12 Vibrant Cities

A soil was not a thing ... It was a web of relationships that stood in a certain state at a certain time. (Logan, 2007, p.96)

12.1 Overview

This chapter explores how vibrant matter may be applied within an urban context through the design and construction of webs of living materials that constitute complex fabrics, such as our soils, which may be synthetically produced within underused and under-imagined spaces within our home and cities (see Fig. 12.1). The careful design and engineering of these fabrics may provide designers with access to a new kind of production platform that may not only change our design practices but also shape new cultural values. Potentially, these post-natural fabrics may offer a fertile field of new possibilities, which may give rise to vibrant cities where human and non-human communities collaborate and codesign our living spaces and evolve alongside us as expressions of Millennial Nature.

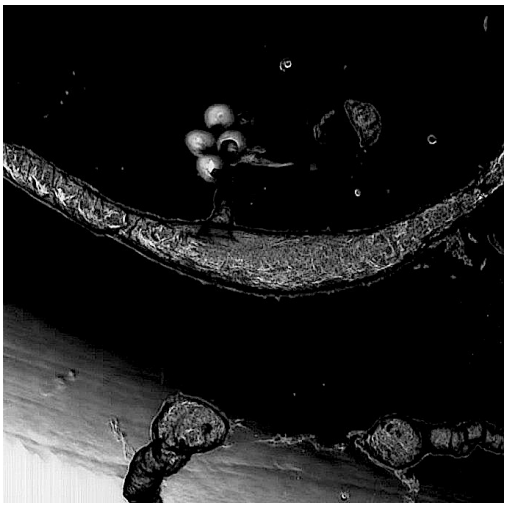

Figure 12.1: Complex chemical structure produced by dynamic droplets in an oil medium is reminiscent of the micro-channels that exist between soil particles. Micrograph, magnification 4×, Rachel Armstrong, August 2012.

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12.2 Soils as ELT

Architecture is both responsible for and can take action against the destructive environmental practices that have characterized the last 150 years, by proposing new ways of underpinning human development that work in opposition to the prospect of a sixth great extinction event (Sample, 2009). Contemporary society draws from a world that is less determined by objects and increasingly shaped by connectivity. This perspective has become more than an academic conjecture, but an everyday reality through our growing reliance on global telecommunications systems. The clear either/or distinctions that formerly shaped our experiences of the world are being replaced by a much more fluid relationship with reality where identity is no longer fixed but can coherently and simultaneously exist in many states. This complex worldview extends to the characterization of Nature, which is made up of many interacting bodies that have been historically recognized as the animal, plant and mineral kingdoms (see Fig. 12.2), which are seamlessly entwined in ecological systems and collaborate through evolutionary acts (DeLanda, 2000, p.26).

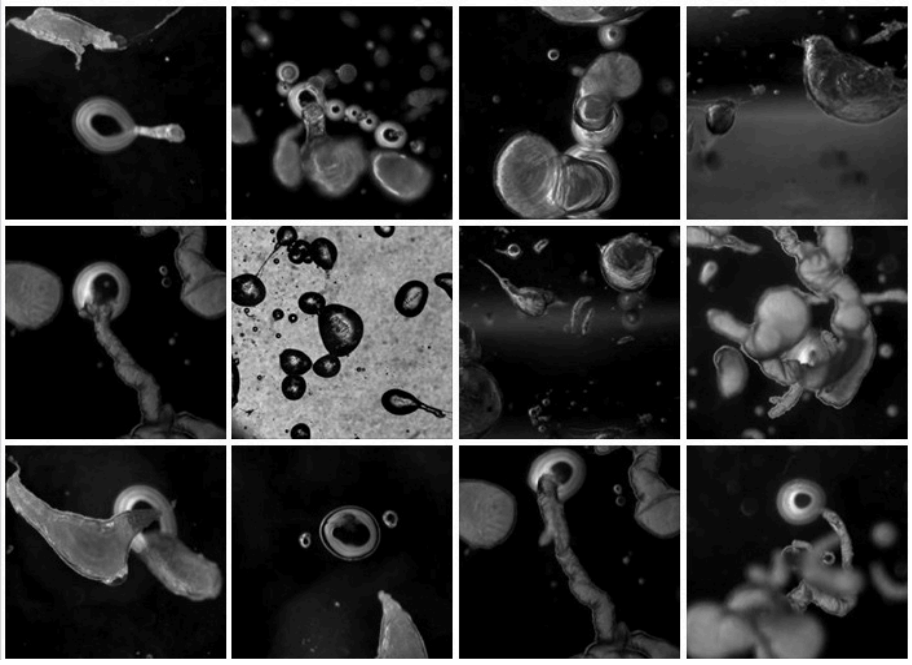

Figure 12.2: Complex structures produced by dynamic chemistries may relate to the spatial complexity produced by metabolisms, which enable the evolution of soils. Micrographs and collage, magnification 4×, Rachel Armstrong, February 2012.

