MEDIUM DENSITY RESIDENTIAL BLOCKS
Research of more effective systems of urban dwelling development

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ABSTRACT BASE

Aim
This research considers how strategies in city design overseas can have practical applications in the Australian context, with an emphasis on economical use of space and preservation of natural resources.

Content
Medium density living strategies overseas have had a proven record in increasing the efficiency of the infrastructure of modern-day society, increasing the individual’s proximity to the multitude of opportunities the community can offer them. The study points to a number of practical examples of this, such as a reduction in motoring necessity and all the financial, environmental and health benefits that result from people being able to leave their car at home. In tandem with tangible benefits such as these, this research also contends that the increased efficiency of a community’s networks offers a greater quality of life for its inhabitants.

Such strategies have been tried before in Australia. However, it is the view of this research that previous attempts have been hamstrung from the outset by both restrictive current planning legislation and the absence of an effective holistic approach.

Conclusion
The research addresses these two obstacles directly, and in doing so proposes a ‘second chance’ for the importing of medium density strategies used overseas. Asking for legislative change necessary to facilitate it, it offers an agenda that learns from mistakes of the past in order to present an optimistic vision for the future.

KEYWORDS:
* Solution to urban growth
* Sustainable neighbourhoods
* Urbanization and health
* Cities in transition
* Rationalization of urbanity and density of Australian cities
* Rationalization of the urban sprawl and built form

1. BEGINNINGS OF AUSTRALIAN URBANIZATION

Urbanisation of Australian continent in the last centuries had some similarities with urbanization in other parts of the globe, especially similar to some western models, while having characteristic differences.

Colonization of Australian continent begun in times when vast natural recourses were available. Australia was low populated continent with the Aboriginal living tradition in coordination with nature.
First colonization, significant for building this continent, begun with arrival of British settlers and their middle-class tradition in developing settlements by the ports, similar to their homeland. Later the migration wave spread deeper into the continent.

2. GENESIS OF THE FIRST BUILD CITIES

First Australian cities were developed along the coast and adjacent to the port and trade activities.

The settlement pattern was largely determined by the arrival of ships with people and goods. First cities development was influenced by necessary functions like ports and warfs, government, manufacturing and housing. Manufacturing and business growth in proximity to ports resulted in building first multi storey buildings. Allocated land for residential use was surrounding first centres. Residential subdivision characterised large single housing estates with accommodation for servants and landscaped gardens. On the other hand two storey houses were built for workers along railway lines and close to industrial estates.

Initially industry occupied land surrounding ports, for the ease of supply and transport, from there slowly it moved along major roads while forming second circle around city centre. Economic, technological and cultural development of 20-th century initiated the significant changes throughout the Australia. The cities grew rapidly. Unstopable land development expansion was taking over green fields and fertile land. Inland townships were formed around mining, farming and agricultural activities.

3. EFFECTS OF METROPOLISATION OF AUSTRALIAN CITIES

By the mid of 20-th century economic, technological, business development and land use rising caused the growth of Australian cities. Their central zones became overbuild.

High degree of ground coverage, land value and increased development pressure in central areas was growing out of control.

On the other hand, suburban residential zones with small houses were rapidly spreading further away from the city centre.
Cities population growth, car industry expansion, and low cost of petrol rapidly increased number of cars, brought increased traffic and parking problems, especially in the central zones. Affordable land appears to be moving further and further away from the centre.

Towards the end of 20-th century, state of land use and vitality of big cities became alarmingly problematic. Their intensive growth led them towards metropolitan dimensions. Cities like Melbourne, Sydney, Pert, and Brisbane... have increased their population and growth boundaries exponentially.

4. AUSTRALIAN CITIES TODAY

Australian cities today are overwhelmingly burdened by number of issues such as: expanded urban growth boundaries, lengthy and complicated infrastructure network, high cost of services producing economic stratification, social alienation and growing ecological unsustainability.
In the most densely built areas, in the city centres, with highest buildings and the highest building density, floor space index rose over the rational levels. The expenses for the technological and infrastructure servicing of these zones became unacceptable.

In the suburbs, the situation is exactly opposite, but with very similar consequences. Low density areas with large backyards and individual houses have inefficiently occupied large land parcels and require oversized roads and infrastructure network to be serviced. Low percentage of land use and high cost of building, traffic and infrastructure servicing, caused hidden but large expenses for investors and home owners.

