A HARBOUR, A RAILWAY LINE, AND A CITY CAMPUS: DENSIFICATION OF THE CITY OF NEWCASTLE (AUSTRALIA)

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Abstract
While more and more of the earth submits to urbanization, we are confronted with a series of new urban design challenges and need for urgent investigations. Among the most significant environmental challenges of our time is the fossil-fuel dependency of cities and buildings and their growing demand for energy. In this context, avoiding mistakes in urban development at the early stages could genuinely lead to more sustainable, compact cities and less greenhouse gas emissions. This paper presents research in the area of *Green Urbanism* and introduces models for sustainability in urban growth and densification of neighbourhoods, as cities need to transform from fossil-fuel based models to models based on renewable energy sources. It presents work from design studios, which addressed the question: how we can best and cohesively integrate all aspects of energy and transport systems, waste and water management, passive and active strategies, natural ventilation and so on, into sustainable urban design and thus improving the environmental performance of an inner-city district, reducing CO2 emissions at district level. The author has explored with students the emergent urban patterns for the regeneration of the city centre of Newcastle, for a step-by-step transformation to a sustainable model, and discussed how urbanism is affected (and can be expected to be even more affected in the future) by the paradigms of ecology, and the need to de-carbonize energy supply and transport systems. Case study analysis: The paper is specific in that it describes three recent examples for the application of such urban design principles for the Australian city of Newcastle: the 'City Campus', 'Green Corridor' and 'Port City' studios.

1 Introduction

Among the most significant environmental challenges of our time are global climate change, food security, excessive fossil fuel dependency and the growing demand for energy – all major challenges of the 21st century and some of the greatest problems facing humanity today. In this context, urban design, and the fundamental principles of how to shape our cities, has only recently started to feature in the greenhouse debate. Previously, much of the debate has circled around ideas about active façade technology for 'eco-buildings' and purely technologically-driven solutions. The urban dimension and the macro-scale of cities have now entered the debate, and substantial literature on this issue is produced. However, it appears that there is no clear consensus on the meaning of the term 'Sustainability' in urban design, and its relationship to urban settlements and the city. This is surprising, since almost half of all energy consumed is used in cities and urban built-up areas, and given that avoiding mistakes in urban development could genuinely lead to more sustainable cities and less greenhouse gas emissions.

As we begin to fully understand the consequences of our dependency on fossil-fuel energy and the automobile, the cost of mobility, and ways to integrate sustainable systems into urbanism, we start to suspect that common aesthetics regarding urban composition in the design of cities and neighbourhoods may no longer be applicable. The studio was set to explore, how urban design deals with these new requirements. The students were asked, how should the traditional knowledge of urban composition and the aesthetical principles of city-making (as was, for instance, suggested by Camillo Sitte, in his pivotal text in 1889) be expanded to meet the new paradigms of ecology? Indeed, are parts of these new paradigms actually well-known already to urban planners and designers, and have become proven knowledge and the established criteria of 'good practice in city-planning' for centuries?

While London was suburbanized well before this period, cities in 19th-century Germany, France and Italy still used to be compact and often surrounded by military walls, with a mix of all ranks of society living closely together. A major break to the model occurred with the introduction of the automobile and the idea of the 'Functional City' in the 1920s. The new mobility led to sprawling suburbanization and to dispersed, low-density settlements encroaching into the landscape. This gave rise to an anti-urban approach, formulated as the Charter of Athens in 1933 by the CIAM, which became the new widespread model, based on separation of functions (zoning), the dissolution of compact urban space, and the reduction of densities.

2 The emergence of Sustainable City Theory

Over the last thirty years or so, an international debate on eco-city theory has emerged and has developed as a relevant research field concerning the future of urbanism and the city itself. During that time, a number of architectural schools of thought have been put into practice worldwide. One such school is Technical Utopianism (a technological idealism that relied on the quick 'techno-fix', as expressed for instance in the work of Archigram), whose political and social agenda is recently making a comeback. Other early writing on green urbanism was available from Ebenezer Howard, on the Garden City idea (although he didn't call it that way), and from Louis Mumford. In 1969, Reyner Banham was a pioneer in arguing that technology, human needs and environmental concerns must be considered as an integral part of architecture. Probably no historian before him had so systematically explored the impact of environmental engineering on the design of buildings and on the minds of architects.

