# PARASITE CITY: RETAINING THE INDUSTRIAL DISTRICT OF ALEXANDRIA, SYDNEY AS AN INTEGRAL PART OF URBAN REGENERATION

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**Abstract.** Industrial lands are the most vulnerable urban typologies in areas undergoing urban regeneration. They are considered less adaptive to integrated residential typologies, and their legacies are threatened under fast gentrification. The goal of this paper is to explore a sustainable strategy to address the conflict between urban sprawl and industrial conservation in Alexandria, Sydney. Through the application of a sequential evolutionary simulation, the presented research proposes a potential mixed-use scheme to rejuvenate the existing industrial district of Alexandria in an integrative manner without necessitating its destruction. This paper provides a prototype of urban regeneration, optimised by a multi-objective evolutionary algorithm, that demonstrates the necessity of industrial integration in the pursuit of true mixed use urban typologies.

**Keywords.** Gentrification; Mixed-use; Urban Development; Sequential evolutionary simulation; SDG 9; SDG 10; SDG 11; SDG 12.

## 1. Introduction

The stresses imposed on existing cities to sustain the demand of population growth is ever-growing. Where the development of new cities attempts to respond to this demand; existing cities face unprecedented challenges of accommodating increased density within a finite space. One such city is Sydney, Australia; with a population expected to grow by 30% in the next 25 years (Greater Sydney Commission, 2018); the city's suburbs are experiencing a continuous cycle of urban regeneration, in which the old is replaced with the new. Much of this regeneration is through the development of mid to high-rise apartment towers in place of low density residential and brownfield sites (Newton et al., 2021). One such brownfield redevelopment area is the suburb of Alexandria which houses an industrial district that has existed for generations, historically serving as one of the city's largest industrial anchors due to its proximity to the airport and the central business district.

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*Figure 1. Existing Condition Analysis of Alexandria*

To support Sydney's growing population, Alexandria has been identified as a key area for urban redevelopment, transitioning towards a high-density residential area over the next 30 years. Inevitably, to meet the demands for residential developments, Alexandria is threatened from going through a gentrification process, in which the industrial districts which have existed for the past century are to be erased to pave the way for new builds. The presented research (academic and industry collaboration) proposes an alternative urban regeneration strategy for the suburb of Alexandria that aims to retain the existing industrial district, minimise demolition and redevelopment within the site, and seek a sustainable way to allow the suburb to support growing numbers in the population. Additionally, through retaining industrial legacy and integrating it within urban regeneration, the potential environmental impact (in response to United Nations Sustainability Development Goals (SDGs)) on urban growth is significant. The research explores how the retention of industry avoids the negative impact of transportation times between industry and the community (SDG 9 and SDG 11); the existing location of industry, specifically with relation to the airport and the CBD, is optimal for maintaining primary transport lines, thus reducing vehicular carbon emissions (SDG 12); and finally, industry integration allowing for greater equity through a varied urban demographic (SDG 10).

Through the application of an evolutionary generative process, the paper proposes an urban growth strategy that maintains the urban structure of the existing and uses it as a basis for the development of new mixed-use typologies that 'parasitically' integrate within the suburb's existing morphology. The paper also builds on recent research (Randall et al., 2020) for the application of sequential evolutionary simulations to tackle complex design problems consisting of a high number of fitness objectives. The simulations address issues of network and spatial organisation, followed by the morphological distribution and relationships of various mixed-use typologies that leverage the existing urban fabric as the basis for the regeneration strategy.

## 2. Background and Context

### 2.1. IMPACT OF URBAN RE-DEVELOPMENT ON INDUSTRY

Urban re-development has left industrial zones vulnerable to demolition and relocation. Throughout Europe, space required for urban growth has overwhelmingly consumed land used for industrial and manufacturing services, creating an increased urban division between industry and 'mixed use', leading to a decrease in working opportunities and a negative impact on economic growth. The separation of industry from the city reduces the benefits from sustainable energy use, waste utilisation, creation of micro economic local networks and improved synergies by different urban typologies (Haselsteiner, 2020). Initiatives to integrate Industry within mixed use development (and thus creating true mixed-use typologies) have resulted in a renewed understanding of 'urban production', in which industry plays an integral role within the urban fabric and not decoupled from it (Cotter, 2012).

