NEW LYNN – AUCKLAND IMM CASE STUDY

Low-density urban morphology and energy performance optimisation

A new pilot project in Auckland using Integrated Modification Methodology (IMM)

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Preface

A new challenge for IMM: a low-density sprawling context

Prof. Tadi and Prof. Bogunovich

Leaders of the IMM workshop

Integrated Modification Methodology (IMM) has already been applied in established metropolitan contexts, such as Porto Maravilha in Rio de Janeiro, the neighbourhood of Shahrak-e Golestan in Tehran, and Block 39 in New Belgrade, with good outcomes.[1] When Professor Dushko Bogunovich from New Zealand's Unitec Institute of Technology came up with the idea of a comparative analysis of two sprawling metropolitan contexts – Auckland and Milan – we decided to apply IMM to a sample of Auckland's low-density suburbia.

Cultural and physical geography specificities of Milan and Auckland aside, these two urban contexts have sufficient similarities to make the outcomes of a comparative analysis relevant in the raging global debate on how to address the issue of urban sprawl.

Both Auckland and Milan are car-dominated cities. They consist of a central city surrounded by poorly connected suburbs, indicating unsustainable levels of consumption, excessive waste generation and heavy dependence on private transport and other types of infrastructure. Both cities struggle to address the issue of urban sprawl – not only in a negative sense as a continued pressure and threat, but also with a more accepting attitude, as an enormous fact of life that has already happened and cannot be rolled back. And in both cases, the areas affected by sprawl are actually much larger than the official metropolitan territory: most of the northern North Island in New Zealand in the case of Auckland, and almost the entire sub-region of western Lombardy in the case of Milan.

While we believe it is not too late to address the issue of urban sprawl – this remains an imperative – we also acknowledge that the strategies of Milan and Auckland will have to differ (Bogunovich, 2015). Divergent approaches were intrinsic to this research workshop, and we welcome them.

It is our hope that the different angles on the two cities offered here will enable us to formulate more generic, theoretical propositions. These should be relevant beyond the specific circumstances of Milan and Auckland, and hopefully be significant globally.

The project presented in the following pages has been developed in a joint international design workshop organised by Politecnico di Milano, specifically the Masters Program in Building Engineering and Architecture, IMMdesignlab, and Unitec Institute of Technology, Auckland, New Zealand.

The workshop entitled: "Low density urban morphology and energy performance optimisation: A new pilot project in Auckland via IMM", was held at Politecnico di Milano, Polo Territoriale di Lecco (Italy), from 25-29 May 2015, as part of the master class teaching activities and IMMdesignlab's research activities. The team, comprising 14 international students from different design disciplines, has been co-ordinated by Professor Massimo Tadi (Politecnico di Milano), Professor Dushko Bogunovich (Unitec), assisted by Engineer Hadi Mohammad Zadeh and Frederico Zaniol (IMMdesignlab). The outcomes of the workshop have then been further developed by IMMdesignlab to demonstrate how by adopting IMM it can be possible to retrofit, renovate and reactivate an inefficient and energy consuming neighbourhood into a more integrated and sustainable one.

The outcomes of this workshop – where the IMM approach focused for the first time on the low-density sprawling suburb of New Lynn in West Auckland – may give us some fresh clues about the pros and cons of one strategy or the other. In addressing the 'sprawling monster' we really need to know what is more effective – to resist it frontally with all the available powers of local government, or accept most of it but make every effort to equip it so that it is prepared to meet the challenges of the twenty-first century.

Professor Massimo Tadi

Milan, 2016

1 Details of the projects cited are available on IMMdesignlab's website. See: http://www.immdesignlab.com

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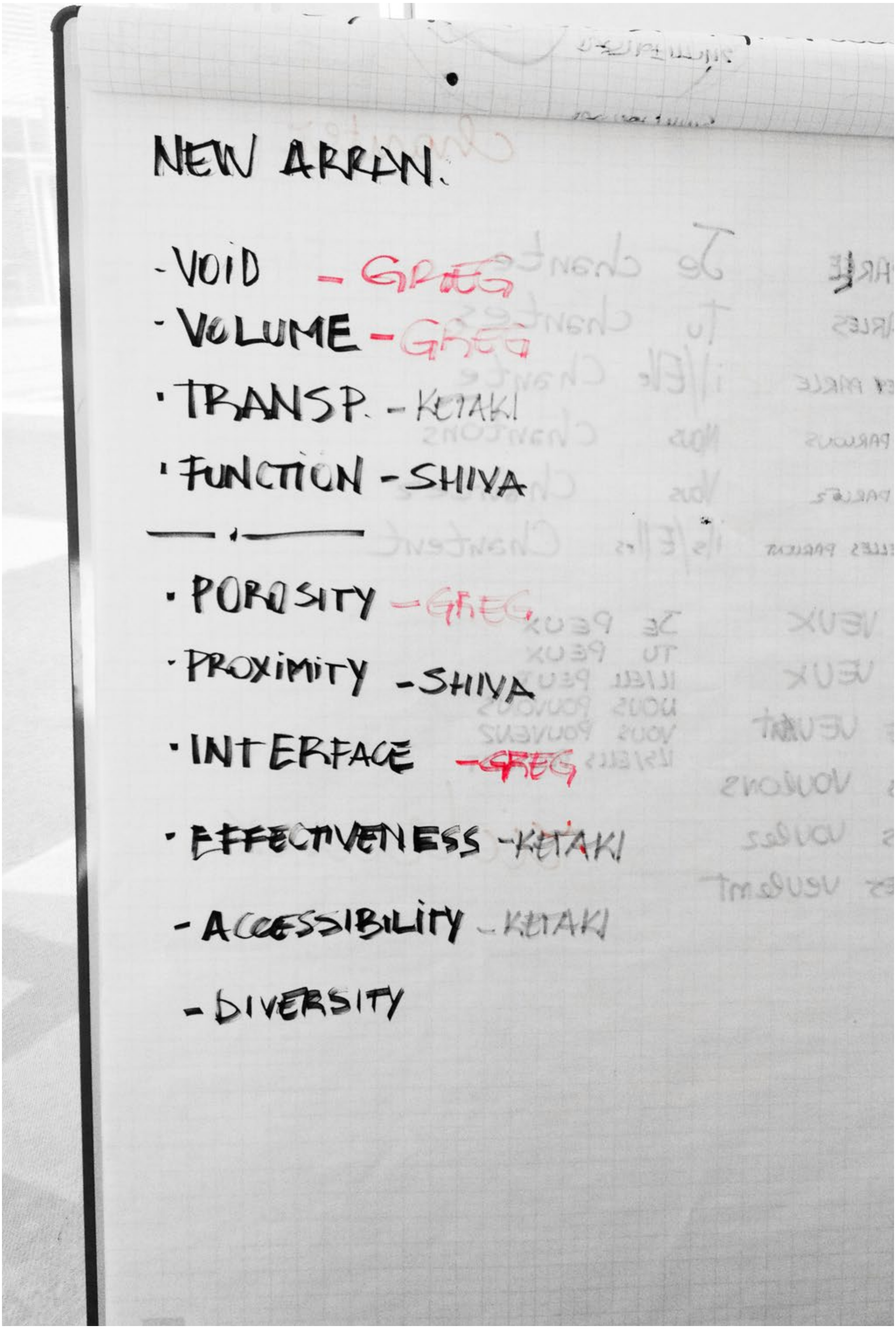
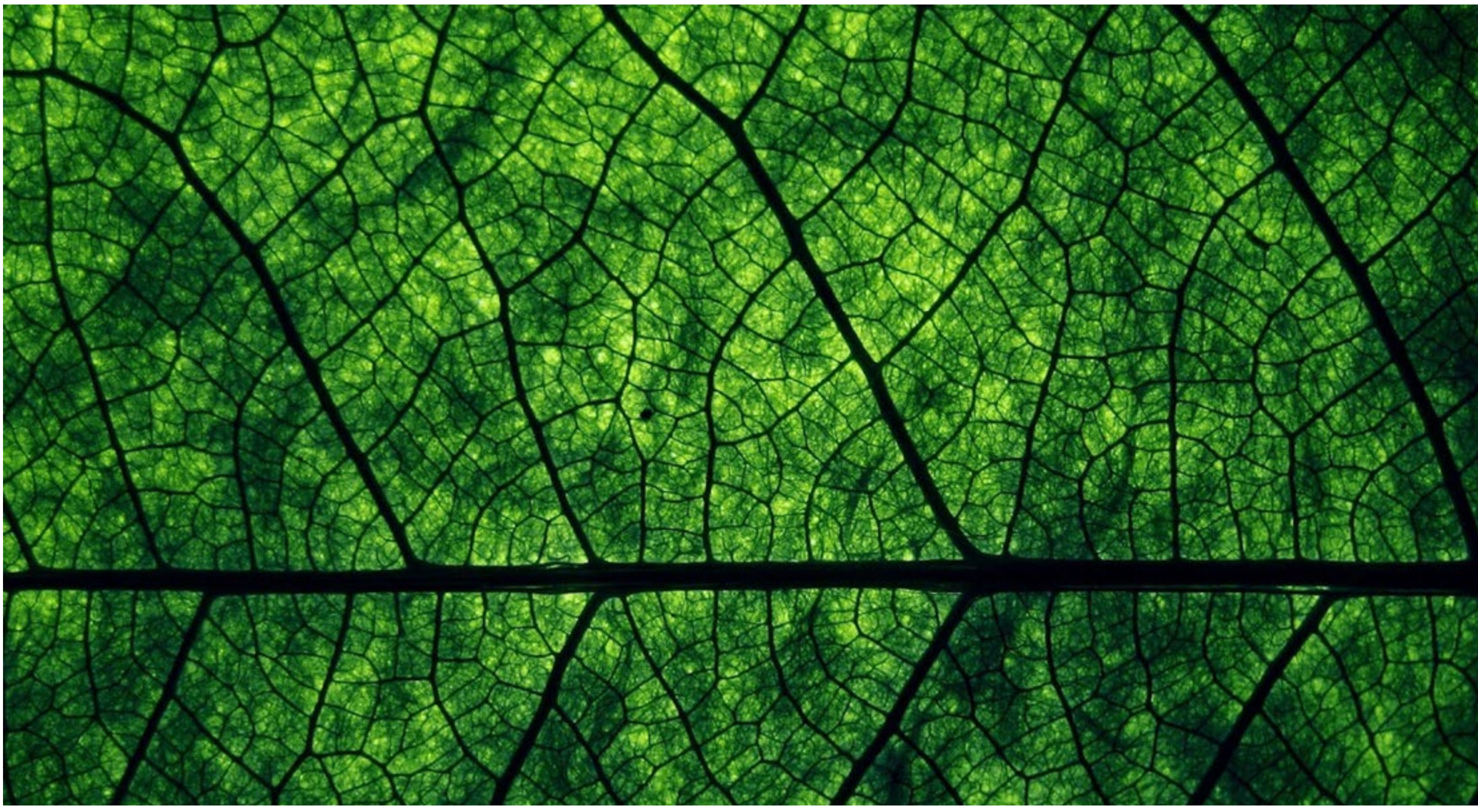

NEW ARRAN.
- VOID - GREG
- VOLUME - GREG
· TRANSP. - KETAKI
· FUNCTION - SHIVA
· POROSITY - GREG
· PROXIMITY - SHIVA
· INTERFACE - GREG
· EFFECTIVENESS - KETAKI
- ACCESSIBILITY - KETAKI
- DIVERSITY



IMM Process

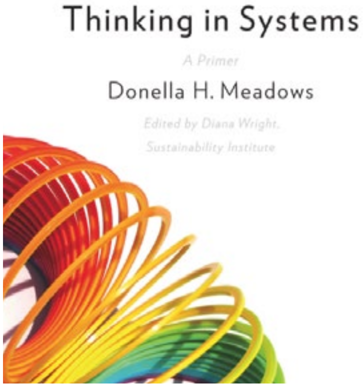
Multi-stage iterative process applied to urban complex adaptive systems optimisation

1

IMM Process

IMM is a multi-stage iterative process applied to urban complex systems. The process aims at improving the systems' performance through a recursive, integrated process made of four phases.

Integrated Modification Methodology (IMM) is a multi-stage, iterative process for improving the performance of cities seen as Complex Adaptive Systems (CAS). It is intended to assist designers and decision-makers, providing them a fully-integrated design process plus a set of Design Ordering Principles (DOP) to transform an existing urban context into a more sustainable one. IMM is a design methodology based on a specific process, with the main goal of improving the urban energy performance through the modification of its constituents and optimisation of the architecture of their ligands. According to this view, the city, considered as a Complex Adaptive System, is not solely a mere aggregation of disconnected energy consumers, and the total energy consumption of the city is different from the sum of all of the buildings' consumption. This considerable gap between the total energy consumption of the city and the sum of all consumers is concealed from the urban morphology and urban form of the city (Salat and Bourdic, 2012).



The main concern of IMM methodology is to improve an urban system performance, regardless of its morphology. The IMM simulation methodology, based on a series of CAS analyses, explicates a way to propel the urban transformation to the sustainable urban form. One can utilise this integrative methodology, based on modification and integration of existing elements, to propel the gradual transformation's process towards a more sustainable direction.

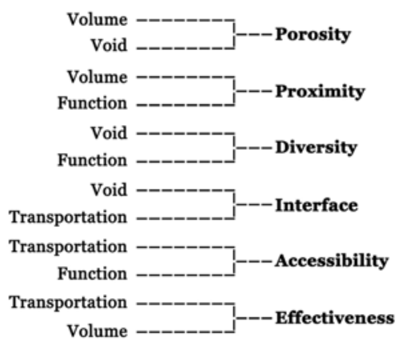
IMM is fundamentally holistic, multi-layer, multi-scale; it investigates the relationships between urban morphology and energy consumption by focusing mostly on the 'subsystems' characterised by physical characters and arrangement.

IMM considers the city composed of 'subsystems' organised structurally and linked together in a provisional physical structure, outlining a distinctive and specific morphology. This individual morphology is a transitory result of the dynamic interaction of the subsystems in which their states are no longer independent. In this model, subsystems are distinguished respectively into:

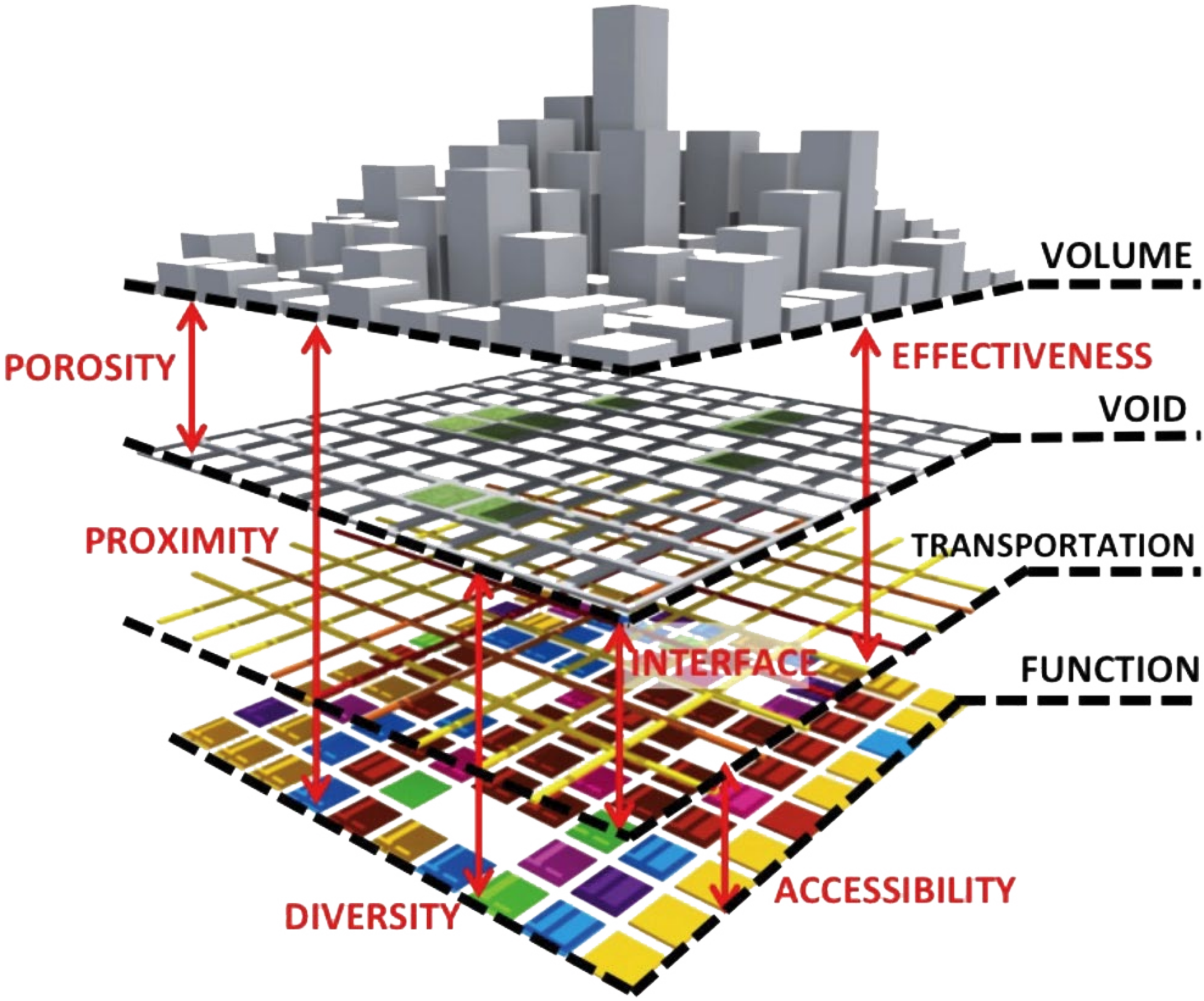
- Urban Volumes (built-up mass subsystem)
- Urban Voids (open spaces, streets, etc.)
- Functional (land use subsystem)
- Transportation and Mobility subsystem

The superimposition, or symbiotic integration, of layers creates morphological, typological and technological feature-determinants of the city, called Key Categories (KCs), which are responsive to sustainable urban design interventions.

KCs play an important role in the IMM, in two ways. One, in the investigation phase, for analysing the urban context and its performance before the design intervention. Two, in the design phase, for changing the entire system's configuration. The KCs are: Porosity, Proximity, Diversity, Interface, Accessibility and Effectiveness. Moreover, 12 indicators – a core set of elements based specifically on environmental themes – are used in the process for objective measurement of the CAS performance prior to and after the transformation design process. Associated with the indicators are the 12 Design Ordering Principles (DOP), which are used to arrange the structure of the CAS in order to affect its structure and performance.



^ Fig. 1
First level of superimposition



To achieve the CAS optimisation, IMM introduces a recursive loop process, which involves an endless succession of modifications of the stabilised state of the system. The design process in one loop goes through four integrated phases: the preliminary phase is named Investigation, whilst the second phase is called Formulation. The third phase is a Design and Modification phase, while the last phase is Retrofitting and Optimisation.

The presented New Lynn study case can be considered as the demonstration of this process. The Investigation phase is finalised to the comprehension of the physical arrangement of the local CAS and its actual energy and environmental performances. Then the choice of the Catalyst of the transformation and, consequently, the design process start with local modifications of the Horizontal and Vertical Catalysts (in the case of New Lynn, respectively: Transportation (Horizontal Catalyst) and Proximity (Vertical Catalyst) implementing it and then checking the chain reaction (Vertical Modification) driven by the response of the reactants (the other subsystems) catalysed to the catalysts.

Sustainability tends to be either overlooked or misunderstood, and is sometimes considered as some urban designers' trend, acting as an ideological constraint and hindering economic viability. A sustainable development is actually a development that meets the needs of the present without compromising the ability of future generations to meet their own needs: environment, society and economy aren't mutually exclusive principles, but the three mutually reinforcing pillars of sustainability.

^ Fig. 2
IMM decompostion of the urban CAS in vertical and horizontal layers.

The comprehension of the configuration of the subsystems play a significant role in the IMM final result. The current structure of the system can is a temporary configuration produced by the preceding superimposition processes.

Each subsystem will be described respectively on a morphological, typological and technological point of view, through features expressed by the superimposition of the subsystems.

Recursive Phases of the IMM process

1	***1.1***	Horizontal investigation	Dismantling the system to investigate	Initial CAS arrangement	**Investigation Observation Measurement Data research**
	1.2	Vertical Investigation	Actual value of Key Categories		
	1.3	Actual performance of the system : 12 indicators		Initial CAS performance	
2	***2.1***	Detection of the transformation's horizontal and vertical Catalysts and Reactants		Catalyst's selection and reactants ordering	**Assumption Interpretation Formulation**
	2.2	Assumption of the 12 IMM DOPs		DOP arrangement	
3	***3.1***	Horizontal modification	Catalyst drives the local transformation of the layers	Catalyser's modification and chain reaction	**Motivation Intervention and Design**
	3.2	Vertical modification	Entire system's configuration's transformation		
4	***4.1***	Performance of the CAS		New CAS performance	**Retrofitting**
	4.2	Local optimization		Local modification of the new CAS	**Optimization**
	4.3	Universal indicators		Comparison	

< Table 1
IMM Design phases table showing steps, sub-steps, object of each sub-step, action or concern about the CAS, state of action on the CAS and overall design approach.

Phase One

This phase investigates the configuration and the characteristics of an urban CAS in a transient state and the effects of an endless transformation process.

The current structure of the system can be considered as a temporary configuration produced by the preceding superimposition processes. The designer activates a disassembling procedure of the CAS into its main physical components or subsystems:

Voids: built volume density, dwelling density, human density

$$V_l = V_{built} / Area$$

Built spaces: open space area

$$V_d = V_{open} / Area$$

Functions: job density, number of legal entities in the intervention area

$$F_n = J_{number} / Area$$

Transportations: number of completed urban trips via public transport

$$N_{tr}$$

The correlations between the subsystems are then analysed in a Vertical Investigation through features expressed by the superimposition, or symbiotic integration, of the CAS subsystems, named Key Categories, as described above. The second step of the investigation phase is also named The First Level of Superimposition (FLS).

This symbiotic integration of layers creates morphological, typological and technological features – KCs. These can be used by designers in the observation phase of the design process to analyse the urban context and its performance before any intervention.