From 'Silent Spring' (by Rachel Carson, 1962), to Reyner Banham's 'Architecture of the Well-tempered Environment' (1969), to Ian McHarg's 'Design with Nature' (1969), pivotal publications by authors re-connecting urbanism with the climatic condition (such as Koenigsberger, or Drew and Fry, in publications in the 1960s and 70s), to the remarkable 'Brundtland Report' (Brundtland, 1987) and the 'Solar City Charter' (Herzog et al, 1995/2007), the field of sustainable city theories and climate-responsive urbanism has constantly been expanded. Architect Otto Koenigsberger, for instance, immigrated from Berlin to India in 1939 and served there as a government architect until 1951, before he became one of the founders of the Department of Tropical Architecture at the Architectural Association School in London, fundamentally transforming architectural thinking and practice with his 'Handbook of Tropical Architecture': He recognized as early as 1950 the limits of resources and energy. Through his experiences in India, Koenigsberger theorized Tropical Architecture as a discourse that was climate responsive and energy conscious, and which used local resources, materials and workers in a sustainable way.

More recent theories for 'Compact Cities' (Burton, 1997; Jenks and Burgess, 2000) and 'Solar Cities' encapsulate the visions based on the belief that urban revitalization and the future of the city can only be achieved through 're-compacting' and the use of clearly formulated, more compact sustainable urban design principles.

The *anti-sprawl critique* was raised by Jane Jacobs, Gordon Cullen, Lewis Mumford and Kevin Lynch in the early 1960s, leading to a mainly negative image of suburbanization. Yet suburbs are still popular, although their low-

density living style is causing inefficiencies on many levels: land use, water and energy use, public transport, car dependency, and so on. There has also been critique of increasing density, e.g. through the research work of Dey et al: They found that inner-city, single-person households (with their higher incomes) have the highest impact on the environment, because they consume significantly more than households in less affluent suburban areas. (Dey et al, 2008) Whichever position is taken, any future implementation of more compact, denser city expansions will need to deal with its own issues and challenges that come with higher densities and less distances between buildings, such as social changes and conflicts in inter-neighbourhood relationships as a result of multi-apartment housing. In Sydney, for instance, some 25 per cent of the population now lives in multi-unit housing, which has started to change the social fabric. This proportion is still low in comparison with European cities, but it is predicted to grow to 45 per cent by 2030. (Newman, 1989) (Burton, 2000) It is likely, that in future, new theories of eco-systems will increasingly be applied to urban systems, with the aim of strengthening the environmental sustainability and dynamic intensity of urban activities by, for example, ensuring the vitality of public space. New models of public space are now emerging. A clear advantage of applying such evolutionary approaches in urban design will be that the complexity of urban life and its related processes will be better understood.

After more than three decades of intensive environmental debate, starting in 1973 with the first 'oil crisis', there is clearly an increasing demand to explore, assess and critically examine theories for fossil-fuel free, low-carbon cities, beyond the scale of the individual building, that is to say, on the urban scale. It is likely that only by approaching the issue on a larger scale and by re-engineering urban environments on the neighbourhood and district (city) level, will we have a chance to have an impact on, and to combat, climate change.

3 Criteria for sustainable urban growth

The emergence of a more comprehensive and holistic theoretical model of urban sustainability and eco-city would be of much benefit to many places, especially in the developing world, where there is most urgency to apply 'green philosophy' and make it take root in the collective mind. The Middle East and the Asia-Pacific Region, for instance, is home to 65 per cent of the world's population; it is one of the fastest growing regions in the world in terms of economic development, urbanization, population growth, energy demands and greenhouse gas emissions. How the leaders and population of the Middle East

and the Asia-Pacific Region will respond to the challenge of sustainable urban development will affect the future of the entire world.

All this suggests that we need to develop urban design approaches based on new concepts of urban energy systems. Recent research published by the *Urban Land Institute* (ULI, 'Growing Cooler', 2007) gives comprehensive evidence that there is a direct connection between urban development, urbanization, energy systems and climate change. Findings point out, applying principles of sustainable urban growth would lead to human settlements that enable their residents to live a healthier quality of life, while using minimal natural resources and supporting maximum biodiversity. These sustainable settlements can be typified by the following criteria (which was part of the studio brief):

- Mixed-use urban consolidation to ensure that new homes are close to employment, education, shopping, health services, etc., giving the option to walk and to bike (mobility concepts, such as the *City of Short Distances*, providing good pedestrian linkages, cyclist facilities and safe bike paths), and to use efficient public transport, thus reducing car dependency;
- Residential and office typologies that are multi-storey, flexible and compact to maximize the land available for green space and gardens, avoiding sprawl (in Europe, we can recognize already a 'renaissance' of the 4 to 5-storey urban block and town house models);
- Buildings that make the best use of passive design principles, renewable sources, such as sun, wind, rainfall (collecting rainwater through green roofs), on-site energy production, and natural cross-ventilation, applying passive design concepts, therefore: minimizing the primary energy demand of cities and buildings, while maximizing the efficiency of energy supply; (see Fig. 01)
- Urban water management strategies are integrated;
- Urban designs that emphasize development on land which has previously been developed and is of little ecological value (inner-city densification and infill projects; re-use of formerly industrial brownfield sites), integrating existing structures, with a strong emphasis on adaptive re-use and retro-fitting;
- Developments where a high proportion of building materials are designed for modular prefabrication, re-use, disassembly and recycling, to minimize the consumption of materials;
- A shift from masterplanning to strategic planning, that reflects 'best practice' of compactness, orientation, density vs. overshadowing, and appropriate internal location of cores, to optimize concepts of passive design and maximum day-

lighting;

- Materials, food and other goods that are sourced from nearby, in order to cut CO_2 emissions caused by transport through shorter supply chains;
- Strict waste management to reduce waste going to landfill and waste during construction; using waste-to-energy strategies, making better use of waste streams.