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The story of soil best embodies the enriching, complex exchanges within the structure of matter. The Earth was not 'born' with soil but has acquired its living web of relationships over the millennia (Logan, 2007). Indeed, Latour proposes that when thinking about natural processes we should use the term 'geostory' rather than 'history'. Geostory is a non-human narrative that stretches back in time before the evolution of our species and is forged by agents such as tectonic plates, microbes, meteorite impacts and ice sheets. It foregrounds all the actors backgrounded by history in an ontology of events where the past is understood as being more like an opera than a formal 'design', whose endurance in the present depends on its constant re-telling (Latour, 2013). Soils constitute the outermost layer of what the 19th-century geologist David Thomas Ansted (1814–1880) called 'the great stone book of nature' (Ansted, 1863), which offers a coherent, unified story that contains its own history. Soils can be up to several million years old, though many North American and European species date to the end of the last glacial period, around 15,000 years ago. Soils are attractors of terrestrial life. Plants take root in their complex chemical bodies, where organic and inorganic particles are entwined within a matrix that harbours fungi and bacteria. These complex assemblages, forged by many participating bodies, form a self-perpetuating system that breaks down the bodies of dead creatures and turns them into more soil. The speed of this dynamic conversion process varies. In fertile areas it may take 50 years to produce a few centimetres of soil, but in harsh deserts it can take thousands of years.

Our living soils age as a consequence of natural causes, such as changes in the climate. Yet, increasingly, their vitality is being impaired as the result of artificial and biological factors, such as overgrazing and deforestation. Ultimately, soils die, and when they do, they are gone forever. These acts of wanton destruction are due to our rapid expansion, technological naiveté and, as Allan Savory notes, our universal tendency to simplify the complex processes of ecosystems in agricultural management practices (Savory, 1998; TED.com, 2013a). In these last few milliseconds of evolutionary time, when Homo sapiens appeared on the Earth, we have globally acted upon our abstractions of the world at an exponential pace. Whitehead warns about our reliance on abstractions, and while he acknowledges that they are vital for our construction of ideas, he asks us to carefully consider what is at stake when we adopt them (Whitehead, 1979, p.15; Whitehead, 1968, p.116).

Indeed, our very modes of thinking have disrupted the existing complex ecosystems that we rely on, as we have embraced an increasingly globalized, industrialized culture. New ways of thinking may therefore help us address the resultant imbalances, although it is impossible to say whether we still have time to turn our environmentally destructive, modern legacy around, since ecologies are as fragile as they are resilient.

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12.3 Architecture As a Site for Ecological Revival

> *Crucially, I think that city making is not a planning process; it's a becoming process. Because we can only partially see the results of what we do, we live in the face of mystery. There's magic and there's enchantment. And that leaves us with deep questions as human beings because we've been taught that we can know, master and optimise. We have to think in new ways about how to do that wisely.* (Kauffman, 2012)

Potentially, architecture offers a site for ecological regeneration and synthesis. Its sheer scale rivals our fertile biotic soils, which promote life, diversify ecologies, recycle resources and propagate globally. Soils are biological cities that are replenished by the diverse communities and countless networks from which they are formed (see Fig. 12.3).

The evolution of soil has laid the foundations for the establishment of life on Earth, the flourishing of ecosystems and the fertile conditions that enabled humans to construct the first cities around the potent soils formed around deltas such as the Nile, Tigris and Euphrates. The archaeology and foundations of contemporary architecture therefore depend upon the rich infrastructure of soil systems. While soils are many