The Key Categories are defined later. Some measurable indicators related to each Key Category are provided. KCs are fixed independently from the context, while the Indicators vary. The Indicators' definition should be chosen differently in every urban context by designers and planners: the selection criteria lie on the contextual constraints, conditions, interventions intentions and available data banks.

Place-specific factors, such as topography, climate and socio-economic conditions, obviously cannot be ignored. These factors are not formulae-driven when it comes to the question of a sustainable city form.

The performance of the CAS before and after the modification process is required. "After all, we are generally confronted not with the task of planning and designing new towns and cities but, rather, that of re-planning and re-designing existing cities, towns and settlements to make them more readily sustainable." (Zumelzu Scheel, 2011, p.2)

The Vertical Investigation Key Categories are:

Porosity: factuality of urban voids

Proximity: number of key functions within walking distance

Diversity: diversity of subdivision use

Interface: mean depth

Accessibility: number of available jobs reachable in 20 minutes, number of accessible modes of public transport

Effectiveness: number of public transport trips, total number of trips

The results of the first and second levels of superimposition of the KCs (for example, Compactness, Complexity and Connectivity), enable the designer to achieve – through a correct balance – a sustainable form. One of these Key Categories alone would not be enough; we're looking for synergy, not for compromise.

Layers superimposition	First superimposition	Second superimposition	Determinants	Sustainable form
Volumes and voids	Porosity	Compactness	Morphology	
Volumes and functions	Proximity			
Functions and voids	Diversity	Complexity	Typology	
Transportation and voids	Interface			
Transportation and functions	Accessibility	Connectvity	Technology	
Transportation and volumes	Effectiveness			

^ Table 2

IMM Key Categories and levels of superimpositions, enabling the designer to get to a more sustainable urban form based on the initial context. At that point, there is no interpretation.

Phase Two

The formulation phase of the IMM process anticipates the design phase and aims at establishing a hypothesis. It is a way to detect the transformation catalyst thanks to the KCs and their associated indicators.

The modification of the selected layers deeply affects the system's performances, thereby changing the CAS's configuration. The Horizontal Layer and the Vertical Key Category selected become the catalysts. The other layers are considered reactants.

Any layer can be a catalyst. The malfunctioning KC is chosen as Vertical Catalyst. In a reaction of the CAS, a reactant is a member that undergoes the modification course.

The Design Ordering Principles are instruments used to arrange the structure of the CAS based on the chosen catalysts. Their application affects its structure and performance.

Phase Three

This phase involves the first level of superimposition of Horizontal Layers. It is the starting point of a chain reaction towards the transformation of the CAS. Once the sub-systems interact, their states are no longer independent.

Modifying local elements, with the aim of achieving global vertical and horizontal transformation, leads the system to a new configuration emerging when all of the superimposed layers meet simultaneously. Practically, local modifications are perturbations causing chained macroscopic consequences for the CAS in terms of performances, hopefully improving its resilience.

They actually enable the propagation of local changes towards the distant parts of the system as a consequence of connectivity and the response of the reactants, which modify the architecture of the ligands (Sawant, Kale, & Torchilin, 2008).

Phase Four

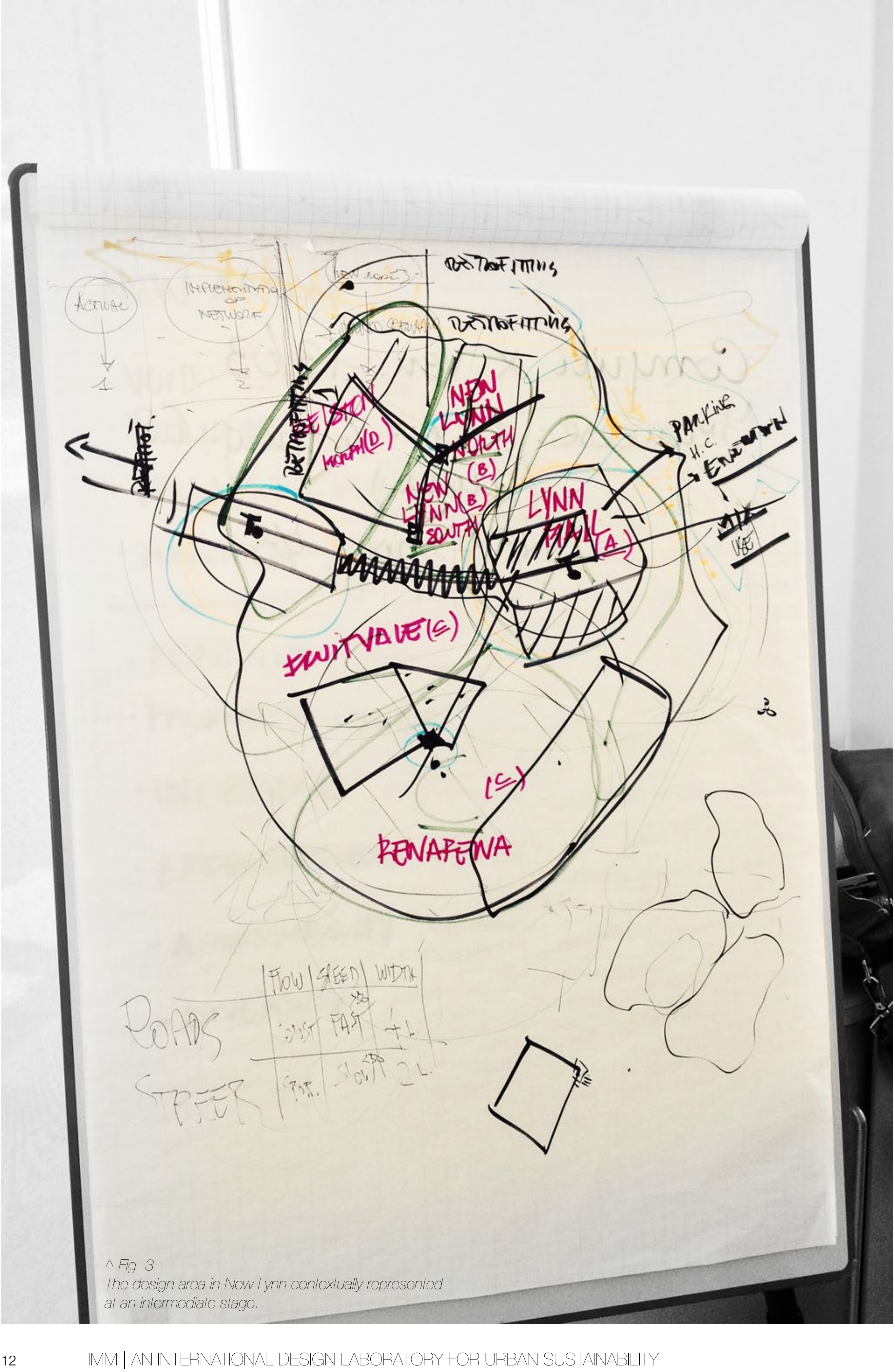
The last step evaluates the performance of the new CAS as a new energy-consuming ¬– and hopefully energy-generating – complex system made of the modified subsystems in their new configuration. The system has reached a stable state, and the recursive loop can go on.

The new CAS will be evaluated and compared with the previous one using the 12 Indicators applied in Step 1b. After the retrofitting process, the local modification/optimisation phase is driven by the KCs to achieve the optimisation of the CAS. Morphological, typological and technological features, such as the following, express the new symbiotic integration:

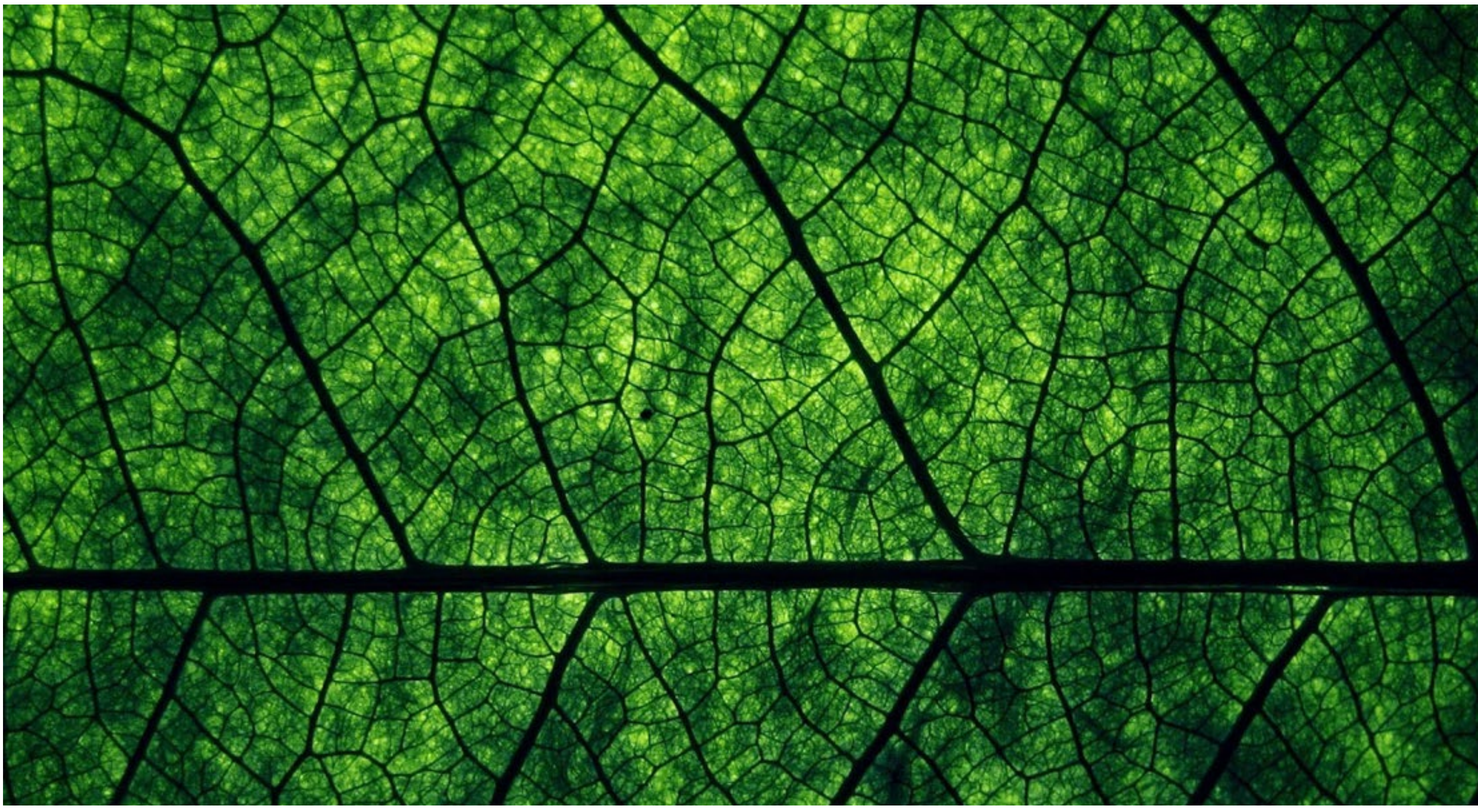
Morphological Test: Porosity and Proximity
Typological Test: Interface and Diversity
Technological Test: Effectiveness and Accessibility

v Table 3: DOP (Design Ordering Principles) organised according to Key Categories, Determinants and in relationship with Morphology, Typology and Technology.

	Design Ordering Principles	Key category	Determinants
Morphology	A. Balance ground use 2. Fostering local energy consumption 3. Promote walkability	Porosity Porosity Proximity	**Compactness**
Typology	4. Fostering mixed-use spaces 5. Biodiversity as part of urban life 6. Connected open spaces system	Diversity Diversity Interface	**Complexity**
Technology	7. Urban public transportation 8. Bikablity 9. Change for multi-modality to inter-modality	Effectiveness Effectiveness Accessibility	**Connectivity**
Management	10. City as food producer 11. Prevent negative impact of waste 12. Implement water management	**Governance**	



^ *Fig. 3*
The design area in New Lynn contextually represented at an intermediate stage.



Context overview

Low-density sprawling context and car-driven culture

2

New Lynn demonstrative practice

New Lynn represents an interesting and challenging study case to test IMM in a very low density and sprawling context. Until now, IMM has been applied, with good results, in many different urban contexts and morphologies - such as Rio de Janeiro, Tehran, Belgrade, Barcelona – all of them characterised, on average, by a good level of compactness as urban cores tend to be, as opposed to a low-density suburban context. So Auckland and New Lynn represent an interesting experiment to investigate whether IMM's procedures, indicators, design principles and formulas work in a low density, suburban context.

But, simultaneously, this project wishes to illustrate that in a sprawling context densification alone is not sufficient to create a sustainable urban form. Rather, the collaborative relation of the compactness, complexity and connectivity, plus an upgrade with green and smart technologies at the lower lever scale, are needed to achieve a sustainable form.

The project developed tries to demonstrate that it is possible, by using the IMM, to activate a morphological local transformation in a selected area (New Lynn), which is then able to transform the whole system in the direction of a more ecological and sustainable arrangement.

IMM aims to develop more sophisticated strategies to help municipalities and local authorities to retrofit, renovate and reactivate inefficient and energy-consuming sprawling neighbourhoods into new integrated and sustainable systems. The experiment aims to find a more complex answer to the problem of 'retrofitting suburbia' and go beyond sheer adoption of simplified and pre-defined 'densification strategies'.

As explained in the Preface, this experiment took place at the Politecnico di Milano, specifically the Masters Program in Building Engineering and Architecture at the Lecco campus in May 2015.

A sprawling context

Urban sprawl has been the dominant form of Auckland's growth and councils of the city and its greater area have been addressing this proactively in their planning policy and strategic documents for the past 50 years (Bush, 2000).

The very end of the twentieth century was marked by the Regional Growth Strategy 2050 when the Regional Growth Forum adopted it in November 1999 (Regional Growth Forum, 1999). The strategy used limits on subdivision and encouragement of intensification of existing urban land as its main sprawl-containment measures. This policy limits the uses of private land, in particular the subdivision of urban fringe properties.

More recently, a new wave of spatial planning at a larger, regional scale has identified urban sprawl as still being the principal enemy (Winder, 2010). The recently completed and submitted Proposed Unitary Plan (2013), prepared by the new, consolidated, single Auckland Council, has taken the firm stance that urban sprawl must be curbed, and prescribed that more than two-thirds of all future growth should be by intensification inside the proposed Rural Urban Boundary (Auckland Council, 2013).

During this latest wave of updating planning documents, a number of non-central areas, which had been designated for redevelopment long ago, received updates of their local plans even before the Unitary Plan has been adopted. New Lynn is one of them. The so called 'New Lynn Transformation', covering the period 2010–2030, represents one of the most radical attempts to increase the density in Auckland's suburbs and orient the residents towards public transport (Auckland Council, 2010). This is a continuation of a twenty-year-old effort, started by a former local council (Waitakere City Council), to turn central New Lynn into a proper town centre. Some of the results – a re-designed local shopping mall, a sunken portion of the railway and a new train station – can already be seen. But a substantial intensification of the wider residential areas of New Lynn had only started when it was derailed by the financial crisis of 2008.

An increase in population is currently having a major impact on transport, housing and other infrastructure, in many cases already considered under pressure. Urban sprawl has resulted from the growth and Auckland City Council has addressed this proactively in planning policy.

A 'Regional Growth Strategy' has been adopted that sees limits on subdivision and intensification of existing use as its main sustainability measures. This policy limits the uses of private land, in particular the subdivision of urban fringe properties. A detailed plan from 2020 to 2030 has already been published for New Lynn.

According to the 2006 Census projections, the medium-variant scenario shows that the population is projected to continue growing, to reach 1.93 million by 2031 while the high-variant scenario shows the region's population growing to over two million by 2031.

Socio-economic and cultural factors behind Auckland's urban sprawl

Auckland, in the North Island of New Zealand, is the largest and most populous urban area in the country. With an overall population of just over 1.5 million, it contains 31 per cent of the country's population. It is part of the wider Auckland Region, which includes rural areas and towns north and south of the city. It includes the islands of the Hauraki Gulf, resulting in a total population of 1,527,100, governed by the recently consolidated Auckland Council.

The Auckland urban area spreads to Waiwera in the north, Kumeu in the northwest, Clevedon in the east, and Runciman in the south. The built-up area between the Whangaparaoa Peninsula and Waiwera is separated by rural land from its nearest neighbouring suburb, Long Bay. The central part of the urban area occupies a narrow isthmus between the Manukau Harbour, opening to the Tasman Sea, and the Waitemata Harbour on the Hauraki Gulf, opening to the Pacific Ocean. It is one of the few cities in the world to have two harbours on two separate major bodies of water.

The 2016 Mercer *Quality of Living Survey* ranked Auckland third in the world. The Economist Intelligence Unit, which ranks cities according to their 'liveability index', placed Auckland ninth in 2016.

Such high rankings have been achieved for some time – for example, in 2010, Auckland was classified as a Beta World City in the World Cities Study Group's inventory by Loughborough University.[2]

These rankings clearly place Auckland City among the most liveable cities in the world. The reasons are complex, but among them are surely an excellent environmental quality in urban spaces, agreeable climate in most seasons, high level of security and reasonably high level of urban infrastructure.

The Auckland Plan – the vision document on which the statutory Auckland Unitary Plan is based – however, aims at making Auckland City 'the most liveable city in the world'. This is to be achieved by providing a high quality of dense, urban living and curbing urban sprawl (Auckland Council, 2011).

Over the past few years a mix of political controversy and the reality of actual developments has cast doubt over the feasibility of the 'compact city' concept.

Between 2014 and 2016 a lively debate about the nature and extent of the 'intensification' proposed in the draft plan has shown that opposition to the Plan is considerable at the level of local communities. At the same time actual development of the city was still more 'out', than 'up'.

Critics of *The Auckland Plan* pointed at the unrealistic nature of the compact city idea early on in the planning process. For example, Bogunovich and Bradbury (2012) and Bogunovich (2013) have argued that the 'compact city' vision and densification strategy are not the right answer in the given physical and cultural context of New Zealand's largest city – at least not at the massive scale envisaged by the proposed plan.

They argued that Auckland is a young and dynamic city, growing fast – it is expected to grow by another million residents by 2040, perhaps even by 2030 – and more likely to grow out even more than in the 20th century due to the influence of powerful transport and communications technology which helps cities function over big distances and at low densities. They also cited the cultural factor: densification and consolidation policies that have worked in some older, European cities may simply fail in a country in which petrol is cheap and the individual car and the individual suburban house with garden is considered the norm.

The same authors have also pointed at the additional concern that climate change and Auckland's geographic site – famously exposed to natural disasters – make a bad combination. On top of the old risks of volcanoes, earthquakes and tsunamis, now comes the prospect of increased frequency and strength of extreme weather events. Surely, then, concentrating population and assets in an ever-denser city, and increasing rather than decreasing the overall dependence on centralised urban infrastructure, are not wise policies?

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2 Laughborough University: GaWC Research Network. See: http://www.lboro.ac.uk/gawc/world2010t.html

Six transformational shifts proposed and a new development strategy: *The Auckland Plan*

Transformational shifts

1. Accelerate the prospects of Auckland's children.
2. Environmental action
3. Move to outstanding public transport
4. Improve the quality of urban living.
5. Substantially raise living standards
6. Significantly lift Māori social and economic wellbeing.

Development strategy

The Auckland Plan's 'compact city' strategy is based on densifying the existing urban area and slowing down the sprawl in areas of cultural or environmental value.

The new masterplan aims at concentrating the development around the internationally acclaimed city centre, 10 metropolitan centres where much of the growth should occur, and 33 town centres such as Glen Eden. Pukekohe in the south and Warkworth in the north will become autonomous satellite towns. In this framework, each town centre is to densify and become a major business area and a hub for employment.

The Auckland Plan has already zoned areas of historic character in need of protection, and rural areas including bush, country living, and rural production. Yet some greenfield land could potentially be left for future residential and business growth.

Guidelines

A generational change

Strong focus on quality housing and compactness. The shift must sustain 13,000 new dwellings per year.

The RUB: Rural Urban Boundary

Limit of growth, at the edge of the new greenfield areas for residential and business land, proposed over the next 30 years.

Housing supply and affordability

Staged release of land within the RUB, annual monitoring of supply, establishment of urban development authorities, use of council-owned land to stimulate urban densification.

Transport

Doubling of the number of public transport trips and improvement of the quality of pedestrian and cycle routes. This translates into a very ambitious programme of long- and medium-term projects (Auckland Transport, 2016).

Urban planning prescriptions for New Lynn 2010–2030

The vision of New Lynn's transformation is to create a unique sustainable urban place centred on a world-class transit interchange that is capable of attracting and maintaining a population of 20,000 residents and 14,000 workers within the area by 2030.

In the New Lynn Urban Plan 2010–2030 (Auckland Council, 2010) it is suggested that the vibrancy and the diversity of the community – with the special characteristics and pride that come from being 'out west' – could be a good lever to initiate a shift.

The plan therefore aims at making New Lynn a place of exceptional quality and the location of choice for people to work, live and play. The council and its partners aim at mandating design standards of development previously unseen in New Zealand.

This vision requires a step change in how New Lynn is regarded and where it sits in the relative hierarchy of Auckland town centres. The move initiated is ambitious: it aims to break the spiral of residential sprawl and avoid the dormitory suburbs effect that has hit sprawling cities around the world.

New Lynn sits on predominantly flat-to-gentle topography with moderate slopes in the south-western corner, associated with the Great North Road ridge. There are significantly sloping banks on the northern extent of the Rewarewa Stream (from Great North Road). The eastern and western ends of New Lynn drop towards the town centre.

New Lynn is not at risk when it comes to floods, apart from some very low areas such as around New Lynn Primary School.

New Lynn's morphology: four fragmented fabrics to be connected and optimised

Fig. 4
Large-scale residential block

Implemented in the northern large street grid of 300 x 300m of New Lynn, it has low porosity and accessibility, and is way out of human scale. Land use is unbalanced. It emphasises a car-driven and individualistic way of life.

Fig. 5
Small-scale residential block

Implemented in the southern street grid of 100 x 100m of New Lynn. It is slightly more porous and less space is wasted for mobility. Yet it is badly connected to the town centre and its intimacy can be seen as imprisonment.