Importantly, most of the mentioned criteria are decided on at a very early stage of a development, some, for instance, are already detailed with the selection of a site. In the same way, early decisions on shape and compactness have ramifications on the crucial ratio that exists between volume and façade surface (see: Fig. 2).

The three recent examples for the application of sustainable urban design principles in studio teaching are the proposals for the Australian city of Newcastle: the 'City Campus', 'Green Corridor' and 'Port City' projects (studios in 2007-09). These realistic case studies gave a cohort of Year 4 students a specific focus to illustrate that it is less environmentally damaging to stimulate growth within the established city centre rather than sprawling into formerly un-built greenfield areas. The studio program did not aim at only a few green buildings, but especially targeted Newcastle's changing, post-industrial city centre area. A crucial aspect was the shift in scale from the level of individual buildings to a cluster and district level. There was much engagement of the studio participants with the actualities of site, stakeholders and real planning processes. The design parameters of the studios were based on the development of principles for green urbanism and sustainable neighbourhoods, with specific investigations about the future of urban energy supply, mobility, mixed-use housing typologies, and concepts of urban farming.

4 An attitude of making *place* and *space*

When we study the architecture of Louis Kahn or Alvar Aalto, we find that those architects designed buildings based on what they regarded as 'timeless fundamentals', such as the human experience of space, but also a resourcefulness in the use of local materials. Both masters designed naturally ventilated office buildings and incorporated climate-responsive design principles long before the notion of 'sustainable architecture' was introduced. Seminars accompanying the studio illustrated how *green principles* can creatively support the architect's main design concept, and how the basic knowledge of such strategies as night-

time cooling, evaporative cooling, solar chimneys, cross-ventilation and thermal mass have existed for centuries, even millennia. Students were introduced to the notion that sustainability in architecture is about a fundamental attitude of making *place* and *space*, and less about the technological solution for 'mechanical/technical ventilation' or additive mechanical solutions. It was important at the outset of the studio to recognize that architecture is predominantly about establishing meaning, about the human experience and substance – and not, *per se,* about technological 'machine' sophistication. Therefore a 'green building' is not always automatically a good work of architecture; however, to be considered a good work of architecture today, the building has to be energy-effective. (Lehmann, 2005) (Scott, 2006)

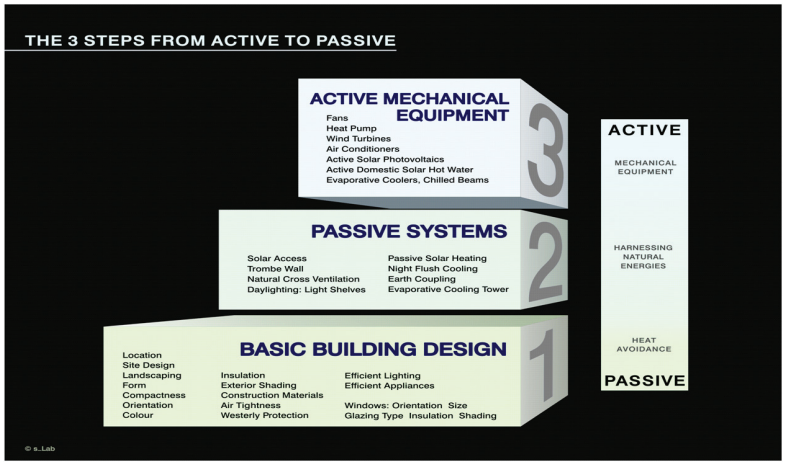

Figure 1: Diagram of three steps from passive building design to active mechanical equipment. As designer we need to take full advantage of basic, passive building strategies first, before adding any mechanical active equipment. Motto: 'Achieving more with less'. (© diagram by the author)

Architecture and urban design have the potential to re-establish our relationship with nature, the climate and the experience of the sun, rain and wind. As Scott notes, such environmentally responsible design is at its best 'when it achieves an outcome in which the environmentally sensible elements are closely linked to the design process, go beyond being additive, and become meaningful parts of an architectural whole.' (Scott, 2006) Integration of sustainability aims within the design process demands that the environmental concept and the urban design concept fully support each other. This requires the identification of environmental strategies that support a unique design idea, which reinforces the urban district's, or building's relationship with the landscape.