In both cases described situations produced specific negative effects.

4.1 Overbuilt Central Zones

With high buildings, high land use, where every m2 of land carry more then 5 stories of build structures, (where Floor space index, Fsi, is much over 5), and population density, in residential zones, indicate more than one thousand inhabitants per hectare, living conditions are burdened with great number of problems. Some of them are:
- Traffic and parking congestion,
- Lack of usable open space,
- Air pollution problems,
- Deficiency of parking and garage spaces,
- Noise pollution,
- Deficiency of all kind of playgrounds.

Such land use problems produce:
- High level of maintenance expenses,
- Social alienation,
- Estranged neighbourhoods.

High density living is therefore made inconvenient and uncomfortable.

4.2 Low Density Developed Suburban Areas

With low land use indicators, (Fsi under 0.5), where population is under 50 inhabitants per hectare, living comfort is also followed with long list of problems:
- Low percentage of land use and low population density make long distances to conveniences of daily life
- long distances to jobs, schools, social activities, health clinics, goods supply and other public institutions are causing unpleasant waste of time,
- Usual technological and daily servicing of individual houses and infrastructural systems are expensive,
- Neighbourhood conflicts may ruin the comfort of using privately owned properties,
- Social interactions are increasingly becoming limited by long distances between friends and lack of time for visitation.
- Spreading of suburban zones produce the ecological damage and loss of green fields.

Better urban environment in the future can be designed through addressing above identified urban malfunctioning and mentioned urban development problems. They were strong enough reason to initiate research of more effective urban dwelling systems for construction and reconstruction.
Strategic, scientific and planners efforts, as well as research of global urbanization problems of existing cities in the last half of 20-th century gave the inspirations for further investigation of compromised solutions for reconstruction, rebuilding, remodelling and reparation of some "bad clusters" of our cities and their longer usable existence in smartly designed systems.

Well designed ancient cities like Mohenjo-Daro, Babylon, Knossos, Rome, and many other of up to more than 6000y ago have established successful infra and supra structures including built form blocks of up to 6 stories high. Interestingly enough history is also teaching us of successful urban blocks, their ergonomic human scale and form that have serviced citizens’ social, political and habitable needs. Walkable environment, we believe a modern term, was a measure for the perimeters of all fortifications in Roman, Ottoman, Austro-Hungarian Empire and many others.

5. GOALS FOR RECLAIMING THE CITIES

Fine thread is linking environmental sustainability with sustainable living at the first glimpse different, they are largely correlated. Reclaiming and revitalisation of existing central city zones can cater for projected population growth while providing great living, working, recreation, education, health, trade and commerce balance. Efforts should be made toward the reparation of actual circumstances of our cities growth and organization.

Some of the principal goals of these efforts should be:
- reclaiming available city areas previously abandoned due to the change in industrialisation and technology innovations
- restricting urban sprawl to existing urban growth boundaries,
- reducing the differences between the extreme levels of land development towards optimising residential densities to high quality of living by number of parameters
- increasing the rational land use,
- developing the traffic systems with new, functional and efficient transport solutions,
- minimising energy use in all processes,
- improving all systems to achieve sustainable levels of operation,
- reintroducing environmentally sustainable status to all urban areas.

These goals can be addressed by number of possible methods. Some of the existing Western and Australian examples have indicated that problems found in high and low density residential models are not present in medium density urban dwelling developments.

6. MEDIUM DENSITY RESIDENTIAL BLOCK

Characteristics of medium density model are directly influenced by population density and high demand for available residential space. Higher population density should be followed by higher density of all supplementary activities. Low population density gives the opposite circumstances.

Population density can determine the residential scale and character of building blocks, therefore medium density solutions can be the model for further development.

The spans of low to high population density in average cities vary between 50 and 1000 inhabitants per hectare. Medium (Optimal) solution could be found around 200-250
inhabitants per hectare. To describe optimal solutions and present few feasible options, number of different densities has been analysed and illustrated.
Calculations begun from well known standard dwelling density and compared with 3 types of densities: 3 storeys high attached housing, medium density block European model and high density Melbourne CBD model.
Experimental location for this calculation was Port Melbourne industrial parcel with closest proximity to Melbourne CBD, and located on the walking distance to all facilities, transport, commerce, recreation, business. Block's gross developable area is around 5ha and is surrounded by major road network with number of transport modes.