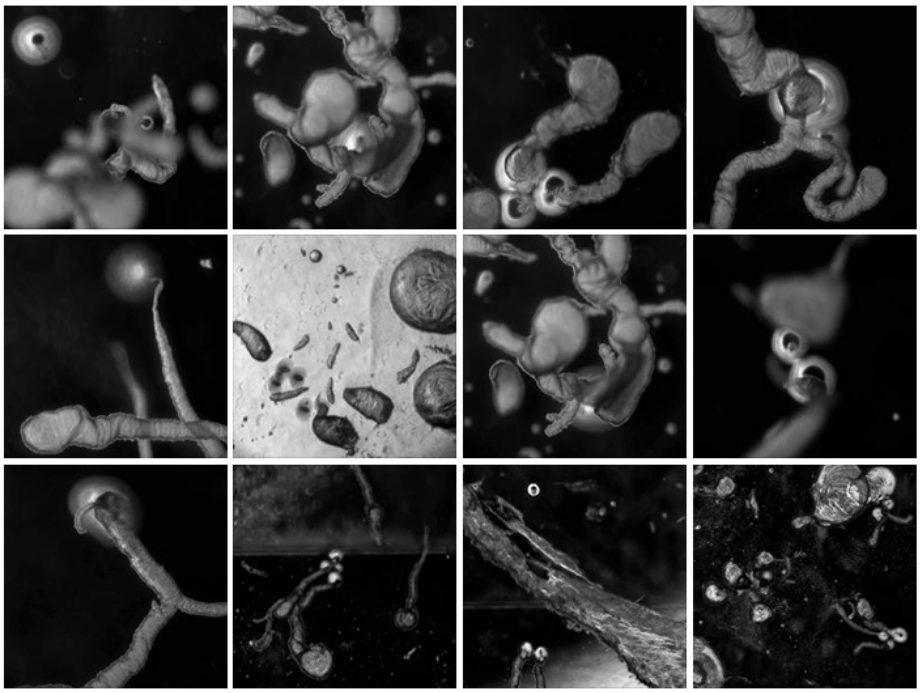

Figure 12.3: Dynamic chemistries depict a series of evolutionary transformations that embrace a range of transformations and capacity to complexify their environment. Micrographs and collage, magnification 4×, Rachel Armstrong, February 2012.

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thousands of years old, even the oldest cities are only very young in comparison to them, being no more than a few thousand years old. Antep is the most ancient currently inhabited city and dates back to the old Hittite period (1750–1500 BC) but many modern cities are only hundreds of years old. George Orwell notes, 'man is the only creature that consumes without producing' (Orwell, 1979, p.4), and our ravenous cities are parasitically draining terrestrial soil bodies of their vast mineral and biotic resources. While biotic soils are self-renewing, the dirt produced by modern cities is not meaningfully returned and recycled in self-regenerating systems of material restoration, but is isolated, sealed in garbage dumps and landfills, or scattered into our oceans as sewage, where it is prevented from forging productive ecological networks.

Modern cities are literally made of the same kind of stuff as soils. What separates a building from soil is simply time's arrow (Prigogine, 1997, p.1). Inert materials such as concrete, brick, clay, stone, steel and wood are simply technologically processed agglomerates of molecules that are already present in dirt and will return to dust if they are not maintained. Indeed, classical building substrates could be thought of as soil components that have been reverse-engineered from complex, heterogeneous systems into simple, obedient geometric forms. Nature abhors homogeneity and seeks to recomplexify these substances (see Fig. 12.4).

So, in the same way that soils have been forged by grinding glaciers over thousands of years, the surfaces of buildings are being weathered and sheared by the

