Michael Batty

URBAN REGENERATION AS SELF-ORGANISATION

Cities are living, self-organising systems that grow organically from the bottom up. They are composed of entities – people and buildings – that have limited lifespans and have to be renewed continuously. Indeed, regeneration is the hallmark of any living system, and in cities, most activity that takes place can be considered as part of this process of renewal. New growth or absolute decay tends to be a relatively small proportion of the total change. Cities are continually in flux as people and their activities respond incessantly to changed circumstances that involve shifts in movement patterns, locations, the use of buildings and in social preferences.

Whether or not the processes of regeneration are sustainable and lead to a better quality of life is not assured simply because a city reproduces itself. Cities change through positive feedback. Change builds on itself and, if there is growth or decline, regeneration might reinforce the cycle, each wave of change building on the previous, often spreading out as well as polarising through intricate patterns of diffusion. Growth is easier to track as a positive feedback, good examples being gentrification where one group, usually the richer, takes over the buildings that were once occupied by the poorer, thus pricing out the resident population. The most visible example of this type of cumulative causation leading to a massive decline is the vacating of the city of Detroit, which has fallen in population from 1.4 million in 1970 to half that today, with the consequent abandonment of whole areas of the inner city and a greening of what were once prosperous residential areas.

(Re)defining (Re)generation

A key feature of systems that regenerate themselves is that they do so spontaneously. To do so otherwise would require control of every basic element of the system, and it thus follows that systems of any complexity must affect self-regeneration through self-organisation from the bottom up. In city planning, regeneration has come to mean something a little different. Urban regeneration is now usually structured through planned interventions that are anything but spontaneous, and often conflict with processes that are intrinsic to the survival of the system itself. Sometimes spontaneous regeneration can be stopped in its tracks by attempts at planned regeneration, which tends to be manufactured from the top down. A city is composed of layer upon layer of interactions that represent a multiplexing of networks acting to deliver energy, information, materials and people to its parts in such a way that the networks contain great redundancy. If fractured, cities usually continue to work because of the enormous redundancy that is built into their fabric through multiple networks, alternative, complementary locations and ways of working, although if their key hubs are attacked they will break down. In the same way, if they become overloaded, their networks jam, but in general, because cities operate from the bottom up through the actions of millions of individuals, they tend to adjust easily and quickly to changed circumstances.

Figure 1 shows in abstract terms how such processes generate positive feedbacks as spirals of prosperity or decline that diffuse across the urban landscape. An idealised urban landscape is broken into regular cells or locations where activity can be located, with the arrows indicating how adjacent cells influence one another. When a seed of growth is planted, say the central red cell in Figure 1, cells around it become activated and the

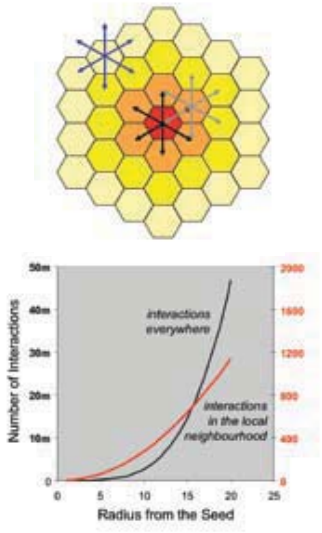


Figure 1. How a seed planted in the urban landscape influences its neighbours by diffusing its success (or otherwise) through interactions.

M. Batty (2012) Urban Regeneration as Self-Organisation, Architectural Design, 215, 54-59.

innovation diffuses as waves: the red cell generates orange, the orange yellow, the yellow beige, and so on. The number of cells and the number of interactions – in this case 6 for each cell – grow approximately in proportion to the area of the circle πr^2 . This exponential effect is even more powerful – it is super-exponential – if each cell influences every other in the growing system, with the graph showing how this positive feedback simulates the spread of influence. This is what we hope for of regeneration, for as areas regenerate spontaneously their 'DNA' causes the cell to 'grow' to form other cells.

