assessed and alternative solutions will be found.

Grasshopper allows access to a range of performative plugins, most of which can be setup to work within Grasshopper. This again allows for ‘live’ results within a matter of seconds (depending on the complexity of the geometry within the model and the process that it is being put through). DIVA daylight illuminance analysis will be used with Grasshopper. Revit also has its own version of daylight illuminance analysis accessible on Autodesk’s 360 cloud. This is another option, but the downside is that each analysis must be manually submitted and then analysed before adjustments can be made and it can be run through the same procedure again.

Available Digital Tools

The previous case studies make it clear that there are a range of digital tools available. Here is a brief survey of commonly available features. Following this, I will assess what tools are available to me and would be useful for this research project.

- associative/algorithmic software
- structural analysis
- daylight illuminance
- solar gain
- solar shading analysis
- acoustics
- wind pressure
- energy usage
- optimisation
- digital fabrication

The workflows shown in the adjacent figure are not necessarily set rules and processes that need to be followed strictly. For example, one could bypass using a BIM system such as Revit or ArchiCAD and work through a whole project in Rhino or Sketchup. There are also plugins for these programmes that can allow them to work similarly to BIM Systems.

In terms of my approach, I am familiar with Revit, ArchiCAD, Sketchup, and Rhino. As for associative software, I am familiar with Grasshopper and Revit’s conceptual massing environment. Other associative software are Dynamo for Revit and Viz-Visual Modelling for Sketchup. All three use a similar visual scripting interface and have a similar logic in use.
8. Unitec’s Needs

Unitec Future Plan and Values

Unitec is set about mass change. The institute is going to/is doing this in multiple sectors all at once. Unitec is taking advantage of the chance to build and rebuild by enhancing facilities whilst compacting the campus into a denser, more connected urban village environment. The following was from a property strategy released by Unitec in 2015.41

The following points are the most relevant ones for this project:

- A compact smart solution that supports live, learn, work and play
- Become a better and more sustainable business
- Long life/loose fit (endurance and flexibility)
- Expand the business park and business partnerships
- Evolving pedagogy of flexible collaborative working and learning environments
- Create a ceremonial spine (Unitec spine)
- Vibrant high street into the campus – this refers to one access point directly off Carrington road which runs along the North-West façade of the chosen site
- Site responsive design – the cultural and natural assets of the site

9. Office Design

Planning Office Spaces

"Planning Office Spaces" by Juriaan van Meel, Yuri Martens, and Hermen Jan van Rie is a book that:

* is intended as a practical sourcebook for all those who work on the creation of new work environments, including designers and consultants as well as managers and end-users. In some cases this will involve the design of a completely new office building, sometimes merely the shifting of desks and partitions in existing space.*

Reinstating their point, they have said who this design guide/theory is designated at; and that being not only designers, but also managers (end-users who will have a big impact on the design due to the hierarchical nature of companies and corporations) and the general employee users of the building (already hinting to the designer and management to get them involved). Immediately this shows that a modern society is targeted, as the guide considers all natures of worker as opposed to the dominating scientific management theory of the past.

This text in summary reviews objectives which can be viewed as the modern fundamental factors of office crucial choices: which further expands on the objectives, the types of spaces: workspaces, meeting-spaces, and support spaces. It gives examples, it gives advice on implementation, and it has further information listing relevant sources from books, journals, research centres and professional institutions etc.

Normally, it wouldn’t be safe to assume that one text can summarize a topic and be the ‘perfect guide’. I have however, reviewed a range of texts on the topic and this was the one found to be most relevant and current. This research project is focused on the method of integrating digital tools. As this text “Planning Office Spaces” is informed by the range of sources stated in the previous paragraph, and covers most of the fundamental factors that need to be considered, “Planning Office Spaces” will be the main informer for office design.

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42 Juriaan van Meel, Yuri Martens, and Hermen Jane van Rie, Planning Office Spaces: A practical guide for managers and designers (London: Laurence King Publishing Ltd, 2010), pg17.
43 Ibid., 15.
44 Ibid.
Office Design: Why?
Unitec buildings 111-115 are mainly used by staff and students for teaching and learning spaces, including some specialist spaces for certain faculties. A large percentage of the remaining space and yet a large percentage overall is used by faculty members and staff for admin and office space. The rest is used as computer labs for students, some retail, and service spaces (vertical circulation, toilets, plant-rooms etc).
So why focus on office design for buildings which function primarily as teaching spaces? Why not use office design for the offices and administration and use a separate design guide for the teaching spaces? The reason being that, as Unitec’s vision is to incorporate professionals and professional ‘practical’ experience into its teaching, office design can be used to create an open environment, thus removing the currently immovable borders between faculties, staff, students, and professionals, and embodying Unitec’s vision by design means. Precedents of tertiary institutes have been researched in a later chapter of this project.

