Tackling Climate Change: Comparing studio approaches in Sheffield and Cape Town

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ABSTRACT The urgency of climate change, and the collective responsibility it entails, requires a greater understanding of cultural approaches to environmental change and its interaction with diverse social contexts. This requires an extension of our understanding of climate change from the scientific to the socio-cultural realm. Cultural understanding implies investigation that extends to the human scale, revealing challenges that are often overlooked at a national or intergovernmental level.

This paper will compare how climate change is approached as a design input in different cultural contexts, detailing work undertaken by design-research studios in the Universities of Sheffield and Cape Town to address local responses to climate change as part of the Worldwide Universities Network 'Transcultural Understanding of Designing with Climate Change' project.

The Sheffield studio's work is focused on adaptation through design, informed by the modelling of future climate scenarios. This represents a cultural context where there is popular political will to devote time and resources to mitigating climate change, and various codes set out minimum standards for response. The Cape Town studio is focused on a context of rapid urbanisation, skills shortages, and a low tax base, where the state is unable to provide basic services such as electricity and water to many citizens. A lack of reliable data about energy consumption means that environmental decision-making is intuitive; while the peculiarities of the unequally developed economic and political context requires a more nuanced approach to engagement with communities.

KEYWORDS: Climate change; adaptation; cultural context; design research; resilience.

Introduction

Temperatures in Cape Town reached 42°C in March 2015 – the highest since records began. Wildfires ignited in Cape Town National Park burned through 15,000 acres of land. The summer fires are part of the natural process of the regeneration cycle of the native fynbos which covers the Cape peninsula – this fire was the worst seen in decades, but the City Fire Service and local volunteers limited the damage to only 13 properties. At one stage, with flames licking the edge of the farm, the historical collection of furniture at the oldest wine estate in South Africa, Groot Constantia, was removed for safe-keeping.

This is the latest and perhaps the most acute example of a changing climate and the still heavily tourist and agriculture-reliant economy of the Western Cape coming into conflict[1], but there are other longer-term examples of systematic conflict. Wine cellars need to be maintained at a long-term average temperature of 13°C. Gradual seasonal changes in temperature are acceptable, but rapid diurnal fluctuations damage wine irrevocably. Daily mean temperatures fluctuate between 11.9°C in July and 20.4°C in January and February, with average highs of 26.5°C.

Load Shedding

It is not only the seasonal fires that threaten wine production. Rolling blackouts, euphemistically referred to as 'load shedding', are increasing in frequency, interrupting the flow of mechanically chilled air that is essential to the maturing process. In the 1990s the South African Government prohibited the state electricity provider Eskom from investing in new power infrastructure in an effort to deregulate the industry; however no private investors came forward to build new power plants. Rolling blackouts were introduced in 2007 as demand outstripped supply for the first time. In 2008, multiple trips across the power network forced production to cease in major gold and platinum mines across the country (McGreal 2008). Despite construction of new power stations, the re-commissioning of mothballed coal power plants, and the introduction of diesel-powered generation at peak times, power cuts have persisted. In November 2014, Eksom could only provide 24GW of electricity, 4GW short of demand and a full 22GW short of a stated operational capacity of 46GW (England 2014). This shortfall was blamed on shortages of diesel, water reserves in hydroelectric facilities, and unplanned maintenance. Depending on the severity of the rolling blackouts, the economic cost in terms of lost productivity is estimated at R20-80 billion (£1.1 to £4.5 billion) per month (Lipton 2015).

Typically power outages hit in the late afternoons at the hottest times of the year, and it is in the major centres of employment that the economic cost is really telling. There is an urgent need to rethink the electricity dependent model of office provision for the financial service industry in the centre of cities like Cape Town and Johannesburg.

Energy Regulations and Buildings

In 2012 the SANS 10400–XA 'Energy Usage in Buildings' Regulations were added to the National Building Regulations. The standards set out minimum targets for energy consumption at the design stage, as well as detailed requirements regarding orientation, daylighting and insulation. These rules can be circumvented by the employment of a 'competent person' who can demonstrate that a notional building can achieve energy savings equal or better to those that would be achieved by following the standard to the letter (Mnguni & Tucker 2012). A further section of the standard requires that a maximum of

50% of the annual domestic hot water requirement of a building can be met by electricity. The regulations affect all new buildings, but only extensions to existing buildings (Sustainability Institute 2012).

The Portside building in Cape Town (Fig. 1) typifies the recent approach to the developer led design of spec office space in Cape Town. Built for Old Mutual and FirstRand Bank at a cost of R1.6 billion, the tower was designed to project an image appropriate for international global investment in South Africa through the provision of 52,000 square metres of Grade A office space. The energy strategy for this type of building, fully air conditioned with more or less efficient measures such as heat recovery systems or intelligent building management, relies on plentiful and reliable supplies of electricity, particularly in the hottest months of the year when infrastructure is at its most fragile.

