Reimagining Heath Park - A complex systems approach to urban regeneration

Ian Bentley
Dip. Arch, Dip. UD

Prachi Rampuria
B.Arch (Hons.), MAUD (Dist.)
Director, EcoResponsive Environments Ltd

Soham De
B.Arch, MAUD
Director, EcoResponsive Environments Ltd

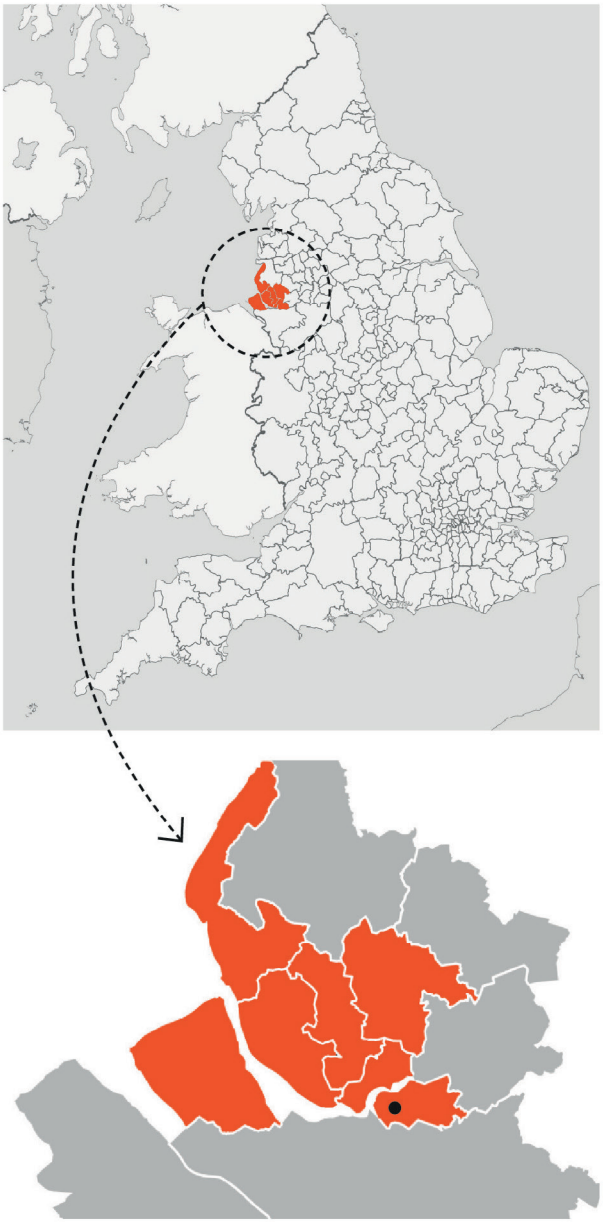
Abstract

This paper presents a newly-developed complex-systems approach to urban regeneration, and demonstrates its feasibility in practice through a live regeneration project which is focused between the limits of a 'social foundation' that supports immediate health and wellbeing, and an 'ecological ceiling' that supports the long-term survival of our species. To achieve this focus, the approach considers built environments as complex systems; built up from nested subsystems - landform, water system, green system, public linkage system, plots and buildings - which must be designed with mutually positive interactions, so that the whole becomes more than the sum of its parts.

The paper explains the use of this process in some detail, and shows that it has proved itself in practice, both as an effective working process and in terms of its design outputs. Project's natural capital accounting demonstrates a significant gain in ecosystem services, both for the site and for the wider region. In terms of financial performance, current feasibility analysis suggests that the project will prove attractive to ethical investors. The quality of the outcome has been recognised at government level as one of 35 'Green Innovation' schemes selected for the UK's Global Investment Atlas and showcased through the 'Global Investment Summit' in London in October 2021.

Keywords

Complex-systems approach, urban regeneration, health and wellbeing



Aim

This paper explains the principles of a newly-developed complex-systems approach to urban regeneration, and demonstrates its feasibility in practice through a live competition-winning project at Heath Park in Runcorn, located in the UK's Liverpool region (fig.1). The project, recognised as a Liverpool City Region 'Beacon Project', was chosen as one of 35 'Green Innovation' schemes showcased to top international investors in the UK's recent Global Investment Summit (Heath Park, 2021; Department for International Trade, 2021).

The context of design

Current ways of life are damaging natural capital's capacity to regulate climate; to provide food, clean air and water; and to offer cultural inspiration. Artificial intelligence is rapidly reducing the demand for all but highly-skilled workers, generating a precariat trapped in poverty and low job satisfaction; though the creative use of ICT has growing potential to support an alternative cooperative economy. Today's social

Fig.1: (anti-clockwise): Location map showing the site's location within the UK's Liverpool City Region and the proposed aerial view of the RIBA competition-winning masterplan for Heath Park.

systems are also problematic; with many people trapped between endemic loneliness and a pervasive sense of stranger-danger, with associated damage to physical and mental health (Reilly, 2003; Collins et al., 2011) now highlighted through coronavirus's impact (fig.2).

Creative design for survival

To survive in this problematic world, as economist Kate Raworth points out (Raworth, 2018), all design decisions have to be focused between the limits of a 'social foundation' that supports immediate health and wellbeing, and an 'ecological ceiling' that supports the long-term survival of our species. Between these limits lies a space for design solutions that support the conditions of safety and social justice within which humanity can thrive (fig.3).