Office Design: Needs

Increase Flexibility
To respond to different types of change, different types of flexibility are required. They are:
1. Building flexibility - easily extended, split up and/or subset
2. Spatial flexibility - Floor plans easily convertible: open plan, cellular
3. Workplace flexibility - workplaces that can flexibly be used by any employee

Encourage Interaction
This ambition is often translated into open office layouts. Literally removing physical and symbolic barriers to communication.
Design solutions:
1. Improved adjacencies between groups
2. The use of transparent partitions
3. The creation of natural meeting points i.e. work lounges, coffee bars

Reduce Environmental Impact
Office buildings are a large consumer of energy, have a significant contribution to greenhouse gas emissions, and require large amounts of water hence lots of wastage.
1. The choice of office concept has a considerable influence on the environmental impact of the building.
3. Focused at building design and fit-out:
   • Use of sustainable materials
   • Low-maintenance detailing
   • Alternative energy sources
   • Only heating or cooling during operating hours

   • What are the options to reduce the carbon footprint of the office?
   • What are the options to reduce the consumption of energy and water?
   • What are the options to reduce the production of waste?
   • What are the options to increase the recycling of energy, water and waste?
Office Design: Types of Spaces

Work Spaces

- Large Group
  - Team room
  - Team space
  - Open Office
- Small Group
  - Shared Office
  - Cubicle
  - Working lounge
- Individual
  - Private Office
  - Study booth
  - Touch down

Meeting Spaces

- Large Group
  - Large meeting room
  - Large meeting space
  - Brainstorm room
  - Meeting point
- Small Group
  - Small meeting room
  - Small meeting space
  - Meeting point

Support Spaces

- Filing Space
- Library
- Pantry area
- Games room
- Storage space
- Print and copy area
- Break area
- Storarge space
- Locker area
- Smoking room
- Waiting area
- Mail area
- Circulation space

Figure 26: Work Spaces
Figure 27: Meeting Spaces
Figure 29: Support Spaces
Both Unitec and “Planning Office Spaces” aim for sustainability and reducing the environmental impact of buildings. By obtaining a better understanding of material usage and their impact, the goal of being sustainable can be well more met. Materials themselves are a possible quantitative design factor in terms of amount needed in comparison to other possible materials.

Could we use other materials as substitutes for steel and aluminium? It is shown in “Sustainable Materials: Without the Hot Air” that aluminium and steel have both a high cost and high embodied energy. If these can be avoided or substituted with other materials it will bring both the cost of the building down and the cost to the environment.

Aluminium - Main Uses in Construction:
- Windows and doors 27%
- Curtain walls 18%
- Other (gutters, spouts) 18%
- Roofing and cladding 37%

Steel - Main Uses in Construction:
- Non-structural 20-30% (mechanical equipment, fixtures, fittings + facades)
- Superstructure 60-70% (columns, beams, slabs)
- Substructure 10+% (shallow foundations, basements, deep foundations)

From the above, it is shown that the main use of aluminium is for roofing and cladding at 37%, and for steel, it’s for the superstructure at 60-70%. If applied to Unitec’s existing buildings, we would see that a high percentage of steel is used as rebar for the concrete structure. Aluminium is used for the infill façade joinery, which is the second highest use listed at 27%.

Alternative materials
It is shown in “Sustainable Materials: Without the Hot Air” that concrete is the cheapest materials with the least embodied energy, but to be used structurally it needs to be reinforced with steel rebar. It is recommended that the use of cement is minimised unless used for long-term construction due to it having a large contribution of process emissions, which occur regardless of energy efficiency. This should be taken into consideration when considering concrete. Wood can perform structurally, but not to the extent that steel or reinforced concrete can. It is safe to conclude that these materials they have a lot of potential, but unfortunately cannot be directly substituted easily for steel or aluminium.
Using less metal by design

The best way to do this is not to try cut it out of the design as some situations require their strengths, but to optimise the shape and reduce scrap and wastage. One option that cannot be architecturally designed in this project but is worth mentioning is, optimising the size needed of the reinforcing steel versus just using the thickest bar specified. This would save on steel rebar and potentially save costs for both the client and the contractor.\textsuperscript{55}

Other Strategies

Reducing yield loss - Yield loss can be reduced if architects and/or manufacturers optimise the designs and orders so that cut-outs can be tessellated and create little yield loss.\textsuperscript{56}

Reusing metal components – Possibilities of reusing steel framing (the text gives an example of this at Carrwood Park) for new construction.\textsuperscript{57}

Cascading Products - The building adaption matrix taken from “Sustainable Materials without the hot air” gives a relative idea of the effort needed on an easy-medium-hard scale. In the case of this project it would be office to office which is classed as easy and office to retail which is classed as medium. Given the actual typology of the buildings and the existing structure I think it can be said that it is not too difficult of a task as the primary and secondary structure will remain relatively the same.\textsuperscript{58}

Conclusions

Aluminium and steel are both high embodied energy products. Alternative solutions would be optimal to be sustainable. From this chapter it is seen that there is no direct alternative that can be substituted. What has been learned is that by design, aluminium and steel can be used sparingly and in situations that require their strengths. Concrete and timber are both more sustainable materials and should be taken advantage as much as they can. Again, concrete should be used for long-term uses. As long as these factors are considered, a more sustainable building can be the result.
11. **Precedent Review**
Le Coruscant
2015
Paris, France
Atelier d’Architecture Brenac-Gonzalez

Overview
Le Coruscant is a large multi-storey split-volume office building. Programmes include offices, studios, and specific activities such as retail and a café. The design also offers a multitude of public, public-private, and private spaces. There is a public park, a public thoroughfare, two public/private rooftop gardens and multiple private balconies.