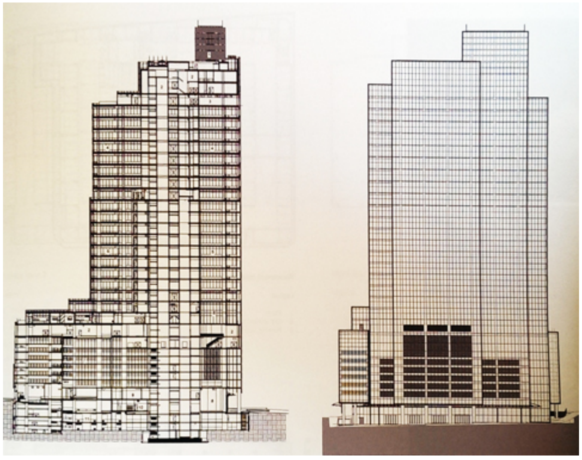

Fig. 1. The Portside building, Cape Town.

The building was the first substantial new build office constructed in Cape Town for fifteen years, and was awarded five stars from Green Star SA Office Design. This rating system is based on the Green Building Council of Australia's rating system, adapted to a South African context. Similar to BREEAM and LEED, accreditation is based on a weighted holistic assessment including criteria such as building management, indoor environmental quality, transport, water use, materials, land use and ecology, as well as energy consumption and carbon emissions (Green Building Council of South Africa 2013). However, the all-glass construction of the building, with deep floor plans requiring high levels of servicing, is an indication that understanding of the reality of the performance gap has not yet filtered down to architectural practice in South Africa, and it is highly unlikely that this building will perform as well as may be assumed from the plaudits it has received.

While the construction of new buildings such as will have a big impact, more often than not it is concrete framed buildings from the 1960s, 70s and 80s that are refurbished and expanded to supply demand for office space in the city. The most intensive part of this process in terms of energy consumption is the replacement of the skin with new glass and panel based façade systems with 'improved' thermal performance. In reality this means higher standards of insulation and increased airtightness, both of which can contribute to greater demand on air conditioning systems in summer.

As post-occupancy data for energy consumption in South Africa is not routinely collected or published, research into energy performance is highly speculative. However the energy consumption of the South African building stock is increasing rapidly, currently accounting for 31% of electricity consumption and 28% of carbon emissions in the country, with emissions from commercial buildings projected to rise from around 30MT of CO2 per annum to over 70MT in 2050, or over 50MT assuming ambitious efficiency savings (Milford & UNEP Sustainable Buildings and Climate Initiative 2009).

University of Cape Town

Energy consumption is therefore an issue which students are encouraged to address at the School of Architecture at the University of Cape Town. The school takes a cohort of around 100 students at undergraduate level and 60 at Masters level each year. Masters students develop 'thesis projects' that are similar in resolution to what would be expected of Part 2 students in the UK. The school lacks the more advanced technological resources that are available in Sheffield (e.g. environmental modelling software), but the studio based teaching approach is similar. Students discuss their projects in a group setting with their tutors, contributing to the review of their peers.

Sophie Zimmermann's project to refurbish Christiaan Barnard Memorial Hospital is an example of an intuitive design response to the need to reduce electricity consumption in the city (Fig. 2). It takes inspiration from a generation of thermally massive concrete buildings constructed in the 1960's and 70s, an architectural response that may be more resilient to warmer temperatures and unreliable power generation in years ahead. If internal temperatures can be maintained at close to comfort levels for prolonged periods without space heating or cooling systems, limited power resources or backup systems can be focused on supplying essential I.T. and other systems needed to maintain operations (essential in a hospital but also desirable in other sectors to reduce economic disruption).

This kind of student-led research into pressing environmental issues is necessarily reactionary – there is a lack of reliable data about energy consumption of buildings in use and projections of future energy supplies and climate are hampered by big uncertainties. Students' work is a reaction to problems as they arise, in contrast to Sheffield where a wealth of information means that students can speculatively address potential problems and propose solutions that are implementable before lasting damage is sustained.