Creating these new solutions is a complex task. To address it effectively we have to understand built environments themselves as complex systems; built up from nested physical subsystems

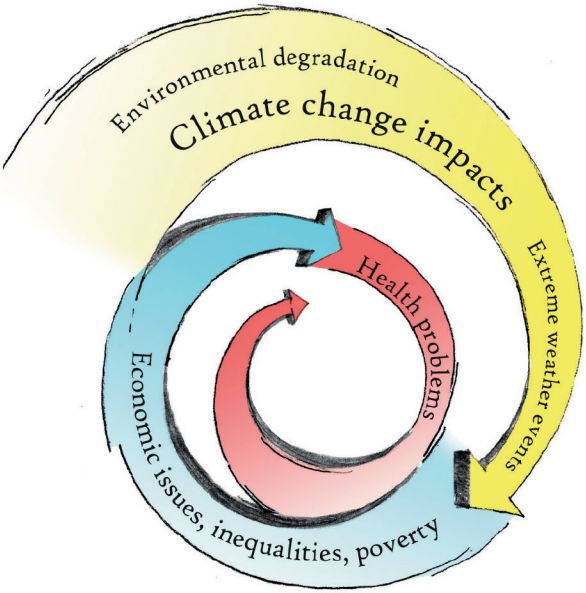


Fig.2: Complex and interlinked issues of the 21st century.

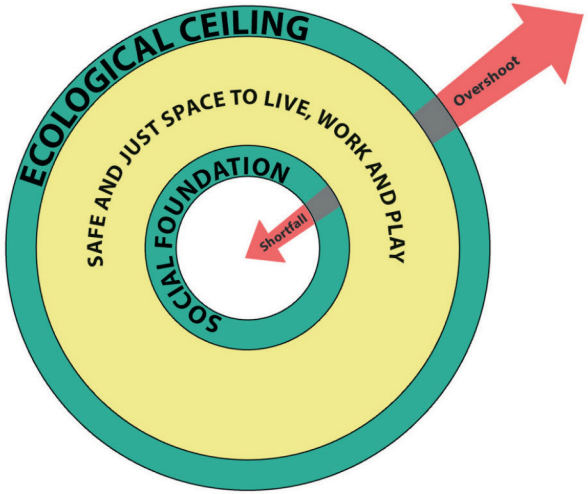


Fig.3: 'Humanity's 21st century challenge is to ensure that no one falls short on life's essentials (from food and housing to healthcare and political voice), while ensuring that, collectively, we do not overshoot our pressure on Earth's life-supporting systems, on which we fundamentally depend – such as a stable climate, fertile soils, and a protective ozone layer'. Source: Diagram adapted from 'Doughnut Economics' by Kate Raworth.

(fig.4) (Vernez-Moudon, 1997) - landform, water system, green system, public linkage system, plots and buildings - at differing spatial scales. These subsystems change through time at different rates; which means that each has a certain degree of autonomy within the system as a whole.

The tragedy of fragmentation

The relative autonomy of each subsystem has enabled different design professions, each seeking deeper understanding of the particular design issues of one particular subsystem, to evolve into separate silos (fig.5): architects for buildings, transport planners for street layouts, landscape architects for the natural infrastructure and so forth.

From within each silo, crises in the overall situation always seem like someone else's problem. Well-intentioned but fragmented professions focus intently on their individual subsystems, but lose sight of their impact on the whole. To overcome this fragmentation, to make the whole once again more than the sum of its parts, we all need to pool our limited influence.

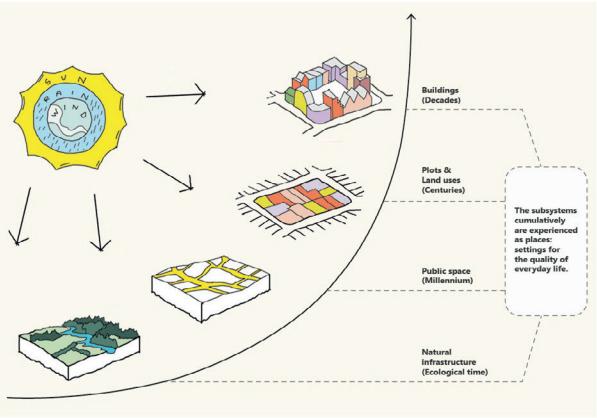


Fig.4: Settlements as complex systems with key multi-scalar subsystems changing at different rates.

From theory to practice

Opportunity to put this eco-responsive approach into practice was presented by an RIBA international competition sponsored by the SOG group, owners of 57-acre Heath Business and Technical Park in Runcorn, near Liverpool. Built as headquarters for the chemical giant ICI, Heath Park's operations were scheduled to be closed in 2000 with the loss of 1,600 jobs (Wearden, 2007). This was seen as the death knell for Runcorn, as ICI was the town's biggest employer and was a vital resource for numerous

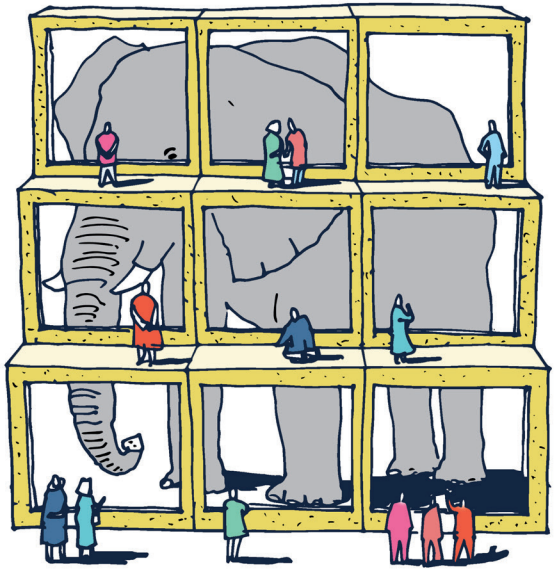


Fig.5: Professional myopia.

other business suppliers across the region. The loss of so many jobs and associated key skills would have had devastating consequences for the economy of north-west UK and its local and regional communities.