Flexibility
In essence, the open plan layout makes this a spatially flexible building. The office/studio spaces can be divided to accommodate multiple tenants due to the clever placement of a number of access stairs and lifts in the building (figure 31). At count, I can see it being divided into 17 clear offices and studio spaces, with two dedicated reception areas, three possible retail areas, and a café (figure 34).

Encourage interaction
The open plan design encourages interaction. There is the possibility that the spaces could be partitioned into cubicles and individual offices, which would create an adverse effect (figure 31). The users would determine this.

Reduce Environmental Impact
The building uses various strategies to achieve its environmental ambitions. Vertical windows are used for thermal efficiency, to provide a good daylight-factor coefficient, and to work well with the aesthetics of the façade. The façade skin is a major element in the design, as it covers most of the building, and has been utilised to act not only as a shade screen device but also as a guardrail. Finally, the building has “a very high level of energy efficiency” as the facade’s window space was limited to 50% to reduce maximum thermal loss. The architect does not state what a very high level of energy efficiency is in comparison to or what the maximum value was of thermal loss. Therefore I would assume it was in comparison to a typical office building with a large amount of glazing.

Summary
Overall, Le Coruscant offers flexible spaces to tenants, good street access and vertical access, the possibility of interaction within companies and between tenants, and has sustainable considerations such as daylighting, natural ventilation, and energy efficiency.

60  Ibid.
61  Ibid.
62  Ibid.
Architectural Strategies

1. Vertical Circulation

Vertical circulation within this building is very important as it is intended to be multi-tenanted. With well-located staircases and lifts, it accomplishes this and remains flexible. There is also single storey vertical circulation for private spaces, creating a spatial variety and offering more square meters for smaller areas.

The flexibility of having a wide range of access points and single storey vertical circulation to either privatize two floors or add another dynamic is useful for this design proposal.

2. In-between Space and Spatial Levels

Le Coruscant’s ground plan is literally a “C” shape (figure 34A). A wide thoroughfare creates a public-private space, as the building masses enclose it from the surrounding context. The greenspace that projects out towards the street creates an inviting public space. Private-public rooftop gardens are available to the buildings’ tenants and private balconies are accessible to adjacent tenants.

In-between space is a must for this design proposal, as it creates meeting points and places for interaction. The range of levels is another strategy to apply.

3. Façade

Le Coruscant’s façade is full-glazing with an aluminium mesh façade patterned across the entire building, with some parts being just glazing. The façade acts as a screen to control overheating and reduce glare, but also as barriers for decks and rooftop spaces.

Multifunctional façade screens are a definite option for this design proposal.
Encourage Interaction

Immediately you can see that interaction and collaboration is a focus as “The design of the building originates in Microsoft’s approach to work, where cooperation and knowledge sharing are key.” Microsoft and the architects do this by: having two departments in one building, focus on developing environments, having a shared atrium that offers space for interactions (professional and social), creating an open and inviting environment, incorporating public programmes, and linking back to the greater urban development. The office functions emphasise this. The design utilises a series of workspaces, meeting spaces, and social relaxing support spaces just like the ones described in “Planning Office Spaces”. Overall, encouraging interaction was part of the design brief and it achieves this in multiple ways from the co-worker level to the public level.

Reduce Environmental Impact

The core sustainable design implications are daylight, indoor climate, and energy consumption. The varying façade openings help keep a lower glazing percentage and create an overall aesthetic. The building uses daylight monitoring and heat reclaim through its plant system. The atrium emphasises the daylighting design. These are all simple but effective strategies that work.
heavier metals. The architects do not state what the concept behind the cladding was and on close inspection there seems to be an alternating pattern algorithm. This is probably determined by a maximum glazing percentage similar to The Daylight-Optimised Façade case study and Le Corbusier. Environmental-response-wise the façade features small overhangs, angled opaque fin-like walls, and blinds to control the glare. Natural daylight itself should not be a problem due to the large internal atrium spaces.

Summary

Overall, Microsoft Domicile being specially designed for flexibility, encouraging interaction, and reducing environmental impact meets all of the criteria. The structure allows flexibility for the spatial planning and the removable internal partition walls allow the building in a whole to be flexible for future programmes. The smart use of the atrium being a joining factor and vertical spatial hierarchy the open lower floors to the closeness of the upper floors create a scene for interaction as a whole. The interior planning of the office, meeting, and support spaces allow for interaction between colleagues and the designed connections to the surrounding and proposed future developments allow for the greater interaction with the public and the community. Finally, simple but effective sustainable strategies monitor daylight, control the indoor climate, and reduce energy consumption reducing the environmental impact as a whole.

Architectural Strategies

1. Vertical Circulation

The vertical circulation is placed around the corners of the boxes, with the ground floor staircase being offset into the atrium space and visible from the main entrance axis and the atrium street axis. On the other levels a central stair is visible in the middle of the two boxes.

2. In-between Space and Spatial Levels

The overall building has been divided up by a ‘V’ and then moved outwards to create the atrium space. Shifting the floor plates a significant distance apart creates a vibrant atrium that can naturally light the building.