7. WHAT IS THE MEDIUM DENSITY DEVELOPMENT?

There are number of interpretations in describing medium density in Australia and unlike overseas it is taking few different forms.
Ray of development models with densities higher than standard residential density represented in single housing model i.e. 1 family / 550m2 and lower then the high rise buildings of 20-30 stories, capable of housing up to 23 families over the same area.

Such undefined form has struggled to be acknowledged by local planning legislation. With clearly defined development density models confusion can be easily avoided.
Internationally adopted density that describes the phrase "Medium Density" is recognized under the term Fsi of 1 where 1 is calculated as ratio that will further be described in detail. Such density by international standards can be best interpolated in the city grid including mixed use of land inclusive of all development needs of modern cities.

8. FLOOR SPACE INDEX

Floor space index (Fsi) is one of the universal indicators in measuring the state of land use in built areas. It may illustrate the amount of built structures for any particular area, village, town, city, region, country or continent.
In our case Fsi is used to describe the amount of built structures on chosen block areas.
For the purpose of this exercise we will measure the Gross Area of the block from the centrelines of the surrounding road network.
The Gross Floor Space Index (GFsi) then is the relation of all floor areas to the total area of the block including allocated portion of roads, while the Net Floor Space Index (NFsi) is relation of all floor areas to the area of the block excluding roads.
In a formula it can be calculated as follows:
Gross Floor Space Index (GFsi) is a sum of all Gross Floor Levels divided by Gross Developable Area.
GFsi=6x2/z2

Net Floor Space Index (NFsi) is a sum of all Gross Floor Levels divided by Net Developable Area.
NFsi=6x2/y2

Furthermore Floor Space Index Fsi can be presented as Net Residential Fsi exclusively related to total residential areas or as part of mixed use blocks.

Description and model comparesment of various floor space indexes represents indicators for critical densities. Too low and too high densities can collapse otherwise well networked cities.
From oversized road networks and low density sprawl to overcrowded city living can all be easily calculated with floor space index equations.

9. **STANDARD DWELLING DENSITY BLOCK L1**

Standard dwelling density in Australia is commonly represented as a single house on the lot size average 450-600m². For model illustration of this kind of living in standard dwelling density our standard city block is divided into 60 lots with average area of about 530 m². The 60 two storey houses can cater for around 180 residents. Percentage of Net Built Area is less than 25% and unbuilt, free space is about 75%. This suburban style built environment can cater for 15 dwellings per hectare with 39 residents/ha (for average family size of 2.6 persons). Calculated Floor Space Index for Gross Site Area is Fsi 0.21 and Fsi 0.34 for Net Site Area.

Urban indicators of this model of standard density solution are as followed:

Residential density in this case is low, (36 res/ hectare on Gross Site Area and 57 res/hectare on Net Site Area). Such density does not automatically guarantee the good living conditions, as low Floor Space Index carry many previously described inconveniences.
10. **MEDIUM DENSITY RESIDENTIAL BLOCK M1**

Test example of low scale medium density residential building block M1 has 116 three story houses for 348 residents. The block is divided in two parts with internal street where each cluster is further divided into 58 lots of up to 6m wide. Average land area for each of 116 lots is 225m².

Each of the three story houses can accommodate an average family of 3.

Gross residential area per lot is 216m² and average usable room space is 172m².

Groups of 5-6 houses are attached. Between every group of attached houses there is 6m wide lane, for access, emergency and services.

Lots have landscaped backyards, gardens, playgrounds for kids or verandas. Every house has a garage at the ground floor or as part of the backyard.

Living conditions for 348 residents in presented model can be qualified as worse than standard individual housing model due to the small and overly subdivided backyards, high overlooking and issues with visitor parking.