The SOG group, a company created by former ICI employees and local businessman John Lewis, purchased the buildings – consisting of research & development laboratories, offices and corporate facilities – and transformed them from a single-occupancy corporate site into a sustainable regional asset: now one of the UK's leading and award-winning business and technical parks - currently housing around 120 businesses involved in scientific research and development (Bounds, 2012). 20 years later, with the region undergoing a renaissance thanks to a multi-billion pound programme of major building and infrastructure projects, an RIBA ideas competition was launched with the vision of regenerating Heath Park into a sustainable, carbon-free multi-use development with employment, housing, leisure and community assets; complementing the existing diverse and thriving research economy and funded by ethical investment (RIBA, 2019). This complex brief, promoted by a visionary client, provided an excellent test-bed for our complex systems approach to urban regeneration. Using this approach, the following sections explain the key aspects of our RIBA competition-winning proposals for reimagining Heath Park, where people can live, work and play their way towards a zero-carbon future.

Building on the foundation of natural Infrastructure

Integrated green and water systems are designed to maintain both the ecological ceiling and the social foundation (Kaplan, 1995; Sandifer, Sutton-Grier and Ward, 2015). To support the ecological ceiling, they manage water flows and protect and enhance biodiversity. To support the social foundation, they provide clean air, water and food for everyday use; and offer continuous everyday contact with natural processes throughout the built-up areas of Heath Park; providing both physical and mental 'Natural Health Service' benefits (The Mersey Forest, 2017; Kuo, 2015; HM Government, 2011).

Fig.6.1: Key character areas a. Wildflower Meadow Ride, b. Woodland Copse, c. Wetlands Nature Park, d. Central Boulevards, e. Wet Woodland Belt, f. Activity and Fitness park, g. Entrance Plaza, h. Southern Parkway .

Fig.6.2: Proposed green system as a mosaic of new ecologically-rich productive landscapes

Fig.7: Before (inset) and after illustration of the proposed Pylon Meadows Park.

The green system is designed to slow flood water and support nature recovery networks by extending the Mersey Forest through the site via a mosaic of new ecologically-rich productive landscapes (fig.6). The National Grid powerline, where built development is impossible, becomes the Pylon Meadows Park - a 500m long wildflower meadow ride - to support pollinating insects currently in decline (fig.7). A forest school, allotments and green gym trail spaces are connected through the central formal boulevard and courtyard gardens with the wider context of nature reserves, sports pitches, traditional parkland, cycle paths and trails to create an extensive park system beyond the site (fig.8).

The green system is underpinned by a circular water-economy (fig. 9), minimising impacts on external systems of supply and treatment. Surface runoff is slowed with green roofs and permeable pavements. Drainage from roads and parking areas is captured by swales and rain

Fig.8: The green system supporting strategic connectivity into the wider context.

Fig.9.1: Living Machine illustration treating waste water on-site

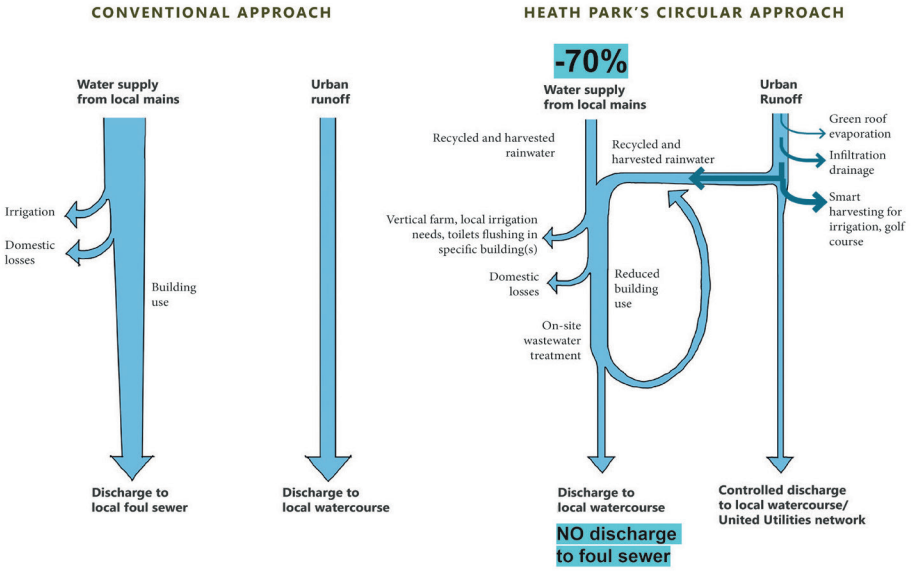


Fig.9.2: Heath Park's circular water economy

Fig.10: Before (inset) and after illustration of the proposed Wet Woodland Belt

gardens, to remove pollutants and maximise infiltration. Waste water is treated on-site by a 'Living Machine' - a constructed wetland - with treated effluent used to flush toilets and irrigate nature zones and allotments.

Excess water flows to the eastern wet woodland for infiltration and attenuation (fig.10), before discharge to the local watercourse. Smart technology uses real-time weather data to control the retention and release of water from the wetland; harvesting it for local irrigation and to enhance habitat-diversity for invertebrates, amphibians and water and wetland birds. Where possible, the surface water drainage system is exposed to public view; running through rills and swales to help people understand that water is a natural system that does not originate from taps.

Street network

The street layout encourages natural exercise and minimises particulate air pollution and car dependency (Douglas, Watkins, Gorman and Higgins, 2011) by supporting walking, cycling and public transport through a highly-connected street network; minimising energy-wasting detours. Space syntax analysis (Hillier and Hanson, 2005) - which indicates highly-connected links in hot colours and less-connected ones in cold colours - indicates the relative flows of walking and cycling, and of driving through each street. Global-scale connectivity shows how each space is connected to all the others within 5km and predicts relative levels of cycling and vehicular movement from outside the site. Local connectivity within 400m predicts footfall: crucial for the viability of shops and local services.