3. Façade

The façade seems to be made of a metal cladding, supposedly a 5mm aluminium composite panel because they are flexible, can be made as a 2d net, and are quite light in comparison to pure 2-3mm aluminium cladding or even
The EA-EURO-HQ buildings offer some flexibility with internal planning. They are custom-designed to embody the organisation’s philosophy of work and play as well as encouraging interaction. They do this through spatial organisation, offering meeting spaces and informal meeting points, and incorporating support spaces such as a games arcade and other fun leisure facilities. They have a low-energy environmental strategy and technology to implement it as well as passive systems to reduce environmental impact.

Reduce Environmental Impact

A low-energy environmental strategy and new technology of the time helps reduce the environmental impact. Given that this complex would indefinitely be a power heavy consumer due to the many computers and systems needed to cool them, the will and want to reduce energy consumption is impressive. A system controls the windows for natural ventilation and if more cooling is needed it will active the VAV displacement system. The focus on natural daylight means that there is less internal lighting needed, hence less heat produced resulting in less energy used for both lighting and cooling. Heat gain is also minimised by the brise-soleils and external louvre facades; the exposed structure acts as thermal mass for cooling.

There is even fritted glazing, and blinds which give users privacy, heat, and glare control and also match the frits and the louvres’ aesthetics.

Encourage Interaction

EA holds an attitude of a flexible non-hierarchical working environment where everyone from worker to managing director has the similar working facilities. This supports creativity and communication as there is no material dominance, enabling a more open and relaxed feeling. Couple this with the organisation’s work and social focus, the design incorporates support spaces such as a games arcade, a sports pitch, a library, a bar, and a large restaurant. The use of informal open meeting spaces along the building edges and within the atrium instructs creates designated or occupiable meeting points. The fact that this complex’s primary mode of travel is walking means that interactions will happen along the ‘street-like atrium’, the external vertical circulation within the in-between atrium spaces, and along internal circulation routes with the optional occupiable meeting points.

The EA-EURO-HQ buildings offer some flexibility with internal planning. They are custom-designed to embody the organisation’s philosophy of work and play as well as encouraging interaction. They do this through spatial organisation, offering meeting spaces and informal meeting points, and incorporating support spaces such as a games arcade and other fun leisure facilities. They have a low-energy environmental strategy and technology to implement it as well as passive systems to reduce environmental impact.

Figure 48: Office space types

Figure 49: EA Euro HQ Floor plan ground

Figure 50: EA Euro HQ Floor plan level one

Figure 51: EA Euro HQ Photo of the ‘street-like’ atrium

Figure 52: EA Euro HQ Cross section through atrium space

Figure 53: EA Euro HQ Cross section through atrium space

Figure 49: EA Euro HQ Floor plan ground

Figure 50: EA Euro HQ Floor plan level one

Figure 51: EA Euro HQ Photo of the ‘street-like’ atrium

Figure 52: EA Euro HQ Cross section through atrium space

Figure 53: EA Euro HQ Cross section through atrium space

EA EURO HQ

Also note that these spatial activity definitions are very specific. Precedents may use spaces for multiple purposes including some of the activities that I have not listed. I am only informed by the available plans and descriptions from text sources.

73  Ibid., 206.
75  Ibid.
77  Ibid.
78  Ibid.
79  Ibid., 211.
Architectural Strategies

1. Vertical Circulation
   The two end buildings both have a front and rear vertical circulation, and the centre building only has the rear. In the space/courtyard/atrium formed in between both end buildings and the middle building, there is a staircase that goes from ground to the top level, and an intermediate bridge joins the two buildings to the staircase landing and a lift (figure 55).

2. In-between Space
   The 'street-like atrium' forms occupiable space between the curved glass façade and the buildings (figure 54), and large courtyards are also formed between the three buildings. The spaces created are occupied freely as well as create informal meeting points and encourage interaction.

3. Façade
   The façade is primarily glazed and from observation, pre-cast concrete panels house the rear vertical circulation and the plant systems. It also has horizontal louver screen walls along the outer East and West facades as well as metallic frit glazing along all the East and West facades (figure 52).
Reduce Environmental Impact

The GCI building is designed as a net zero-energy and carbon neutral ‘living building’ in the sub-tropics: it has no mains grid power-use bills, employs advanced technological control systems. For a building of this scale this is a highly sustainable solution as sustainable buildings go.\textsuperscript{80} It runs only on onsite renewable solar energy; collects 60,000 litres of rainwater in an onsite tank used for cooling systems, amenities, and kitchens; has a thermal chimney and automated louvres to respond to humidity and temperature; has motorised sunshades to deflect sunlight and protect against the wind; has a hydroponic green wall; incorporates a low-carbon produced low emission structural geopolymer concrete; natural cooling measures such flushed chilled water through the exposed concrete.\textsuperscript{81} Furthermore this list could continue to include material usage, water treatment, and additional technical information but the above is a very good indication of the methods used to reduce the environmental impact. This building is truly sustainable.

Summary

The Global Change Institute is a highly sustainable building. It incorporates both high performance and low emission materials, passive energy practices, and live-feedback technological systems for controlling the internal environment and minimizing the external environment. The spaces are flexible to allow for both teaching and learning and give more options of how to work to the occupants. The central atrium space encourages interaction through lots of informal working spaces, meeting points, and break spaces.