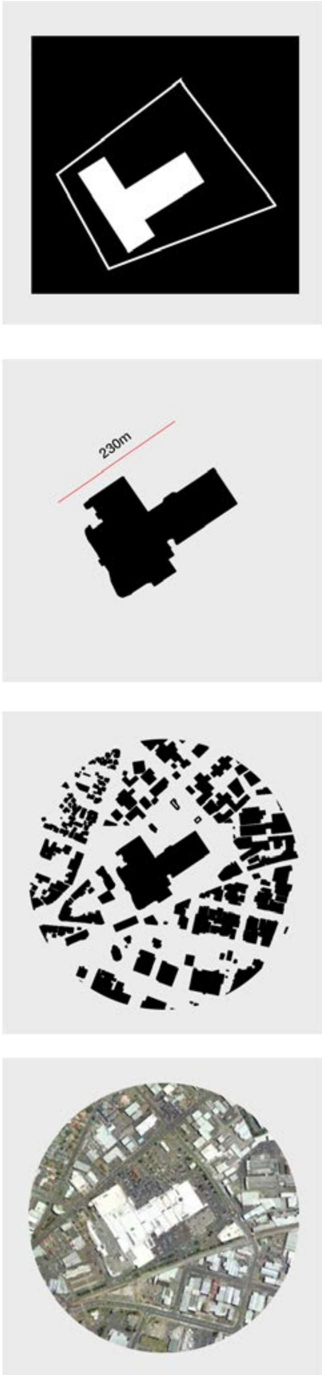
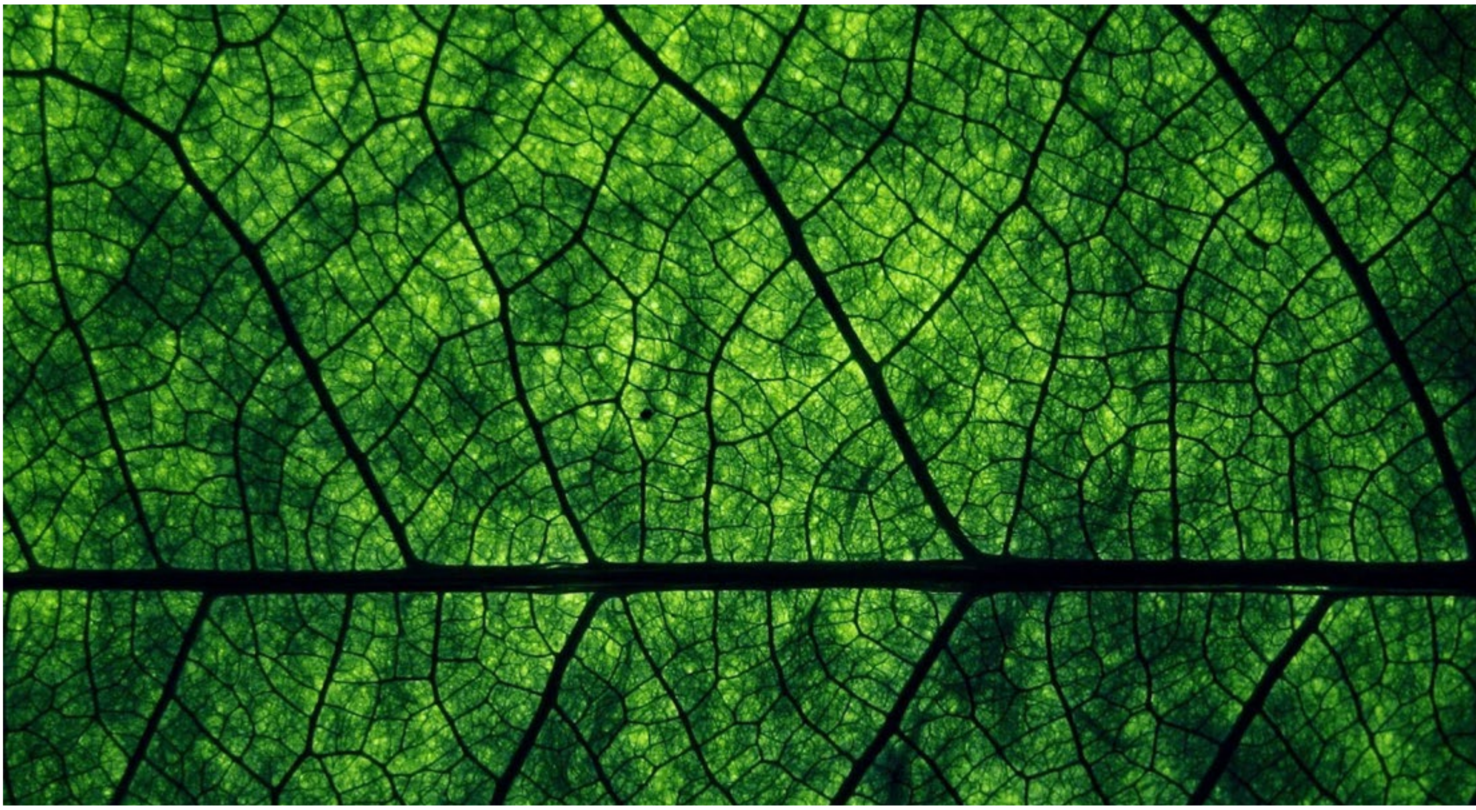


Fig. 6
City mall business district

Located along the transportation east-west axis. It is again largely out of human scale. Even though it gathers most of the commercial and administrative activities, it emphasises a car-driven society and is badly connected to the context.

Fig. 7
Topographic residential block

When the residential pattern gets closer to the boundaries of our area, some streets adapt to topography and context and tend to become more organic. The residential blocks are thus set in a friendlier way for pedestrian and cycle routes.



Investigations

Horizontal Layers: Volume, Voids, Transport and Functions

3

volumes

Built-volume density

A fragmented urban landscape

Four main morphologies were identified in the intermediate scale of New Lynn. The issue is not so much about the morphologies themselves, but about their integration: the street grid tends to become out of human scale in some areas, the urban landscape ends up being extremely fragmented, in particular in the areas surrounding the two business cores identified previously.

The building footprint also seems clear and well distributed due to the shapes provided by the streets, the railway, the waterfront and the topography. But a quick look at the local scale proves this assumption to be wrong, since the residential area has spread with no or few prescriptions for land consumption.

^ *Fig. 8*
The disassembling process of the CAS's components by Horizontal Investigation.
Analyses of physical assessment of the subsystem: Volume.

Legend

- Void
- Volume

voids

Open-space area

Disconnected open spaces within a rich physical framework

New Lynn has a large number of small open-space areas, some of which are in the town-centre core. These areas depict heritage values in that many have memorial structures or artworks. The Waitakere Ranges Regional Park in the west is significant because of its value for tourist activities and leisure.

The Titirangi Golf Course is the largest (and privately owned) open space, and is an often-forgotten component of New Lynn's natural character. It was designed in 1927 by world-famous designer Alister MacKenzie, and is intensively used. But by whom? There are doubts that the golf course is enhancing social encounters between inhabitants.

^ *Fig. 9*
The disassembling process of the CAS's components by Horizontal Investigation. Analyses of physical assessment of the subsystem: Voids.

Legend

- Volume
- Void

transport

Number of trips made via public transport

Underuse of the public transport network

As evident in the width of the roads and the prevalence of the car for personal trips over other means of transportation, the transport network is clearly car-oriented. The landform and the grid roading pattern have themselves shaped the views and gateways to New Lynn.

The bus network is well developed. Bus stops are well distributed and connect the residential suburbs with the rail transit node. However, the timetables and the bus lines, together with cultural prejudice, discourage people from using bus public transport.

The transport network and infrastructure in New Lynn cause a physical split between the northern and southern areas. This disconnect is due to New Lynn being one of the busiest transit destinations in greater Auckland, as well as a result of the twisted geography of the Auckland Isthmus, with many deep estuaries.

^ Fig. 10
The disassembling process of the CAS's components by Horizontal Investigation. Analyses of physical assessment of the subsystem: Transportation and Links.

Legend

Train station

Bus station

Walking distance
400m / 5 min

functions

Job density, number of legal entities

Concentration of activities and functional deserts

Based on the population of New Lynn, the number and variety of functions provided is high. But in such a car-driven context, the clear tendency has been towards concentration instead of integration. The southern and northern residential areas are functional deserts, where only a few corner shops ('dairies') can be found.

Two cores are identifiable, one centred on Lynn Mall (east core), the other one developing to the west, at the intersection of the two main roads. At these cores, the open public spaces that could have been provided to the inhabitants have been allocated for car parking.

Legend

- Business activity
- Culture and community
- Restaurant
- Religious and sport

^ Fig. 11
The disassembling process of the CAS's components by Horizontal Investigation. Analyses of physical assessment of the subsystem: Functions.

porosity

Factuality of urban voids

Low porosity as a reflection of the land use policy of New Lynn

While studying the porosity of the area, we faced the issue of comparing different areas when their absolute porosity value is close to zero. Indeed, with low ground-use and one-storey buildings in the residential areas, there were issues in using the classic calculation method.

We therefore overlaid the population density, the floor-area ratio and dwelling density maps together to distinguish zones between them. The result is thus closer to a morphological analysis than a classical urban porosity analysis.

Four typologies have been identified. The area around Lynn Mall and part of the Avondale expansion zone have the higher values, because of the high concentration of businesses. Then, the porosity decreases in the residential areas north and south, and gets to its lower value in the low-rise sprawling context to the west of the area, where the neighbourhoods are completely car-based.

Legend

^ *Fig. 12*
The disassembling process of the CAS's Key Categories by Vertical Investigation: Porosity Map of the design area.

proximity

Number of key functions within walkable distance

A low walking trend and a low walkability

From the horizontal investigation and context analysis, New Lynn was identified as a car-driven urban context. The proximity emphasises the scarce distribution of functions within the area, worsening the individual car transportation mean tendency.

Northern New Lynn, near the Whau River estuary (medium-sized block) and Southern New Lynn (big blocks) are best served, with dairies at the corners of each block. As cycle-ability is also low, the inhabitants are even more inclined to use their cars instead of walking.

An important feature to notice is also the extremely low walkability near schools in the east, south and north of New Lynn. Even if school bus services are well developed in New Zealand, low walkability creates an insecure environment for outdoor activities in the arteries between the blocks.

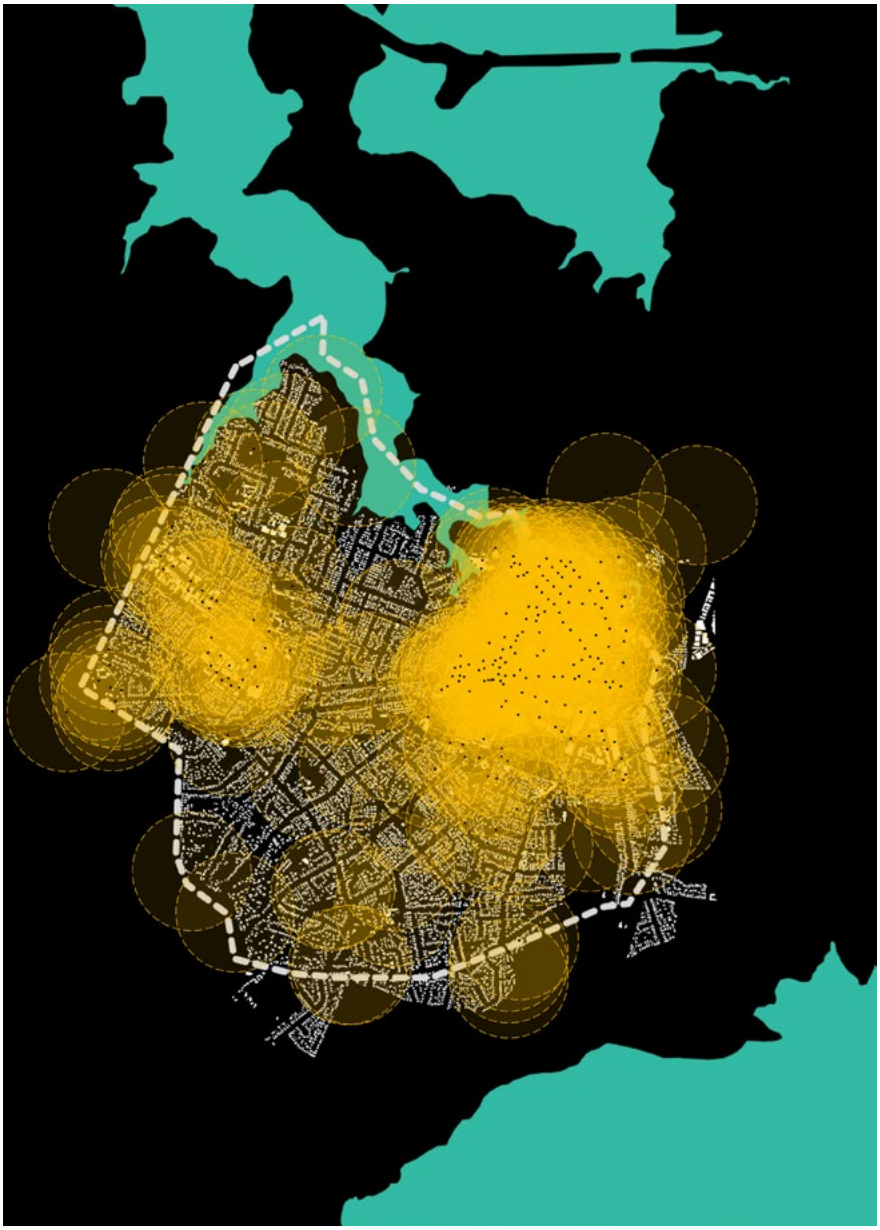


Fig. 13 >
The disassembling process of the CAS's Key Categories by Vertical Investigation: Proximity Map of the design area.

Legend

Key functions

Walking Distance
400 m / 5 mins.

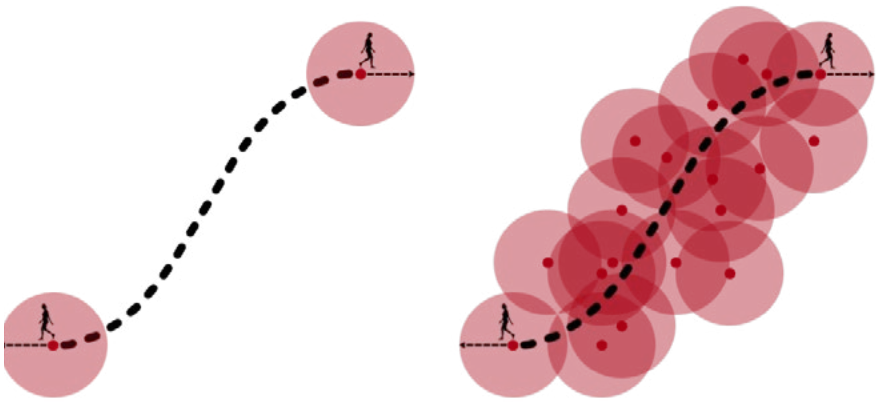


Fig. 14 >
The car-driven city versus the walkable city

diversity

Diversity of subdivision use

A concentrated pattern of activities revealing two axes of development

Jan Gehl's division between necessary, optional and exceptional activities enabled the team to reveal two axes of development:

Outside the two commercial cores individuated in the function layer analysis, no necessary activities can be found. These two cores will then not only concentrate the commercial activities – in particular around Lynn Mall ¬– but most of the job opportunities, and thereby empty the rest of the town of all activity. Such a distribution is anything but resilient.

An interesting feature is the green axis development from north New Lynn to south New Lynn. This basically means that the opportunity exists to enhance the connectivity of these two areas through new means of transportation, open spaces or new commercial activities.

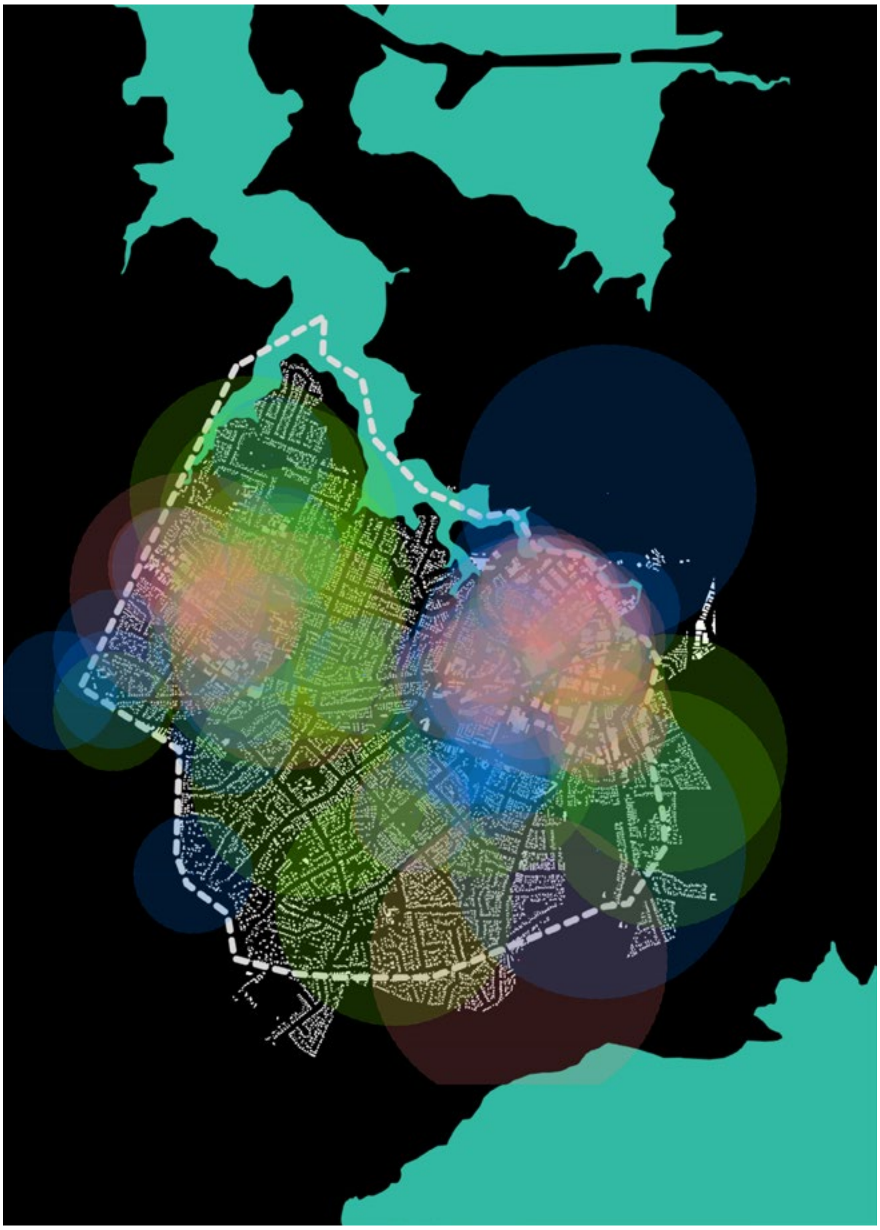


Fig. 15 >
The disassembling process of the CAS's Key Categories by Vertical Investigation: Diversity Map of the design area.

Legend

- Necessary Regular Act.
- Necessary Occasional Act.
- Optional Act.

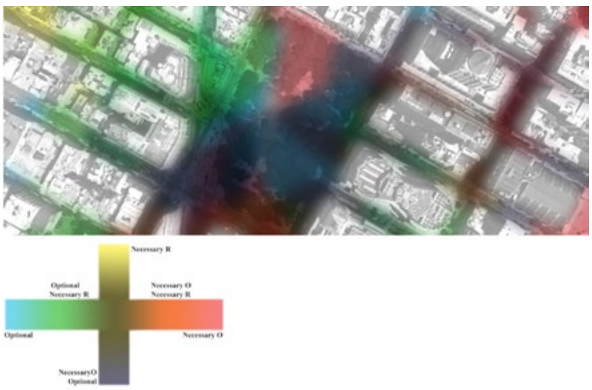


Fig. 16 >
Distribution of activities between necessary, optional and social/exceptional activities

interface

Mean depth of street segments

Linearity and connection potential around two cores

The interface map is a way to evaluate the integration of each street within the global street network. Each segment, its relation to other segments and how easily it can be reached, is indicated with a gradient of colours going from red (higher relative interface) to blue (lower relative interface). (Careful – the red value is the higher value of interface: it doesn't mean the interface is good).

There is a main core area within New Lynn, starting from Lynn Mall and heading west along the railway and the main arterial road. The overall interface quality is heterogeneous: it increases really quickly near the commercial cores and decreases where the grain in the residential area gets bigger. It is probable that these areas will prove to be badly connected by the next level of superimposition.

Fig. 17 >
The disassembling process of the CAS's Key Categories by Vertical Investigation: Interface Map of the design area.

Legend

Relative porosity scale

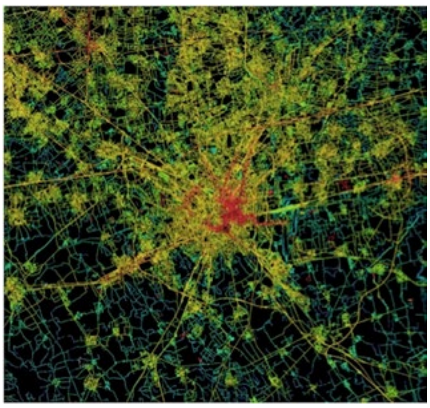


Fig. 18 >
Example of the Interface map for Milan at urban scale

accessibility

Number of available jobs reachable in less than 20 minutes

Potentials for easy and quick improvements

The transportation catchment areas can be visualised by comparing them to the economic (job producing) zones.

The yellow areas represent the public transport catchment radius of 400m for buses and 800m for the train station. Overlaid are the economic zones in green. We can clearly see that there are two main core areas within New Lynn that provide the majority of the available 6000 jobs.

Furthermore, since the public transport is well connected, it is reasonable to suggest that the residents within these areas could use carpooling or the public transport network to commute. With these simple actions, workers could save on petrol consumption and reduce greenhouse emissions.