This analysis shows that the heart of the site is not currently well-connected; either locally or globally. To maximise wider connectivity, we link Heath Park Boulevard - the core of the existing layout - as directly as possible to the main global link of Heath Road South. The layout is then further extended and subdivided, to maximise its internal connectivity; with junctions never more than 120m apart to minimise pedestrian detours whilst slowing local vehicular traffic (fig.11).

Fig.11: Existing space syntax analysis (left) and proposed local space syntax analysis (right) indicates how the site's existing low levels of connectivity into the wider context is transformed with a permeable and joined-up street network for walking, cycling and vehicular flows.

Public transport is routed on globally-connected streets, with bus stops within five-minutes walk from everywhere. Everyone has direct vehicular access to their front door for deliveries, creating a functional hierarchy from 'social streets'

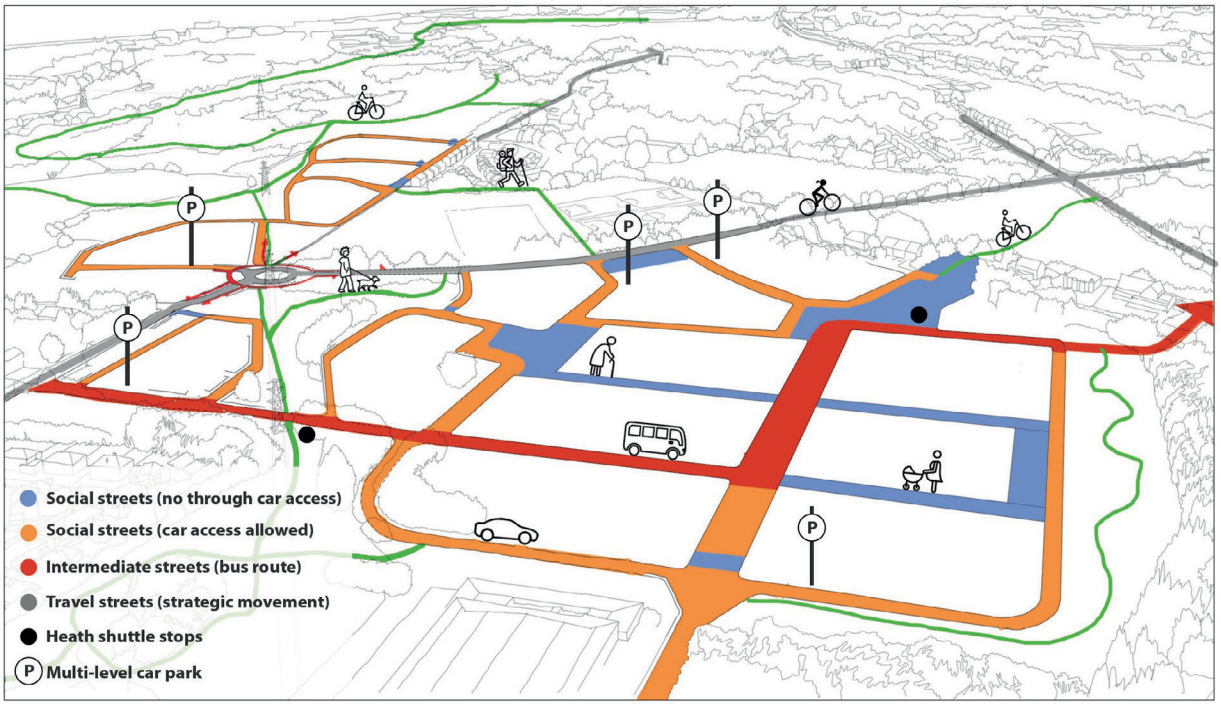


Fig.12: Proposed street network with hierarchy of street types and public open spaces.

Fig.13: Before (inset) and after illustration of the proposed Central Boulevard.

with no through-traffic, 'intermediate streets' for local through-movement, and 'travel streets' for longer journeys; all contributing towards a low traffic neighbourhood (fig.12, 13) (Living Streets, n.d.; Sustrans, 2020). Streets are orientated to protect pedestrians from prevailing winter winds on this relatively exposed hilltop site.

Building on current trends (Klein and Smart, 2017), cars are parked not on streets or plots, but in mechanically-stacked multi-storey car parks, constructed using reclaimed steel and clad with solar panels, and located within 3-minutes walk of everywhere in the scheme. Visitor permits allow direct access to ground floor parking spaces with full headroom: these also accommodate repair shops and electric vehicle-charging stations. Community car club vehicles and e-bike hire pods powered by renewable energy are distributed across the site, further minimising the need to own a personal car.

All streets have trees, positioned to reduce driving speeds by minimising perceived carriageway widths. Main-street trees and front boundary hedges filter particulate traffic pollution, with small-leaved species spaced to prevent their canopies from trapping pollution. Trees on quiet streets are chosen to reinforce distinctive street identities through spring flowers and autumn fruit and foliage.

Land uses

Though plots last longer than the uses they support, the initial pattern of land uses is key to generating an economic potential attractive to ethical investors. Heath Park must therefore perform well in financial terms, within the limits of the social foundation and the ecological ceiling. To make this work, the land-use pattern requires a plot-system that offers synergic relationships with the wider local economy, with the system of streets and natural infrastructure, and between the individual land uses themselves.