In an equivalent way, Figure 1 has a mirror image as a process of decline with a bad cell affecting its neighbours and in turn making them 'bad'. This is much more akin to the way industries begin to decline, with one industry failing and destroying the linkages to neighbouring industries, often leading to a spiral of deindustrialisation. There is also uncertainty as to how much the seed affects its neighbours, and if this is built into the model, diffusion becomes more random.

As the life of any activity comes to an end, it needs to be renewed. The wave-like structure of regeneration that occurs as old activity is replaced with new is also subject to uncertainty and ultimately the original structuring of the city in areas of like development is destroyed through differential renewal, thus mixing land uses. The theoretical logic for this process is explained as part of the logic of complexity theory,[1] and the practical applicability of the idea is demonstrated by Nabeel Hamdi.[2] A picture of this process can be seen in Figure 2, which is a simple version of the model shown in Figure 1. It breeds wave after wave of regeneration which successively mix the cells in terms of the time when they are developed, making it harder and harder to detect what influenced what as the initial structuring washes itself away in the resultant mix.[3]

The trick for urban planning is to identify key points where small change can lead spontaneously to massive change for the better.[4] We need to figure out ways to plant seeds that do not fall on stony ground, leading to regeneration that is sustainable from the bottom up, avoiding more and more investment from the top down. Growth as well as decline can be pathological and urban sprawl is often regarded as unsustainable. However, it is inner-city decline in areas that once housed industries whose equivalents are now highly automated and footloose, requiring little labour, that fall into vicious cycles of progressive decline that are hard to break. Areas of such decline are to be found in most large cities where their industrial base has gone, only to be replaced with financial services and high tech, located elsewhere. Indeed, the proposal to locate the Olympic Park – the heart of the 2012 Olympic and Paralympic Games – in East London is primarily because there is much vacant, abandoned land. However, much of the land is contaminated and over the last 20 years there has been enormous investment in the area, which has led to little.[5]

The mission now is to attempt an even bigger wave of planned regeneration which will kick in after the event has taken place, for it is the legacy that is crucial to the regeneration.[6] In a sense, to enable little seeds of growth to do their work, the current project is to provide the right kind of conditions (in the soil) in which regeneration can work its magic. Most of these seeds are envisaged to be privately funded, and thus it is generally regarded that large-scale development and extensive

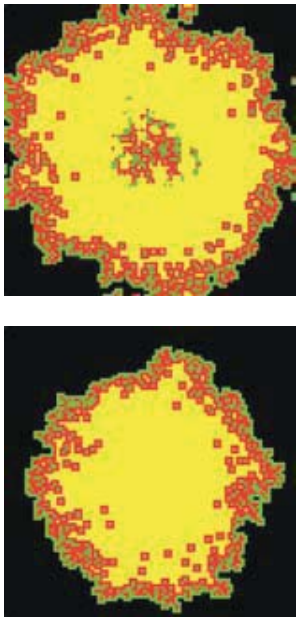
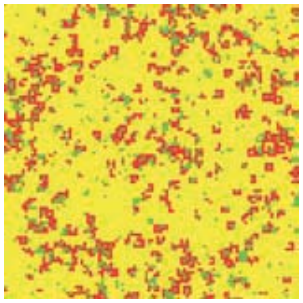


Figure 2. Successive waves of growth and then regeneration wash away the initial structure (top) to generate a mix (bottom).



The mission now is to attempt an even bigger wave of planned regeneration which will kick in after the event has taken place, for it is the legacy that is crucial to the regeneration.

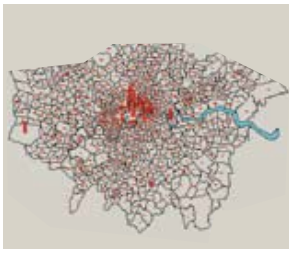


Figure 3. The pattern of employment across Greater London (bottom) with the East London Olympic Park site marked at Stratford (and Newham) (top).