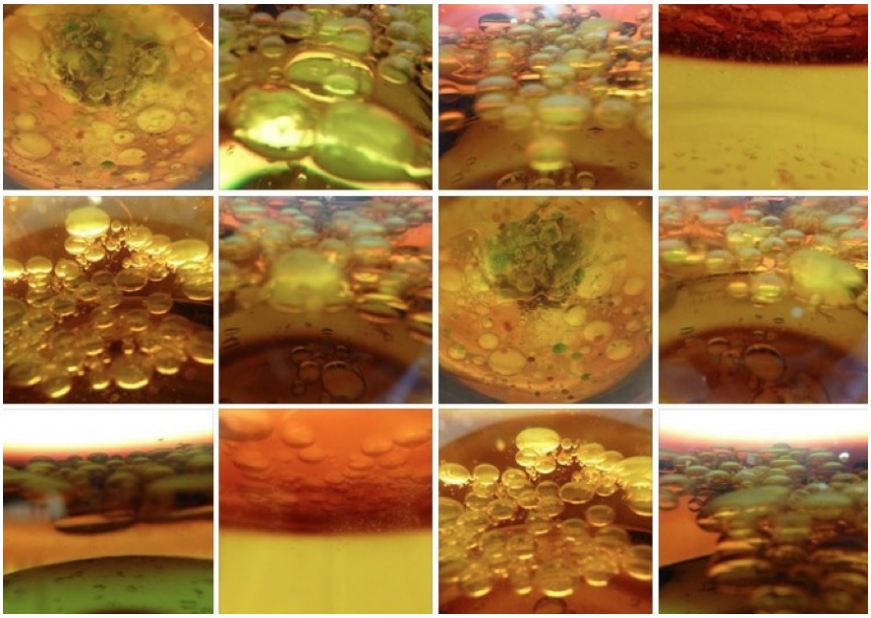

Figure 12.4: Like soils, mineralized structures produced by dynamic chemistries may become more complex by virtue of their metabolisms. Photographs and collage, Rachel Armstrong, February 2011.

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same forces that created our primordial dirt. Moreover, they are invaded by microbial life that tears apart their inert infrastructure to reveal, expand and vitalize new surfaces, which can be further colonized by living invaders and through the biological process of succession. Sites of decay can be thought of as unfolding, active chemical interfaces that are symptomatic of the presence of life-giving processes and may be regarded as ecologically potent locales. Indeed, Hundertwasser notes that there is much to learn architecturally from the decomposition process. 'When rust sets in on a razor blade, when a wall starts to get mouldy, when moss grows in a corner of a room, rounding its geometric angles, we should be glad because, together with the microbes and fungi, life is moving into the house and through this process we can more consciously become witnesses of architectural changes from which we have much to learn' (Hundertwasser, 1976). Ambasz worked more directly with the notion of soils as regenerating substrates by promoting the use of landscaped terraces, earth-sheltered roofs and underground dwellings as a way of returning the very land that cities took away. He sought not only the disappearance of architecture, but for it to be absorbed into new artificial natures (Dean, 2011, pp.230–231).

Although cities (Kazan, 2008) and the Earth's ecosystems[79] have been likened to organisms, technically they do not qualify as such. The current definition of 'organism', or life, does not embrace the pervasive bodies that comprise soils and cities, and nor do they possess any centralized genetic program. Yet the similarities between cities and soils are striking, as they are complex and share, in principle, many of the characteristics of organisms. Jan Christiaan Smuts noted that materials possessed a unique spectrum of agency, or lifelike characteristics, which ranged from crystals to biology (Smuts, 1998, p.88). The importance of lifelike systems lies in their subtle, persistent behaviours, which, without human intervention, spontaneously generate infrastructures and systems where life may thrive. It is this quality that falls apart in cities, as their materiality is eroded with time and not re-enriched through ecological cycles of material exchange. For example, the city of Venice, with no living characteristics, is simply unable to fight back in the struggle for survival against the elements. Yet, a myriad of biological agents are extracting minerals from the water and (re)assimilating the city fabric to build their own accretions and microbial 'cities' (see Fig. 12.5).

79 In 1785 James Hutton, the father of modern geology, envisaged the Earth as a metaphorical 'super-organism'. He suggested that its circulatory and respiratory cycles were geological processes such as erosion.

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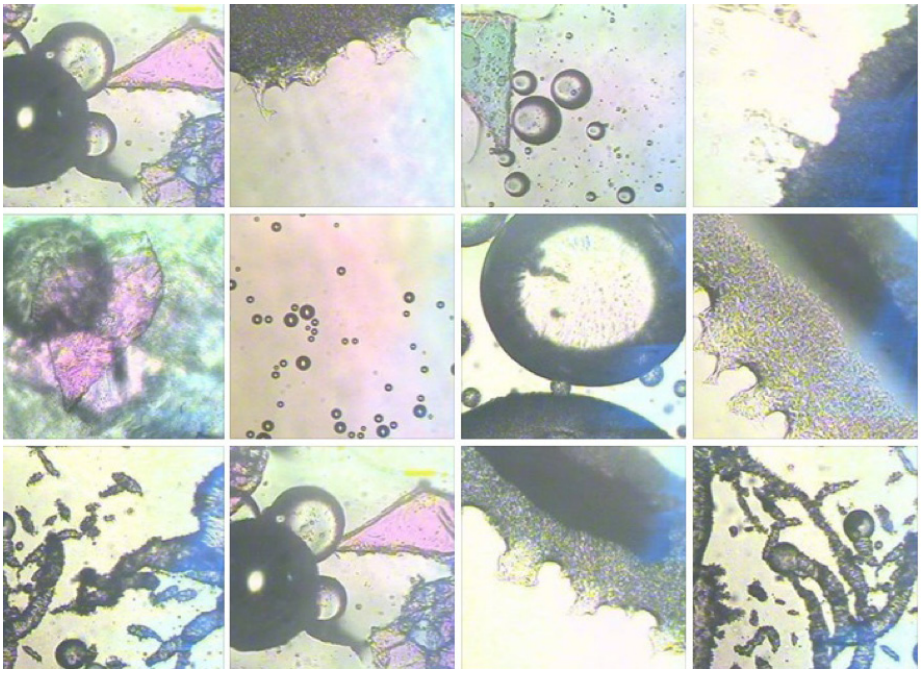