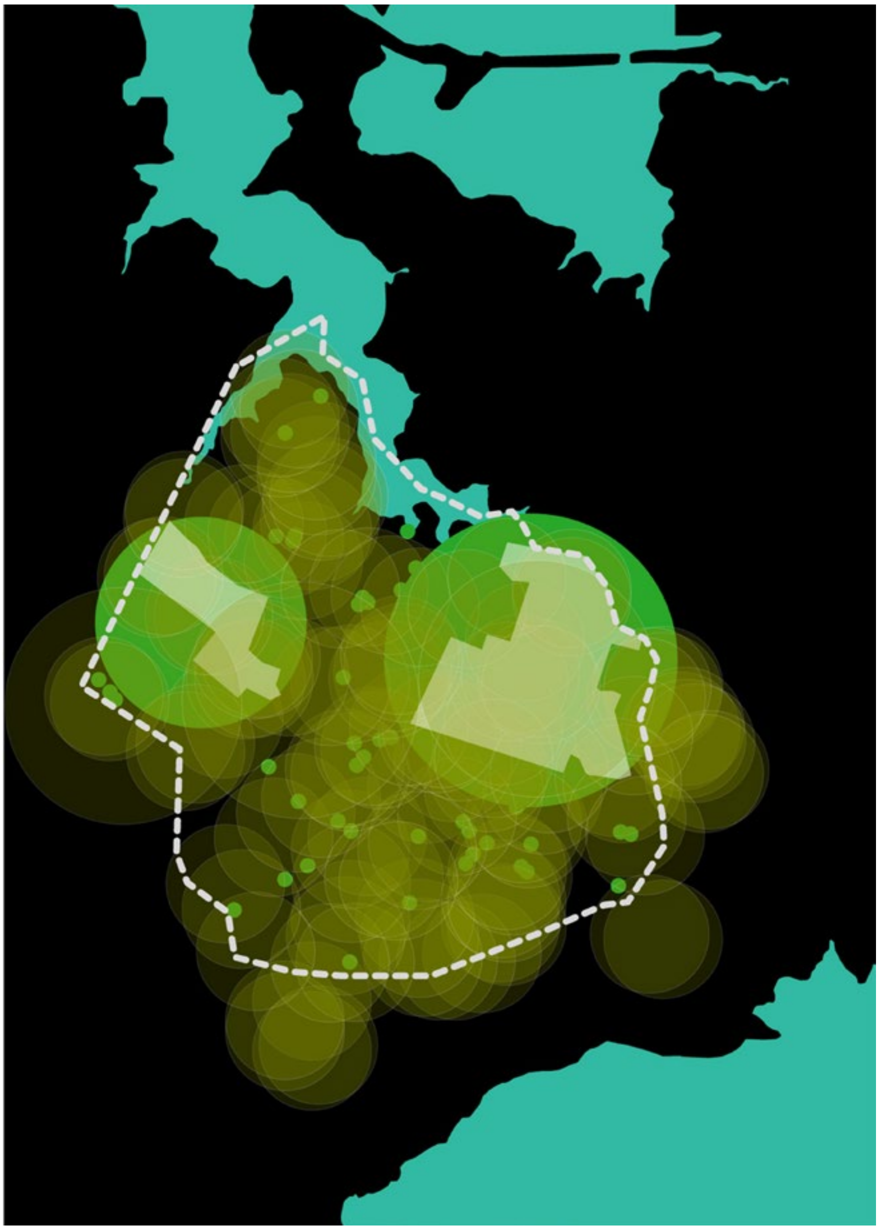


Fig. 19 >
The disassembling process of the CAS's Key Categories by Vertical Investigation: Accessibility Map of the design area.

Legend

- Primary Job Producing Hubs
- Secondary Job Producing Hubs
- Low Job Producing Stores

effectiveness

Number of public transport trips

An effective public transport segregating part of the residential areas

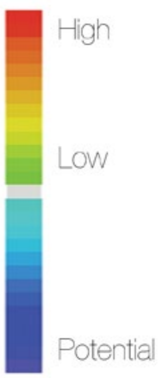
After careful analysis of the performance of public transport in respect to the built volumes, we concluded that the central area of New Lynn has the best access to public transport.

This central area consists of the suburban network between the two main employment areas of New Lynn. The areas of potential development are in the north, which could be part of a public or commercial development in future.

The other zones with potential include public parks and a golf course, which could be used for the implementation of resilience-enhancing solutions.

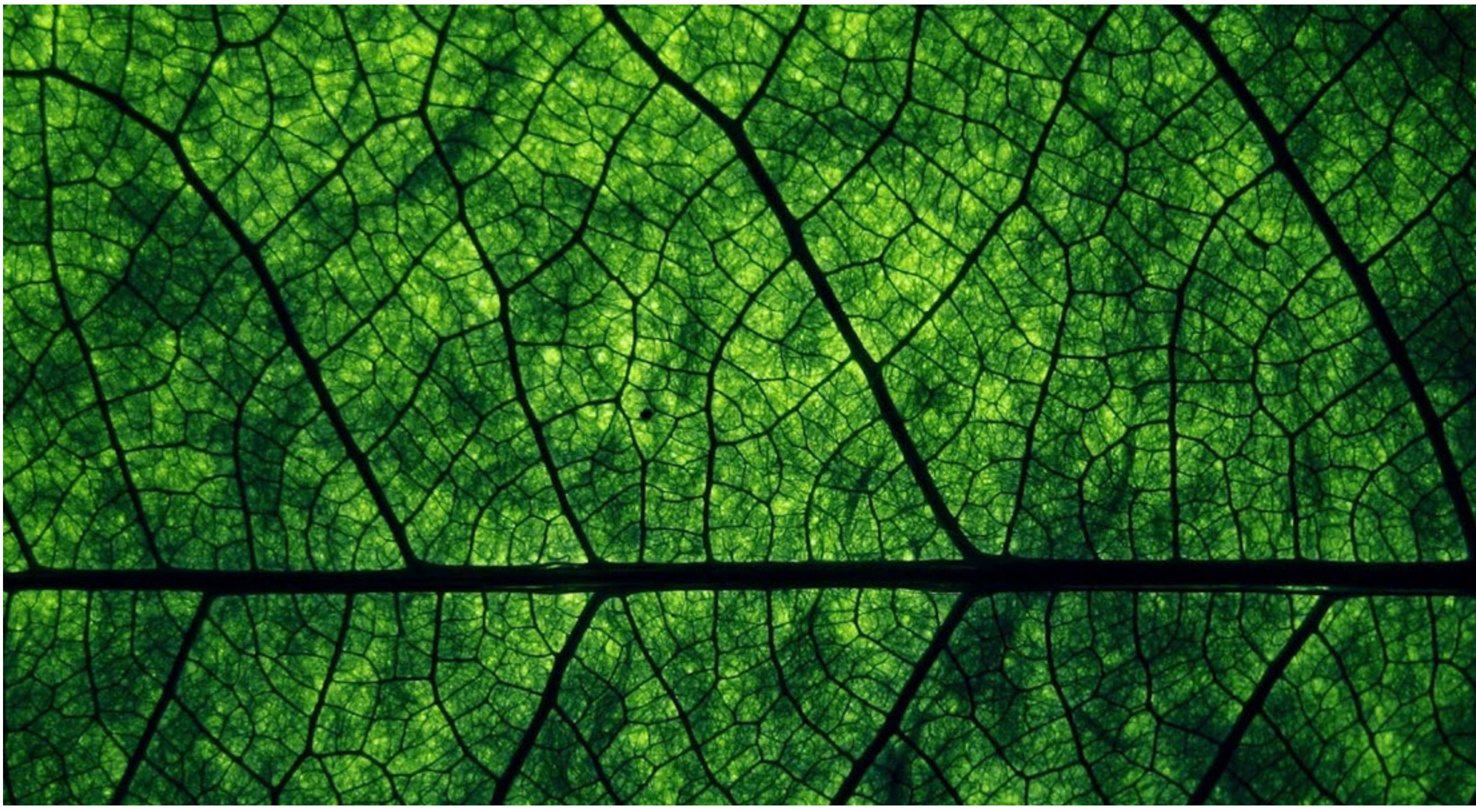
Fig. 20 >
The disassembling process of the CAS's Key Categories by Vertical Investigation: Effectiveness Map of the design area.

Legend



	IMM indicators	Indicator	Description	Value
Layer	Volume	Horizontal	Built area	0,909
	Voids		Unbuilt area	0,8
	Functions		Activities in the area	0,242
	Transportation		Private or public transportation trips	6795
Key category	Porosity	Vertical	Dwelling density	0,0007
			Floor area ratio (FAR)	1,2964
			Population density	0,0016
	Proximity		Job opprtunity within a walkable distance	5,85
	Diversity		Variety of activities within walkable distance	0,82
	Interface		Movability within the urban voids	22,8326
			Integration HH	0,339
	Accessibility		Feasibility of reaching destination	5,98
	Effectiveness		Number of public transportation on total trips	0,129

^ Table 4
Indicators' values before the intervention on the intermediate scale



Catalyst selection

Estimation of the CAS performances and choice of the catalysts for the intervention

4

compactness

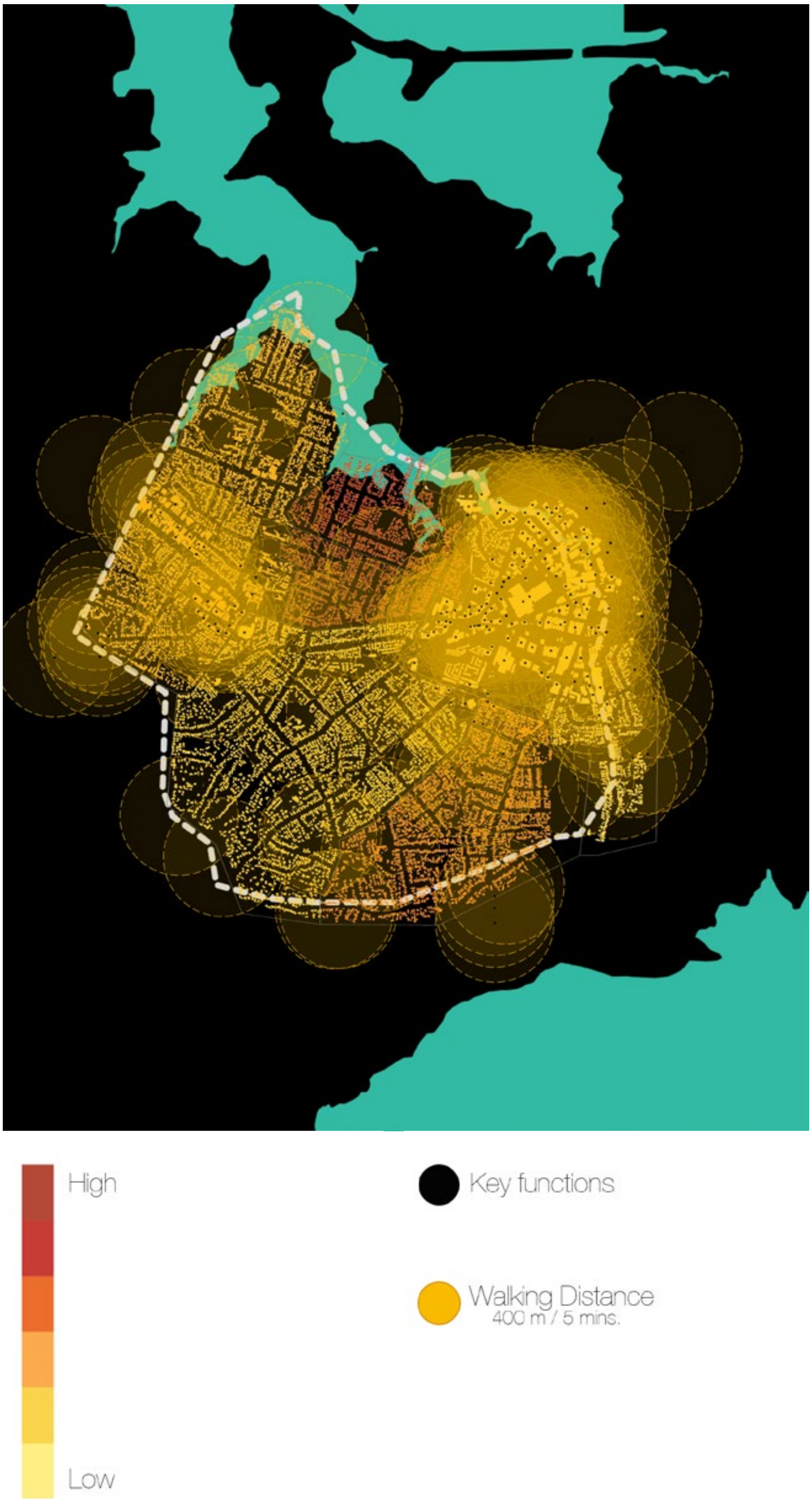
Level of integration of Proximity and Porosity

A very low compactness and uncoupled Porosity and and Proximity

The compactness describes how dense or diffuse an urban context is and how close or far different functions are from one another. This morphological feature has a huge impact on both resilience and overall energy consumption, mostly because of the issues of bringing the energy itself to the final consumer.

In the New Lynn context, the most compact zones are concentrated in the southern and northern residential areas, made of the smallest blocks. We also confirm that Porosity and Proximity don't overlap. This means that the compact context isn't actually improving resilience, because functions are distributed in some other area. The actual compactness value is close to zero, since the residential area is made up of one- or two-storey individual houses, hardly optimising the ground-use.

Fig. 21 >
The reassembling process of the CAS by second level of Superimposition: Compactness Map of the design area.



connectivity

Level of integration of Accessibility and Effectiveness

High connectivity in the cores, contrasted with low connectivity in residential areas

In the IMM the integration of Accessibility and Effectiveness, or superimposition of Volume, Function and Transportation layers, draws attention to the connectivity aspect of the city. Connectivity is the level of internal interdependence of a system and it is reflected in the exchanges occurring between the components making up the system. In urban systems in particular, Connectivity is highly related to the transport of people, goods and data and it correlates with diversity.

In the context of New Lynn, it is quite clear that connectivity increases near the train station and the Lynn Mall core, mostly due to the value of Accessibility and Effectiveness when living closer to the transit hub and commercial areas.

On the other side, the connectivity with the borders of the area (in the north along the estuary and in the south in the residential area connected to Green Bay) is unsurprisingly low, as the bus lines and Functions become even more scarce.

Fig. 22 >
The reassembling process of the CAS by second level of Superimposition: Connectivity Map of the design area.

complexity

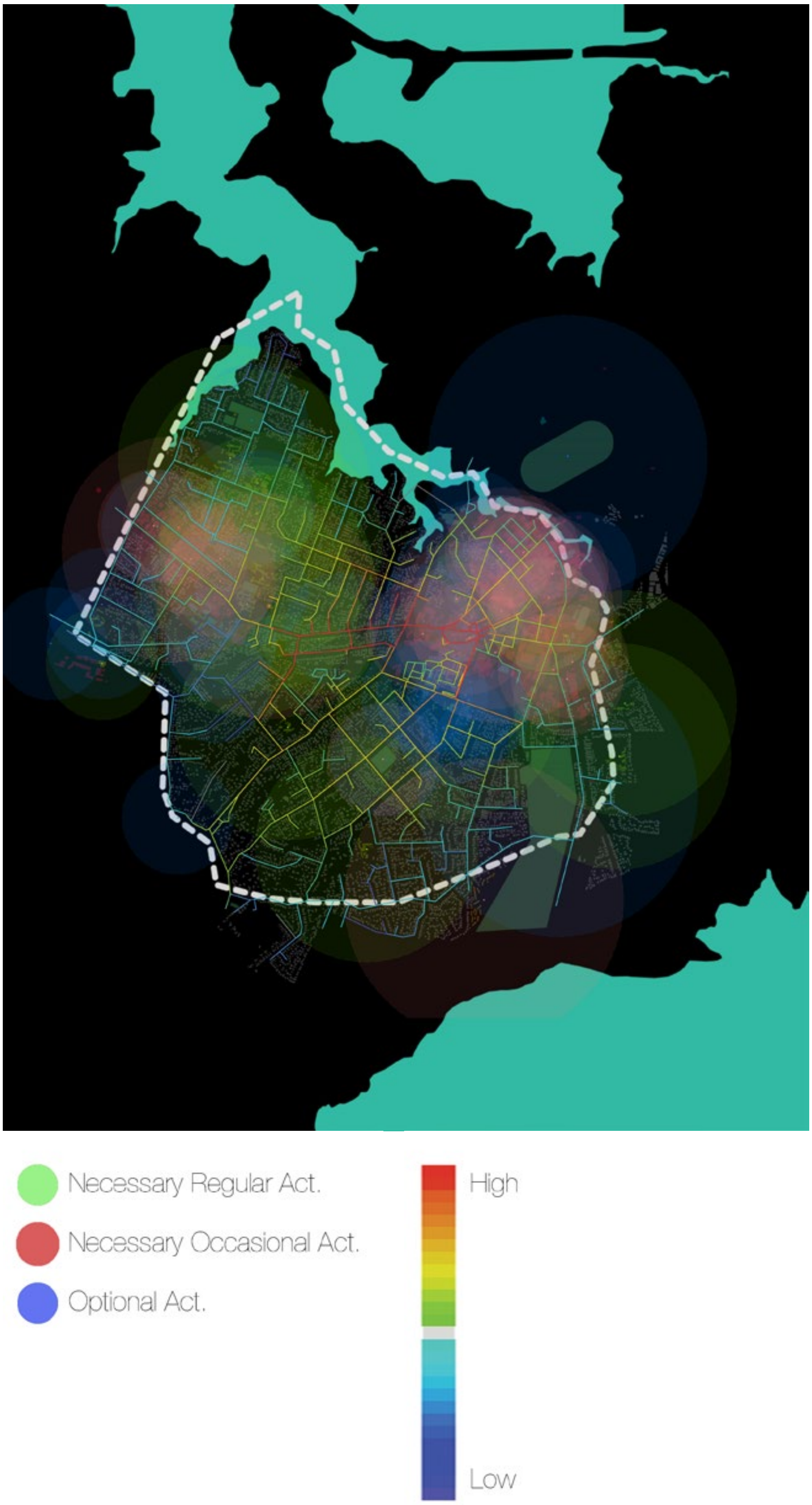
Level of integration of Diversity and Interface

Commercial activities leading the interface improvement

In IMM the complexity of the city is defined by the integration of Diversity and Interface. Complexity is a crucial variable in identifying weaknesses in the distribution of Functions, or, even more interestingly, of aggregated categories of activities; it explains diversity and mixture of the CAS. Complexity is thus linked to a certain mixture of order and disorder, an intimate mixture that in urban systems may be partly analysed using the concept of diversity. How high is the integration between different and in or simple is a city and how close or far different functions are within the city, describe the complexity of a city?

In our case, it is quite clear that the architecture of the urban texture favours the functioning of the commercial areas around the New Lynn mall and in the west of the area. The Interface proves to be really good in between the two cores: we will rely on that opportunity to improve the Transportation network and the Proximity vertical Key Category. Some local modifications in the retrofitting phase could also improve the Interface in the disconnected residential areas.

Fig. 23 >
The reassembling process of the CAS by second level of Superimposition: Complexity Map of the design area.



catalyst selection

Selection of the catalyst and the reactants

The main purpose of the Hypothesis phase is to detect the transformation catalysts, thanks to the result of the previous phase, Investigation. The Catalyst is the weakest member in terms of performance. The transformation process could be initiated by the modification of the weakest link. To reiterate, the Key Categories of the study site (Table 2), with the consideration of the interventions' goal, are measured, and then they will be compared with the rest of the urban fabric data. At this stage the malfunctioning Key Categories are considered as the Catalyst and the transformation process will be initiated with the modification of this malfunctioning member. In the other words, the Integrated Modification process initiates with local modifications of the Catalyst's structure. The local modification as designed perturbation of a system causes a series of effects that lead to macroscopic consequences starting up a chain reaction, which can transform the CAS structurally.

