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

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Sheffield and Cape Town

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.

The Worldwide Universities Network 'Transcultural Understanding of Designing with Climate Change' project undertaken at the Universities of Sheffield and Cape Town sought to examine how climate change is approached as a design input in different cultural contexts. An exchange of academic staff from both institutions permitted comparison of work addressing local responses to climate change undertaken by design-research studios in each university. The research explored the extent to which approaches to resilience are interchangeable, or need to be grounded in local conditions.

The research began from the starting point that conventional design solutions vary between cultures according to local conditions (Anderson 1984). However, climate change presents a common global challenge, and this implies that systematic design approaches may be necessary to overcome the often arbitrary nature of local solutions, in order to successfully address the multifaceted nature of the problem in our ever-more interconnected world. On the other hand, participative design processes are required to address the needs of a range of demographic groups and societies with different values and resources, which need to be reconciled to local conditions. The former approach runs the danger of ignoring realities on the ground, while the participatory model, in foregrounding the resolution of local conflict, may fail to address the global nature of climate change. Education therefore plays a pivotal role in reconciling these two models of design, acting as a filter through which systematic approaches can be tested against the limiting empirical conditions of a given locality.

The Sheffield studio's work focuses on adaptative strategies that mitigate against the consequences of climate change, informed by evaluation of existing case studies, dynamic simulation modelling of student projects, and assessment of future climate scenarios. Sheffield represents a cultural context where there is a 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, in contrast, focuses 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 often intuitive; while the peculiarities of the unequally developed economic and political context requires a more nuanced approach to engagement with communities regarding the need for adaptation.

This chapter will first examine climate change in South Africa, and how the pedagogical approach at the University of Cape Town builds upon a history of addressing social and spatial apartheid. This is contrasted with Sheffield, where a more technical approach to design pre-construction is supported by the latest technology and software, but problems with the performance of completed buildings are easily overlooked in a context where many of the consequences of climate change have yet to be experienced, and remain relatively abstract.

The impact of climate change in South Africa

Temperatures in Cape Town reached 42°C in March 2015 – the highest since records began. Wildfires ignited in Table Mountain 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 one of the latest and amongst the most acute examples of a changing climate and the still heavily tourist and agriculture-reliant economy of the Western Cape coming into conflict, but there are other longer-term examples of systematic conflict.

According to the 2014 statistics, the wine industry in South Africa directly or indirectly employs 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). However, 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. Currently, 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.

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 of wine. 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. The blackouts are phased so as not to disproportionately affect any one residential area, however the impact on industry adversely impacts the lowest paid. In 2008, multiple trips across the power network forced production to cease in major gold and platinum mines across the country

(McGreal 2008). Banks and other services industries are also forced to stop work. 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 use of buildings in South Africa

As post-occupancy data for energy consumption in South Africa is not routinely collected or published, research into energy performance of individual buildings is highly speculative. What is certain is that the total 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).

While the construction of new buildings 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.

Teaching environmental design at the 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 85 students at undergraduate level and 40 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.

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 and distrust of 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 examined the motorway buffer zones between Cape Town and Somerset West – devised in the apartheid era as racial dividers – and the potential regenerative inhabitation of the spaces around them, in order to knit the urban fabric and society back together (Fig. 8.1). By mapping different existing demographics and land uses (residential, agriculture, water, infrastructure etc.) the project identified connections that could be made in the short term, taking advantage of flyovers and bridges to knit communities back together, while also envisaging new forms of transport in the longer term that might replace the concrete fortifications of the twentieth-century highways. 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 can reinforce spatial and social exclusion. In this context, infrastructure that might otherwise be viewed from a neutral engineering perspective may need to be actively destroyed before regeneration can happen.

[INSERT Figure 8.1 HERE]

In contrast, Sophie Zimmermann's project to re-use Christiaan Barnard Memorial Hospital explored the potential of refurbishing existing buildings to increase residential diversity and reduce energy consumption in the city (Fig. 8.2). It took inspiration from a generation of thermally massive concrete buildings constructed in the 1960's and 70s, which reflect a more intuitive architectural design response to climate (designed according to rules of thumb such as sun paths, prior to the development of sophisticated energy modeling) 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 reactive – 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 large political 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.

[INSERT Figure 8.2 HERE]

Teaching environmental design at the University of Sheffield

At Sheffield, students 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. For example, in 2015 Hannah Towler's third year dissertation project investigated whether improved awareness of energy consumption on the part of building occupants can encourage them to 'load-match' energy demand to production, by utilising energy-hungry household appliances such as washing machines and cookers when there is spare generating capacity. The case study, LILAC, was a 21 unit community housing development in Leeds with a sizable photovoltaic installation, but the research also explored the constraints imposed by occupancy patterns, peak loads, and public misconceptions about energy use on a much wider, national, scale (Fig. 8.3).

[INSERT Figure 8.3 HERE]

Fifth year Alex Johnstone's research explored the environmental performance of the Alfred Denny building at the University of Sheffield, constructed in the 1960s. His thesis investigated the embodied carbon content of the existing superstructure of the building, representative of similar concrete frame buildings from the period, and explored potential refurbishment options (including the impact on operational energy consumption and carbon emissions) (Fig. 8.4). Alex's research concluded 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 non-domestic buildings often consume up to five times as much energy as they are designed to (de Wilde 2014).