In the current Runcorn economy, private residential development - particularly family houses, but also flats, senior living and extra care units – performs best in financial terms. To support both social foundation and ecological ceiling, however, we must also maximise support for affordable housing, and diversify employment opportunities including affordable workspaces and social facilities. To include these less-profitable activities and support an inclusive development while still attracting ethical investment, the overall financial performance is optimised by locating each land-use to make most cost-effective use of the accessibility afforded by the street system, of the potential for creating affordable space by refurbishing existing buildings, and of the therapeutic value of natural infrastructure (fig.14).

Retail and social facilities have the most stringent access requirements. For their economic survival, we have located them where space syntax analysis shows that the street system affords both local footfall and global access. Here facilities such as shops, a nursery and a weekly market, are easily accessible both from Heath Park and wider afield; reducing the need to travel by encouraging people to do things locally.

Housing is less sensitive to street connectivity,

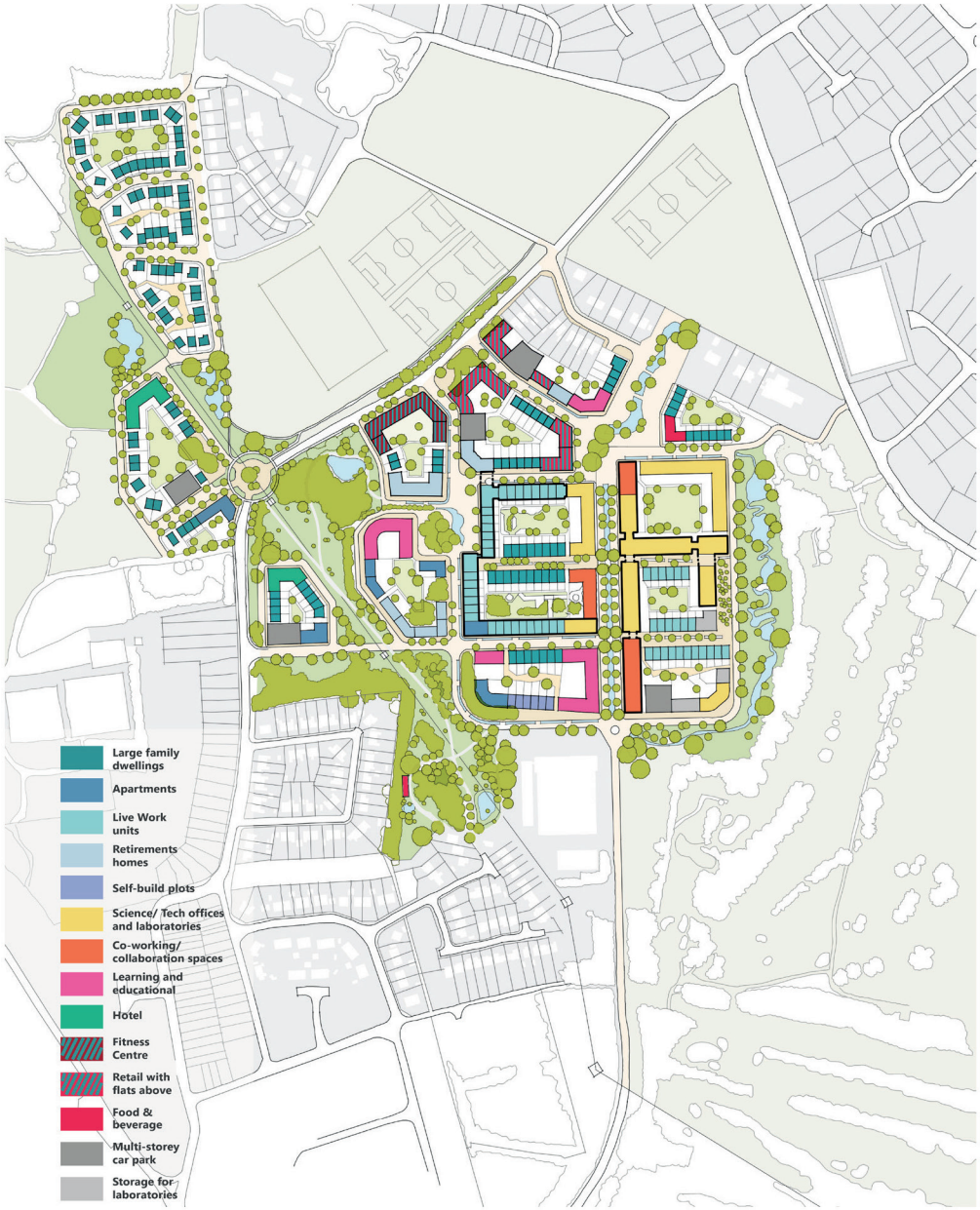


Fig.14: Proposed land use distribution within the masterplan.

but benefits greatly from green infrastructure. All our major green spaces are therefore bordered by housing; with live-work units and denser flats on the most-connected streets, larger family houses on the quietest streets which are safest for childrens' play, and terraced houses and retirement homes in between. Simply-refurbished existing buildings minimise the potential impact of gentrification by allowing a proportion of affordable live/work units, artist studios and maker-spaces in the heart of the scheme.

To create an effective 'beacon' to inspire future development, Heath Park needs a thriving productive economy. The site already has some world-class businesses, but needs diversification to strengthen the social foundation by providing local employment and developing the skills of a wider working community. Heath Park has a strong research tradition, but this is a time for radical innovation: we aim to create a centre for renewing the nature of innovation itself.