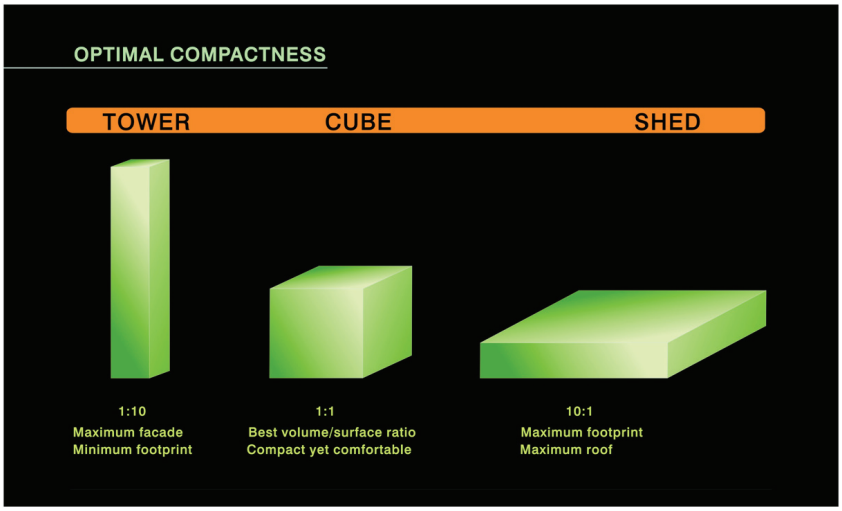

Figure 2: The search for optimal compactness of buildings ('compact yet comfortable') is relevant, as we want to maximize the passive solar gain, without resulting in overheating in summer. However, the ideal building shape per se does not exist; the optimization process depends each time on location, climate and orientation. We don't want a 'city of cubes' either.

5 Is a new symbiosis between countryside and city possible?

Can denser, more compact cities support their energy requirements through localized solar and wind energy generation? While it might not yet be fully technically feasible today, the local use of solar and wind energy will allow the reconnection of energy production with the place of final energy consumption. This means that with the possibility for decentralized, on-site energy production with small units (close to the point of energy consumption), the chance for an entire new type of urbanism emerges. With the end of the 'old' fossil-fuel energy system, urban designers can now re-think the relationship between city and countryside as a whole, where the city does not grow at the expense of its rural hinterland. It can be assumed that in ten or fifteen years, the concept of decentralized, distributed energy generation will become standard for newly planned models of green neighbourhoods, where the existing infrastructure of the long-distance grid network will become obsolete and sustainable city districts will be able to act as 'powerstations' for their own demand. Consumers become producers: Every citizen in such a green, compact district could generate the energy needed locally and become self-sufficient. (see: Fig. 3) The result will be housing districts that generate more energy than they consume. It's likely that the ability to cheaply store this energy as back-up within the community will soon be solved by the development of better battery technology.

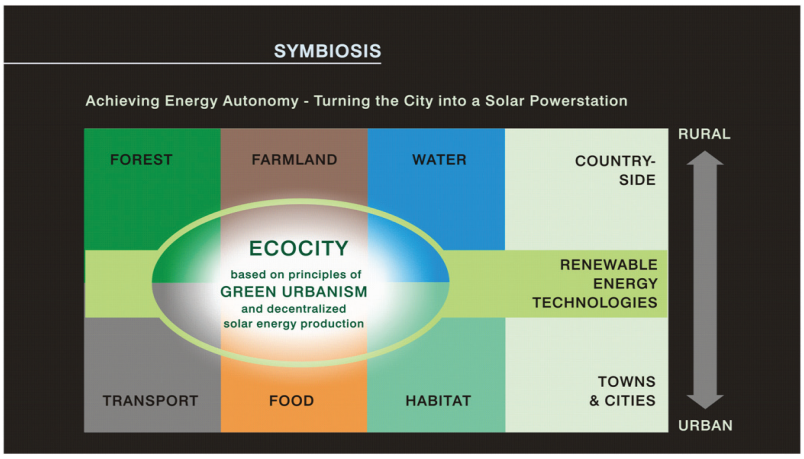

Figure 3: The entire urban metabolism is based on energy and food supply. In the recent debate, a new symbiosis between countryside and city is now emerging: The century-old tension between 'rural' and 'urban' edge condition might finally get resolved, where the city stops growing at the expense of its rural hinterland. It is even predicted that a new city model will emerge out of the better re-connection between city and countryside. (Lehmann, 2008)

6 Background to the City of Newcastle

For over one hundred years, the city of Newcastle was the most industrial city in Australia, hosting such heavy industries as steel manufacturing, aluminum smeltering, coal mining and ship building. The city centre was designed around the one function, to transport and load coal and other goods onto ships in Wharf Road, a function that doesn't happen there anymore since a long time. Employment in manufacturing, mining and heavy industries in the Hunter region had, historically, always been high (accounting for over 25 per cent of jobs; data: HVRF, 2009). However, over the period 1980–2000, with further diversification of the economy, these industries went slowly out of business and many closed down. As a result the identity of the city has changed: Newcastle today is clearly different. This 'new identity' is connected with a growing service sector, creative industries, education and conference tourism. Growing employment sectors are in education, training and health care. Previously derelict land and former industrial sites in prime waterfront location are now ripe for development.