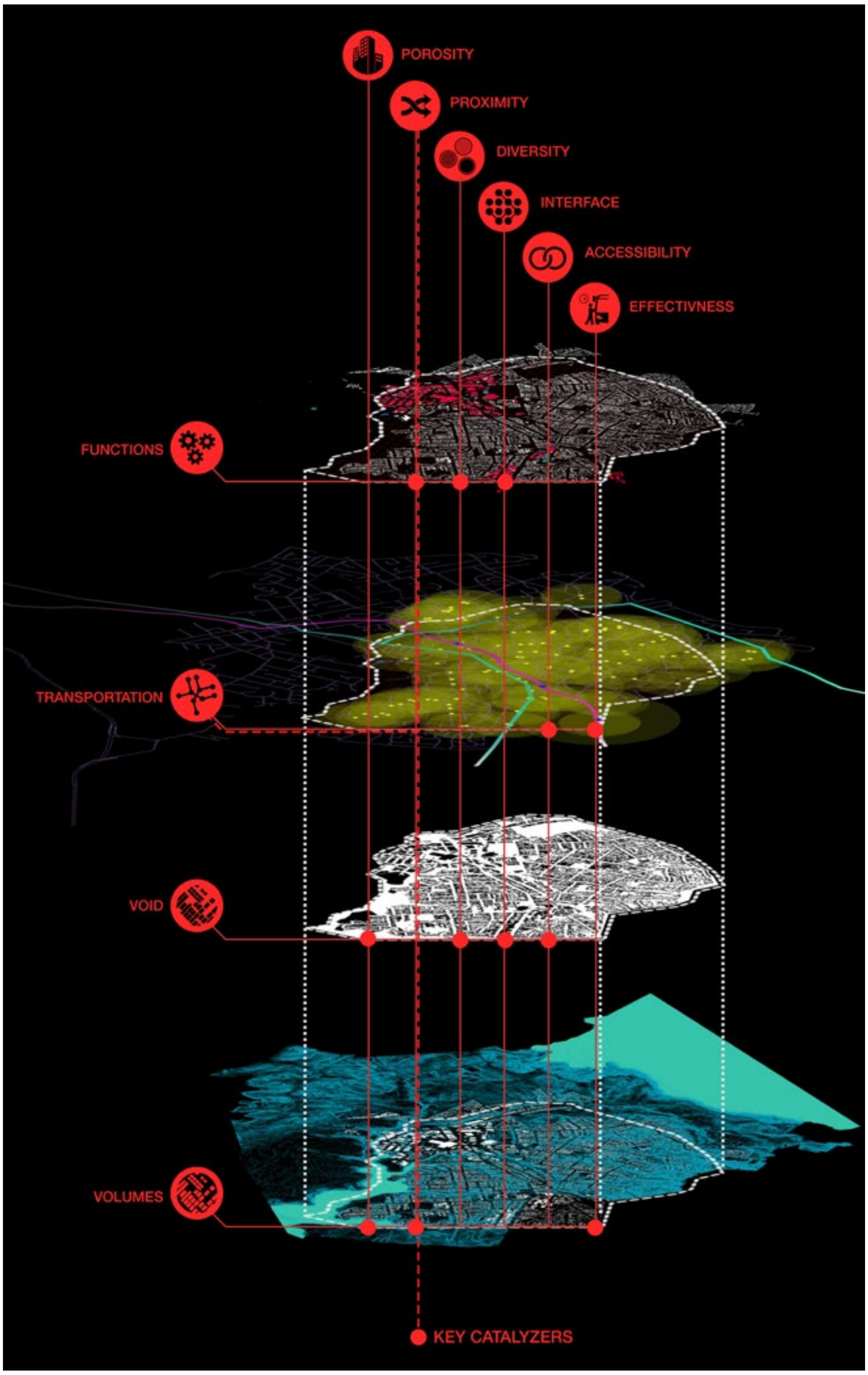
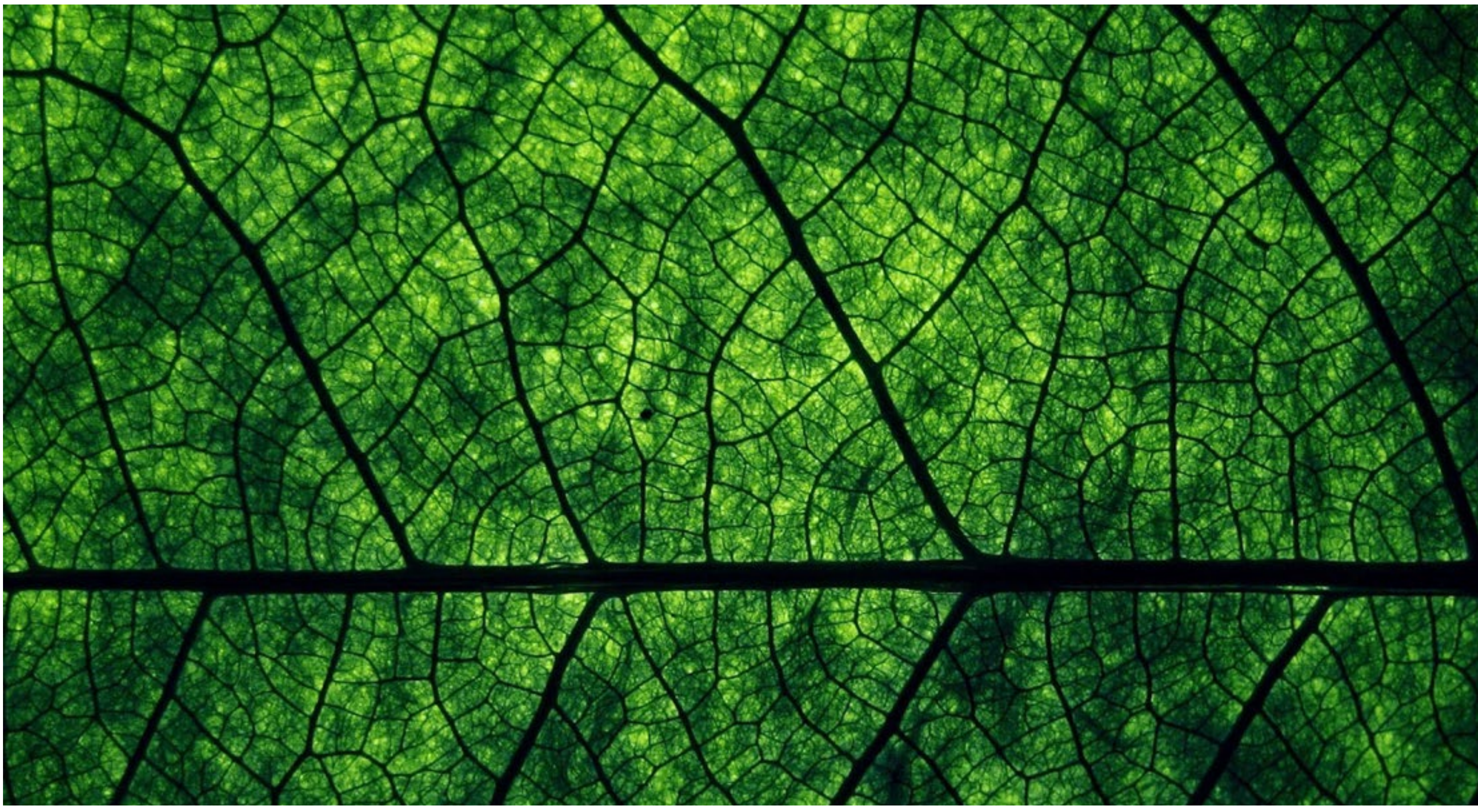


Fig. 24 >
The choice of one subsystem (layer) as horizontal catalyser and one key category as vertical catalyser as a first driver of the transformation. It makes possible to act transforming globally the entire system (CAS).



Design Ordering Principles

Interventions related to each DOP

5

	Design ordering principles	Key categories	Determinants
Morphology	1. Balance ground-use	Porosity	Compactness
	2. Foster local energy production		
	3. Promote walkability	Proximity	
Typology	4. Foster mixed-use spaces	Diversity	Complexity
	5. Enhance urban biodiversity		
	6. Create connected open spaces system, activate urban metabolism	Interface	
Technology	7. Balance the public transportation potential	Effectiveness	Connectivity
	8. Promote cycling and reinforce public transportation		
	9. Promote inter-modality	Accessibility	
Management	10. Convert the city in a food producer	Governance	
	11. Improve waste management		
	12. Improve water management		

^ Table 5
DOP (Ordering Design Principles) organised according to Key Categories, Determinants and in relationship to Morphology, Typology and Technology before the ranking process.

The Design Ordering Principles' ranking in the New Lynn intervention

1. Promote cycling and reinforce public transport
2. Promote walkability
3. Promote intermodality
4. Balance the public transport potential
5. Foster mixed-use spaces
6. Foster local energy production
7. Create connected open space systems
8. Improve water management
9. Enhance urban biodiversity
10. Improve waste management
11. Balance ground-use
12. Convert the city into a food producer

DOPs in IMM methodology

In IMM an important role is played by the DOPs (Design Ordering Principles). DOPs are a set of tools/instruments used to arrange the structure of the CAS. The application of these principles intends to modify the structure of the CAS and consequently its performance (Tadi and Vahabzadeh, 2014).

The DOPs application is consequent to the previous phases in IMM (Investigation and Assumption) and it is a fundamental stage in addressing the modification process of the CAS towards a more sustainable and efficient form.

DOPs are not a fixed list of design recommendations but a dynamic structure of integrated design principles arranged in each instance in consideration of the specific conditions of the CAS, and specifically organised to deal with the weakness of the system and in particular to modify the malfunctioning of individual components of the actual CAS, responsible for its own actual performances.

It is crucial to consider that the DOPs are ranked in relation with the elected Key Category as catalyst or reactants and that they belong to a specific determinant. They are associated with the indicators used for measuring the energy performance of the CAS in the actual state and after the transformation (retrofitting process).

The DOP in the New Lynn case study

In the New Lynn case study, the Investigation phase (horizontal and vertical) reveals that the major malfunction is related to those features dealing with Transportation and Proximity. The key role of Transportation and Proximity in the New Lynn area is expressed both in terms of weaknesses and potential opportunities, and can be understood through the results obtained by the horizontal and vertical investigations. In consideration of that, the DOPs in the New Lynn case have been ranked as follows:

new cycling network

Promote cycleability by creating a new integrated network.

Piezoelectric water-collecting bike lanes creating an integrated biking network

The first DOP aims to promote cycling as a new means of transportation. While the bicycle cannot replace the private car, so deeply culturally ingrained in the New Zealand way of life, it can significantly improve the mobility resilience of the area.

Under our hypothesis, the train station should become an intermodal hub. Large bike-sharing stations, located where the bus lines and railway converge, in a new car-free zone, should be the starting point of green fingers (a wildlife corridor, habitat corridor, or green corridor is an area of habitat connecting wildlife populations) and bicycle lanes completing and enhancing the actual network.

Based on the design of a prefab concrete panel for bicycle lanes in Copenhagen, we designed analogue panels provided with a paving layer and a stormwater collection system that redirects the water to stormwater buffers and eventually to green areas able to absorb or store the collected water. These green fingers actually increase the environmental, mobility and social resilience.

We suggest the implementation of four main bike-sharing stations near the commercial zones of New Lynn, which also happen to be near schools and the existing transportation network.

Fig. 25 ^ The new cycling network at the diagram of the catchment's area in New Lynn, proposed by the project.

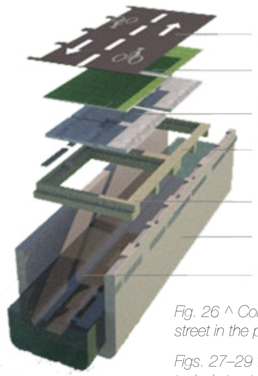
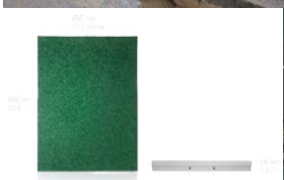


Fig. 26 ^ Constructive section of a typical street in the proposed network

Figs. 27–29 > Constructive details of a typical street in the proposed network



car-free zone

Promote local walkability within a car-free zone

Pedestrian-friendly car-free zone enhancing social and economic resilience

Auckland City is already facing the growing problem of extreme congestion. If 13,000 new dwellings per year are to be created in the Auckland region by 2031, and if New Lynn's population is to reach 20,000 (a 20 percent increase by 2030), it is obvious that this problem will worsen.

To address this issue, initiating a shift from car access to pedestrian, cycle and public transport access for the core of the town must be a priority. In particular, the attractive area at the city centre around the station could, as a starting point, switch to a slow-traffic area (similar to the Woonerf areas in the Netherlands) or a monitored traffic area (like Area C in Milan) to discourage citizens from driving their cars to the city centre.

Fig. 30 ^
Pedestrian-friendly city center in Reggio Emilia (Italy)

Fig 31 >
Pedestrian public space promoting commercial activities and social interaction: car-free zones enhance resilience

inter-modality hub

From a car-dominated neighbourhood to an intermodality mobility strategy

Improvement of the overall connectivity between the two cores identified

In order to make Auckland City the 'world's most liveable city', *The Auckland Plan* aims to integrate the diverse modes of transportation in one multimodal system.

The same concern has led this team's development in the New Lynn area. The public transport system is underused, but with small interventions its full potential could emerge: to connect the four surrounding employment areas around New Lynn. Additionally, the rush hour traffic will be reduced, greatly decreasing CO_2 emissions during workdays.

We would expand already existing cycle routes and connect them together at multimodal nodes, and add pedestrian-friendly zones in the city centre. As has been pointed out, there is a need for a bold move, an ambitious incentive to shifting from the car-driven way of life to resilient means of transportation.

Fig. 32 >
Improvement of the public transport network in New Lynn and the Intermodality map proposed by the project.

- Bike station
- Train station
- Bus station
- Cycle path network
- East-West railway
- Street network

public transport

Enhance the public transport potential

An integrated multi-modal transportation system

In order to make Auckland City the world's most liveable city, *The Auckland Plan* aims at integrating the diverse modes of transportation in one multi-modal system.

The same concern has led the team's development in the New Lynn area. The public transport system is underused, and its full potential could appear with small interventions. It actually is to connect the four surrounding job-producing areas around New Lynn. The rush hour traffic will be reduced, greatly decreasing CO_2 emissions during workdays.

We are expanding already existing cycle routes and connecting them together at multi-modal nodes, and adding pedestrian-friendly zones in the city center. As it has been pointed out before, there is a need for a bold move, an ambitious incentive on shifting from the car-driven way of life to resilient means of transportation.

Fig. 33 >
Improvement of public transport potential in New Lynn. Transport hubs (red) and catchment areas cover the whole design area.

- Bike station
- Train station
- Bus station
- Cycle path network
- East-West railway
- Street network
- Main roads
- Catchment areas
- Job-producing zones

distribution of functions

Balance the scarce distribution of functions through morphological arrangement

Suggest a more sustainable and resilient residential layout without iconic statements

The new masterplan emphasises densifying through diversification, by redefining the existing block structure via a new morphology. Its elements are more sustainable and resilient.

The morphology arrangement is based on shared common gardens in between the courtyards of residential units. By considering various building heights and masses that can be adopted to provide a shaded cluster of buildings, the new residential structures adapt to their context, consisting of an intermediate scale on the one hand, and on the other a smaller, more intimate scale with a lively and accommodating environment.

The units are developed around a green common courtyard, creating good sun and daylight conditions for the apartments. Furthermore, the building masses have been dismantled into smaller units with various heights and different unique envelopes. The building's division into smaller buildings relates to a human scale and creates affinities between the residents and the individual 'townhouse'. The project differs from the bulk of existing masses in the fact that it does not attempt to be a major iconic building.

Fig. 34 >
Masterplan of the design area with highlighted different building typologies characterised by mixed use.

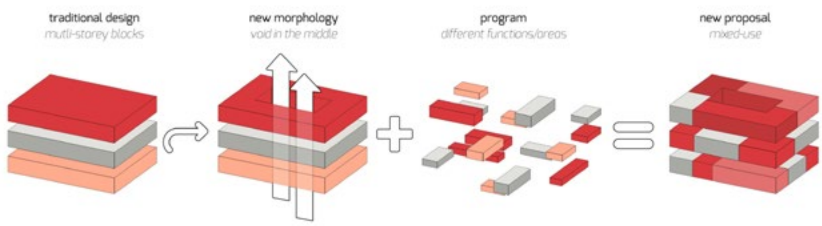


Fig 35 >
Diagram of the distribution of function in the selected areas of the masterplan.

local energy production

Foster local energy production

An innovative energy-mix strategy

After running a precise diagnosis on the energy-consumption behaviour in New Lynn and other suburbs of Auckland, the team identified the area as vulnerable due to its reliance on fossil energies. Given the catalyst chosen, the reliance on the automobile is addressed by other strategies.

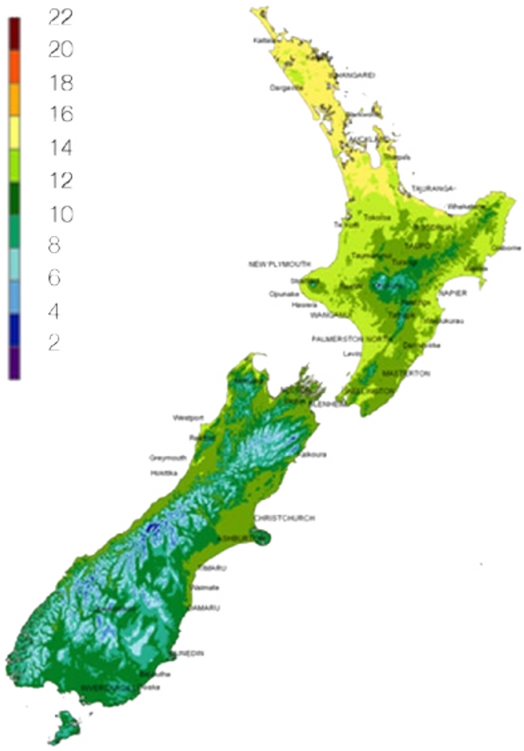
Therefore, to improve energy resilience in each local neighbourhood, a new energy mix is suggested by the team to resolve the issues of cooling, heating, and networking of geothermal energy.

Energy strategy

The team considered several different strategies to design the energy network. First, as a general comment, the increasing development of solar energy technologies and the significant available roof area in New Lynn convinced us IMMediately. The issue was then to implement it. Would it work better using hubs and distributing the energy for domestic use, or should we orient the strategy towards local domestic installations, combined with wind strategies and geothermal energy cores?

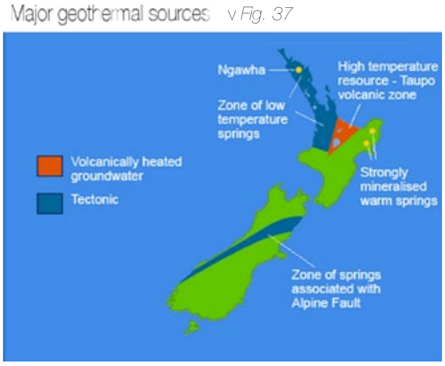
New Lynn proved to be in an interesting area for wind energy, thanks to regular wind currents in this part of the Pacific Ocean. However, wind energy is much more prevalent in other parts of New Zealand, where the land available for windmill farms is more suitable. Eventually, for domestic use as an individual initiative, we decided to concentrate on other solutions.

v *Fig. 36 Median annual average 10cm earth temperature*



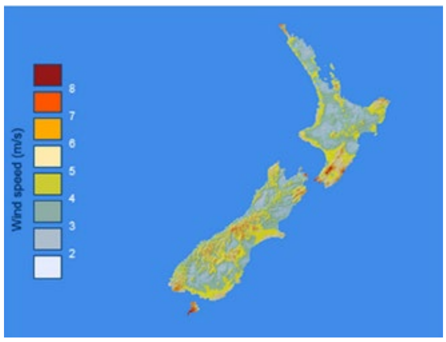
Geothermal energy

Major geothermal sources v *Fig. 37*



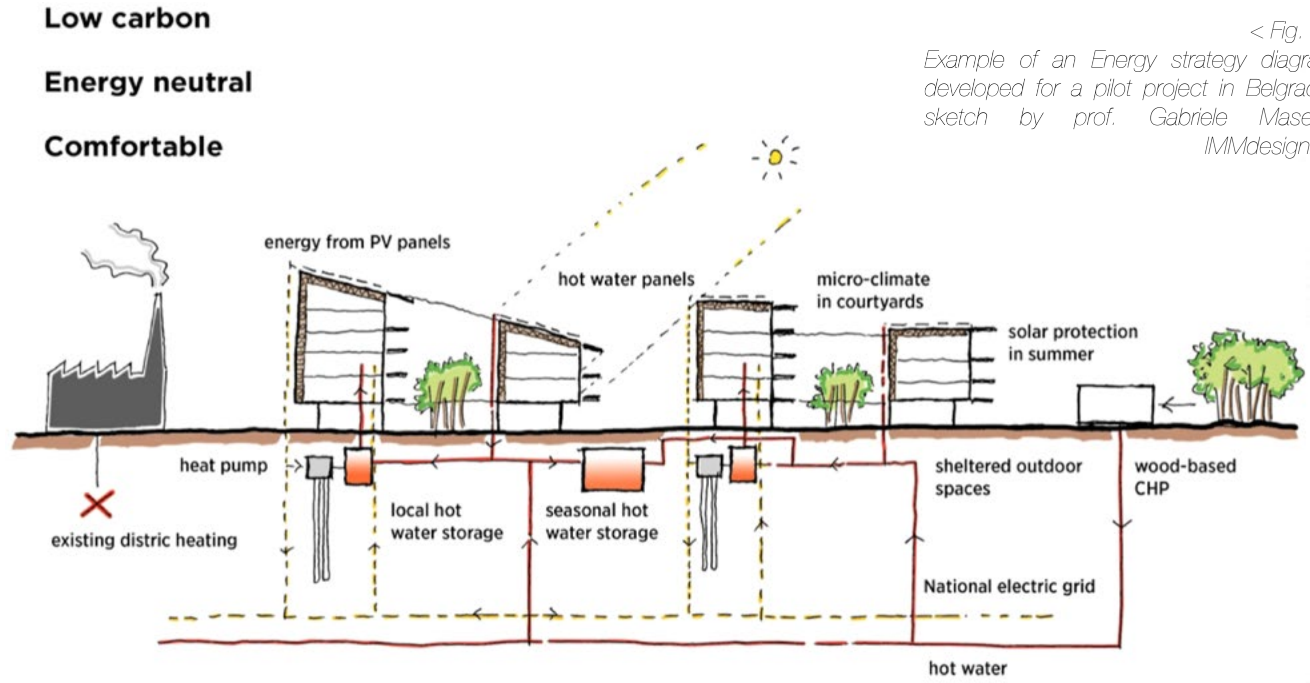
Wind energy

Median wind speed v *Fig. 38*



From the data obtained, we finally decided to base our energy mix on one or more geothermal installations combined with water collection systems, which could eventually function as a rainwater management buffer. This model is stable and has good energy potential.

The overall strategy uses energy from rainwater and geothermal energy, and then uses this water for active cooling and energy production for the residential blocks.



< Fig. 39
Example of an Energy strategy diagram developed for a pilot project in Belgrade, sketch by prof. Gabriele Masera, IMMdesignlab

Energy network

The network is based on two cores pThe network is based on two cores producing most of the energy for active cooling, heating and the electricity for the residential area. These cores are located in the two main zones identified in the Investigation phase, which are estimated to consume most of the energy produced. The rest of the energy is then distributed to residential areas. The crux of the matter was then to support this network through an alternative energy source that could compensate for part of the losses in the network in between the cores.

The team adapted an implemented and consolidated technology used in the Copenhagenize project for the biking city to address this issue. It consists of light prefab concrete panels used to build bike lanes. Owing to their regular shape and the prefabrication process, it is possible to enhance these panels with devices. For instance, in the Copenhagenize project, such panels were provided with heating coils, preventing frost on the lanes' surface. We replaced these heating coils with a Pavegen layer, a device relying on piezoelectric technology to produce electricity from mechanical energy: the movement of the cyclists and the cars will support the electricity network and generate the energy required for the lighting of residential blocks.