[INSERT Figure 8.4 HERE]

Comparison

The availability of data and improved technology allows students at Sheffield to simulate and quantify the performance of their work in a manner that is not possible in Cape Town. Students can model design solutions using dynamic simulation software packages such as IESve, and numerically quantify predetermined design objectives for environmental performance.

However there are dangers in an over-reliance on technology to teach environmental design. It is a relatively straightforward task for an architecture student to model his or her project and simulate low energy, even carbon neutral, performance. The modeling process is biased towards the application of active environmental solutions relying on operational system efficiencies rather than passive or free-running design strategies, the benefits of which – due to their dynamic daily and seasonal variation – are much more difficult to quantify. Analysis is usually conducted on a completed design with 'black-box' computation employed to assess performance over a notional period of time. However, if the inputs to the software are not fully understood, they can be easily manipulated to simulate unrealistic performance scenarios. A common example is occupancy patterns – it is often assumed that an office building will only be inhabited between e.g. 8am and 6pm, but the presence of cleaners and caretakers will require environmental systems such as lighting to be on 24 hours a day. This may lead to a to a profound skills deficit, with students lacking the basic skills necessary to critique and develop their work in an iterative manner as they design. The design process becomes instead a 'stab in the dark', as the post-rationalised analysis of a simulation model does not inform the design strategy. Similarly, a focus on technological solutions overlooks the social and political dimensions of adaptation that will be required given the future warming scenarios we face.

In Cape Town, graduating students are in high demand in local practice, where they are actively engaged in developing alternatives to the energy-intensive air-conditioned mode of living in this climate. House KW by Kevin Fellingham Architects is a refurbished Cape Dutch house in the Bo-Kaap area of the city, which has been transformed into a modern live-work unit reinterpreting its historic use with studio and office left and right of the main entrance, and living and dining spaces to the rear. This project was used a case study for students to engage with the design of passive environmental solutions for local urban microclimates. A small internal courtyard is shared with the neighbouring property to naturally cool the interior through passive downdraught ventilation, while the bedrooms reach up the roof to access a terrace overlooking Table Mountain. This creates a natural air path for the purging of warm air from the inside, supplanting the need for air conditioning (Fig. 8.5). The property is currently being monitored to record outdoor and internal temperatures and to quantify the thermal effects of the natural ventilation strategies that have been adopted.

[INSERT Figure 8.5 HERE]

At an urban scale, urbanisation and resource depletion will present more challenges to the already creaking infrastructure of the Cape Town in years ahead, including increased pollution and shortages of clean water as well as electricity. Design solutions at the building scale, learning from the vernacular traditions of the past, may be the most appropriate way to develop an architecture more resilient to both the natural and manmade challenges of the future. Technology can breed dependence, and eventually lead to a loss of tacit knowledge.

In a Western context, a dependence on technology, together with new modes of production such as BIM, has gone hand in hand with the division of the construction industry into ever more discreet specialisms that make it more and more difficult to challenge orthodox working practices, and prevent the collaboration that makes low-tech cross-disciplinary solutions possible. Students at the University of Cape Town – less reliant on technology – are re-building their understanding of vernacular techniques, and modifying these skills to help the process of adaptation to an uncertain future.

Conclusion

The latest available data from 2007 suggests that electricity use within cities in South Africa accounts for 44% of total consumption across the country, an increase from 41% in 2004 (Sustainable Energy Africa 2012). In 2006, Cape Town as an urban area was responsible for emissions totalling 27 million tCO2e, compared with 47 million tCO2e in London (Kennedy et al. 2009). 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 at a building scale is vital.

In comparison, electricity generation by coal has reduced by 74% in the UK over the past decade (Evans 2017). As a result, the consequences of increased electricity use by environmental systems in UK buildings may seem less significant. However, there is a real and present danger that the benefits brought by decarbonisation of the National Grid could be undone by design solutions unfit for our warming climate.

It is therefore important that architects of the future learn to proactively engage with the consequences of climate change in different contexts. Research-led teaching provides opportunities for students to contribute to the development of built environment policy. Students can test their newly developed specialist expertise through engagement with policy 'influencers' at both institutional and governmental levels, as well as in practice. There is much to learn from the transfer of expertise and knowledge between countries like the UK and South Africa, both in terms of technical understanding of energy performance of occupied buildings, but also of the need to make the most efficient use of existing buildings and infrastructure that can be adapted to meet future requirements.

Cultural differences, impacting on building design and pedagogical approaches, have led to the development of diverse tactics for adaptation to climate change, ranging from the reactive to the speculative – each with implications for the other as well as across diverse contexts. This requires recognition that environmental design is about more than solving perceived short-term problems, but about developing resilience to climate change that can make a real and long lasting contribution in different social and economic contexts.

The work undertaken in Sheffield and Cape Town teach us that different cultural conditions give rise to different approaches. Speculation in the absence of local knowledge leads to design approaches that are often arbitrary, failing to address problems that call for a more reactionary approach, but on the other hand, speculative propositions forearmed with the benefits of local knowledge can unlock design solutions that address previously insurmountable problems across cultural boundaries.

The key is to learn from each other.

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