Figure 56: GCI Building Facade 1

Figure 57: GCI Building Facade 2

Figure 58: GCI Building In-between Space
Architectural Strategies

1. Vertical Circulation
There is a large central stair within the atrium and a lift with a neighbouring vertical services shaft located just behind that. Another smaller access stair is located off the atrium possibly as a required isolated fire stair and probably used as another option for circulation.

2. In-between Space
The atrium itself is fully enclosed and created within the space bordered by existing buildings. The stair landings protrude at mid-storey heights adding a dynamic to the space as well as marking vertical circulation. A tree structure grows and branches out to support the arching canopy. Level two has an occupiable chillout/study space. In this case the in-between space has been fully designed and enclosed and acts as a vital core.

3. Façade
The façade is fully glazed with operable louvres and an operable sun shading system that moves to block wind, block glare, and reduce the thermal loading.
Design
12. THE SITE
The site is located in Auckland, New Zealand, on Unitec's Mount Albert Campus.

Figure 61: New Zealand
Figure 62: The wider Auckland Aerial
Figure 63: The whole Unitec Campus in Colour, Mount Albert, Auckland
Figure 64: Existing Building Layout Diagram

Figure 65: Unitec Aerial Photo of the existing site and surroundings

Figure 66: Unitec Future Plan proposed by Unitec
Figure 67: 3D of the Existing Unitec Site and Neighbouring Buildings
Figure 68: Existing Unitec Plan, Campus Coverage in Blue, Arial photo
Figure 69: 3D of Unitec’s Present Proposal for the Site and Neighbouring Buildings
Figure 70: Unitec’s Present Proposed Plan, Campus Coverage in Blue, Proposed Siteplan Zoom
Figure 71: 3D of Unitec’s Future Proposal for the Site and Neighbouring Buildings
Figure 72: Unitec’s Future Proposed Plan, Campus Coverage in Blue, Future Siteplan Zoom
The Existing

The following problems have been identified with the existing buildings:

Space
- Non-flexible and underutilized interior spaces
- Underutilized and undeveloped exterior spaces
- Unoccupied spaces both internal and external

Reduce Environmental Impact
- Overheating on the northerly facades
- No existing shading devices to minimise and control thermal gain
- Deep floor plans and lots of solid interior walls, which makes it inadequate to naturally light many internal spaces or at least to a good working standard as well as preventing cross ventilation
- Minimal natural light, too much artificial light
- Energy wasted on artificial lighting especially in underused and unoccupied spaces
- Excess heating from artificial lighting and thermal gain in smaller spaces, particularly corridors
- Underutilized natural ventilation

Unitec’s Proposal

The following problems have been identified with the proposed buildings:

- The buildings are only being recladded. That will fit Unitec’s new image literally by creating a new façade but there is more potential to develop them further than this as a long-term investment.
- The only addition to the buildings is an extension on the ground floor. This is extended near-flush to the front edge of building 112 and significantly reduces the size of the courtyard between buildings 114 and 115.
- The ground floor extension also creates an even deeper floor plan making it harder for natural light to penetrate the spaces.
- Extending the ground floor flush creates a flat linear façade to the new ‘Unitec spine’ which is good, but on the other hand it does not draw users in and disengages with the openness of the greenspace opposite it.
13. THE BRIEF

The project’s proposal is to redesign Unitec Institute of Technology’s buildings 111-115 embodying Unitec’s core values (see chapter Unitec Needs) alongside the central aspects identified in office design (see chapter Office Design). The existing programmes will be kept as there is no apparent information suggesting they will be moved. From the prior chapters, spaces to incorporate businesses to provide both a collaboration with Unitec and a work-teach-learn environment will be included. Retail spaces will also be included to create a vibrant street and anchor and interaction points for businesses and people. More programmes will also be added if their activities are deemed relevant or useful.

This project will also consider the engagement with the overall site from an urban context to an immediate context and the site’s future development into the Unitec core. Moreover, environmental considerations will be made for daylight, solar shading, natural ventilation, energy (electrical) usage, and material use. Daylight will be initially analysed with the software Revit: illuminance, and all the mentioned environmental considerations will be incorporated into the design via a computational associative model, thus having a performance architecture outcome.
14. Design Process
**PROPOSED BUILDING HEIGHTS**

From the blown up diagram on the left, the proposed buildings on the site will remain at their existing heights with an addition of an extension one storey tall on the ground level.

Overall the indicated heights of buildings is shown, some of which are/or will be built, others which will be demolished in place for other uses.