Energy core

The energy cores are two big buildings producing most of the energy for the residential area, in particular for active cooling. One of them, with the largest roof area, is provided with hybrid panels covering 2000 square metres, producing at least 1000 kWh of energy per year. Hot water is stored in a seasonal storage tank: it can be used either directly for passive heating or indirectly for active cooling systems. The core is supported by the piezoelectric lanes, which produce up to 150 kWh per year.

Connected to that first core through the piezoelectric bike lanes, a co-generation centre produces energy thanks to biogas obtained from organic waste gathered from domestic refuse. A similar seasonal storage tank again serves for passive heating and active cooling. The electric energy contribution is thus much higher from the co-generation centre, since it produces up to 75,600 kWh. This co-generation centre is located in the Lynn Mall area.

Solar energy

The solar installation implemented in the first centre was designed based on the solar exposure of the area.

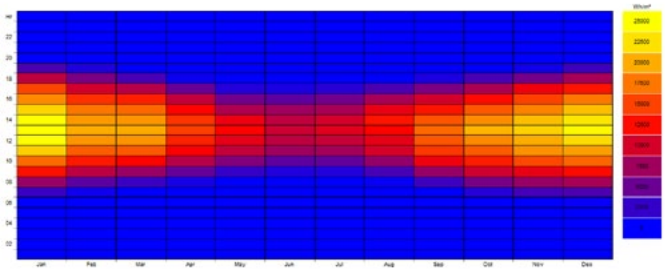
A first analysis was conducted to determine illumination levels on a flat surface on the rooftop of a disused building that could become a core for the energy network, depending on the shading (or not) of that surface. Based on these results, a first potential energy input was estimated. Using the same building for the heat pump, the seasonal storage and for the solar panels, the impact of the network in terms of footprint is limited.

Secondly, the team focused on optimising the inclination of the solar panels. The diagram and related tables are presented on the next pages.

To receive the best solar radiation, panels are oriented 7.5° east and their inclination is 36° from the horizontal plane. We used the flat surface of the rooftop for implementing this solar farm.

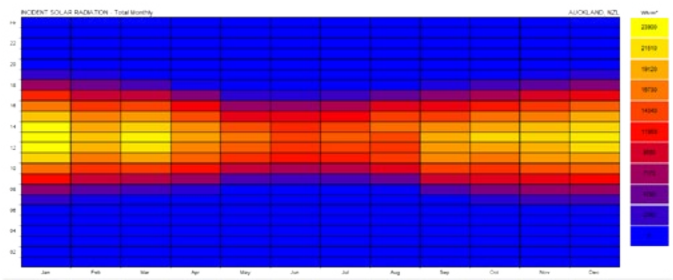
The team finally chose the typology of the panels, taking into account the assets of hybrid solar panels in a system that relies on both thermal and solar energy to produce electricity and provide active cooling.

Fig. 40 Incident solar radiation on flat roof surface - unshaded



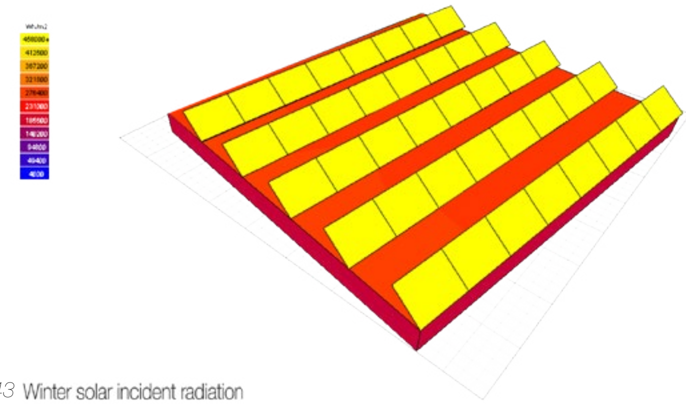
MONTH	AVAIL. Wh/m²	INCIDENT Wh/m²	ABSORBED Wh/m²
Jan	259995	208038	102979
Feb	190061	150907	74699
Mar	178648	132625	65649
Apr	154480	97609	48317
May	107612	65777	32560
Jun	101517	53617	26540
Jul	107055	57958	28689
Aug	125608	80467	39831
Sep	161266	113923	56392
Oct	188046	148204	73361
Nov	206765	169539	83922
Dec	221053	182485	90330
TOTAL	2002106	1461149	723268

Fig. 41 Incident solar radiation on best oriented surface



	AVAILABLE Wh/m²	ABSORBED Wh/m²	TRANSMITTED Wh/m²
Jan	259995	191894	70617
Feb	190061	150798	55494
Mar	178648	46962	54082
Apr	154480	126316	46484
May	107612	90446	33284
Jun	101517	82536	30373
Jul	107055	86995	32014
Aug	125608	104107	38312
Sep	161266	131369	48344
Oct	188046	150368	55335
Nov	206765	158782	58432
Dec	221053	165187	60789
TOTAL	2002106	1585759	583559

Fig. 42 Summer solar incident radiation



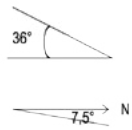
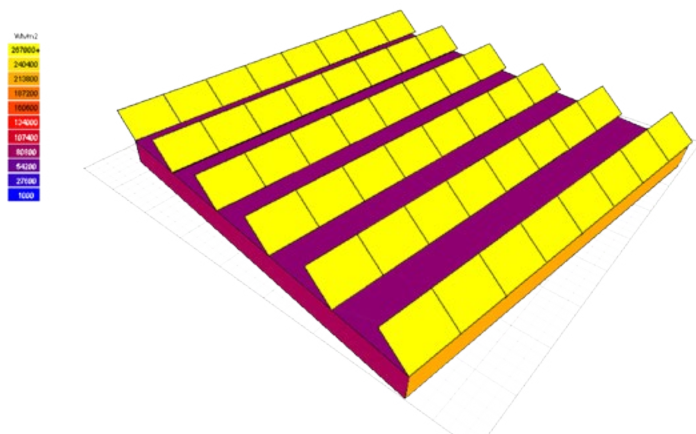
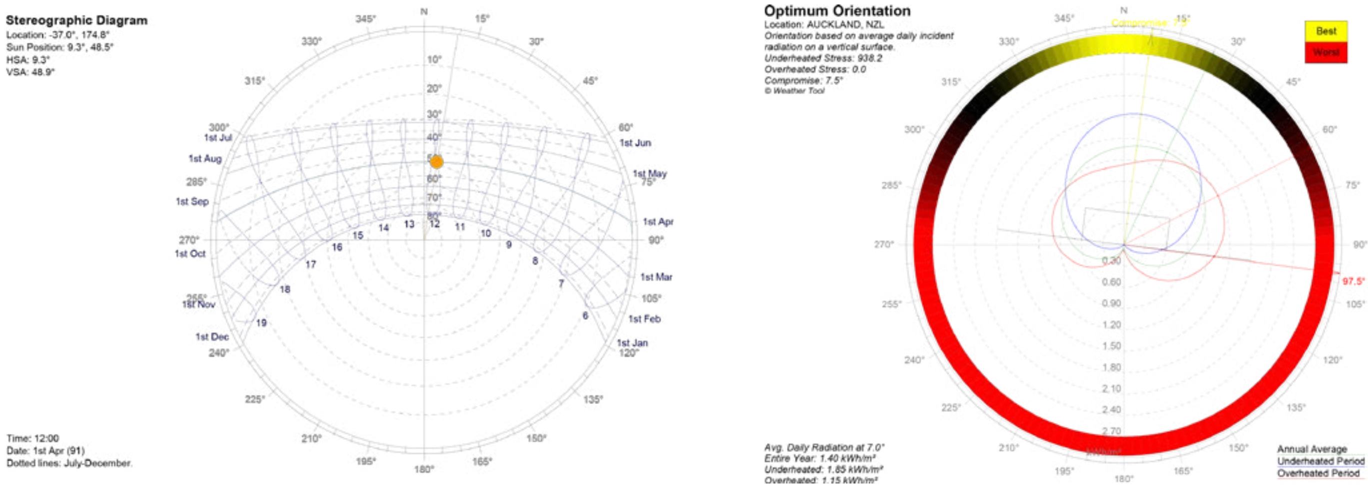


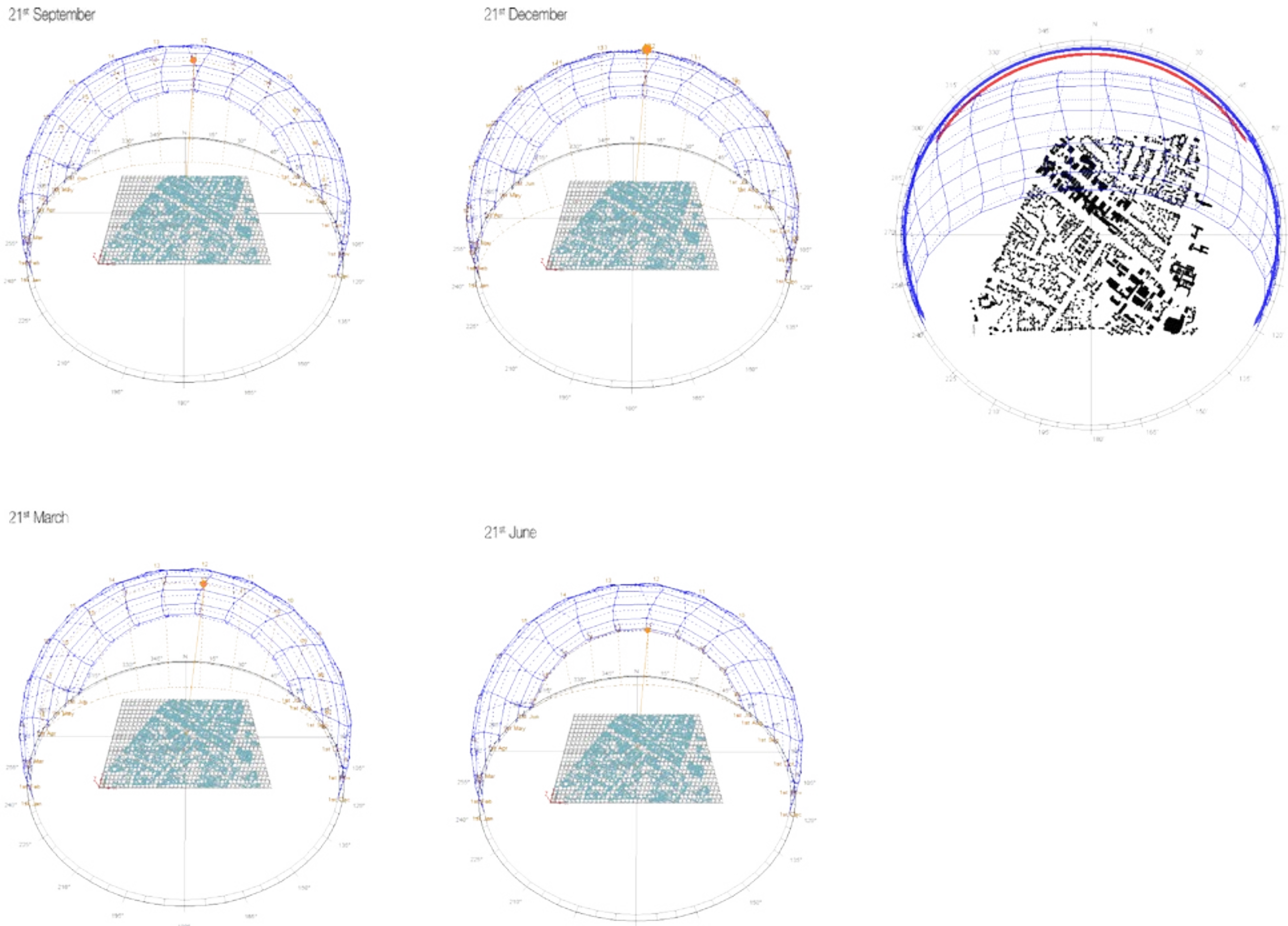
Fig. 43 Winter solar incident radiation



v *Fig. 44 Solar analysis*



v *Fig. 45 Solar path analysis in New Lynn*



green-fingers system

Create a connected open space system

Green network to manage rainwater, stormwater and enhance connectivity

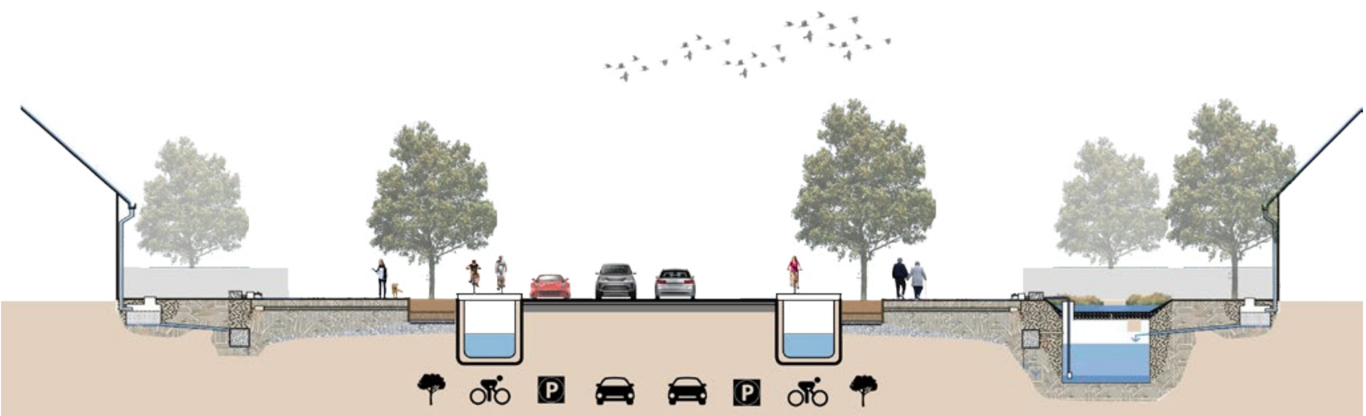
The Investigation phase identified unused open spaces. Instead of adding functions or activities in these areas, the team focused on enhancing connectivity and water management.

Green fingers are designed to create a network of green open spaces which function, from a water management perspective, as a buffer during storms and avert floods in high-risk areas. These open spaces are also connected to the bike lanes, under which are implemented water-collection systems. An added value of these green fingers is their beneficial effect on preserving urban biodiversity and protecting endemic species.

Finally, these green fingers will also function as acoustic and pollutant screens, preventing noise pollution from busy commercial streets to residential blocks and schools.

^ Fig. 46
Diagrammatic collage for the green finger design

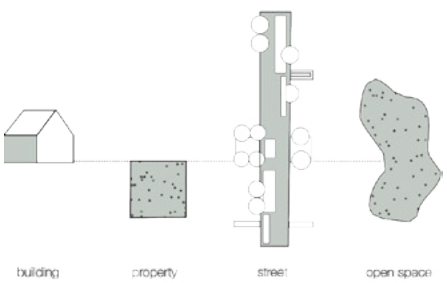
v Fig 47
Environmental section of a classic street



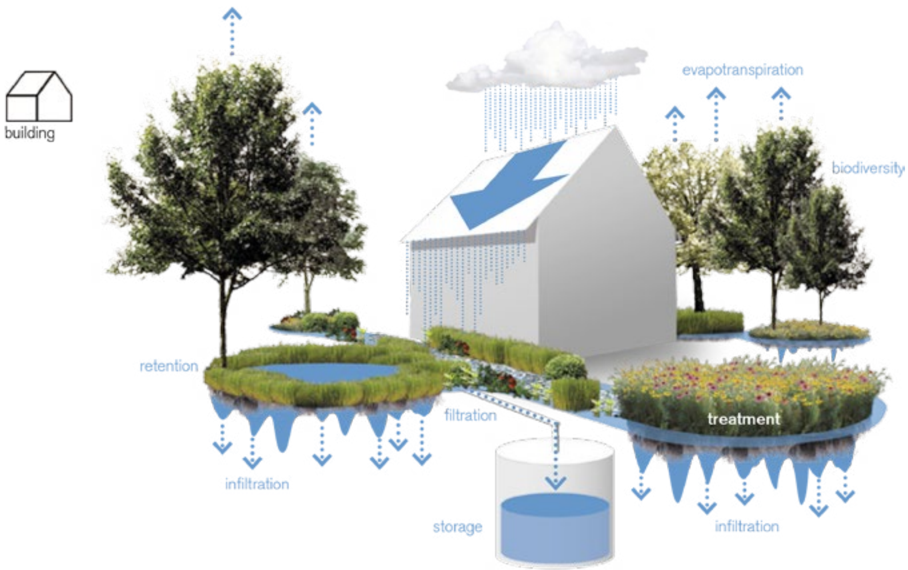
rainwater management

Improve water management

Integrated rainwater and stormwater systems



^ *Fig 48*
Integrating Hard engineering and Soft engineering



Even though water distribution is starting to become a challenge in the spreading suburbs of Auckland, we were surprised to discover that there was a very low incentive for innovative and resilient water management techniques in the area of New Lynn. Individual houses aren't designed to recover rainwater and filter it for reuse. Open spaces, being disconnected and fragmented, can hardly assume a buffer role in collecting stormwater and preventing floods. The same point can be made for the streets and private gardens.

The team therefore decided to solve this issue through different interventions defined in the previous sections and described diagrammatically in this section. As a reminder, we should insist on the fact that the green network also serves other purposes, such as enhancing safety in commuting, connectivity of open spaces and urban biodiversity.

^ *Fig. 49*

Domestic rainwater storage

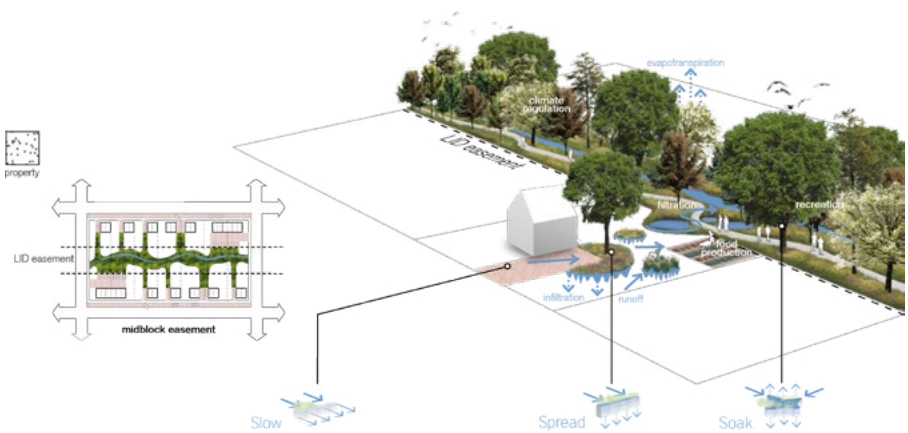
Due to the low compactness of the residential blocks that consist of individual one- or two-storey buildings, most of the privately owned land isn't contributing to the retention and buffering of rainwater.

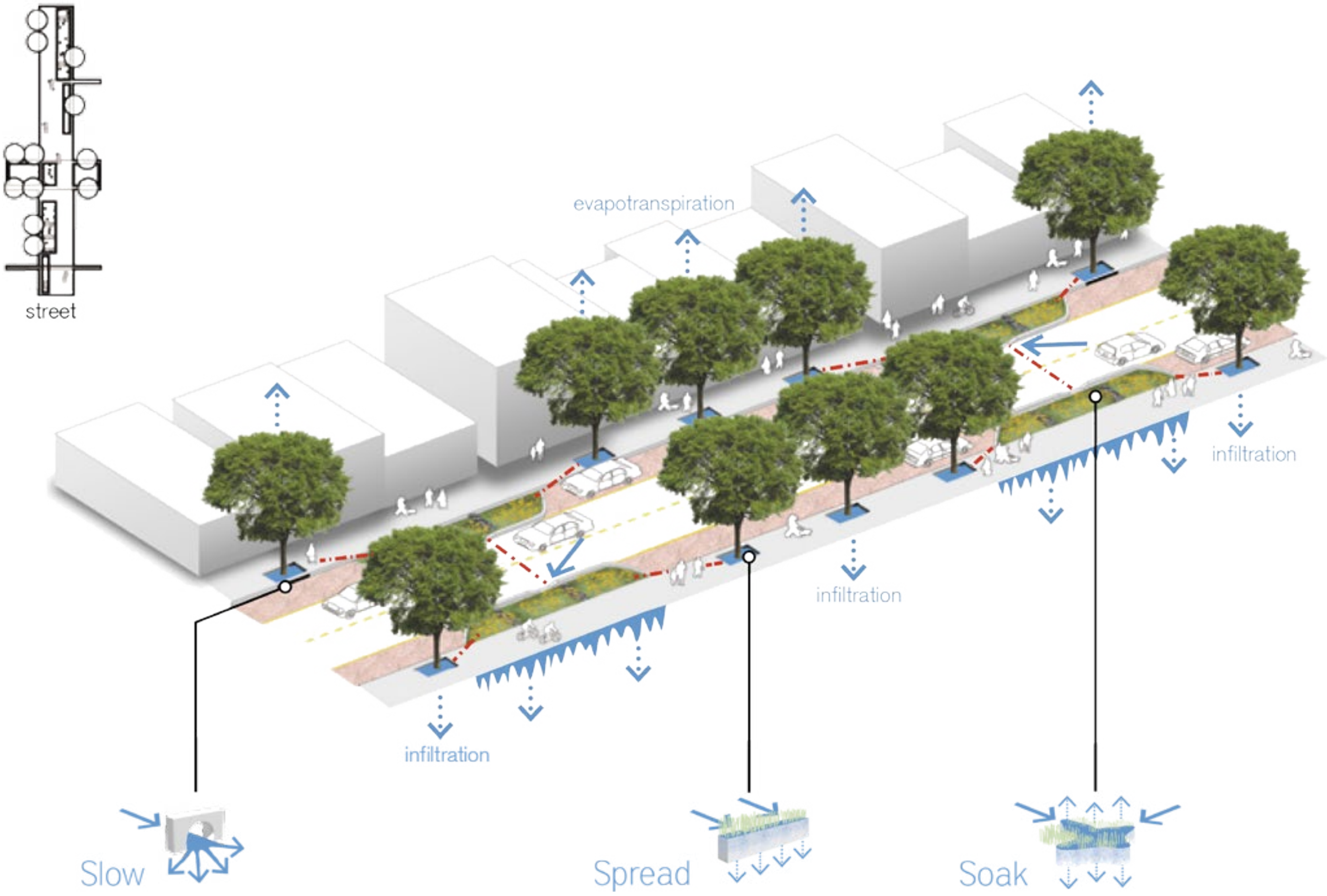
The team therefore suggests an incentive for domestic rainwater collection, filtering, treatment and retention, to lower the potential damage caused by floods.

v *Fig. 50*

Resilient gardens

Backyards occupy a lot of land. We're suggesting that part of it could be put in common to implement practical solutions such as urban farming, but also serve as a connectivity enhancer and a buffer zone for water collection. The private land could slow down the flow of water, preventing it from being evacuated by the sewers and redirecting it towards the buffer instead. The reuse possibilities are infinite.