Manufacturing and research have traditionally depended on so-called STEM knowledge-areas : Science, Technology, Engineering and their common basis in Mathematics. This STEM silo, however, now limits innovation: it is time to break out; placing increased emphasis on creative as well as critical thinking by integrating more closely with the Arts, to develop a STEAM culture of 21st century innovation (Braund and Reiss, 2019). To promote this at Heath Park, we use minimally-refurbished buildings as affordable arts spaces; supported by a management strategy to promote the use of the streets and social facilities as widely-publicised venues for STEAM art installations, events and discussions.

From land uses to long-life plots

Once a financially-feasible pattern of land uses has been decided, it has to be supported by a longer-lasting system of plots; designed to continue performing well into the future. Any land-use needs a plot of land with an entrance from the street. The frequency of entrances is key to the liveliness of human presence; supporting the overall sense of safety and, in turn, encouraging walking and cycling (Jacobs, 2020).

To support the potential for healthy streets that is embodied in our highly-connected overall layout we need frequent entrances between streets and plots. Security issues, however, mean that we can only guarantee one entrance per plot. To maximise the frequency of entrances, therefore, we have kept the plots as narrow as particular land uses will allow. In the context of our highly-connected street system, active street fronts have been achieved through a 'perimeter block' layout (fig.15).

To encourage social interaction, in a time of stranger-danger exacerbated by coronavirus fears, we have created plots for safe communal interaction and recreation, with controlled community access, within each block. Surrounded by a mix of building types and tenancies, these spaces offer opportunities to meet a wide range of people – addressing the problem of loneliness (Cattan, White, Bond and Learmouth, 2005), but with a 'gasket' of private gardens as a protective interface for family life. Safely disconnected from the wider settlement, these

communal gardens support childrens' development by allowing relatively unsupervised play in outdoor green environments (Louv, 2005). These spaces also include allotments; not only to provide fresh food, but to show children that food does not spring unaided from the supermarket shelf (Parham, n.d.).

Buildings

Working patterns and household structures are changing fast. A mismatch is therefore developing between activity patterns and building design; aggravated by a mainstream design culture of use-specific, non-adaptable buildings responding to short-term market needs and contributing to ever-shorter building lifespans. This has implications for construction-industry waste generation and carbon emissions (BIS, 2010).

Financial pressures limit the diversity of activities that any project can initially contain. Long-life buildings open up possibilities for sidestepping these pressures in the longer term. As buildings age, their rent levels typically fall relative to those that newer buildings can attract; enabling a wider range of users to afford the lower rents;

Fig.15: Multi-plot perimeter block with private back gardens and a resident-only communal garden.

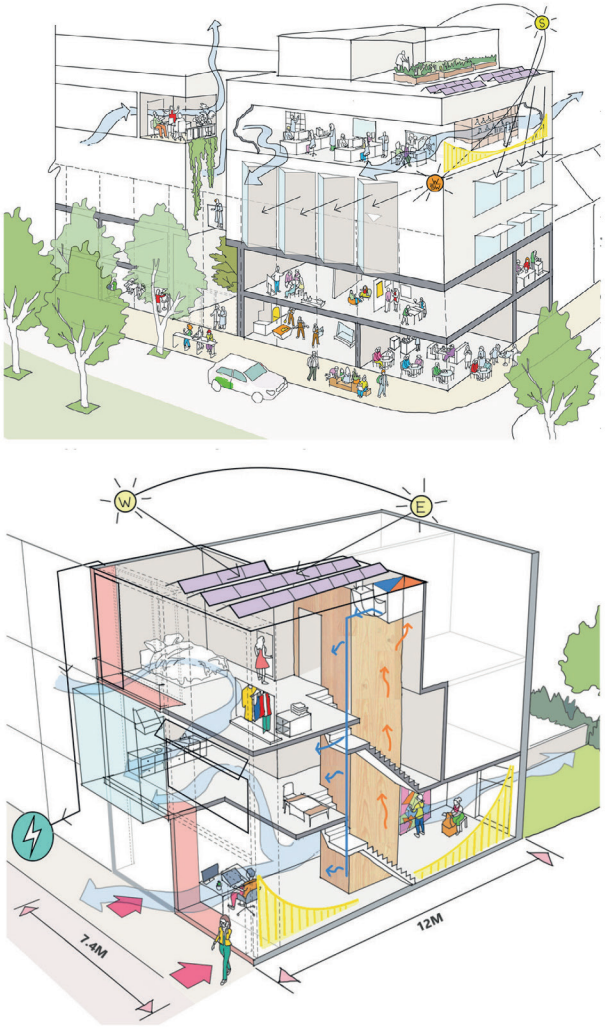


Fig.16: Refurbish and reuse Heath Park's existing building stock, unlocking opportunities for affordable incubator spaces.

increasing diversity over time, and offering people a greater range of activities (Lynch, 1990; Jacobs, 2020) within cycling and walking range, thereby supporting public health. We therefore refurbish and reuse as much as possible of Heath Park's existing building stock, conserving the embodied energy and unlocking opportunities for affordable incubator, art and maker-spaces, powering our transition from STEM to STEAM-led regeneration within upgraded energy-efficient envelopes (fig.16).

Where we propose new buildings, we consider them as complex systems containing tightly nested subsystems. These subsystems typically change at different rates, as human purposes change. The internal space-plan changes faster than the services; which themselves change faster than the services; which themselves change faster than the building's external skin; which in turn changes faster than the structure. The interrelationships between subsystems are designed to ensure that shorter-life ones can always be changed without disturbing others that change more slowly (Greater London Authority, 2020). We call this overall strategy 'slow architecture': the creation of adaptable buildings with active frontage that remain useful long enough to cope with more rapid cycles of social and economic change, contributing to everyday health and to the settlement's overall energy efficiency (fig.17).