**FLOOR AREA COMPARISON**

<table>
<thead>
<tr>
<th>Level</th>
<th>Existing Floor Area</th>
<th>Unitec’s Proposed Floor Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>3139.68m²</td>
<td>5087.07m²</td>
</tr>
<tr>
<td>1</td>
<td>3228.50m²</td>
<td>3613.83m²</td>
</tr>
<tr>
<td>2</td>
<td>2651.35m²</td>
<td>3028.28m²</td>
</tr>
<tr>
<td>3</td>
<td>1622.68m²</td>
<td>1875.64m²</td>
</tr>
</tbody>
</table>

Total Floor Area=10642.21m²

Total Floor Area=13604.82m²

Extra Area=2962.61m²

---

Figure 79: Site Plan with development scheme

Figure 78: Unitec Proposed Building Heights & Zoned Diagram
The programme for Unitec’s proposal will be the same as the existing as taken from the existing facilities management plans:

**Main**
- Admin
- PC Lab
- Café
- Meeting Room
- Lecture Theatre
- Tutorial Room
- Staff
- Services IT
- Archive
- Classroom
- Retail (ANZ Bank)
- Science Lab
- Prep Room
- Tech Room
- Drawing Room
- Seminar Room
- Studio
- Darkroom
- Locker

**Secondary**
- Kitchen
- Sanitary
- Circulation
- Storage
- Services
- Plant

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**Figure 60:** Desired Activity Spaces based on “Planning Office Spaces”
The intent of this project is to reuse the buildings the existing structure must be examined.

The existing buildings' have a concrete structure, which consists of:
- series of concrete columns.
- series of concrete beams.
- the pair of elements above acting in harmony as moment frames in two directions, and also as both primary and secondary structures.
- rib and infill flooring with a rib around outer edges where the infill facade is fixed.
- cantilevered slab boundaries to provide shading and act as a thermal mass in this design.
- infill facade spandrel and glazing panels framed by the column bays, beams, and floor.

The solar study on the right shows how the existing building deals with glare, overheating, and thermal mass. The window openings are so small only a minimal amount of natural light penetrates the building. That is the major problem with this scheme.
The diagram to the right shows:

1. The retail centres around the local areas. Unitec has the potential to become another retail centre.

2. The railway line and train stations, and the local bus stops in the vicinity of Unitec. This gives an overview of the transport infrastructure.

Figure 83: Infrastructure Connections

Figure 84: Possible streetfront development (top) & proposed development building 111-115 heights remain the same

Figure 85: Diagram showing the important East facade and the gateway idea

Figure 86: Diagram showing the links to the businesses

Figure 87: Link with tower and bridge concept also acting as a gateway
15. Concept Design
Concept One: Redesign of the Middle Towers

This first concept was a narrowed attempt to apply the lessons from "Planning Office Spaces" and the precedents whilst taking a minimised sample of the programmes from the existing buildings. In doing this I decided to directly redesign the two middle towers (buildings 112-114) within their existing bounds and extend the core tower between them.

The general scope of this concept is as below:

- retail on the ground floor (orange)
- student facilities located from the ground floor up: a mixture of work/meet (yellow/blue) and break/study/interaction spaces within the circulation (red)
- faculty rooms with support work/meet spaces located in the right tower building 114
- a leasable space for an external business is located in the right tower building 114 on a proposed new 4th and 5th floor as an example of integration and that more floors could be added on both towers
- both towers internal spaces were extended out to the edge of the slabs with a glazed curtain wall and a heat and glare reducing mesh
- a central atrium was introduced to get more daylight into building 114 and became an anchor for planning those spaces
- the new extended core tower has an atrium space to get more daylight, two lifts, toilets, and an exposed staircase to encourage interaction.
The following drawings reiterate the points above and show the vertical circulation spaces (the inserted atriums) and display the triangulated mesh screen.
A- Replanning the existing buildings

B- Adding atriums to the existing buildings and replanning them

C- Vertically extending the existing buildings distinctively and replanning the existing buildings

D- Extending the existing buildings in plan focusing on the in-between spaces created

E- Directly connecting the existing buildings to existing and proposed business hubs within the Unitec site and integrating them as a major driver into the redesign project

Advantages and disadvantages

Option One
- Re-planning is basically the ‘control’ in this conceptual design experiment (note that actually the real control subjects are the Unitec existing buildings and the Unitec proposed redesign of the buildings).

Option Two
- This is subtractive design by removing parts of the existing.

Option Three
- Expanding upwards is additive design. This coupled with subtractive design can create vast atrium spaces and a variance of spaces on all levels.

Option Four
- This is additive design like option three. This also could be coupled with subtractive design to create long atrium spaces and a again a variance of spaces internally and externally. This also could be combined with option two and be extended upwards. In doing so, this allows the freedom to expand and subtract at will.

Option Five
- This concept is again basically connecting the business partners physically to one another, literally showing their connection to Unitec. This concept could also apply the options stated in option four. The biggest problem with this concept is it could deter from the major aims of this research document.
This model is useful because it illustrates the locations of the existing vertical circulation are not obvious to the users. This is also shown in figure XXX where it shows all the existing building entrances, the vertical circulation locations, and the main circulation paths to and from the buildings. The potential these spaces have as daylight voids is minimal for all of these apart from building 111 and 113 as these voids are small and located on the edge of the buildings predominantly on one side or another. The voids on the edge of the South West facades would just hinder the building performance through thermal loss.

Existing and Concept Models

These models were made to examine the existing building masses of the chosen site and to apply the conceptual strategies explored in XXX PART.

Figure XXX is a massing-model of the existing buildings as the are now. One prominent thing from doing this show the relation between the proportional relationships between all four buildings shown in figure XXX.