The major urban regeneration development (the 'Honeysuckle' development) was started in 1992, with the NSW State Government's 'Building Better Cities' program, and today it is almost completed. It has redeveloped 50 hectares of derelict land and buildings along Newcastle Harbour, adjacent to the city centre. The development has introduced a denser form of apartment living and retail. However, it is frequently accused of having sucked-out the vitality of the historical city centre, the now derelict Hunter Mall and the decaying Hunter Street (formerly the main commercial street). Over the last twenty years, most

of the retail facilities (72 per cent) have moved away to new shopping mall precincts in the suburbs. Despite many attempts, the 'Honeysuckle' precinct remains an isolated fragment cut-off from the historical city centre by the railway corridor, only weakly connected to the existing city through overpass footbridges, which have never worked well.

There is now increasing pressure for an overall urban vision, removal of the railway line, and to deliver a robust framework for future large development investments (which otherwise would remain 'dispersed mosaic projects').

Figure 4: The city of Newcastle, once Australia's most industrialized city. It is the capital of the Hunter Region and is located around 150 kilometers north of Sydney, in New South Wales. The greater population catchments of Newcastle are around 600,000 people. The city centre is located on a narrow peninsula between the Pacific Ocean and the port. Through its close proximity to the city centre, the area around the Inner Harbour and Dyke Point (see 'Growth Area') is ideal for a sustainable city expansion along the waterfront, which currently consists of a series of underutilized and derelict spaces.

The irony (or tragedy?) of sustainable development in Newcastle and the Hunter Region is that this city and region is also the world's largest coal exporter and has an extremely large ecological footprint (while the government still pays massive diesel subsidies to the coal mining industries). For instance, the use of the automobile in the region is around 20 per cent higher than the Australian average. In addition, the Hunter Region receives comparatively little benefit from its coal mining burden. In this regard, Droege noted: 'Australia's domestic coal addiction is staggering but pales in comparison to its exported carbon pollution load.' (Droege, 2009) The political reality in 2009 is that Sydney does not generate its own power and the Hunter Region has to carry much of the burden for the metropolis, while Sydney needs the cash flow from Newcastle's coal exports to finance its profligate spending habits. All this does not assist the Hunter Region's path to sustainability greatly.

If we ignore for a moment the short-term benefits to the primary polluters – for instance, the mining companies, who actually want to increase coal's

share to 2030 – it becomes obvious that there is no alternative to phasing coal out. If Australia could move from coal (and coal-burning power stations which currently generate 95 per cent of all energy; data 2008) into massive solar thermal and wind-based process energy production for heavy industry, it could start to introduce low-carbon industrial processes. Office buildings, aluminum smelters and cars are all proximate polluters – and they could run entirely on renewables. Locally, in this debate, there is frequently a lack of distinction between de-industrialization (the Newcastle urban area already has a service based economy) and 'de-coalification'. De-coalification means reducing the amount of mining of coal in the Hunter Region and its export through Newcastle Port, and the associated power generation and energy intensive industries (i.e. the aluminum smelters).

What does all this mean for the urban regeneration of the city centre? One needs to be mindful of the relatively low population density of the Hunter region, and the difficulty in building critical mass for things like viable light rail or other initiatives. This posits a major difference between the Hunter and the much more intensive development of most of the international examples that are frequently quoted in the literature (e.g. Barcelona, Copenhagen, Vancouver, and so on). The region's population base is only 600,000 people. Not to set expectations that cannot be met, the studio participants were asked to look at case studies and viability models from smaller cities (less than one million), without another similar sized city 30 minutes away; for instance, Solar-City Freiburg, in Germany, was studied.

For the city centre, the official modest predictions are: 10,000 new jobs and 6,500 new residents in the next twenty years. Since 1996, people have started to move back into the city centre, and, over the last ten years, the city centre has witnessed a population increase of around 5,000 residents. Exploring these issues about the transformation of Newcastle offered a good starting point for the studio projects.