### 2.2. ALEXANDRIA INDUSTRIAL HISTORICAL BACKGROUND

Since the mid-19th century, industrial facilities have considerably contributed to Sydney's urban growth and technological advancement. During the 1920s-30s, Sydney's thriving industry expanded to the city's nearby suburbs, including Alexandria. Due to the cheaper land value, isolation from the population, and close proximity to the city and recently built Sydney Airport, various manufacturing plants were concentrated in this suburb. By 1943, more than 500 factories had occupied Alexandria, the peak for the suburb, with the post-war period marking a boom of Australia's industrial history. This has shaped Alexandria into a symbol of Australia's industrial past; informing the urban fabric through oversized property lots, broad roads and a multitude of car parks (City of Sydney 2014).

### 2.3. GENTRIFICATION IN ALEXANDRIA

Given the decline of secondary industry in the 1970s, the former industrial model failed to adapt to the shifting social pattern in Alexandria. Its industrial urban fabric started to vanish (Karskens and Rogowsky, 2004). The industrial facilities have since been suffering an inevitable decline. Meanwhile, the 'Inner city redevelopment plan' by the City of Sydney aims for the major re-development of several inner-city suburbs in Sydney, one of which is Alexandria, towards high-density residential suburbs over the next 30 years. As one of the closest suburbs to the Sydney CBD, Alexandria is experiencing an increasing demand for residential property due to the increase of Sydney's urban population. Clover Moore, the Mayor of Sydney as of writing, stated that "[The] Alexandria industrial site was chosen for its proximity to residential areas and public transport" (Gorrey, 2018). Thus, the residential area aims to propel local commercial, cultural, and recreational events. Alexandria's overwhelming gentrification, represented by the swell of land value and the rapidly growing number of apartments, is threatening the local industrial legacy that has been existing for the past century.

### 2.4. WHY CONSERVE THE INDUSTRIAL LEGACY

According to The Burra Charter (2013), Australian identity and experience can be illustrated by the place of cultural significance. The local industrial urban fabric is a record of Alexandria's history that archives the prosperity of manufacturing in Australia. Even today, many of those industrial facilities are still indispensable parts to the city, as they are still contributing to Sydney's urban services and logistics and providing a large number of working opportunities. By 2018, industrial land occupied 8% of Sydney however made up 19% of jobs (Hill 2018). Considering the irreplaceable value and current contribution of those industrial facilities, it is urgent to find a balance between the local housing demands, urban growth and legacy conservation according to the "principle of intergenerational equality" (Burra Charter 2013). Inspired by the ethos of "never demolish" advocated by Lacaton & Vassal, the presented research examines an alternative architectural solution to conserve Alexandria's industrial legacy.

### 2.5. THE POTENTIAL FOR INDUSTRIAL MIXED-USE

Industrial spaces are usually associated with urban characteristics (noise and pollution) not conducive to residential spaces. However, according to Howells and Openshaw (2021), this association has slowly changed through new innovations around sustainable materials, cleaner emissions and advanced technologies. Furthermore, new paradigms of what constitutes 'industrial' has been rapidly changing in recent years. Small businesses that support online marketplaces and homemade goods are emerging. These new aspects of industry are more cohesive with other uses, helping support a more diverse characteristic of mixed-use developments. This enables the possibility for a mixed-use development to be utilised as a hybridisation strategy between local industry and current residential, commercial and cultural demands. Whereas industry is not typically a component of mixed-use developments, this research suggests an alternate strategy that allows industry to remain, and be supported by various other uses to create a truly mixed-use urban fabric. A place that supports social sustainability, local business, economic growth and the culture of Sydney's industrial legacy.