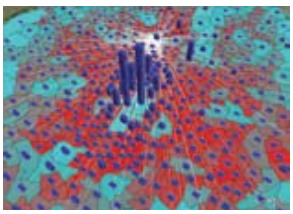
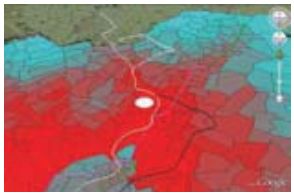
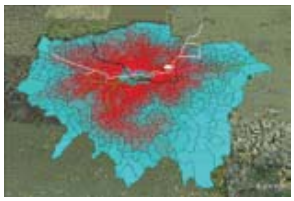


Figure 4. Bird's-eye view of Westminster and the City of London with Stratford beyond (upper centre). The bars represent employment volumes, the red to blue colouring represents population density from high to low by ward, and the white flows are traffic volumes centred on Stratford.





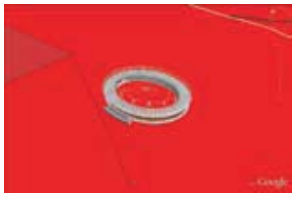


Figure 5. Transport in East London: accessibility, Tube lines in Stratford, and the location of the Olympic Park site. Accessibility is the relative nearness over all modes of transport of every ward to every other, coloured from high (red) to low (blue). The Central, District, and Jubilee lines are shown with the Olympic Park site marked by the ovals in each picture, as we zoom in.

site preparation are required if private development is to have the flexibility to flourish.

Identifying Critical Points for Intervention

Regeneration is part of the process of enabling the city's various networks to keep functioning, and declining areas that we might consider problematic are key to the processes of natural regeneration. If we interfere in them without understanding all the possible ramifications, such planned regeneration can be disastrous, leading to exactly the opposite effects than those intended. The causes of decline and poverty usually relate to industries that have long outlived their usefulness. The spiral of decline that sets in further impoverishes the remaining population as the youngest and brightest leave, and with an ageing population and workforce such areas become increasingly unattractive for new industries and services. Many regeneration proposals simply try to address these issues by providing new property-led infrastructure that is everything but a new basis for jobs. Housing is one of the classic remedies, but all this succeeds in doing is providing updated residential facilities for the same population.

The key is to find the right mix of activities, to plant seeds that lead to the regeneration attracting related activities because of their evident synergy. This does not necessarily require large-scale investments, but it does require activities that lead to new synergies. In fact, large-scale infrastructure projects are probably the wrong types of activity for regeneration because the jobs they bring tend to be few – simply for building and then maintaining the infrastructure. In East London, all of the activities to date prior to the Olympic Games (with the exception of the Jubilee Line extension linking Stratford to the City) have all been modest investments. The Olympic Park site will provide massive infrastructure whose success will be after the Games are ended when the stadia are used for high-profile sports events and the shopping-centre complex will continue to attract people into the area.

The biggest dangers, however, are that though people will come into the area to shop and use the facilities, much of the expenditure they generate will not benefit the local community. If one provides infrastructure and facilities for people to come to a place, they can equally well leave a place using that same infrastructure. East London's proximity to the City of London is a major advantage and there are already some evident spillovers, but it is surprising that there have not been more, given house price differentials. Nevertheless, a parallel agenda in social reconstruction and the provision of better services by the local authorities involved could well resolve some of these potential difficulties.[7]

Tracing the Impacts

The multipliers that ripple through the city, which are expressed in both physical terms as networks and less visible social and information interactions, condition the extent to which we can explore how effective regeneration might be. The Centre for Advanced Spatial Analysis (CASA) has built a land-use transportation model of how populations relate to employment, largely in terms of simulating the journey to work and to shop. Here, the city is divided up into small zones, like the cells in Figures 1 and 2, and the key urban networks are built through