6.1 Models of urban design: *City Campus, Green Corridor* and *Port City*

Large areas of formerly industrially used land – brownfield sites in prime waterfront locations – have become available for new ideas of sustainable urban development and partial conversion into parkland. The following is a short description of the studio projects: *City Campus, Green Corridor* and *Port City*, all based on a balanced approach to include renewable energy technologies and inner-city green space. These case studies to renew the post-industrial landscape are:

- Densification model: By 2015 - The *City Campus/Green Corridor* projects

will be a major contribution to the densification, urban infill and revitalization of the City Centre;

• Expansion model: By 2020 - The *Port City* will be a unique opportunity to expand the city centre along the waterfront.

6.2 First urban infill and densification; then growth along the waterfront

City Campus – Strategies for Urban Infill aimed to accommodate educational facilities for 3,500 to 5,000 students in the area around centrally located Civic Park. The brief asked for University facilities, including a public library, a flexible performing arts theatre space, buildings to relocate the School of Business and the School of Law, and related research and student services facilities, to be partially accommodated into new structures as well as into existing buildings (50 per cent of the brief was to be accommodated in existing buildings through adaptive re-use). The step-by-step relocation of significant parts of the University from its 1960s suburban campus back into the city will increase the University's presence and revitalize this neglected centre. A new landscape design for Civic Park was part of the project, aiming for a high quality green space, green roofs and increased biodiversity. Students were asked to design the new *City Campus* based on optimized density and include eco-buildings with ideal day-lighting conditions. Each city block had to gain maximum solar exposure for the use of renewable energy generation, combined with good shading devices for western facades. We found that the urban renewal of the existing city centre can be generated through programs that carefully develop new densities around transport nodes or along park edges and cultural precincts, thereby improving the quality of urban life for all groups, including disadvantaged residents. 'Sustainable neighbourhood' has been defined as 'a compact community cluster using as little natural resources as possible, with careful consideration for, and improvement of, public space.' (Breheny, 1992) (Gauzin-Mueller, 2002) The *City Campus/Green Corridor* projects would facilitate the revitalization of the city centre and be instrumental in halting any further decline. The design proposals were publicly exhibited and discussed, and key recommendations for policy-makers have been formulated.

The world's most intriguing city centres are the ones located on the water edge, and the most successful waterfront cities are those that are based on developments that celebrate the relationship between the city and the harbour. Large port infrastructures juxtaposed with the cityscape are always an inspiration for any planner and architect. In preparation for this urban design

project, similar port redevelopment projects, such as in Hamburg, Rotterdam, Genoa, Vancouver and Barcelona, have been analyzed. *'Port City – reclaiming the post-industrial waterfront'* was based on strategies for reclaiming former industrially used waterfront land; a mixed-use urban waterfront development of ten hectares, of which about half had to be dedicated to public parkland. Once the industrial working harbour has moved up the Hunter River (in around eight to ten years), it is proposed to connect the Dyke Point peninsula with the city centre by a new pedestrian and cycle bridge, so that the now under-utilized land can be turned into a green carbon-neutral city precinct. This mixed-use extension of the city along the waterfront land would be strongly connected to the Honeysuckle precinct by the footbridge. Forging such a strong link between the city centre and the waterfront development, and integrating the existing local community, are both found to be crucial to the success of the *Port City*.

The aim for the *Port City* is to be a low-emission development, to demonstrate that it is affordable and achievable to make such a major new urban development as carbon-neutral as possible. The brief asked for all energy to be provided by distributed power generation systems from a variety of sources – photovoltaic and wind (utilizing building roofs and facades), as well as biomass and consideration of geothermal technology. These measures would turn the new city district itself into an 'urban powerstation', covering its own energy demands. Students explored the concept of 'energy exchange': the strategic combination of programs that complement each other (e.g. a supermarket has constant cooling demand and generates waste heat that can be used for heating apartments and a pool).

Students were also asked to test economic realities: There are reliable studies available on the issue of payback on such urban investment and the transformation of the city to sustainable models based on decentralized renewable energy generation. For instance, American scientist Greg Kats is the internationally known author of the most widely referenced study of the costs, benefits and payback times of green buildings and districts. (Kats, G. et al; 2003: '*The Costs and Financial Benefits of Green Buildings'*; a report to California's Sustainable Building Task Force). (Kats, 2003) This study has demonstrated conclusively that sustainable building and the use of renewable energies is a cost-effective investment. Furthermore, according to Sir Nicholas Stern's review (Stern, 2006), delaying the shift to clean energy will cost us more in the long run; he convincingly pointed out that to weaken or delay the clean energy shift would be poor economic management. (Stern, 2006) (Head, 2008)