## 3. Method

### 3.1. EVOLUTIONARY SEQUENTIAL SIMULATIONS

The experiment presented utilises sequential multi-objective evolutionary simulations using Wallacei X (Makki. 2018). Each simulation examines the site at a different scale and optimises for various fitness objectives accordingly. The aim of the simulations is to address the complexity of the site without the need to abstract the formulation of the design problem, allowing for each simulation to tackle a unique set of fitness functions at different scales, in which the output of the first simulation (network and plot divisions) translates as the input for the second simulation (block typology and programmatic distribution). Additionally, to achieve a better understanding of Alexandria's urban network, accessibility and spatial configurations, Space Syntax theory (Hillier and Hanson, 1984) is integrated within the simulation as both an analytic and generative tool to better understand the spatial and network distribution of the site, as well as develop solutions that respond to integration, choice and centrality.

The pseudo code (Figure 2) presents both evolutionary simulations and their relationship to one another. Sequence 1 analyses the existing infrastructure of the site and its surrounding context. In order to minimise demolition and redevelopment within the site, industrial activities are to be retained through maintaining the industrial footprint, while introducing infrastructure above the existing built forms. The main objective of this sequence is to evolve a solution set that minimises interruption to the existing industrial activity, while maximising pedestrian integration within the existing circulation. Sequence 02 assigns new built forms above the existing industrial buildings based on the resulting phenotypes generated by the first sequence. This sequence analyses the phenotype and each program's proximity to each other through a thorough analysis of the relationship of various mixed-use typologies and their impact on one another.

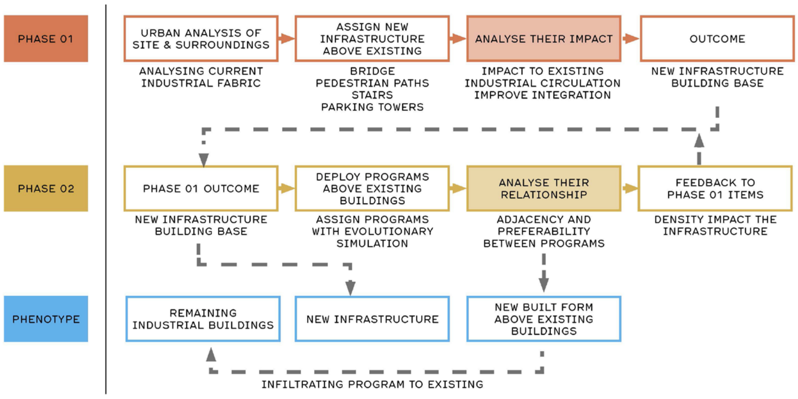


*Figure 2. Pseudo Code (Evolutionary Workflow Diagram)*

## 4. Experiment Setup

### 4.1. SEQUENCE 01

#### *4.1.1. Construction of the Superblock and Fitness Objectives*

Figure 3 presents the various parameters that contribute to the construction of the phenotype for sequence 01. Various plots within the site are identified for the integration of new programmatic functions or parking towers, serving both existing industry as well as added typologies. The impact of the parking towers on the existing industrial vehicular circulation is assessed and reconfigured accordingly. Rooftops with an area above a certain threshold (in this case 1000sq.m) are identified and are divided and connected via a network of pedestrian paths and bridges. Finally, the upper-level network is connected to the ground level network through a series of vertical access points that maximise the integration value of both levels. The fitness objectives being optimised in the algorithm aim to maximise the integration between the existing network and the newly added network, while also optimising the distribution of parking spaces, bridges and pedestrian paths (Figure 4).