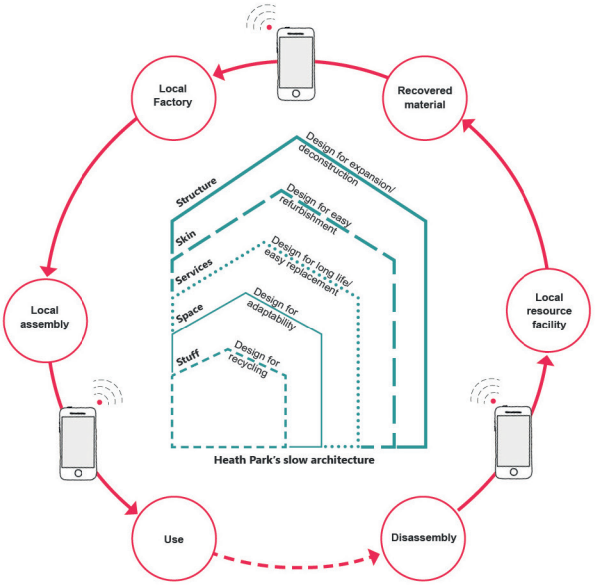


Fig.17: Heath Park's slow architecture.

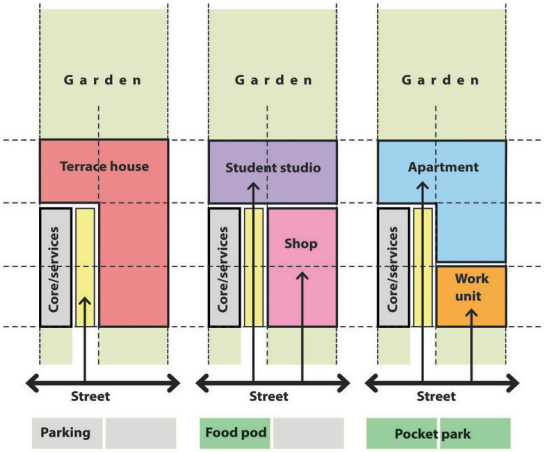


Fig.18: Diagrammatic representations of house plans showing grouping of the 'hard' services and circulation spaces, within a simple grid structure supporting easy re-configuration of the 'soft' internal spaces and external skin.

Each of Heath Park's existing buildings is reimagined as a series of flexible spaces that can be updated to reflect the needs of each generation. Particularly on main streets with potential 'passing trade', the street interface allows alternative configurations to support emerging types of socially-positive commercial businesses or community amenities (fig.18).

The main living spaces of dwellings embody focal spaces such as nooks, bays, and window seats, enabling a variety of individualised activities to take place at the same time and supporting family togetherness (fig.19) against the tide of increasing isolation while supporting the potential for flexible working.

At a closer focus, buildings are designed so that their subsystems together support a circular materials-economy (Greater London Authority, 2020). Materials are selected from renewable sources, and components are designed so they can easily be dismantled for re-use elsewhere.

Fig.19: Internally, the main living spaces benefit from multiple focal spaces, such as nooks, bays, and window seats, allowing a variety of individualised activities to take place at the same time and supporting family togetherness.

Where possible, we use organic materials that will finally degrade to compost, supporting future growth. 'Passive house' environmental standards are achieved through modern methods of construction, creating an overall circular economy for each building.

Utilities and infrastructure

Our utilities infrastructure maximises the potential for resource-sharing and energy efficiency through data-connected networks of energy, water and waste; enabling the operation of a cooperative economy and raising awareness of opportunities for moving towards a carbon-neutral future (fig.20).

To save on-plot space, foster hygienic environments and minimise visual impact, a smart waste system is organised in underground cassettes containing bins for each waste-stream. The separation of waste-streams at source encourages a culture of waste-responsibility, and waste-workers' health is safeguarded by avoiding the need for manual handling of the waste or containers. A smart sensor-based system reduces the overall carbon footprint by summoning the collection vehicle only when bins are nearly full; avoiding the need for disruptive regular 'bin days' whilst minimising vehicle-miles and pollution. Separately-collected organic waste is transported to a Composting Centre adjoining the Living Machine, itself a source of organic waste. Compost is then distributed to local growers; enabling an overall system of soil to soil agriculture.

Tuning for atmosphere

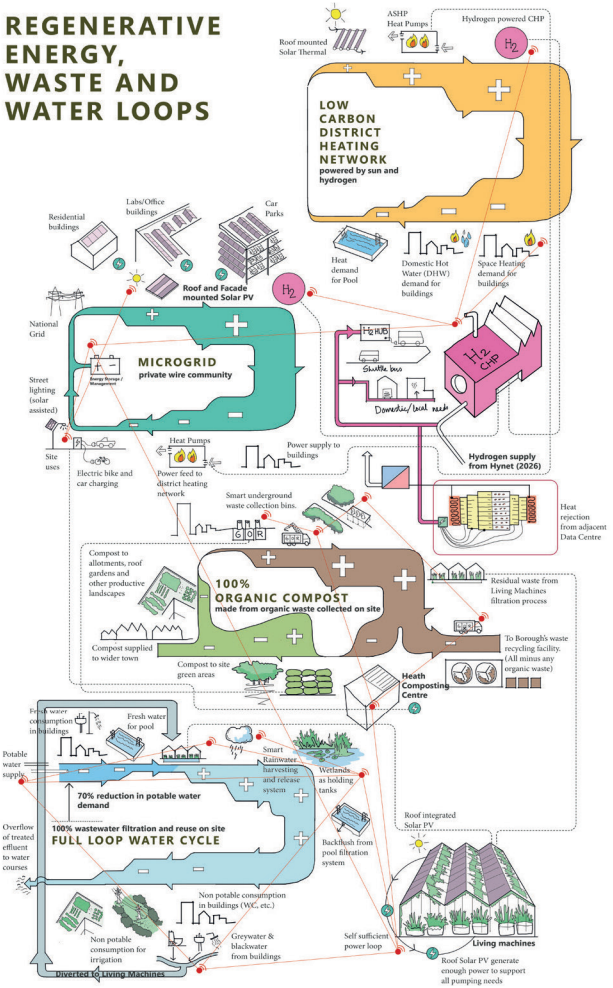


Fig.16: Regenerative utility loops of energy, water and waste.