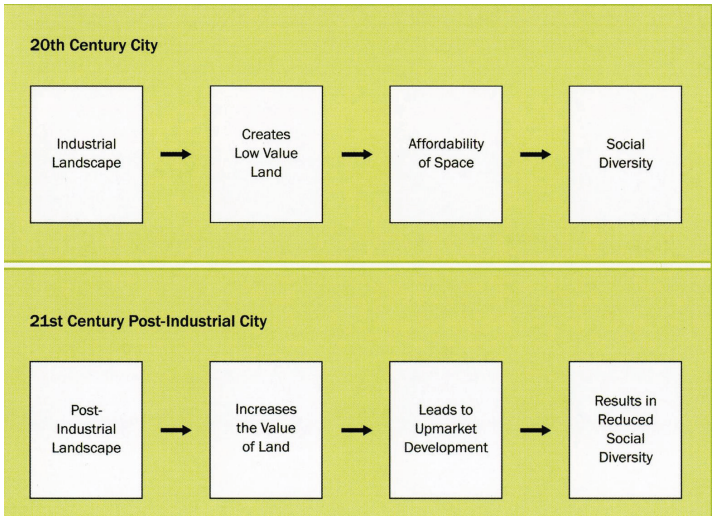

Figure 5: The city's transformation from the 20th century industrial to the 21st century post-industrial condition is not without problems: The increase in land value leads frequently to singular up-market developments, which result in reduced social diversity and loss of the vibrant mix that every city needs. (© diagram by the author)

Urban design encapsulates a series of critical and complex dependencies. Questions of scale, ecological footprint, connection to urban public transport, optimized solar orientation, and the maritime heritage of the working harbour are all critical to the project, as is the social integration of the established local community and the need to maintain social diversity. (see: Fig. 5) Optimized building shapes, appropriate orientation, internal layout and the position of openings and sun shading – all these criteria can enhance natural ventilation and reduce the need for air-conditioning during the hot summer periods. Students ensured to give special care to the urban layout of the *Port City*, to ensure maximum solar gain in winter (when the sun is low), and – at the same time – to avoid buildings too close to each other (which otherwise would hamper natural lighting and create over-shadowing). It is important to note that the implementation of most of the mentioned urban design rules is made easier if the urban layout of the new district has been properly and carefully configured. Our study has taken a cohesive approach to demonstrate this. The project study has also illustrated how staging of the *Port City* development and the site remediation could be used to drive the design approach and enable a step-by-step transformation. For instance, at the beginning, one could activate the existing Carrington Pump House (heritage, built 1877) as a catalyst and starting point of the development. It was envisaged that in the final stage, the *Port City* will offer 2,000 units in a very special inner-city waterfront living and working environment. (see: Figs. 6-9)

Figure 6: The 'City Campus/Green Corridor Project – Strategies of Urban Infill' studio, proposal (2007-08) from the author's studio, by students M. Smith and T. Hulme. Half of the new educational facilities will be accommodated in existing buildings, through adaptive re-use strategies, reinforcing the role and primacy of the city centre.

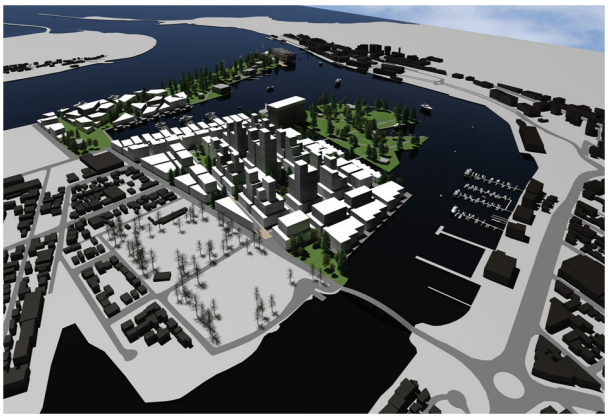

Figure 7: The 'Port City – Reclaiming the post-industrial waterfront' studio, proposal (2007-08) by student B. Campbell. This new city district will act as its 'urban power station', harnessing solar and wind energy to generate decentralized energy; the harbour water can be utilized for cooling the buildings.

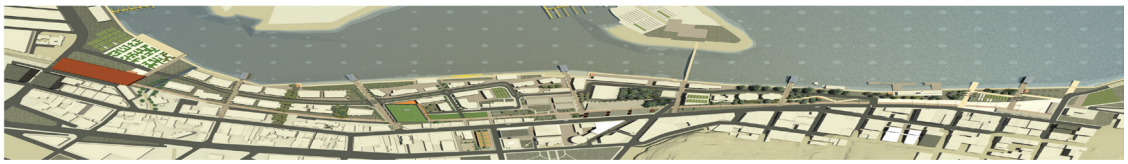

Figure 8: The 'Green Corridor' studio, proposal (2009) by student L. Bateman. After removal of the railway line, a linear landscape will connect the series of public spaces like 'pearls on a thread'.

Figure 9: The 'Green Corridor' studio, proposal (2009) by student J. James. The urban bushland absorbs CO2 and reconnects the city centre with the harbour.