Figure 12.5: Dynamic droplets form weak bonds to produce assemblages which amplify their effects through recruitment. Micrographs and collage, magnification 4×, Rachel Armstrong, February 2009.

12.4 Soils as Architectural Infrastructure and Technology

> *... its substance is dark and malleable and thick, like the pitch that pours down from the sewers, prolonging the route of the human bowels, from black hole to black hole, until it splatters against the lowest subterranean floor, and from the lazy, encircled bubbles below, layer upon layer, a faecal city rises, with twisted spires ... a city which, only when it shits, is not miserly, calculating. Greedy.* (Calvino, 1997, pp.111–113)

The greatest challenge to our near-future cities is in how we can grasp the full material potential within our urban environments to create a new relationship with the natural world. So, rather than depleting resources and polluting our environment with toxic waste, we may be purifying and enriching it. To invoke Cedric Price's metaphor of cities as different types of eggs (Jacobs, 2011) – we need to stop cooking our cities and enable them to develop embryologically from their primordial clay so they may become chickens with a completely different set of properties than they currently possess. So, if we are to embody truly sustainable environments in our cities, then a positive, new relationship between soils and architecture must be established. It is time to end the doom, gloom and skinny corporate corset that has been wrapped around the shapely

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architectural profession by the industrial sustainability agenda. Indeed, 21st century architectural design must crack a few austerity whalebones with an expanding girth of voluptuous substrates that transform the current paradigm of consumption into a new relationship that is blooming with mutual exchange and generosity between humans and the material world. This is not a call for more primitive lifestyles, but highlights the need for architectural tactics in the development of infrastructures and processes, which promote the use of materials in ways that support regenerative and life-giving systems. It is simply not sufficient to reduce our consumptive practices to uphold imposed conditions of scarcity, but essential to develop and promote materially enriching ones, which promote environmental fertility.

Specifically, our cities need to re-establish a productive relationship with their soils as spatial technologies that can organize chemical events and transformational sequences (Tschumi, 2012, p.60). Soils are complex entanglements of self-replenishing vibrant matter, which are penetrated by elemental infrastructures. Such vastly complex overlapping programs enable soils to exist as more than simple surfaces but as entire bodies, with non-hierarchical architectures, which swallowed Darwin's wormstones through living subtractive and printing processes (Bennett, 2010, p.96). Soils are integrating infrastructures on an architectural scale that enables materials to be transformed through their bodies as sequential encounters that occur in the free flow of elemental systems through them, such as air, water, heat and matter. Applying the technology of soils within buildings may not only make better use of our waste water and organic matter, and enable us to grow native, not transplanted, greenery (BBC.com, 2013), but also offer flexible architectural tactics that can deal with multiple, overlapping spatial programs (see Fig. 12.6).

While complex terrestrial forces spontaneously build natural soils, the possibility of artificially engineering soils within an architectural context creates the opportunity to transform the artificial landscapes that characterize the urban environment into fertile sites. For example, the Liesegang ring plates in the Hylozoic Ground installation explored the principles for developing a simple soil matrix, where a homogenous gel was transformed into self-organizing, evolving layers of different colours and thicknesses, where multiple programs – precipitation, dissolution, colour change, gravity – entangled to create a range of events (structural and process-led) that changed with time. Of course, much work still needs to be done before the gel could be functionally likened to the complex self-enriching systems of natural soils. A soil system would, for example, need to facilitate cycles of exchange and feedback, contain air-filled cavities and organisms, and be capable of compost production. However, these first design-led experiments suggest that it may be possible to produce complex, self-regenerating bodies by orchestrating the interactions of multiple biological, physical and chemical agents. Currently, the production of synthetic soils is bio-inspired and follows a terrestrial paradigm that relies on particular chemical blends and physical properties. Reimagining the nature and functions of soils in ways that go 'beyond' our current knowledge and expectations of them could create an