Figure XXX is a massing-model of the existing buildings as they are now with the existing voids shown. All of these are primarily for vertical circulation and are firecells. Only the void in building 111 acts as an atrium space for daylight as the internal partition walls are glazed.

Figure XXX is a transparent simplified proportional massing-model of the existing buildings (existing footprint is drawn on the base) illustrating a figure-ground style approach of inserting voids as masses internally into buildings 111, 112, and 114.

Figure XXX is a massing-model of the existing buildings with the existing voids plus an addition to all the masses by extending them horizontally. This increases the overall footprint and would create darker spaces due to the deeper plans of the buildings.

Figure XXX is a massing-model of the existing buildings with an addition to all the masses by extending them vertically. This increases the gross floor area and would create more shading due to the increase of height.

Figure XXX is a massing-model of the existing buildings with large voids subtracted from each of the masses. This strategy would definitely increase the natural lighting of each space as all plans have been narrowed in depth. This strategy largely decreases the gross floor area and would involve a huge amount of effort dissecting the existing structure and reinforcing it to ensure structural stability.
Concept Two: Repurposing the Buildings

This concept now applies some of the transformations investigated in the prior study models. Again the floor plans are colour-coded to apply the lessons from "Planning Office Spaces". One limiting factor about doing this is that I still have not started on the scripting side of this project. Revit daylight studies were done before this concept testing the illuminance levels of the existing building versus a fully gutted out and glazed version. I should have applied that to this attempt. The facade has been left as a glazed curtain wall with some opaque parts for the specialized programmes located in building 115 (which will remain there as it is a building with awkward column spacing and angles). Having a solid opaque facade on the North-East and partially on the South-East facades is reasonable as they could be used for signage displays.

The planning is similar to the previous concept but this time applied to all the buildings.

The ideas of the central lecture hall keeping circulation around the outside of the slab and the central void allowing spaces to be positioned around it creating the narrow floor plate are still strong.
16. DEVELOPED DESIGN
This first option is similar to the previous concepts essentially dividing the different programmes into different building groupings. It relies on the central break atrium spaces like vertical plazas to be a main place of interaction.

The second option mixes the different programmes as an attempt to encourage interaction. The left tower continues to house faculty (support) spaces and the right tower houses the lecture theatres on the first two floors. Ground retail remains. The end right tower again stays isolated as that little central retail/admin/business building.

The third option removes one retail space from the end building providing another ground floor space for support. Business space locations are the focus of distribution. Inbetween support it encourages the idea of being taught. Inbetween work & learn it encourages giving back and also new ‘youthful’ approaches.

The final option here focuses on mixing businesses around the work & learn spaces, and also alongside work & learn spaces. Being integrated on all sides like this will undoubtedly encourage interactions between all walks of people. Also the ability to mix spaces freely like this mean that the spaces themselves will be flexible.

Overall option four, being the most drastic and diverse seems like the best option to incorporate the desired values for this project. Come to final design time, I think the format to be selected will be the one that works most reasonably with the desired scripting tool.
**Developed Design: Scripting Approaches**

In this stage of design I have formulated an approach to tackle the issues in a logic-based way. Throughout this project natural daylight has been a highly considered design factor and, to me, it was considered the major driver for the endgame. Early on, case studies were looked at for inspiration and as ways to apply these tools. Now, I see that the best way forward with this scripting approach applied to a group of existing buildings is to inform the design of the facade through performance factors (performative design). Now this does not mean that the facade and only the facade is being designed per se, but the facade is one of the main environmental barriers to the contained spaces. This will be explained further alongside the framework of the developing design.

**Sun-path Script**

This is a sun-path Grasshopper script in Rhino created by using the plugin DIVA by Solemma. I have used it to display the Summer Solstice (in orange), Winter Solstice (in light blue), and the equinoxes (in red) at the times of 9am, 12pm, and 3pm. I have then generated line geometry from the plugin to use as 3D sun rays in order to test for glare. I manipulate these with various transformations and vectors coupled with maintaining data trees and reorganising lists.

**Applying the Scripted Tool**

To the right is an image showing the 3D solar rays at the top of vertical louvres positioned on the North-Western facade (note there will be an overhang at the highest point of the louvres but it is not shown for clarity when looking in plan view). The louvres are adjustable and those changes can be accessed live visually. At this stage the louvre width, depth, and spacing can be adjusted. The script can easily be fixed to include shape and angle. It can also be changed so that specific limits could be set such as how deep Winter rays could project into the space for passive heating, louvre depth becoming dependent on the location of where the infill facade is placed, the material on the infill facade, or limited to no glare getting past the louvres. My intentions are to apply this script individually.
to sections of the North-West facade - specifically to the buildings, and to the circulation and interaction cores/buts to create a significance to the entry points.

Figure 123: Louvre & Overhang Sun Ray Script Gill Definition (continued on opposite page)

Figure 124: Plan views of a manipulated series – Louvre & Overhang Sun Ray Script (continued on opposite page)
Scripting Concept

To the right the elevation and section both display steep sections through the site contours. The green link is very important as it projects out directly in front of the North-West facade of the buildings. This facade is important because it will be part of the new Unitec Spine. The walking/cycling route is the main transportation infrastructure focus so it makes sense to help accentuate this.