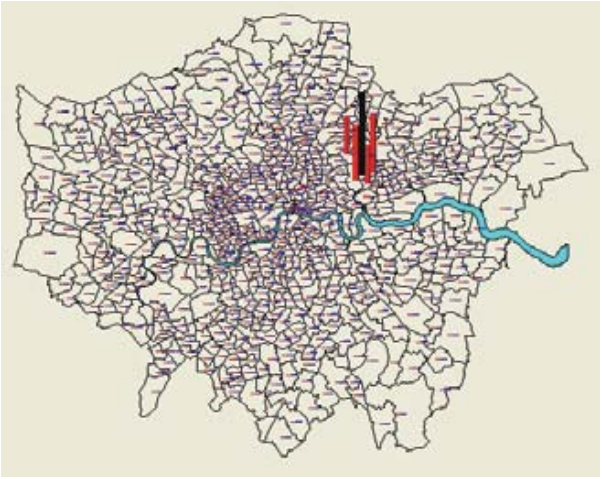
the various transportation modes – road, Tube, bus and heavy rail – that link them together. There is a long tradition of building models of this kind that largely look at the impact of new transportation proposals, but this extended model allows us to ask many 'what if?' questions. For example: What will be the impact of locating 100,000 new jobs in the Olympic Park area, which is what the London Borough of Newham is predicting for the next 20 years.[8] If this many jobs do materialise, there is no doubt that there will be an enormous regeneration on the scale of the London Docklands, but the key question is will they materialise, and if they do will the associated population live locally or commute in from elsewhere? Some jobs will be pump primed, but most will need to be generated spontaneously.

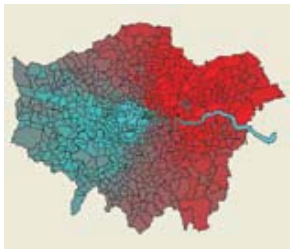
One of the other big infrastructure projects is Crossrail, which is designed to link West to East London by 2015. Whether or not a greater proportion of the population will drift west even though there are new jobs in the east is a critical question that the CASA model is designed to answer. A visual walkthrough of how these impacts might be assessed using data from the model in map and 3-D form begins in Figure 3, which shows the highly concentrated pattern of employment across London with Stratford marked out. In Figure 4, all this data has been imported into Google Earth showing employment as a bar map, population density, and the transport flows into the Stratford hub. The proximity of the City is evident in terms of jobs, and the advantages of the area are graphically demonstrated in Figure 5, which shows the relative accessibility – nearness of places to one another (highest red to lowest blue) overlaid with the Tube lines that serve the area.

The key to assessing the regeneration is to develop a series of scenarios where we plug new jobs, homes, retailing and transport links into the area and then predict what the impact will be. Various scenarios can be developed in this way, and here we will develop two: first, simply locating 50,000 jobs and the current planned housing into the key cells around Stratford and then doing the same by adding twice that many jobs – 100,000, putting in the planned Crossrail from West London into the area, and adding new retail employment, already approved and planned. In Figure 6, the jobs are simply plugged in to show the population that is generated and redistributed by this regeneration. In essence, what we need to demonstrate is that the population that is generated from these jobs stays largely in the area and does not move out to what are historically more attractive areas. What happens, of course, is that populations not only grow through these new jobs, but the existing population redistributes in response to the changed urban landscape with losses in some areas as well as gains overall.

Figure 7 shows that although the scale of these jobs and the new housing leads to largest absolute changes in population across East London, when the percentage change is examined, apart from a small area in Stratford itself population leaks to more prosperous areas southwest of the centre. There is population loss in the centre itself due to congestion charging still working itself out, and the concentration of transport links in the corridor between the City and Stratford is shown in Figure 8. But it is when the second scenario is tested, adding 100,000 jobs, building Crossrail and locating retailing and housing in the area that the real problems emerge. As can be seen in Figure 9, Crossrail (shown in Figure 10) tends to draw

Figure 6. The location of new jobs and housing in East London and relative shifts in population. The green bar is 50,000 jobs in Stratford, while the red and blue bars are gains and losses in population due to a restructuring across the metropolis.





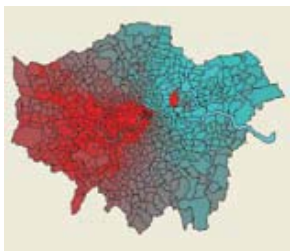


Figure 7. Mixed blessings: Absolute larger gains in population in East London due to regeneration, but relative percentage gains in West London. These maps reflect a ranking of population gains from highest rank (red) to lowest (blue). The top map shows that, in general, the east gains the most population, despite a shadow to the immediate southeast of Stratford, but the below map shows that relative gains tend to be higher in inner West London and along the Central Line, despite the highest relative gain being in the immediate vicinity of Stratford.