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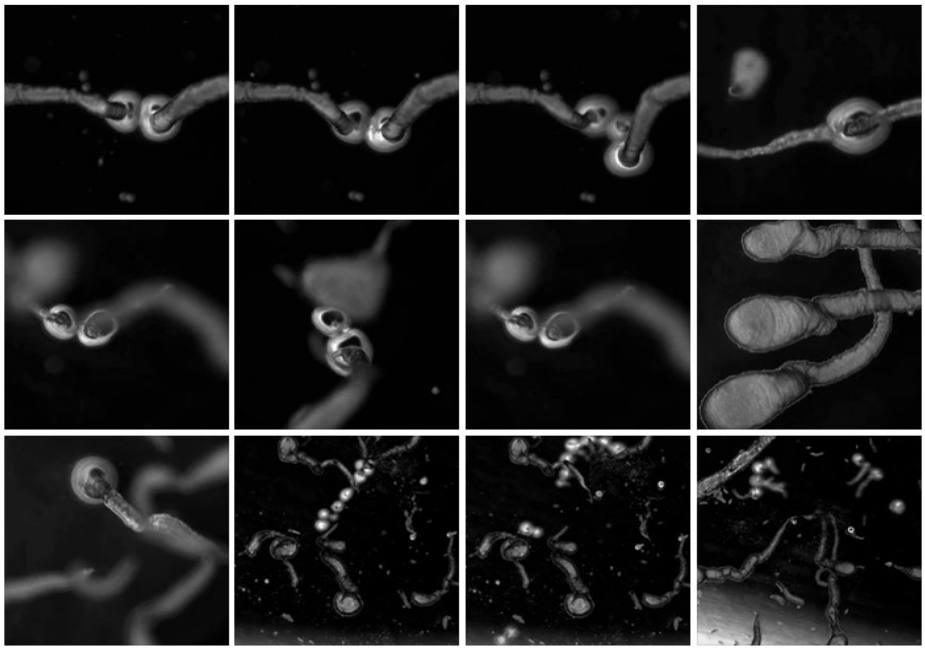

Figure 12.6: Dynamic chemistries introduce new temporal and spatial programs into microscale construction sites by spatially transforming, rather than consuming, their surroundings. Micrographs and collage, magnification 4×, Rachel Armstrong, February 2012.

additional portfolio of architectural strategies to increase fertility within desert-like urban landscapes and sustain healthy organic recycling systems.

By framing the idea of soils as complex assemblages of self-regenerating vibrant matter that are designed to support the development of all kinds of habitats, it may be possible to develop an architectural design practice that is concerned with many facets of evolving soil-like systems. These materials may be designed from a portfolio of codesigning agents such as lifelike chemistries, self-assembling systems and different species of ELT. Yet, the degree to which lifelike chemistries will integrate with simple cellular systems, such as algae, is not known. Future research will aim to produce a soil system in the long term that draws from chemical self-organization using liquids, gels, foams, colloids, coacervates and solid matrices such as fibreglass to establish catalytic sites for chemical transformation and physical means of transport. These may then be evaluated to build a coherent system that facilitates meaningful physiological exchanges within architectures which may, for example, act as possible nutrient delivery systems for the propagation of biofuel-producing algae, or harvest substances from traditional composting methods (see Fig. 12.7).

Such activity could take place invisibly in existing architectural spaces that are under-imagined. Currently, cavity-wall insulation is filled with inert materials, such as fibreglass and foams, which perform no useful functions other than to trap