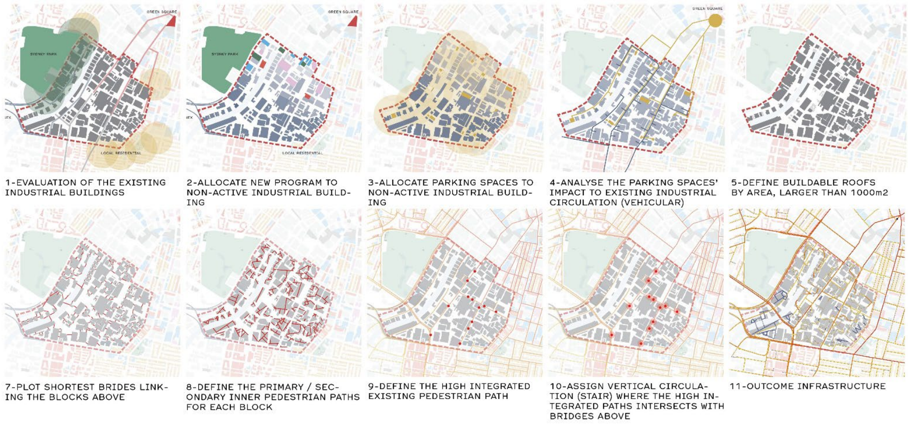


*Figure 3. Construction of the Sequence 01 Parametric Definition*

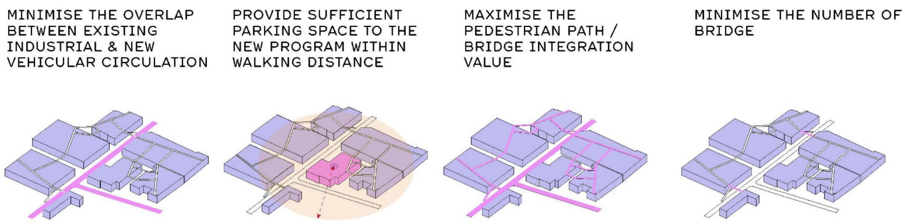


*Figure 4. Fitness Objective of Sequence 01*

## 4.2. SEQUENCE 02

### *4.2.1. Construction of the Superblock and Fitness Objectives*

Sequence 02 uses the output from sequence 01 as the base phenotype and deploys mixed use block typologies that respond to the network generated in the first sequence. Rooftops are subdivided into building plots based on size and orientation, each one attributed with a use and associated typology that responds to the typology of its neighbours. This is informed by various parameters such as building height, proximity to parking towers and programmatic relationships at multiple scales (Figure 5). The fitness objectives identified and integrated within the algorithm for this sequence examine programmatic distribution and its influence on each building block defined in the urban fabric (Figure 6).