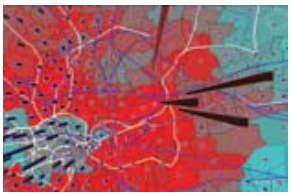


Figure 8. The location of new housing in East London superimposed on the overall transport accessibility surface. Big gains in absolute population in the three wards around Stratford, but relative losses in parts of the City probably due to the increased accessibility of East London. This is compounded by congestion charging, which is the low-accessibility bluish area to the bottom left of the map. Note the importance of the transport hub in East London where Tube lines (white) and surface rail (blue) coalesce.

population into the new key hubs mainly in West London that come from the location of new stations. This massive increase in linear accessibility across the entire metropolis leads to a complete reversal of population locations with the west becoming more favoured in absolute and proportional terms, as shown in Figures 9 and 11. The impact of growth in the Crossrail corridor in Figure 12 is stark, and far from letting Stratford retain its newfound working population, much of it leaks west along the new high-speed line.

Of course, this is a very artificial picture and inevitably an extreme scenario. But it does raise very basic concerns about what the long-term future of this area will be like. There are many things that the model does not do with respect to building on the kinds of cumulative causation that could lead to a successful regeneration. All it does is assume that if the present patterns of behaviour and interaction persist, then the area will lose more than its fair share of investment to other parts of London. In a sense, this is what has been happening in the past, and the trick will be to somehow get the mix right that reverses this pattern. This will require some very clever investment in jobs that are high value and resilient, and it will require some ingenious ideas about future transport. A revival of British manufacturing is being talked about. This would be a wonderful context in which to make this work as all the other supporting investment is there.

To make a success of the legacy of the Olympic and Paralympic Games, the CASA model shows that it is essential to develop a sequence of investment opportunities in jobs of a high-enough quality that they become self-generating. The notion that these must be in high tech is passé, for there are other parts of London such as Soho and Hoxton that have much greater advantages. In one sense, the legacy is something that will only be successful if the area positions itself for the next new wave of high-value manufacturing, and even then this is a fiercely competitive market. The transport links will be second to none after Crossrail and the new International Eurostar terminus at Stratford are completed, but good transport can take as many people out as bring them in. The trick will be to reverse the multiplier effects that attract people to live elsewhere, and in this, selective investment will be required on all fronts. AD

Figure 9. 100,000 new jobs located in East London and the population hubs generated by Crossrail. Due to increased accessibility from Crossrail, many of the jobs generated in East London ultimately lead to population growth west along the rail corridor.

100,000

NUMBER OF NEW JOBS IN EAST LONDON WHICH LEAD TO POPULATION GROWTH WEST ALONG THE RAIL CORRIDOR

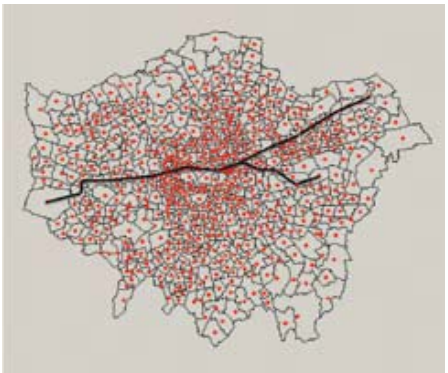
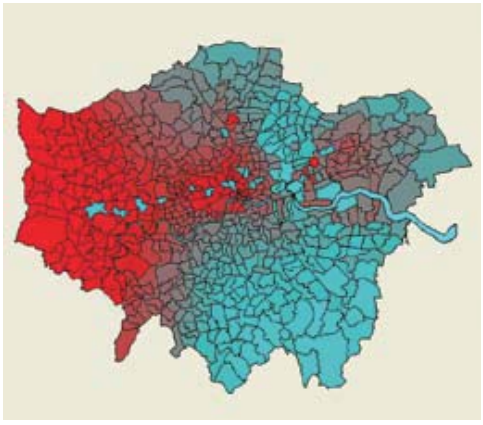


Figure 10. The location of new lines in the Crossrail project.