There is widespread evidence that aesthetic experience affects people's sense of wellbeing (Altman and Wohlwill, 1983). As any developer knows, this means that perceived aesthetic quality also affects the financial value of any project. Aesthetic experience also affects how long buildings last: all things being equal, well-loved buildings last longest. A low-carbon circular economy, in which buildings are reused and recycled to the maximum, requires aesthetically-valued buildings that will become the listed buildings and conservation areas of the future. For all these reasons, aesthetic quality will directly affect our proposal's ability to compete in the ethical investment market.

Climate crisis has triggered a revolution in Modern Methods of Construction (MMC), but nobody loves buildings with 'prefab' connotations. Heath Park gives us the opportunity to reimagine architectural aesthetics from this new low-carbon perspective; to generate new, aesthetically-positive forms for MMC. To find this new aesthetic, we have had to broaden our understanding of the nature of architecture as an art form; taking a STEAM approach to working with ideas and colleagues from biology, psychology, neuroscience and mathematics.

Our starting point is the fact that the human sensory system evolved - long before the first towns - for the efficient processing of survival-information from natural systems; ranging from coastlines through trees and plants to birdsong (Joye, 2007). Though most of us now live in towns and cities, these have only existed for a fleeting moment in evolutionary time, so we are still adapted to processing 'natural' information. As mathematician Benoit Mandelbrot discovered (Mandelbrot, 1983), the huge diversity of natural systems all exhibit the same 'fractal' organisation; in which elements are nested together at multiple scales: many trees in a forest, many branches in a tree, many twigs on a branch, many leaves on a twig; with many veins on a leaf at the smallest scale our unaided senses can register. Our senses are adapted to processing sensory information from structures that have these fractal characteristics: as psychologist Richard Taylor puts it, we have 'fractal fluency' (Taylor and Spehar, 2016). For us, fractal fluency is a fundamental aesthetic principle, guiding the design of Heath Park's materiality.

To create this fractal aesthetic at Heath Park, we start from the overall scale of each street space. We then organise this into functionally-useful sub-spaces, defined by large elements such as trees, lighting, major building articulations or occasional STEAM artworks. Then smaller-scale functional elements, such as street lamps or plants, subdivide each of these spaces in turn. Then, at a smaller scale still, particular surfaces of buildings or floorscapes are subdivided by joints between materials, glazing bars and so forth; and so on down to the fine-grained textures of particular building materials (fig. 21).

This process of tuning the materiality of design to its users' fractal fluency is not a 'new design style'. As far as possible, we are not making arbitrary stylistic decisions at any point in the overall design process: for us, design is a process of balancing sensible functional deci-

Fig.21: Multi-scalar fractal architecture rooted in organised complexity: details within the simple overall forms maintained at every scale – so as you go closer and closer something new is revealed.

sions against their fractal outcomes. In the case of small-scale, short-life elements that are easily altered, we are keen to exploit the capacity of modern technology such as 3D printing to help users create their own personalised elements such as door and window details, much as the village blacksmith might once have done: this is modern technology's version of vernacular design.

Conclusions

This complex-systems design approach, strongly-supported by the SOG group as an enlightened client, has proved itself in practice; both as an effective working process and in terms of its design outputs. At the process level, it helped the client and other members of the design team to understand how their individual concerns fitted together to make a complex whole more than merely the sum of its parts. The holistic quality resulting from this process was acknowledged in the RIBA jury panel's comments on the competition-winning masterplan proposals (fig.22).

In terms of design output, the RIBA competition-winning scheme later formed the foundation for a more detailed feasibility study for the SOG group. At this stage, the competition proposals were pressure-tested, and further developed to balance the environmental and social values against the commercial value required to attract ethical investors and the residual land value desired by the SOG group.

In terms of the social foundation, analysis suggests significant increases in on-site employ-

Fig.22: RIBA jury panel comments on Heath Park 'Vision of the Future' competition-winning proposals.

ment, apprenticeship, training and volunteering opportunities, both during and after construction; together with benefits to the wider local economy through employment associated with the wider supply chain, and significant increases in disposable income to support the local economy. In relation to the ecological ceiling, natural capital accounting demonstrates a significant gain in ecosystem services, both for the site and for the wider region. Economic assessment of environmental value also suggests that the natural infrastructure will impact positively on land and property values, and will contribute positively to the broader economic context through improved health and biodiversity – areas where there is no "market" to provide a pricing mechanism. Financial analysis strongly suggests that elements supporting the social foundation and the ecological ceiling, traditionally regarded as costs, can have positive implications for overall financial viability.

Overall, then, the feasibility study indicates that our complex-systems approach, supported by a sympathetic client, has enabled the negotiation of a new future for Heath Park in which financial value is balanced with values that support both the social foundation and the ecological ceiling (fig.23).

Underpinned by its high ESG credentials, the project has been recognised at government level by selection for the Global Investment Atlas, and showcased through the 'Global Investment Summit' in October 2021.

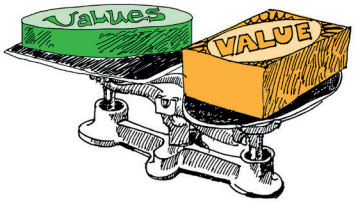


Fig.23: Financial value balanced with design values at Heath Park.

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