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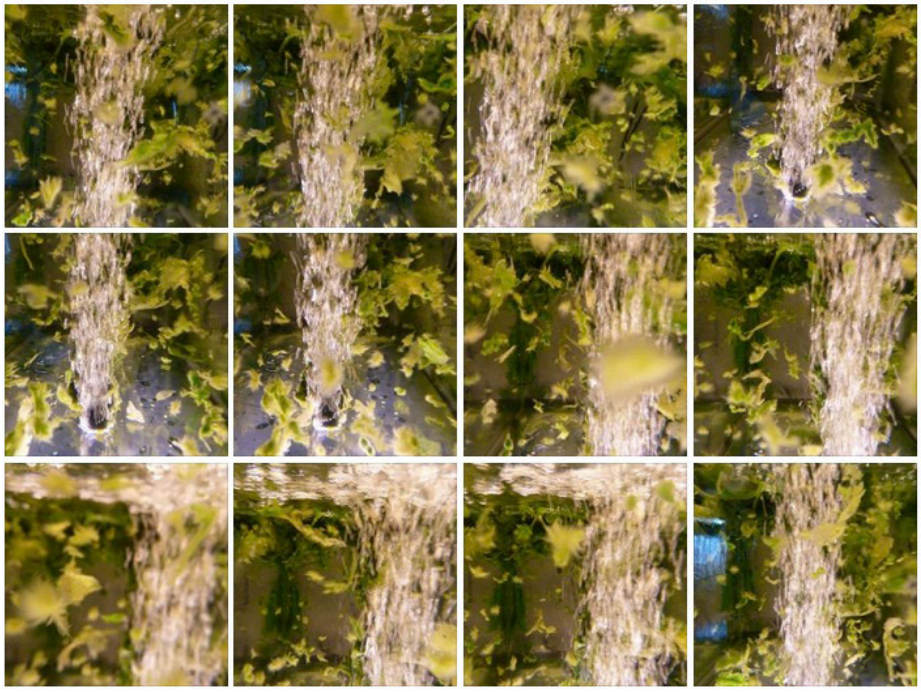

Figure 12.7: Algae can fix light and carbon dioxide to produce rich, organic landscapes whose biomass – which seemingly comes from the ‘air’ – may contribute to the development of fertile soils. Photographs and collage, Rachel Armstrong, August 2012.

insulating air. Yet, within these same spaces, soils could act as filters for purifying wastewater, transforming organic matter into heat, provide insulating functions and convert these passive spaces into physiologically active sites. The composting process produces comfortable, slow-release chemical energy that could be controlled simply by letting more or less air into the system. Should our grid systems fail in an emergency, then soil-producing units may increase our survival by filtering grey water, dealing with human waste, growing food and providing heat. They may also increase the city’s resilience to withstand and recover from potentially catastrophic assaults by enabling its inhabitants to subsist, at least for a while, off-grid. Indeed, composting is already growing in popularity. Armed with ‘red wrigglers’, a species of worm, New Yorkers have started a composting revolution where organic waste is turned into nutritious soil (Robbins, 2012). Yet waste matter may also be transformed and applied in different ways, using different techniques and technologies. For example, composting materials could be pressed into bricks for building, or may even be saleable to soil collectors who would transport fresh compost to farms outside the city. The winners of the Bill and Melinda Gates concept challenge to ‘redefine’ the toilet have developed novel systems for transforming human waste into electricity

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with microwaves (Ungerleider, not dated), recycling urine to flush (ABC Science, 2012) and turning excrement into charcoal (Rodriguez, 2012). Yet, although the substances involved in soil production are culturally regarded as base matter, design practice is also able to confer new meaning on them. For example, the Philips Microbial Home project (Microbial Home, 2011) proposes a series of luxurious products where the house of the future is viewed as a biological ecosystem capable of filtering, processing and recycling what would normally be considered as garbage (McGuirk, 2011). Rather than following the modern obsession for sterility – the idol of a death-centric culture – Philips proposes a new relationship with microbes to run our homes and invite them in as productive members of our community through the process of soil production. For example, bacteria may provide bioluminescent lighting (Myers and Antonelli, 2013, pp.68–69), make biogas and even recycle unwanted plastics (Kanellos, 2009). It is possible that by incorporating the principles and practice of vibrant matter into our near-future cities, our living spaces will have a much richer infrastructure than today.

These soils and elemental infrastructures may nurture living communities of biological and chemical agents whose outputs could be monitored through smart sensors, or even developed as urban gardening practices. They may be conspicuous structures or invisibly woven into the building fabric to make more efficient use of resources. Yet these radical solutions are also compatible with our diverse needs and lifestyles, being applicable across a breadth of architectural styles, property types and geographic locations, so communities may adopt them without sacrificing historical traditions and cultural identities. Different soil-producing systems may share the same kind of local variations, complexity and ability to influence biospherical systems as native soils, which transform our biologically desert-like urban environments into fertile, biodiverse ones (Armstrong, 2013a). Rather than being the horizontal, geometrically defined amount of dirt we have beneath our feet, soil may be regarded as an architectural technology that nurtures the development of vibrant cities. Reconnected to an ecological set of relationships that link the development of cities to soil production, human development may then begin to thrive on the multitudinous networks that exist between human and non-human communities (see Fig. 12.8).