7 Some concluding remarks: Prospects for the future

Clearly, there cannot be one definition of the term 'Sustainability', as various concepts have expressed a diversity of possible positions and meaning. The term 'Sustainability' in urban design has multiple meanings – some of which are complementary while others are oppositional and even contradictory. In the recent debate about the theory of urban sustainability, the tension between the technical and the social has been an obvious one, but so has that between the ecological and the economic. Eco-civilization appears to be society's reflection on global industrialization and capitalism.

The contribution of the case studies (studio projects) to the discourse can only be a beginning to formulate ongoing explorations, to define a new set of design principles for the city district, and to arrive at a critical interpretation for future studio teaching.

This paper has explored how we might be able to best address in teaching the need for environmental sustainability on the urban scale. The wish to achieve a real difference requires urban designers to re-think the city and urban planning conventions. New compact models for urban growth will be part of long-term strategies for urban renewal and help to achieve a sustainable, revitalized city centre. Many students were interested in integrating and re-using existing structures, as the most sustainable building is the one that already exists (due to its embodied energy). This approach also has the advantage that it keeps the city centre authentic, and the public space network vital, while enabling to carefully develop higher densities around transport nodes and cultural and educational facilities.

Today, in many cases, large corporations and department stores have abandoned the city centre, while downtowns are increasingly turned into residential districts and centres of entertainment, education and culture. The *City Campus/Green Corridor* projects propose a denser, mixed-use and revitalized city centre, where educational facilities and the University will play a major role. On the other hand, the *Port City* project recommends a model for urban expansion – to be applied after having first densified and revitalized the city centre. Our study has revealed the tremendous potential of a harbour to the city in general, and of port-related waterfront sites in particular.

The transition from fossil-fuelled urbanism to renewable city planning will be incremental. Sustainability approaches are to be embedded in all new precinct planning guidelines for urban growth areas.

Therefore, in conclusion, some of the findings from these studios are:

• Low-density has been for too long a principal contributor to carbon emission, while compact development fosters less driving and ensures that cities remain walkable.

• We need incremental change in our existing city districts, a step-by-step transformation towards more energy-effective districts and neighbourhoods (possibly through street by street retrofits): Retrofitting the urban infrastructure, improvement of public transport and installation of a 'smart grid'.

• Retrofitting entire business districts requires physical improvement of office buildings, e.g. exchanging the external envelopes to improve thermal efficiency and natural ventilation, removing old inefficient technology, and increasing the floor area by putting extra floors on top (to increase the land use, which will pay for these measurements).

• Demonstration projects are helpful, based on the power of the 'good example', however, there are significant complexities involved in defining a formula for sustainable urban form, and the definition of which urban form is most suitable in any given locality requires each time a complex optimization process.

• Savings in infrastructure are associated with compactness and urban intensification.

• Making better use of the available potential at local level, by generating district-wide renewable energy, utilizing waste heat and cascade energy concepts.

• Achieving sustainable, more energy-efficient urban form depends on a number of criteria, such as size, configuration, orientation, density, and response to context with integration and re-use of existing structures, mix of use pattern, social condition, and the detailed design solution.

• Overall, balancing the regions projected growth with environmental considerations is likely to continue to be a challenge.

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الملخص

خلال انتشار التحضر على الأرض، نجد أنفسنا نواجه سلسلة من التحديات في مجال التصميم الحضري والحاجة إلى مزيد من البحوث. ومن أهم التحديات البيئية في عصرنا الراهن هو اعتمادنا على الوقود الإحفوري في المدن والمباني وحاجتهم المتزايدة للطاقة. وفي هذه الحالة يجب تفادي الأخطاء السابقة في التنمية الحضرية وفي مرحلة مبكرة حيث أن ذلك يؤدي إلى مدن أكثر استدامة وأكثر كثافة وأقل إشعاعاً لغازات الاحتباس الحراري.

تقدم هذه الورقة بحثاً في مجال التحضر الأخضر وتقترح نماذج لاستدامة النمو الحضري ورفع الكثافة للمجاورات السكنية، مع ضرورة تحول المدن من الاعتماد على الوقود الأحفوري إلى نماذج تعتمد على مصادر الطاقة المتجددة.

يقدم البحث أعمالاً من مشاريع استديو التصميم والتي تطرح الأسئلة التالية: كيف يمكن أن نحقق تكامل بين جميع جوانب الطاقة ونظم المواصلات والنقل والنفايات وإدارة استهلاك المياه والطاقة والتهوية وغيرها، وذلك في تصميم حضري مستدام، وبالتالي تحسي الآداء البيئي؟

وكحالة دراسية تركز الورقة على وصف ثلاثة أمثلة حديثة لتطبيق تلك المبادئ للتصميم الحضري لمدينة نيوكاسل بأستراليا: وهما مركز المدينة، خط قطار أخضر وميناء بحري.