^ *Fig. 51*

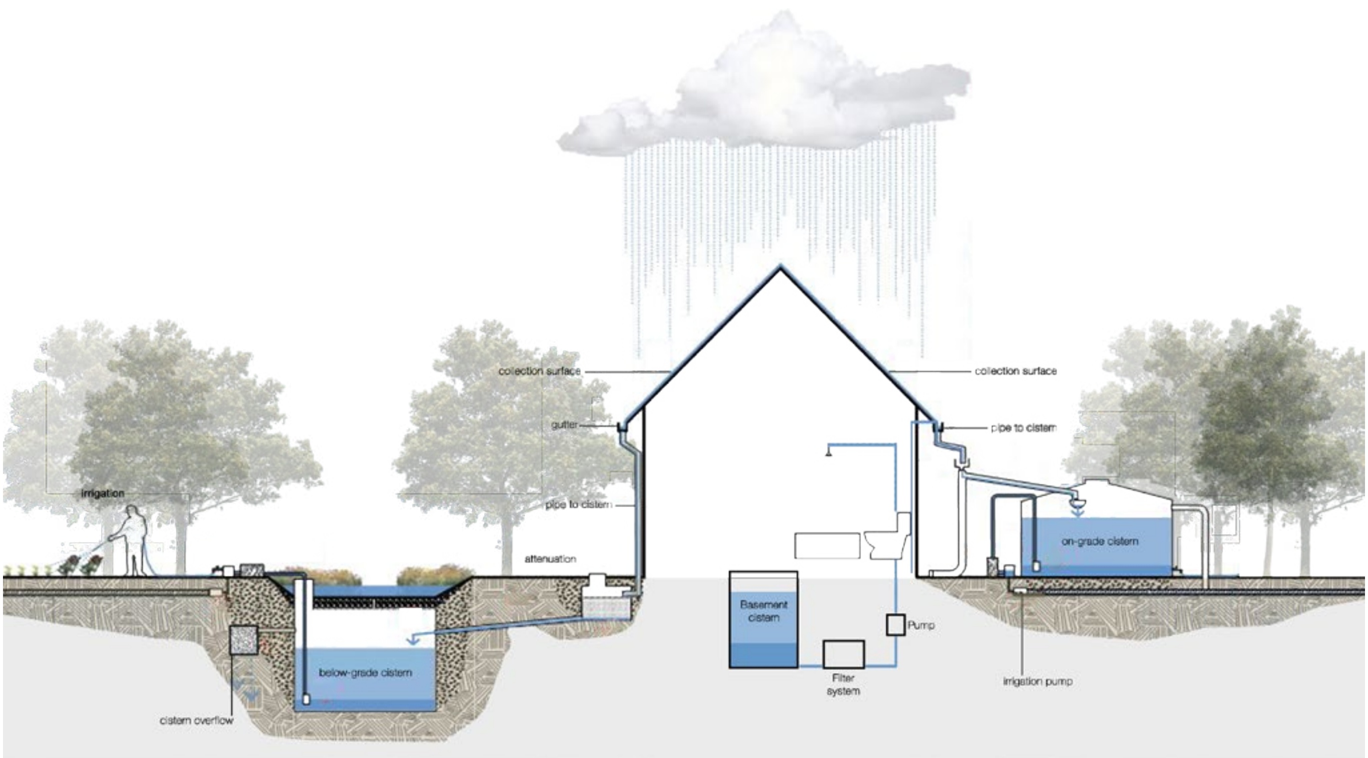
Buffer zones on the street

The greenery improves quality of life, but its purpose here is water filtration and desaturation of the sewers.

v *Fig. 52*

Diagram of the water collection system

Rainwater collection for domestic use and public networks for stormwater buffer zones function synergically



urban biodiversity

Protect urban biodiversity

Continuous green open-space network

The map shows the superimposition of the new biking network with the expansion of the green fingers increasing the connectivity of the selected open spaces. The green finger's typical layout is described at the bottom of this page.

It is clear from their distribution that these green corridors will enhance connectivity of the open spaces and considerably increase the overall green area, replacing lost land and sometimes privately-owned land with public open and green space.

The public benefits can be significant, since cycling transportation is far more resilient than the individual car. In addition, *The Auckland Plan* should implement more efficient cycle routes in the east-west direction: a denser cycle network for New Lynn could add considerable value to the area.

Fig. 53 >
The new green network proposed by the project connects the existing green areas.

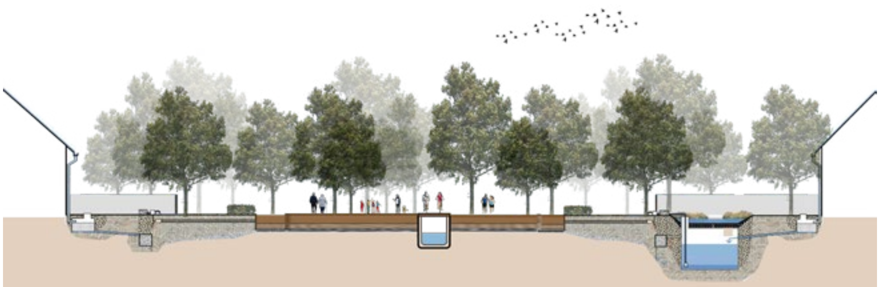
Preserved green space

Public green space

Privately-owned green space

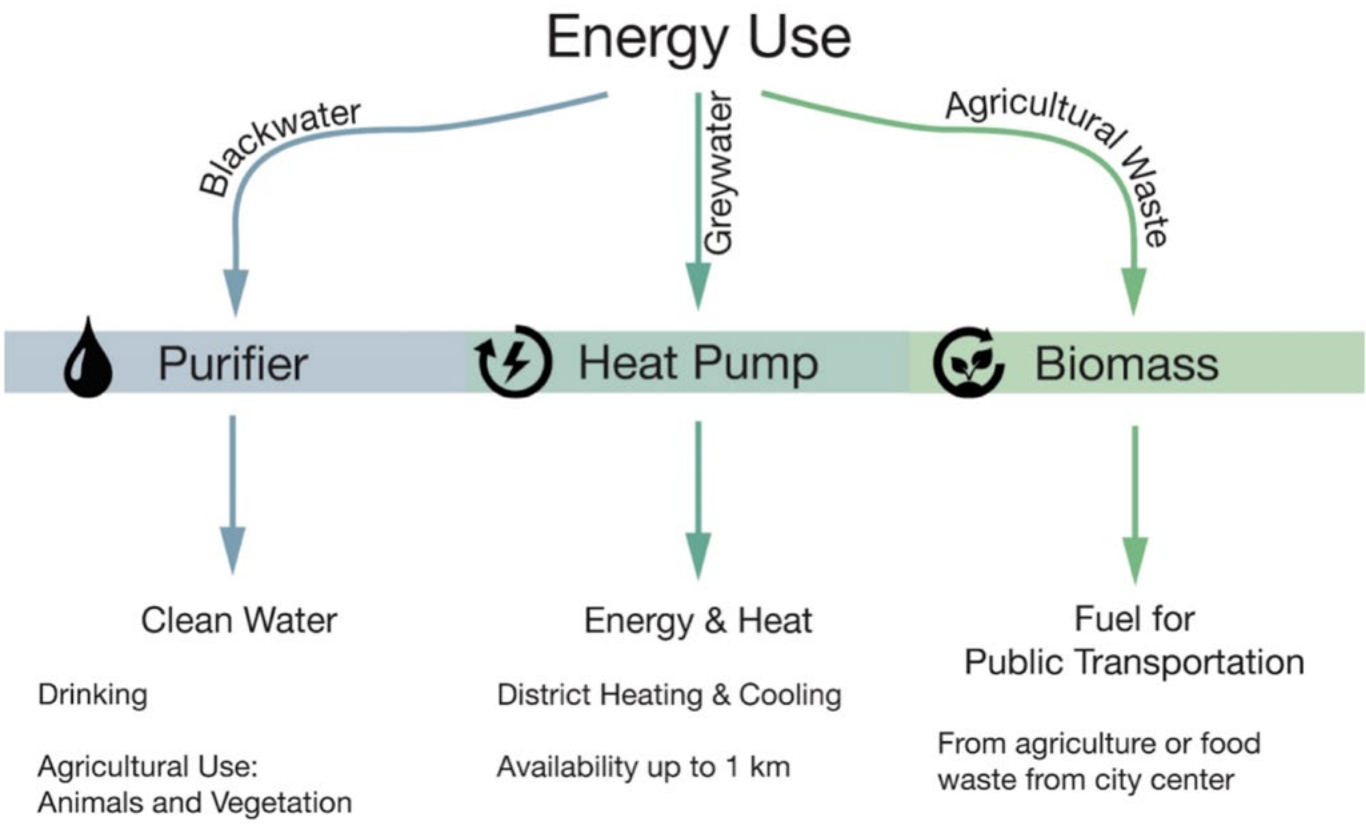
Cycle path network

v Fig. 54
Environmental section of a typical green finger



biogas energy

Improve waste management



^ Fig. 55
Diagram of the energy production-use of waste materials.

The waste management implementation is based on decisions that require significant behavioural changes in New Lynn's population:

- *Private buildings to low-energy consumption buildings*
- *Increased consumer responsibility in the environmental impact of waste*
- *Creation of waste collection centres where recycling is performed*
- *Shift in the design perspective*
- *Reuse of organic waste to produce thermal and electric energy with biogas*
- *Creation of 6000 new job opportunities within New Lynn.*

^ Fig. 56
PET Recycling facility in Auckland, funded by the government

ground-use balance

Advocate for land-trust community-oriented policies

Reduce private ownership in favour of shared land for community resilience

The different interventions suggested by the team may induce a significant reduction in privately-owned residential land. The size of backyards will undoubtedly shrink, replaced by community gardens and green-fingers connections.

Thus, this DOP advocates a change in land allocation, rather than bringing in practical design and spatial solutions: we believe that there could be a softer transition from the public street to the private space of the private house surrounded by its private garden. The addition of a semi-private space, such as a community garden or a local green finger, with the function of a biodiversity enhancer and a buffer, could help in solving the issue of segregated blocks within the residential areas. Each block would improve its independence and foster a sense of community.

^.Fig. 57
Example of engagement in community gardens

city as a food producer

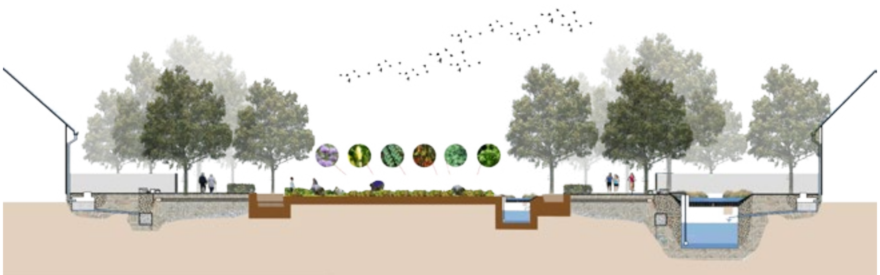
Convert the city into a food producer

Urban farming to feed the sense of community

One typological feature of suburbs is the backyard. Some areas of New Lynn have large communal backyards that have the potential to become food-producing areas for those communities. This idea could become a pilot study that in the future may be replicated in other blocks if proven efficient and feasible. This concept will tell us a great deal about the impact on the community of urban farming and edible plants, vegetables and fruit grown at micro level.

Unused and inaccessible areas between private properties have huge potential for such initiatives. They can be used as common half-private spaces shared among the people living around them to create community farming, promote local food production and to re-establish the food tradition.

^ *Fig. 58*
Distribution of community gardens for food production
v *Fig. 59*
Environmental section of the community gardens between two residential rows.



masterplan

Optimising New Lynn's morphology

< *Fig. 60 New Lynn final masterplan based on IMM methodology* ^ *Fig. 61 Preparatory sketch for the final masterplan*

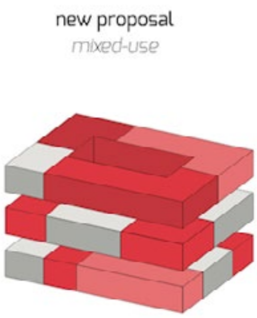
A new masterplan for New Lynn driven by connectivity

The final proposal for the masterplan, chosen by the team, envisages significant shifts from the strategy presented in the New Lynn local plan for 2010–2030.

Morphologically speaking, the choice of densification was maintained, mainly for two reasons. First, from a practical point a view, a complete shift would hardly serve the development of the city after having taken a strong position in favour of *The Auckland Plan* incentives. Second, functionally speaking, the urban plan considered by Auckland Council also gave us a good opportunity to connect different urban blocks together. The softening of angles when two urban grids were brought together resulted in an overall improved integration.

In terms of functions, the implementation of multi-use buildings enables a better diversity of functions. The accessibility of these functions is also improved, as can be seen in the following retrofitting analysis.

The most interesting and relevant element to be considered in the masterplan is the green-fingers network. Given the importance these were given in the design phase, they had to be thought of as expandable and replicable, in the sense that they had to be the continuation of the existing network and benefit from it. But they also connect currently excluded open spaces and different residential blocks, and serve the intermodality desired by the team.



^ *Fig. 62 Preparatory diagram for a mixed use building*

The ground-use balance is also completely different, mainly for typological reasons. The typology consisting of a building with a central courtyard, with functions on the ground floor and offices and apartments on the upper floors is a typical input from the old European compact city and has proven to function reasonably well for improving resilience.

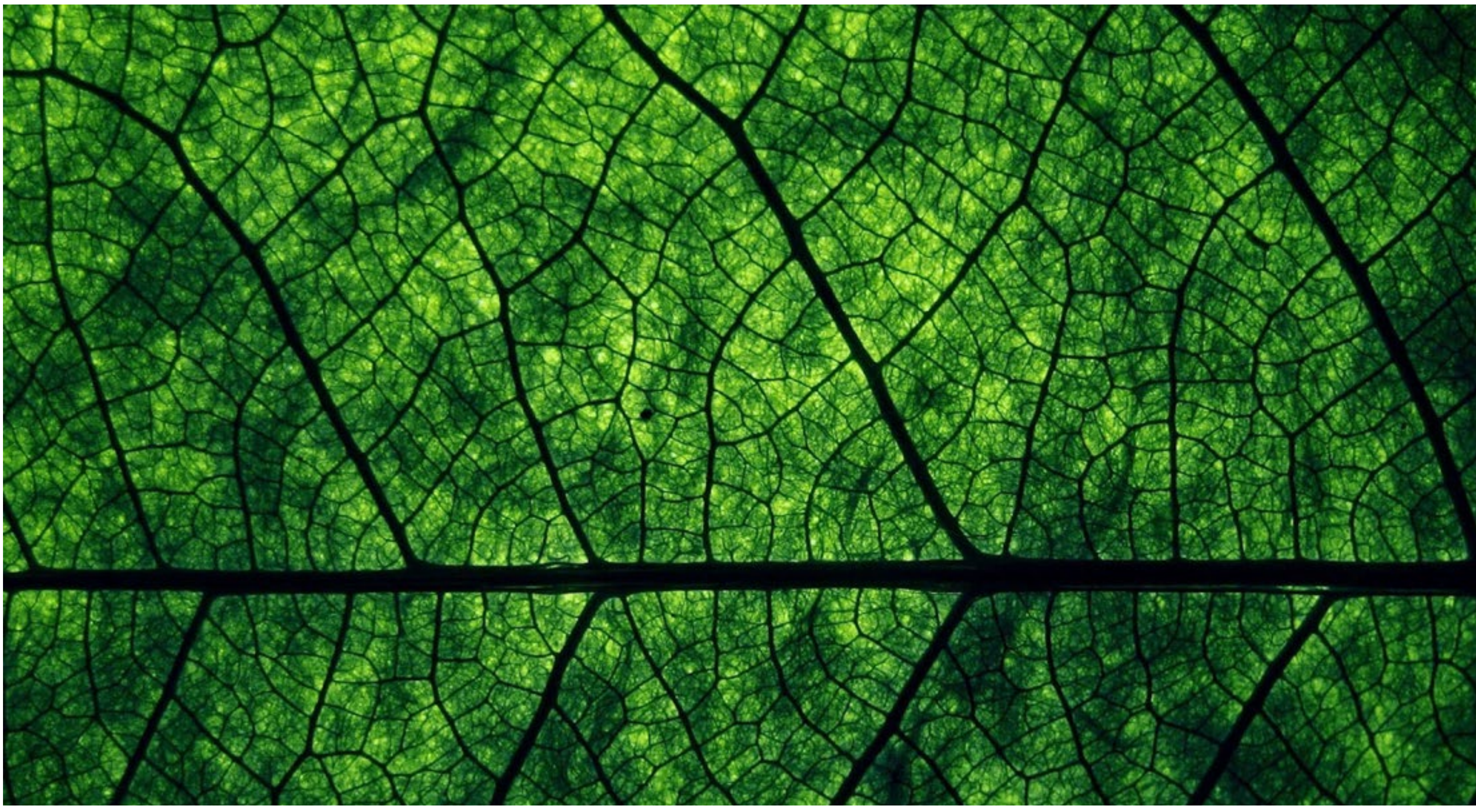
Given the decisions described previously, we are suggesting that the shift towards a densified town centre should be accompanied by other urban design actions, in particular the networking of the open spaces and the connectivity and intermodality of transportation. Given the congestion of New Lynn, and its expected growth, an IMMediate and clear policy in that direction should be advocated.

Layer	IMM indicators	Indicator	Description	Value
Layer	Volume	Horizontal	Built area	0,909
	Voids		Unbuilt area	0,8
	Functions		Activities in the area	0,242
	Transportation		Private or public transportation trips	6795
Key category	Porosity	Vertical	Dwelling density	0,0007
			Floor area ratio (FAR)	1,2964
			Population density	0,0016
	Proximity		Job opprtunity within a walkable distance	5,85
	Diversity		Variety of activities within walkable distance	0,82
	Interface		Movability within the urban voids	22,8326
			Integration HH	0,339
	Accessibility		Feasibility of reaching destination	5,98
	Effectiveness		Number of public transportation on total trips	0,129

^ *Table 6*
Indicators values before the intervention on the intermediate scale

v *Table 7*
Indicators values after the intervention on the intermediate scale

Layer	IMM indicators	Indicator	Description	Value	Improvement
Layer	Volume	Horizontal	Built area	0,934	2,73%
	Voids		Unbuilt area	0,776	3,19%
	Functions		Activities in the area	0,281	16,05%
	Transportation		Private or public transportation trips	6795	0%
Key category	Porosity	Vertical	Dwelling density	0,0015	111,2%
			Floor area ratio (FAR)	1,2637	-2,52%
			Population density	0,0041	148,57%
	Proximity		Job opprtunity within a walkable distance	6,769	15,79%
	Diversity		Variety of activities within walkable distance	0,994	0,74%
	Interface		Movability within the urban voids	20,298	12,49%
			Integration HH	0,393	15,95%
	Accessibility		Feasibility of reaching destination	13,17	120%
	Effectiveness		Number of public transportation on total trips	0,129	0%



Retrofitting

Estimation of the CAS performances and choice of the catalysts for the intervention

6

volumes
Built-volume density

voids
Open-space areas

Void

Volume

^ Fig. 63
Retrofitting the new CAS's components by Horizontal Investigation. Analyses of physical assessment of the new subsystems: Volume.

Volume

Void

^ Fig. 64
Retrofitting the New CAS's components by Horizontal Investigation. Analyses of physical assessment of the new subsystems: Voids.

As can be understood from the Volume and Voids maps of the intermediate scale area after intervention, most of the DOPs had a soft influence on the urban framework. We took into consideration the urban planning prescriptions from the New Lynn plan for 2030, and tried to implement subtle or strong modifications on its proposed layout.

For example, the interconnections of Voids have been significantly increased, but given the scale of the area, the actual value of the indicator used for the evaluation might not be far from its initial value. Indeed, the aim of the green-fingers intervention was to enhance urban biodiversity, walkability, ground-use balance, and to retain stormwater. Its effect on the urban grid in New Lynn centre was less significant.

In the centre though, the modification implemented according to the urban plan for New Lynn is significant. Morphologically, it is revolutionary for such an urban context, and completely European in its layout. In terms of ground-use, it is a clear step towards compactness of the city centre, thanks to the mixed-use orientation of the multi-storey buildings.

Finally, we should insist on the fact that not only do the Voids themselves have a different layout, but also their ownership and accessibility is improved. The difference between privately owned open space and publicly or semi-publicly owned open space is nearly halved.

transport

Number of trips made via public transport

functions

Job density

^ *Fig. 65*

Retrofitting the new CAS's components by Horizontal Investigation. Analyses of physical assessment of the new subsystems: Transport.

^ *Fig. 66*

Retrofitting the New CAS's components by Horizontal Investigation. Analyses of physical assessment of the new subsystems: Functions.

As expected, the transportation system increases in density closer to the train station intermodal hub. But it's also worth mentioning the promising development towards the west as the emerging second core of the project, as well as the green fingers initiated in Avondale to the northeast and Green Bay to the south.

The functions distribution remains unchanged, with a significant increase in the area IMMediately near the cores: the shift towards the cycleable and walkable city isn't too abrupt.