Notes

1. Michael Batty, *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals*, MIT Press (Cambridge, MA), 2005.
2. Nabeel Hamdi, *Small Change: About the Art of Practice and the Limits of Planning*, Earthscan (London), 2004.
3. Michael Batty, 'A Digital Breeder for Generating Cities', *AD* Digital Cities, Vol 79, No 4, July/August 2009, pp 46–9.
4. Hamdi, op cit.
5. Simono Florio and Michael Edwards, 'Urban Regeneration in Stratford', *Planning Practice & Research* 16, 2001, pp 101–20
6. Ed Hammond, 'London 2012: The Games are a Sideshow. The Real Story is the Urban-Renewal Program', *Financial Times*, 19 June 2011, available at www.slate.com/id/2297346/.
7. Gavin Poynter, 'The 2012 Olympic Games and the Reshaping of East London', in Robert Imrie, Loretta Lees and Michael Raco (eds), *Regenerating London: Governance, Sustainability and Community in a Global City*, Routledge (London), 2011, pp 132–48.
8. Newham *Regeneration: Regen 38*, written evidence submitted by the London Borough of Newham to the Parliamentary Select Committee on Communities and Local Government Committee, 4 April 2011, available at www.publications.parliament.uk/pa/cm201011/cmselect/cmcomloc/writev/regeneration/m38.htm.



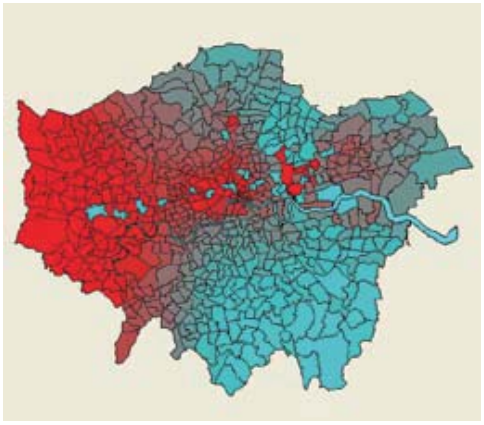


Figure 11. Highly localised gains in population in East London generate bigger gains in the west along Crossrail. Unlike the regeneration (which occurs without Crossrail) that has bigger gains in East London, absolute (left map) and relative (right map) gains go largely to West London. These are gains ordered by ranking. Note the pockets that are not connected directly to Crossrail stations in the west, which reflects the limits of the simulation.

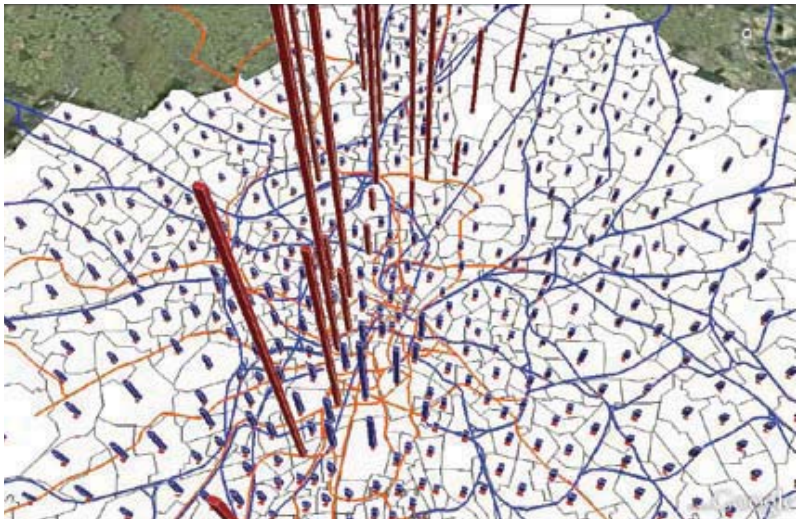


Figure 12. The cluster of transport infrastructure and growth in population along the Crossrail corridor looking west into Stratford. Mainline rail in blue, Tube lines in orange, and the bars represent new population in the corridor