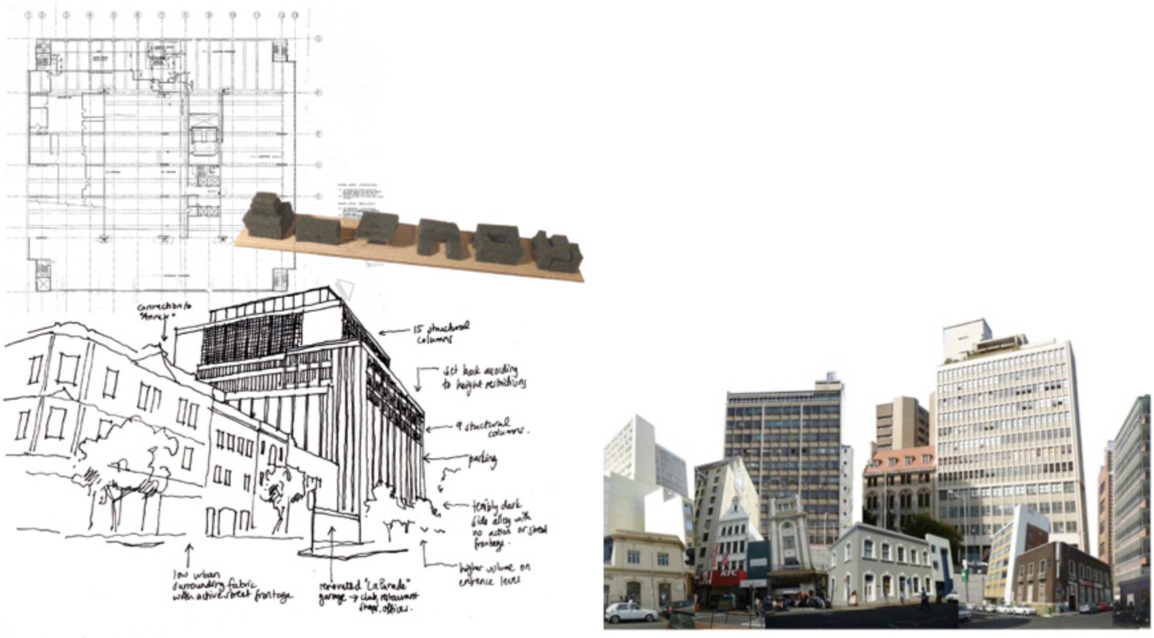

Fig. 2. Sophie Zimmermann's exploratory drawing of the Christiaan Barnard Hospital, and precedent analysis, Cape Town

The University of Sheffield

In some cases students at Sheffield are actively engaged in the gathering of data that can better inform how we think about designing buildings that can be used more efficiently in future. Hannah Towler's third year dissertation project asks whether improved awareness of energy consumption on the part of building occupants can encourage them to load match energy demand to production. The case study, LILAC, is a 21 unit community housing development in Leeds with a sizable photovoltaic installation, but the research also explores the constraints imposed by occupancy patterns, peak loads, and public misconceptions about energy use on a much wider, national, scale (Fig. 3).

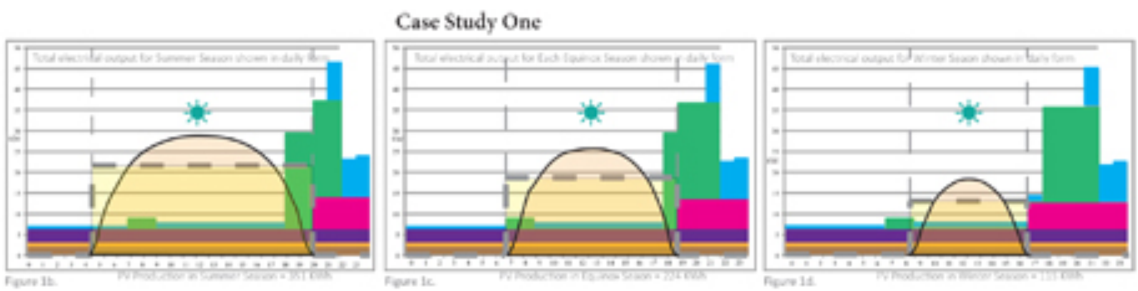

Fig. 3. Hannah Towler's infographic of PV generation and demand at LILAC.

Fifth year Alex Johnstone's research explores the environmental performance of the Alfred Denny building at the University of Sheffield, constructed in the 1960s. The thesis investigates the embodied carbon content of the existing superstructure of the building, representative of similar concrete frame buildings from the period, and explores potential refurbishment options (including operational energy consumption and carbon emissions) (Fig. 4). The performance gap between between predicted and actual operational energy consumption has received much attention in the UK recently as post-occupancy evaluation of newly completed buildings reveal that there is little correlation between predicted and actual energy use (Steadman & Hong 2013).[2]

Alex's research concludes that the structure can be re-used in an energy efficient manner, a conclusion with serious implications for the demolition of similar buildings across the UK, where it has been demonstrated that new buildings often consume up to five times as much energy as they are designed to (de Wilde 2014).