Urban indications of this proposed medium density solution is as followed:

| Proposed layout can be rational alternative for reconstruction initiatives, as it can be achieved with low building cost, while keeping the character of private housing for families that are not yet ready for different kind of urban living. |
Proposed system of low scale medium density residential located on the 6 m frontage with 5 or 6 attached three stories houses in the row. Houses can have garage and hobby room at the ground floor. Dining room, kitchen and study can be on the first floor and bedrooms on the second floor. There are also the possibility to build the liveable roof area with additional two rooms, bathroom and roof terrace.
11. MEDIUM DENSITY RESIDENTIAL BLOCK M2

Medium density mixed use residential building block M2 solution is organised around central courtyard with playgrounds and landscape while catering for half underground half above ground garage. Block is surrounded with 4 and 6 stories mixed use buildings which have commercial, retail, services or business on the ground floor, and 368 apartments in upper stories. It is can house total of 1,104 residents. Under the central courtyard is the garage for 288 cars. Over the garage, 1.2 m raised, is the open space with playgrounds for children including active and passive recreation for the residents. Raised playground and surrounding area is landscaped and can include small parcels for communal gardens.

Urban indicators of this proposed medium density solutions are as followed:

Gross Floor space index for this type of housing is 1.00 and net Floor space index is 1.51 what is estimated as optimal value. Height of 4 - 6 stories buildings are also acceptable regarding fire escape, safety, building repairs, overshadowing and number of other liveability parameters.

Block organization gives secure playground for kids and if necessary can be securely closed late at night. Underground garage minimises possibility of traffic collision with pedestrians.

The building height and disposition gives optimal insulation without shaded parts of the block. Apartment’s orientation and design can also be within desirable orientation.
Landscape strip around the perimeter of the block can have street trees and planter boxes along the footpath to minimise the noise and air pollution while providing pleasant pedestrian experience.

This building lay-out, is also allowing optimal possibilities for the infill or reconstruction, it is a feasible investment with optimal land use, it can have acceptable green building design and desirable population density for socialising.

Retail, business, commercial, and services can easily be accessed at the ground floor and provide lit and safe environment over night. First floor onwards apartments are concentrated around the stairwell carefully designed to allow natural sun light to all communal areas as well as all rooms in the house. Apartments can be with different number of rooms, and different net areas. Kitchen including dining rooms and bedrooms of every apartment have balconies. Presented floor plan example is connected to modular system of 10m and 12m and can be combined in different variations.

Such built environment is allowing to “live work and play” in the area which will hopefully make use of cars redundant.
12. HIGH DENSITY RESIDENTIAL BLOCK H1

Example for high density residential block model was taken from existing location from Melbourne CBD. For easier comparison, existing built form is incorporated in our experimental block.

On total area of 5.06 hectares there is 3.36 hectares of Net Development Area. Total area of all floors under buildings is around 375,000 m² what makes the Net Floor Space Index FSI 11. Unbuilt area is 33%, and free space available for landscape or common open space is unacceptably minimal.

In used modelling situation, (which is taken from real built block), in 375,000 m² total added built floor area of 42% is for residential use, 36% is used for businesses and 22% the garage area above ground.

There are 1,257 built apartments with approximately 3,260 residents. Total Net residential density per net developable area is 973 res/ha but residential density per net residential area is 1,536 res/ha. Beside 3,260 residents, local hotel of 24,176 m² caters for 1,200 guests, what makes 4,500 residents, permanently and temporarily residing on this site and adds to residential density of over 1,330 res/ha.

Existing business capacities of 100,000 m² are used by more than 4,000 employers who are spending minimum of 8 hours in the block.

Urban indicators of this kind of living in the city centres are as followed:

These figures represent very clear how dramatically endangered living conditions may be in the city. It is clear that such examples must be the signal for large initiative to change existing...
situation in and around city centres, and make effort to build liveable environments, where residential densities are accompanied with the evident quality of living. This action requires engagement of numerous institutions and professionals and evident legislative support.

13. COST BENEFIT

Cost benefit method for evaluating rationality of development is convenient for analysing where we are now and influencing decisions for development of future cities. Immediate real-estate interest should not be the only guide in decision making. Smart building design, its durability, usability and ways of remodelling built environment will allow us to reuse and adopt liveable space through many years of usage.

In Europe, for example, buildings life expectancy is minimum 100y and exceeds that time with minor amendments. In general, urban structures as well as ownership patterns live long life and are very difficult to change easily and successfully.

For demonstrated medium density residential block or reconstruction of the existing block in similar fashion it would be important to harmonize the rational cost of building and establish the best possible condition for living in actual and future life of our cities. Realizing more functional land use and lower building cost provide sustainable housing and protect further city expansion over green fields and therefore protection of the environment. Comparing of presented models against provided quality of living, gained time, money spent in traffic and lifestyle clearly signalises the need for change.