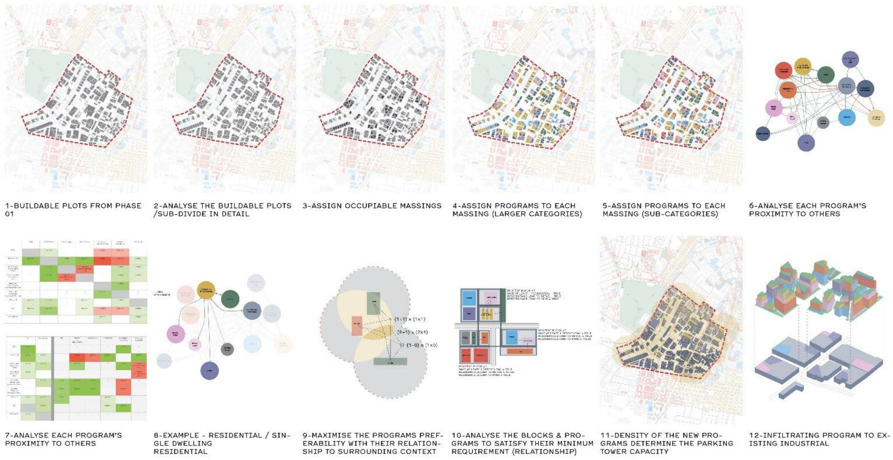

*Figure 5. Construction of Sequence 02 Parametric Definition*

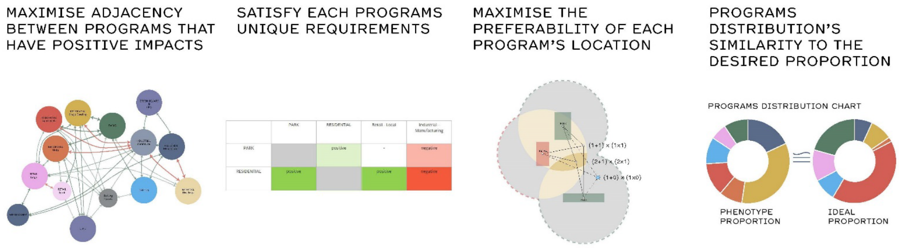

*Figure 6. Fitness Objective of Sequence 02*

## 5. Experiment Results & Selection

### 5.1. SEQUENCE 01

#### *5.1.1. Results and selection*

The algorithm for sequence 01 generated a population of 1000 solutions (generation size of 20 and generation count of 50). This is primarily due to the large simulation runtimes resulting from the integration of space syntax analysis methods within the algorithm. From the 1000 solutions, 116 solutions formed the pareto front (the most non-dominated solutions in the population) which were selected for further analysis for the purposes of selection. The pareto front solutions were clustered (using hierarchical clustering) with a K-value of 9, with each cluster centre analysed against additional criteria to inform selection. The matrix presented in Figure 07 presents the performance of each solution against several metrics, including the distribution of parking towers, bridges, vertical circulation and the integration value of the street network (vehicular and pedestrian). Through ranking the cluster centres against these metrics, the top 3 performing solutions were selected for further detailed analysis, in which they were evaluated according to the key objectives of sequence 01, which is to improve the integration value of pedestrian paths and bridges, as well as minimise the disruption of existing vehicular networks. The results identified solution ‘generation 11_individual 17’ as the most optimal against the evaluation criteria utilised (Figure 8). This solution is extracted as the primary input for sequence 01.