- Bike station
- Train station
- Bus station
- Cycle path network
- East-West railway
- Street network
- Main roads
- Catchment areas

- Business activity
- Culture and community
- Restaurant
- Religious and sport

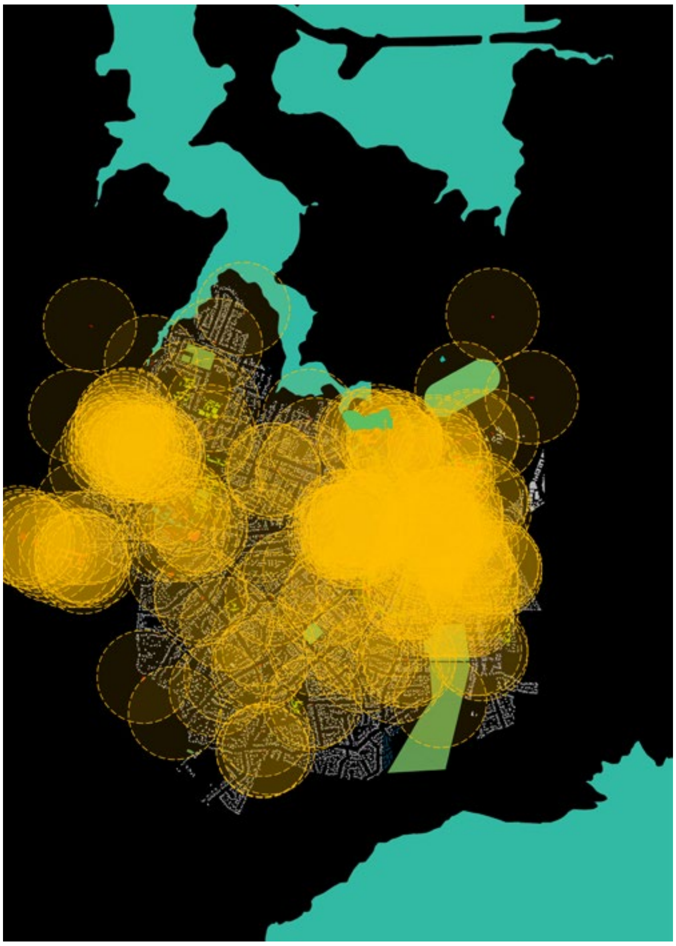
porosity

Factuality of urban voids

proximity

Number of key functions within walkable distance

^ *Fig. 67*
Retrofitting the new CAS's Key Categories by Vertical Investigation: Porosity map of the project.



^ *Fig. 68*
Retrofitting the new CAS's Key Categories by Vertical Investigation: Proximity map of the project.

These two maps show the evolution of Proximity and Porosity after the intervention. With the urban planning strategy driven by densification in the town centre only, it is not surprising to see the Porosity remain constant outside the centre and only increase in the cores.

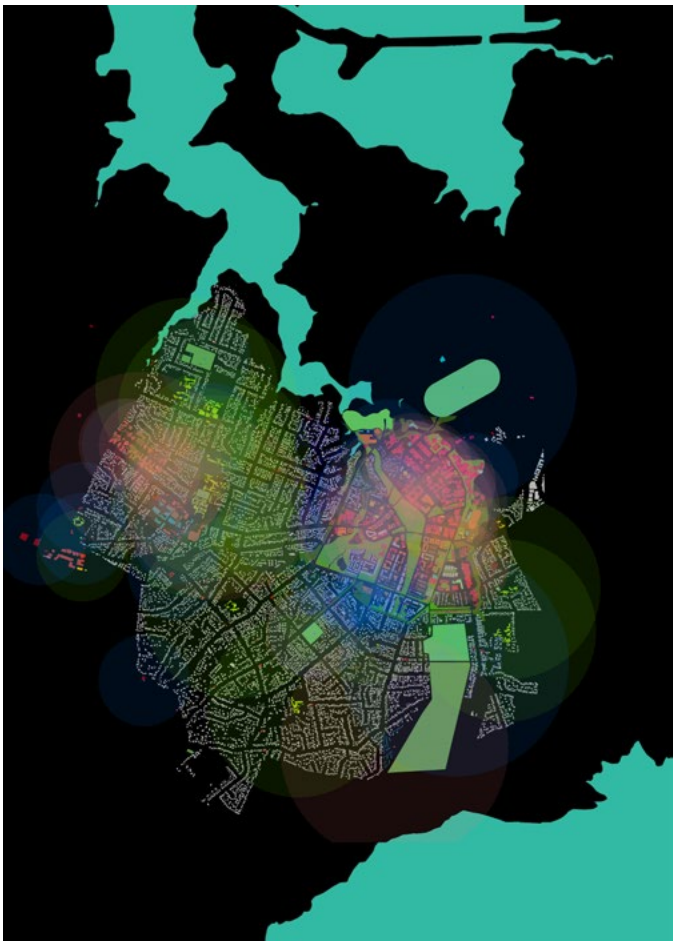
But the Proximity also shows that the added Functions and the increased connectivity enable a better distribution of key functions, in particular in the south of the centre, where the Interface and the Porosity were more significantly modified.

Key functions

Walking Distance
400 m / 5 mins.

diversity
Diversity of subdivision use

interface
Mean depth of street segments



^ *Fig. 69*
Retrofitting the new CAS's Key Categories by Vertical Investigation: Diversity map of the project.

^ *Fig. 70*
Retrofitting the new CAS's Key Categories by Vertical Investigation: Interface map of the project.

The Diversity and Interface maps provide us with the most promising results: owing to the enhanced grid within the former Lynn Mall area, the Interface that was previously only efficient in the area of the train station is significantly improved.

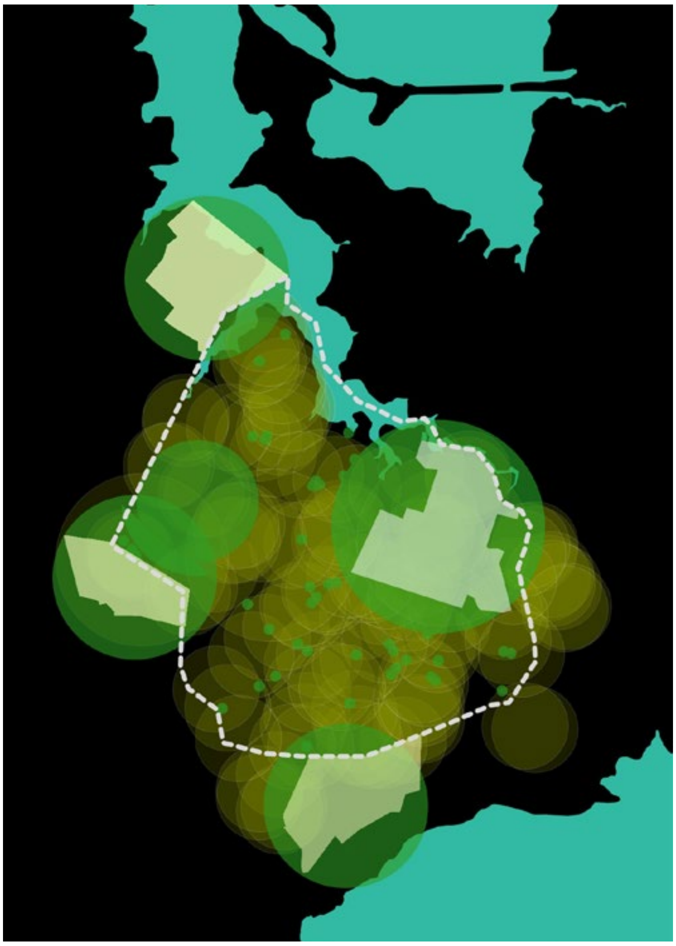
The same point can be made concerning the Diversity of activities provided in the cores and along the connection between them: owing to a new morphology of multi-use-oriented buildings, it is also significantly improved.

accessibility

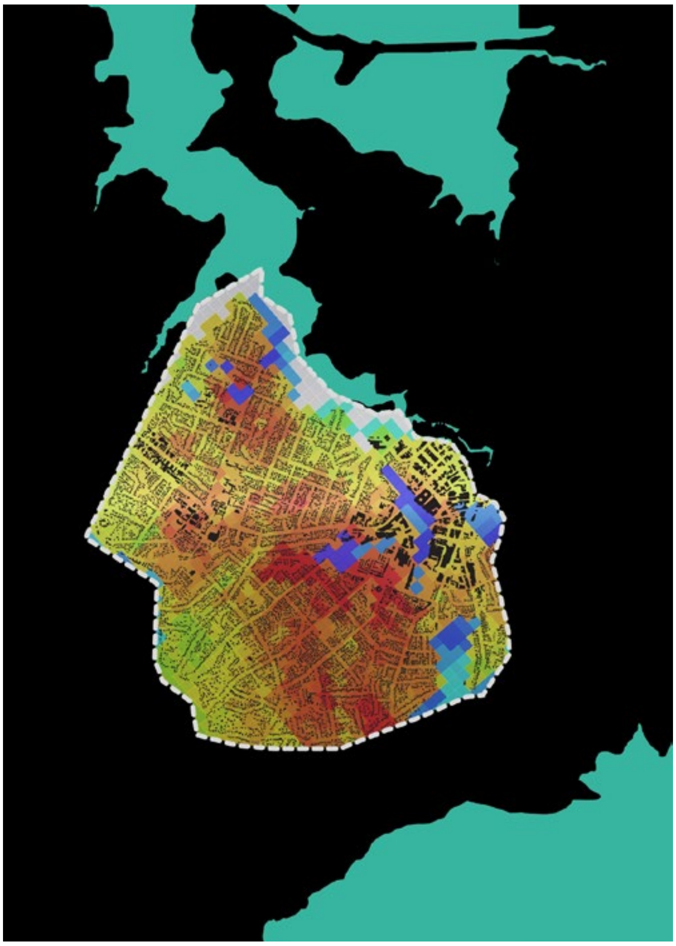
Number of available jobs reachable in less than 20 minutes

effectiveness

Public transport trips



^ *Fig. 71*
Retrofitting the new CAS's Key Categories by Vertical Investigation: Accessibility map of the project.



^ *Fig. 72*
Retrofitting the new CAS's Key Categories by Vertical Investigation: Effectiveness map of the project.

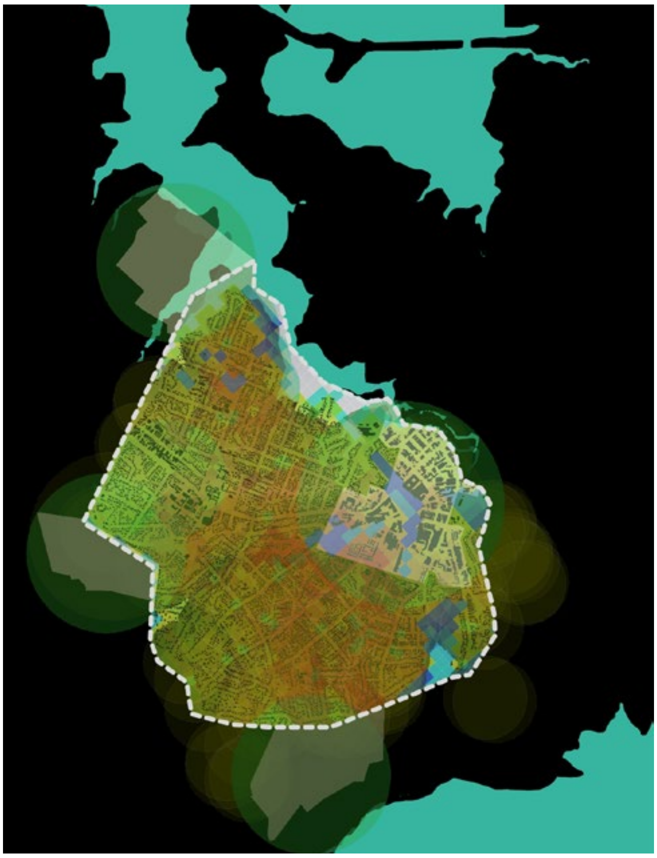
From the Accessibility map, the main suggestion is to foster two job-producing hubs that benefit from the environmental initiatives described previously. This is an opportunity to differentiate New Lynn from the nine other satellite town centres.

In addition, the two employment areas connected via the bike network to the core increase the Effectiveness in the north-south direction. It indicates the potential for the residential context to develop into connected areas. The white area to the north indicates a Transportation desert.

compactness

^ *Fig. 73 Retrofitting the new CAS's Determinants: Compactness map of the project.*

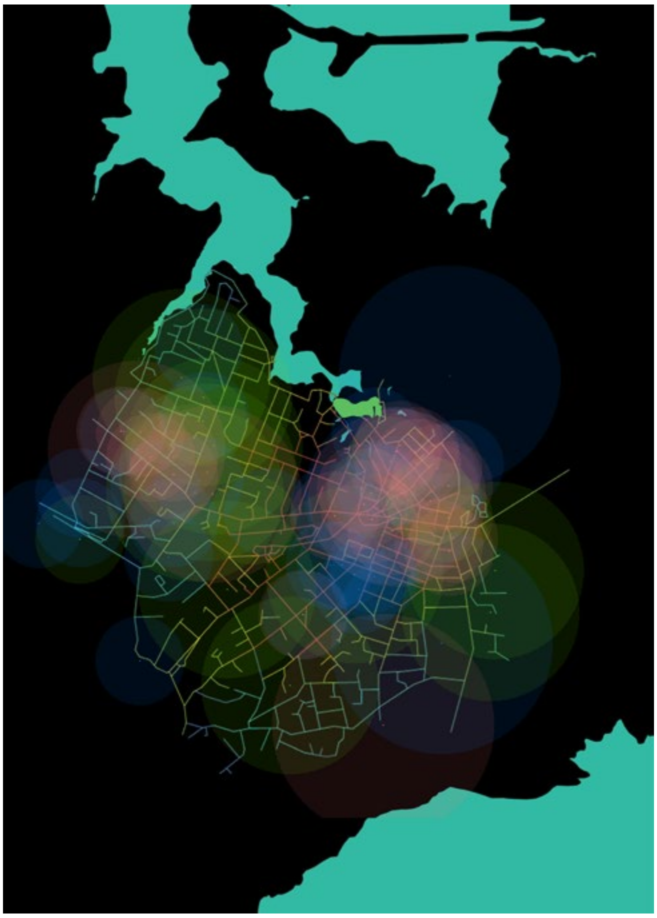
connectivity



^ *Fig. 74 Retrofitting the new CAS's Determinants: Connectivity map of the project.*

complexity

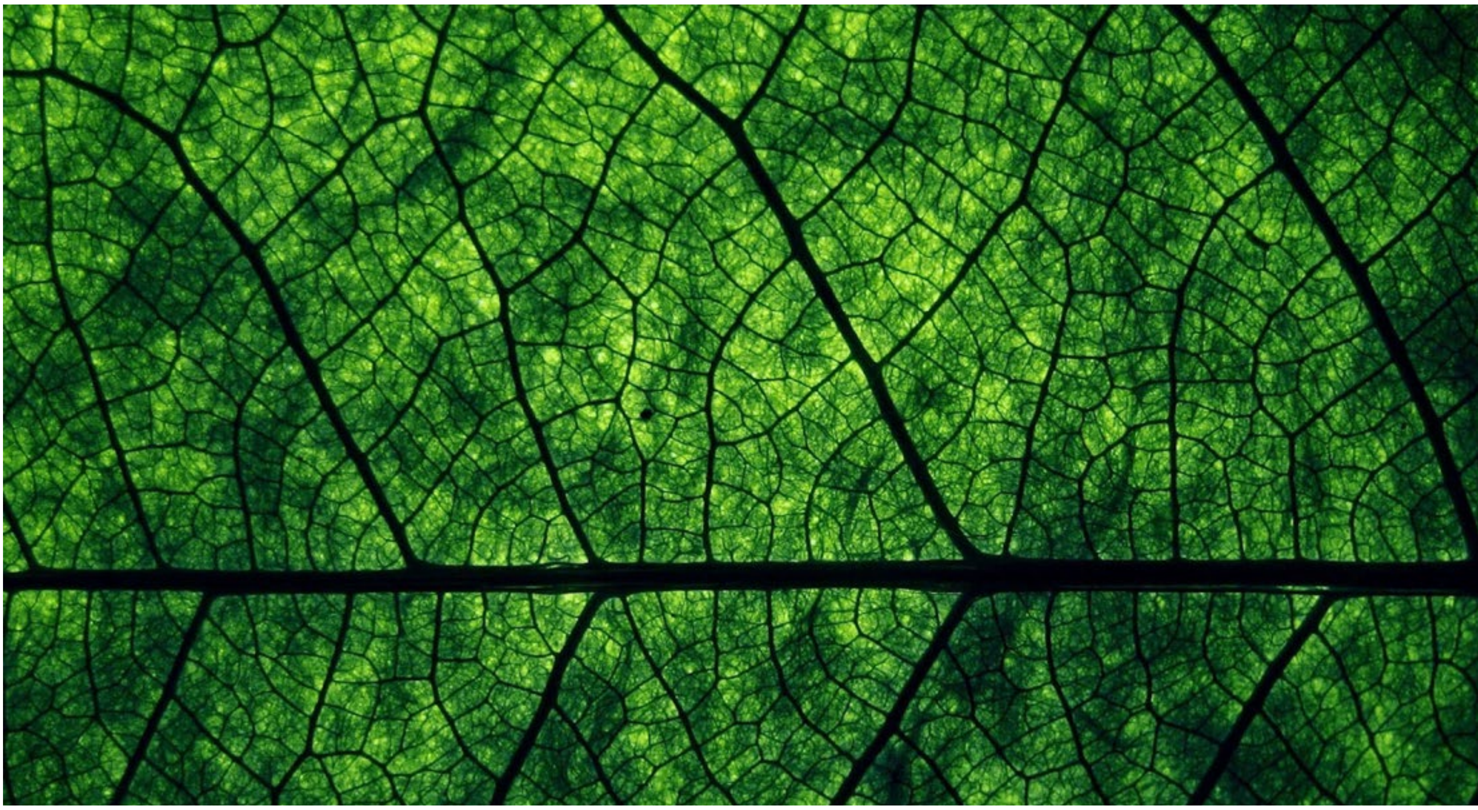
Fig. 75 > Retrofitting the new CAS's Determinants: Complexity map of the project.



The last superimposition of the modified masterplan maps brings in interesting features. First, it is clear that the intermodality and transportation modifications have had positive influence on the layout of the city. But, in addition, this increased connectivity has enabled a better integration of the job-producing areas and a globally improved coherence of the urban frame. This was possible above all thanks to the green fingers and bike network.

It is worth mentioning, though, that when the morphological features of a sprawling context are too much above human scale, local modifications and incentives have a low influence. The evidence for this can be seen in particular in the northern area of New Lynn, where the Interface and Diversity remains really low even with a satisfying Effectiveness and Transportation system. When the Accessibility is too low due to the large scale of the blocks, the Interface remains low.

Finally, the urban planning prescriptions suggested a densification of the city centre. We have shown that an additional effort on connectivity, intermodality, multi-use buildings and green-space network could enhance this policy.



Conclusion

A successful challenge and promising outcomes for IMM team

promising perspectives for IMM

The first challenge of the sprawling context

^ *Fig. 76*
Workshop team on the final day: not even tired.

The excessive horizontal expansion of cities around the world is one of the biggest challenges that urban designers, governments and citizens are facing in the twenty-first century. The governance failure in this matter has in some cases brought cities and megacities to the edge of economic, social and environmental collapse.

Excessive urban sprawl is actively denounced by economists, environmentalists and urban designers, from both practice-based and academic perspectives. In many places, initiatives to limit or reduce sprawl have been undertaken, but the legal, technical and financial instruments for disposal in the real world too often prove themselves ineffective or weak. On the other hand, whatever positive aspects sprawl might have – an enormous potential for solar energy and for natural stormwater management – these have been largely ignored or underused.

Indeed, professional urban planners and designers have to cope with too many constraints in the real world. These constraints favour reliance on convention and familiarity, rather than experimentation and innovation. In the conditions of academia, however, the controlled conditions of studios, laboratories and workshops allow alternatives, hypotheses and tests. Here, political, cultural and physical realities can be suspended for a while, until the principles of the solution are figured out. Then follows their modification and calibration, in order to make their application practical and effective in reality.

This was the opportunity we saw when presented with the case of New Lynn. We were an international and multi-disciplinary team: some of the students are qualified and experienced architects and urban designers, others are qualified engineers, still learning about architecture and urban design, and how to come up with fresh ideas and a broader knowledge of practical solutions. But all of us were animated by one central idea: the possibility of providing in New Lynn something more than the conventional policy of sprawl containment and urban intensification.

The process and the outcomes of the workshop were interesting. We did face the limits of our European perspective in the low-density, car-dependent context of the West Auckland peripheries. The main difference was in the spatial scale and associated culture of urban living: solutions that have proven themselves efficient in the framework of European cities obviously didn't provide the same results in the context of Auckland.

While applying the Design Ordering Principles, the scaling of the urban texture still enabled the team to imagine new energy networks; bolder stormwater management strategies; extending of green open-space fingers; global and interconnected bike networks; intermodality hubs; and finally, to envisage the city as a food producer.

In the end, all these elements were integrated into a package of urban design guidelines, which at the start of the workshop seemed impossible for New Lynn.

Our modelling exercise indicates that improvements are possible no matter how degraded the land has been by the industrial era and how dependent on cars everything has been in the automobile era. These improvements are not always very efficient or economic, but the point is that change is possible and that it starts with changing awareness among the local residents. Once the seeds of sustainability and resilience are sown, they will grow over time and new paradigms of (sub)urban living will take hold.

What we, the students of this academic workshop, are suggesting is that it is already possible to implement bits of what most practising urban designers would describe as a utopian plan. Our quantifications show that a higher level of sustainability, resilience, functionality and liveability are possible now, and that this can be done with changes in the physical structure and human behaviour which are neither radical nor prohibitively expensive.

We hope that readers will find this book inspirational for similar interventions on real life projects in other parts of Auckland, and beyond.

Feel free to contact us on facebook or on the IMMdesignlab website.

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^ Fig. 77 Presentation of the pilot project in Auckland using IMM methodology held at Politecnico di Milano. In front: prof. Dushko Bogunovich.

^ Fig. 78 Public presentation, by prof. Massimo Tadi, of the New Lynn project at Rotary Club Lecco Manzoni in Lecco.

v Figs. 79–80 Students and staff at work during the one week intensive design workshop held at Politecnico di Milano, Lecco Campus.

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A multi-disciplinary team from around the world

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