<table>
<thead>
<tr>
<th>MELBOURNE RECONSTRUCTION</th>
<th>SOLUTION MODELS OF RECONSTRUCTION DEVELOPMENT ANALYSIS of EXPERIMENTAL BUILDING BLOCKS</th>
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<tbody>
<tr>
<td></td>
<td>Low density &quot;L1&quot;</td>
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<tr>
<td>1000 Total Area</td>
<td>ha</td>
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<td>1100 Roads</td>
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<td>1200 Net Development Area</td>
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<td>1210 Net Built Area</td>
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<td>1220 Underground Garage Area</td>
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<td>1230 Unbuilt Area</td>
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<td>1231 Landscaped Area</td>
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<td>1232 Footpath / Pedestrian Links</td>
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<td>1233 Playground over Garage Area</td>
<td>ha</td>
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<tr>
<td>1240 Unbuilt Area with Playground over Garage</td>
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<td>1250 Number of lots</td>
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<td>1260 Average lot</td>
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<td>2000 Total Gross Spread Built Floor Area</td>
<td>m²</td>
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<td>2100 Gross Spread Apartment’s Built Floor Area</td>
<td>m²</td>
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<tr>
<td>2200 Gross Spread Business Built Floor Area</td>
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<td>2300 Gross Spread Garage Built Floor Area</td>
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<td>3100 Percentage of Net Built Area in Net Dev.Area</td>
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<tr>
<td>3200 Percentage of Unbuilt in Net Dev.Area</td>
<td>%</td>
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<td>4100 Floor Space Index of Total Area</td>
<td>Fai</td>
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<tr>
<td>4200 Floor Space Index of Net Area</td>
<td>Fai</td>
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<tr>
<td>5100 Number of Apartments</td>
<td>m²</td>
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<tr>
<td>5400 Number of Residents</td>
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<tr>
<td>5500 Unbuilt Area per Resident</td>
<td>m²/res.</td>
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<td>6100 Gross Residential Density</td>
<td>res/ha</td>
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<td>6200 Net Residential Density</td>
<td>res/ha</td>
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<tr>
<td>7100 Average Apartment Gross Floor Space</td>
<td>m²</td>
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<td>7200 Average Usable Apartment Floor Space</td>
<td>m²</td>
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<tr>
<td>7300 Number of Parking Space</td>
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14. IMPLEMENTATION

The degree of change in planning policy, particularly in terms of implementation, should not be underestimated. Chance for implementation has presented itself with the removal of outdated and abandoned industries particularly incompatible with housing from the first circle surrounding city centres, great example can be found in Perth. Existing so called standard residential density also is present in close proximity to city centres. Areas with low floor space index as potential locations are already available and equipped with infrastructure and services.

Reclaiming underdeveloped inner city circles will be popular amongst those that value the quality of life and are in need of understandable level of social interactions, proximity to work, walkable neighbourhoods, cultural life, sport facilities and much more. Possibility of market gardens or roof gardens and implementation of all elements of green building design can finally be realised and will present a practical example for other developers. It can be expected that low running cost of proposed buildings and chance for better living will support this described model of more effective systems of the future urban dwelling development.

15. CONCLUSIONS

“We live in yesterday’s cities in an idealized dichotomy of rural and urban landscapes. Many of the urban patterns that we see today – such as buildings, roads and land ownership – are legacies of the past urban policy and decision making. The way we think about regional differences is conditioned by an early 20th century vision of distinctiveness of rural and urban localities. Tomorrow’s cities and their closely independent regions will be shaped by the decisions we make today that transform the legacies from the past. While there is much that is uncertain about this urban future, history shows that some urbanization pathways are more desirable than others. “Urban Resilience, CSIRO 2007

The only functional built form is the one that satisfies number of criteria other than shelter. The best way of assessing our current design capabilities is to question all restrictions, produce good model and then retroactively adopt legislation to suit, otherwise within given restrictions we don’t see the solution.

Our intention was to illustrate one of the possible and operative ways for reconstructing core urban areas and better tackling urban growth. This land re-use will provide opportunities to generate greater community sustainability on many levels.

This has to be the proposition for all participants of urban development processes, and the initiative for other planners and government to develop further investigations in this field.

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