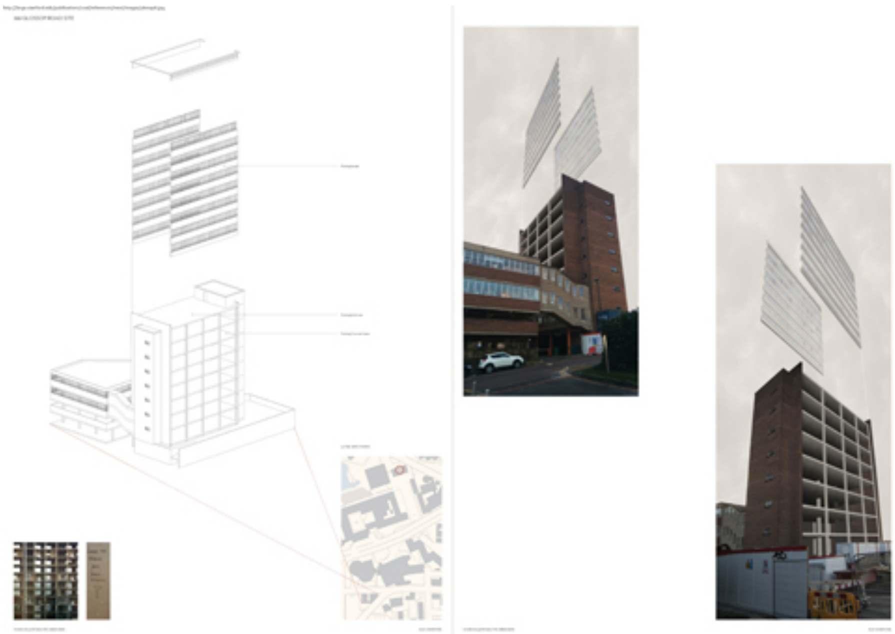

Fig. 4. Alex Johnstone's analysis of the structure of the Alfred Denny building.

The Importance of Social Context

The direct way in which Cape Town students are encouraged to address the architectural consequences of environmental change builds upon a reputation of addressing seemingly insurmountable social problems e.g. income disparity broadly divided along racial lines.

Projects often tackle complex sites in the Cape Flats, dealing with informal settlements, transport interchanges and other places of economic exchange, as well as service provision for the urban poor. There is no room for overly idealistic thinking. Many years of experience has led to a critical pedagogical approach to engagement with disenfranchised communities, where the emphasis is on ensuring that unrealised projects do not cause further disengagement with planning professionals and local government, but instead that future architects and planning professionals are equipped with as complete a knowledge as possible of the challenges that these communities face, so that students are better prepared to practice with confidence in their future professional careers.

Louwrens Botha's thesis project examines the motorway buffer zones between Cape Town and Somerset West – devised in the apartheid era as social dividers – and the potential regenerative inhabitation of the spaces around them, in order to knit the urban fabric and society back together (Fig. 5). The provocation is that while a resilient design philosophy may imply thinking about structures that can survive intergenerational change, some spatial structures are so rooted in the conditions of the past that they may need to be actively destroyed before regeneration can happen.

Fig. 5. Lowrens Botha's re-imagining of motorway infrastructure.

Conclusion

The latest available data suggests that electricity use within cities in South Africa accounts for 44% of total consumption across the country (2007), an increase from 41% in 2004 (Sustainable Energy Africa 2012). According to (Kennedy et al. 2009), Cape Town as an urban area was responsible for emissions in 2006 totalling 27 million tCO_2e, compared with 47 million tCO_2e in London. South Africa is still in a process of urbanisation, and due to its dependence on electricity predominantly generated by coal, it is the twelfth largest emitter of greenhouse gases in the world. In this context, deepening understanding of the root causes of poor energy performance in buildings is vital.

At the same time, it is important that architects of the future learn to proactively engage with the social consequences of climate change in different contexts. Planning human settlement requires a great deal of expertise and knowledge. Without the application of engineering, cost controls, knowledge of material and environmental science and architectural construction, design 'by' the community can, despite the best intentions, turn into an arbitrary exercise in satiating short term desires, rather than development that can be resilient and long-lasting.

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Notes

[1] According to the 2014 statistics, the wine industry now employs directly or indirectly some 300,000 people in the Western Cape, contributing R36.1 billion (£2 billion) to the GDP of the region (the contribution of the industry to GDP has increased by 10% per annum for over a decade) (Wines of South Africa 2014).

[2] Note: There are related reasons for this: prediction models systematically underestimate energy consumption of buildings in use (often they are based on models required for compliance that do not measure total energy consumption); and energy consumption can vary widely between physically similar buildings (partly because there is little understanding or modelling of behavioural impacts on energy use).