12.5 Summary

> *Her knowledge goes back only to the dawn of Time. But if she could have looked a little further back, into the stillness and the darkness before Time dawned, she would have read there a different incantation.* (Lewis, 2001, p.176)

By applying the material and technological principles of vibrant matter in architectural design practice, it may be possible to develop vibrant cities. The kinds of infrastructure that may support these lively communities of collaborating human and non-human bodies may be similar to our biotic soils (see Fig. 12.9). Potentially,

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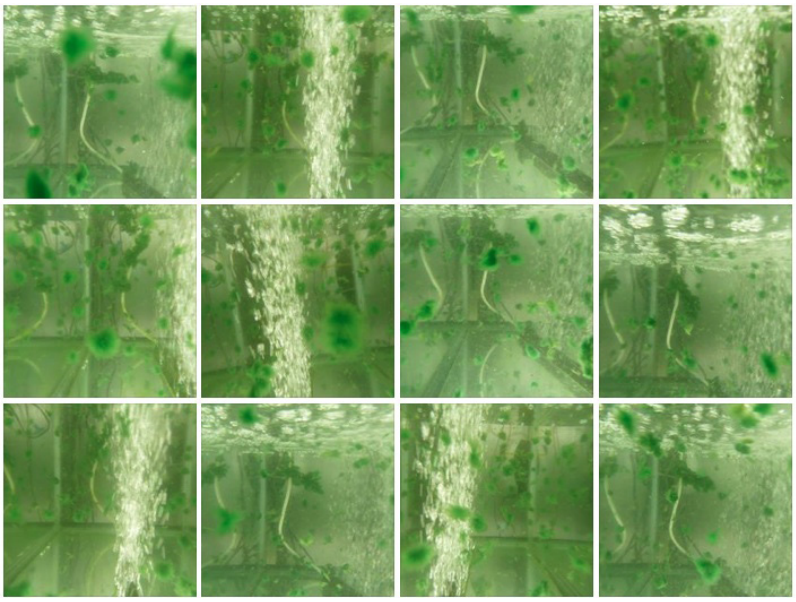

Fig 12.8: With the right infrastructural support, algae perform active roles in the construction of space and generate the infrastructure for further chemical events. Micrographs and collage, magnification 4×, Rachel Armstrong, February 2012.

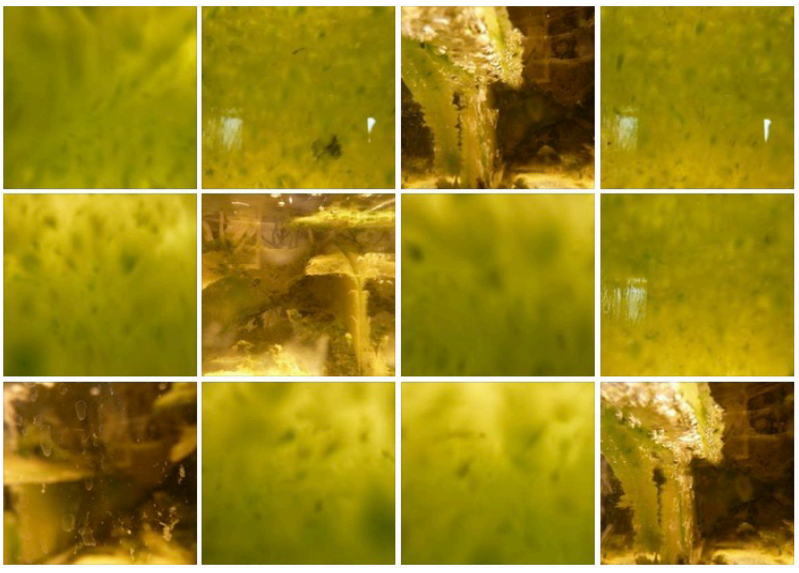

Figure 12.9: Metabolic exchanges can produce fabrics with generative potential. Micrographs and collage, magnification 4×, Rachel Armstrong, February 2012.

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by strategically orchestrating the flow of matter through our cities, we may discover new ways of developing our homes and cities as continual, collaborative acts of co-evolution with non-humans. These developments may extend the traditional notions of architecture as barriers between humans and the natural world, which are concerned with site and shelter. Instead, the built environment may be considered as the urban-scale production of synthetic soils and post-natural landscapes, which may ultimately contribute to our collective survival.

The following chapter speculates on how urban post-natural fabrics may influence and even alter catastrophic natural events, by conferring our living spaces with resilient, robust qualities that can deal with unpredictability and, in essence, are designed to promote 'life'.

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