These two views are simply to show how a new facade design could relate to the site by caressing the rise of the natural contours.

The designed facade in these views and the following is a series of vertically spaced louvres with a shielded canopy section near each finished floor level. This design is generated by a profile i manually drew following intuitive logic: the louvre profiles need to be deeper near ceiling height and also include an overhang near fl. I then varied the heights at the edges of each building. Firstly i tried offsetting them by 200mm up and down from zero displacement, and found that was too little variation to give a noticeable aesthetic dynamic to it. I then tried 800mm and ended up with the displayed result.

Again at this stage the facade has not been informed by quantitative data thus this is just one possible method of generating an informed geometry once that data is linked to it.

The previous section talks about my desired approach. Another weakness of this at this stage is that it consists of straight vertical louvres on a North-West facing facade. The louvres could be tilted to make up for the northerly angle. Horizontal louvres would be a plus but would not have the same effect. The best thing to do would be to test both of these options in the solar ray definition.

Facade options:
- horizontal louvres with infill facade
- vertical louvres with infill facade
- mesh screens with infill facade
- partial-mesh screen with infill facade
- varying curtain wall panels

I think that vertical louvres with overhangs or a mesh/partial mesh screens would be the best options for this design. They have the opportunity to flow with the concept and alternate according to internal programme directives.
Scripting Strategy

The way ahead is to link the screen/louvre geometry to the inner facade. That way internal spaces can then be pronounced with balconies and inset facades making no two floors feel exactly the same. This will also create a sense of place from both the inside and the outside.

The diagram to the right shows how distance ‘x’ will parametrically associate itself with distance ‘y’ and both will be determined by the solar ray data from ‘z’. Please note ‘A’ stands for atrium/break space.

This is not all. Now the base can be set up, the other earlier mentioned factors can now be brought in and added into this abundance of possibilities.

Daylight illuminance, natural ventilation, energy (electricity-used), and material use (m2 and accessed by the designer sustainability-wise). In doing this these other factors can be prioritised. They can be arranged in hierarchies and the designer can choose or test them against one another. Ultimately if the script could be joined to the evolutionary solver ‘Galapagos’ then it could test endless variations set within the parameters of one’s liking.
Figure 130: Perspective of Atrium/Break Space - A Vertical Circulation Core (looking North)

Figure 131: Perspective of Atrium/Break Space - A Vertical Circulation Core (looking South)
The design solution presented has begun to incorporate both the associative methodology within the context of the redesign of the spaces. The work-teach-learn reuse was the focus of early conceptual work and with the redesign began to overshadow the idea of the associative methodology. Performative studies were done during the conceptual stage but this was outside of the associative system of parametric and algorithmic design methods. This did however still achieve the aim of using the computer as a design tool and allowed myself and readers to see some of the advantages it has to offer. That said, the final design will have used the associative design methodology as the current design is beginning to do and will encompass the following performative factors: solar shading analysis (as it is currently doing), daylight illuminance, natural ventilation, energy (electrical usage), and material use.

Conclusion

This research project looked at two parts. Firstly, how to display the advantages of the computer as a design tool, and secondly, re-using Unitec’s existing buildings 111-115 to update them through renovation.

In the first part the project explored understanding digital design method terminologies, discovering what the computer is being used for and how it is being used, and finding out what digital tools are available to implement these methods and processes. This set the stage for using the computer as a tool in an informed way.

The second of the project explored how Unitec’s existing buildings 111-115 could be updated through renovation. It reviewed Unitec’s needs as an institution, investigated office design and spatial planning, and studied the sustainability of materials in the need to reduce environmental impact and as a possible design factor. Precedents relevant in programmatic manners and that were flexible, encouraged interaction, and reduced environmental impact were studied.

This lead to the posing the question - How can a digital associative design methodology inform the redesign of a series of modern work-teach-learn buildings?
Bibliography and Figure List
BIBLIOGRAPHY:


Other relevant tests reviewed by the author in context of this project:


BiBliograPhy:


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Figure List

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Figure 22: Toni Stable Student Center F

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Figure 24: Le Coruscant A

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Appendix A - Final Design
ASSOCIATIVE DESIGN METHODOLOGY
Performative Design for a Modern Work-Teach-Learn Unitec

Henry Lukaszewicz
Daylighting

As architectural digital software is improving, features like daylighting analysis have begun to be integrated into these software packages or available via downloadable free or paid plugins. These can become key design tools and informers, but they tend to be overlooked or undiscovered. Again, typically architectural digital software is used as a drafting machine and a tool for 3D representation (perspective and orthographic drawings) rather than for design exploration. Here I intend to investigate the tools at hand and show the power of their use individually and when bringing them together to really inform the design with the nature of that composed by the designer themselves.

Appendix : Daylighting Studies

For all the daylighting studies completed, the measurement of illumination Lux (lumens per metre squared) was used. The range and expected values were determined by the values from the following charts.

Daylighting is an important factor in modern design in New Zealand, and it was seen both as part of Unitec’s core values and a key tool in “Planning Office Spaces”.

Daylighting

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Daylighting Studies
Superseded Designs
Unitec
Institute of Technology

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