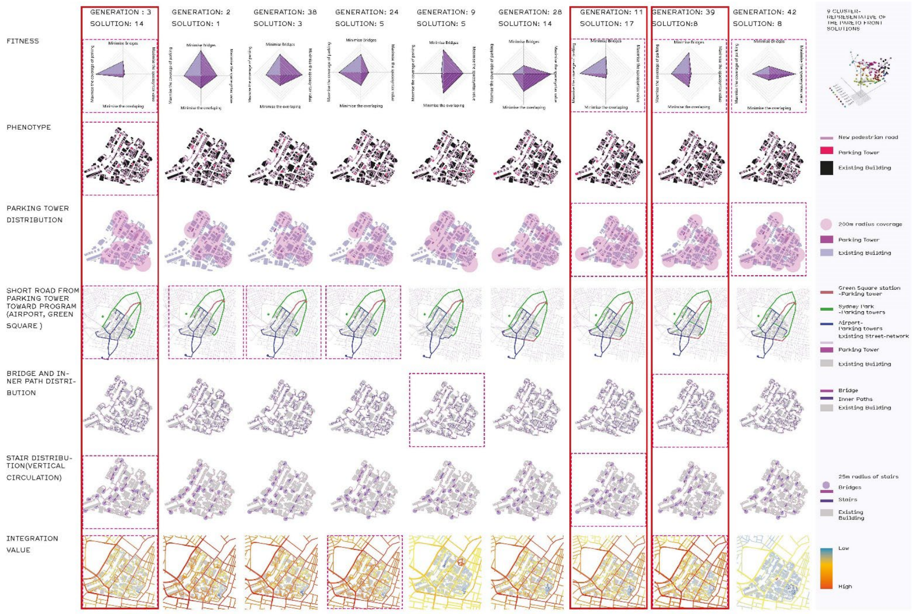


*Figure 7. Simulation Matrix for Sequence 01’ Selection*

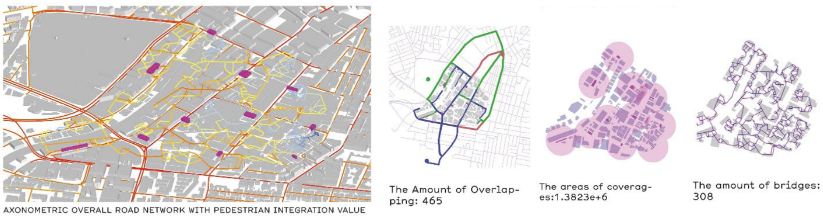


*Figure 8. Selected Solution from Simulation 01 (Gen. 11 Ind. 17)*

## 5.2. SEQUENCE 02

### *5.2.1. Results and selection*

A lower runtime for sequence 02 allowed for a larger population size of 5000 solutions (generation size of 50 and generation count of 100), generating a pareto front of 172. A similar clustering approach is also applied in sequence 02 in which the pareto front is clustered into 16 clusters. Each cluster centre was assessed according to their fitness values (using a diamond chart) and 4 solutions were selected for further analysis according to their performance across all objectives. Each of the four solutions is analysed against additional metrics focusing on programmatic distribution and relationships, in which the proximity of different program types is assessed and evaluated according to the degree of mixed-use typologies within each block. The results from the analysis are presented in Figure 9. The selected solution that most optimally met the programmatic requirements and relationships of the space was 'generation 82_individual 04' (Figures 10 and 11).

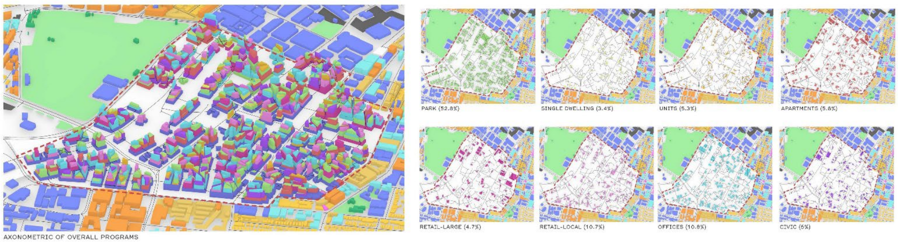


*Figure 09. Selected Solution from Simulation 02 (Gen. 82 Ind. 04)*

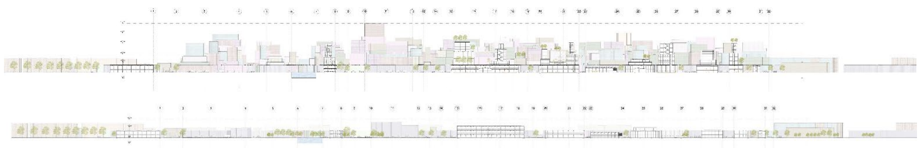

*Figure 10. Existing Section (Top) and New Section (Down)*

## 6. Conclusions/Discussions/Future Work

*Figure 11. Final Axonometric (left) and Renders (right) of the Proposal.*

The mix-use strategy presented above examines the potential advantages for integrating industry as part of mixed use urban fabrics. In suburbs such as Alexandria, where industry holds a historical significance, its integration within urban redevelopment initiatives is imperative to the retention of historical urban value. The presented experiment illustrates the potential integration of industry within the urban fabric through a multi-level urban model, in which industry is retained on ground level, while new urban development is integrated on upper levels, maintaining network and spatial relationships between the activities taking place between the two. The use of sequential evolutionary simulations avoids the necessity to simplify the design problem, allowing each sequence to tackle different scales and typologies (network in one and block in another). However, as the process is sequential, the decisions and results applied in the first sequence holds greater significance to the results of the second sequence, as such great attention must be given to the formulation of the phenotype and chromosomes of the first sequence.

Future work that addresses various aspects of demographic structure and social relationships is required. Moreover, the growth and future adaptation of the redeveloped superblock is critical; questions that address the temporal scale of integrating industry with mixed use development, and its impact on growth patterns, requires further interrogation.

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