CIRCULATIONS AND METABOLISMS:

(HYBRID) NATURES AND (CYBORG) CITIES

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Abstract

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The first objective of this paper is to foreground the tropes of ‘circulation’ and ‘metabolism’ as possible entries to theorise and analyse socio-natural things. While a host of fashionable metaphors, such as collectives, networks, imbroglios, associations, hybrids, cyborgs, have been proposed in recent years as entries into the understanding and excavation of socio-natures or techno-natures, this paper maintains that ‘circulation’ and ‘metabolism’, situated within a historical-materialist perspective, might offer a view of the ‘production of nature’ that is more sensitive to change, process, conflict, and flow, while transcending the modernist binarisation of the world into a social sphere on the one hand and a natural sphere on the other. The second, related objective, is to mobilise ‘metabolism’ and ‘circulation’ as socio-ecologial processes that permit framing questions of the environment, and in particular, of the urban environment, in ways that are radically political. Thirdly, we wish to propose a framework for analysis that permits viewing the modern city as a process of fusing the social and the natural together to produce a distinct Cyborg urbanisation. The paper concludes by considering how politicising ‘metabolism’ opens up the theoretical and practical possibility for creating the (urban) environments we wish to inhabit.

Keywords: Modernity, Hybridity, Metabolism, Circulation, Political Ecology, Urbanisation

Human beings have a history because they transform nature. It is indeed this capacity which defines them as human. Of all the forces which set them in movement and prompt them to invent new forms of society, the most profound is their ability to transform their relations with nature by transforming nature itself (Maurice Godelier, 1986: 1ff).

Il faut être absolument moderne! (Arthur Rimbaud, 1873)

Nous n'avons jamais été moderne (Bruno Latour, 1991)

1. Cyborg Cities: the Urbanisation of Nature.

> 'A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction' (Haraway, 1991: 149)

Frederic Jameson (2002) concludes his most recent discussion of Modernity with Arthur Rimbaud's clarion call to become modern, to embrace the modern, to turn becoming modern into a life project. It sounds exciting and exhilirating, particularly because Rimbaud declared (in 1873) that we are not modern yet; it is about getting there, becoming, it 'gives us something to do' (Jameson, 2002: 211). Latour (1991), almost a century later, reminds us that we have not completed this mission; in fact, he insists, the project of becoming 'modern' derailed even before it was well under way. The mesmerising and tantalising experiences and practices unleashed by the vortexes of modernity were too chaotic, confusing, and complex for modern science to embrace and live with. The uncertainties of acting within the confusions of the

modern experience were plainly too threatening and frightening to contemplate. And this anxiety around the ambiguities, the uncertainties, and 'risks' of becoming modern is a spectre that keeps haunting both theoretical and political praxis. While the fear of the modern keeps us in its grip, modernity as a process of intensifying socialisation of nature and of an accelerating urbanisation of nature unfolds under the aegis of those who are enchanted by its promises and enthralled by what it delivers.

As Raymond Williams already pointed out in *The Country and the City* (Williams, 1985 (1973)), the transformation of nature and the social relations inscribed therein are inextricably connected to the process of urbanisation. The dialectic of environment and urbanisation consolidates a particular set of social relations through "an ecological transformation which requires the reproduction of those relations in order to sustain it" (Harvey, 1996: 94). These socio-environmental changes result in the continuous production of new 'natures', of new urban social and physical environmental conditions. Urbanisation is a process of de-territorialisation and re-territorialisation through metabolic circulatory flows, organised through social and physical conduits or networks of 'metabolic vehicles' (Virilio, 1986). These processes are infused by relations of power in which social actors strife to defend and create their own environments in a context of class, ethnic, racial and/or gender conflicts and power struggles. Under capitalism, the commodity relation and the flow of money veils and hides the multiple socio-ecological processes of domination/subordination and exploitation/repression that feed the urbanisation process and turn the city into a metabolic socio-environmental process that stretches from the immediate environment to the remotest corners of the globe (Kaika and Swyngedouw, 1999). Indeed, the apparently self-evident commodification of nature that fundamentally underpins a market-based society not only obscures the social

relations of power inscribed therein, but also permits the disconnection of the perpetual flows and circulations of metabolised and commodified nature from its inevitable foundation, i.e. the transformation and urbanisation of nature (Katz, 1998). The environment of the city (both social and physical, public and private) is the result of a historical-geographical process of the urbanisation of nature (Swyngedouw and Kaika, 2000), and is deeply caught up in evironmental ideologies, practices, and projects (Kaika, 2004). In sum, the city embodies produced socio-ecological processes and, consequently, the process of urbanisation is an integral part of the production of new environments and new natures in which socio-natural processes combine to produce historically specific geographical configurations (see, among others, Smith (1984; 1996; 1998); Cronon (1991); Castree (1995); Davis, 1998; 2002; Desfor and Keil (2004); Gandy (2002); Swyngedouw (2004)). Such perspectice requires sensitivity to urbanisation as a socio-metabolic process rather than to particular ideologies and views about the assumed qualities that inhere in nature itself (Heynen and Swyngedouw, 2003). We need to consider how nature becomes urbanised through proliferating socio-metabolic processes.

'Metabolism' and 'Circulation' will be, as already hinted to above, the central metaphors and material processes that will guide us in this endeavour. Both concepts have a long conceptual, cultural, social, material, and arte-factual history. They emerged as coherent concepts and materially mobilised principles in the mid-19th century and both were deeply connected with projects, visions, and practices of modernisation, and with the associated 'modern' transformation of the city. Most importantly, in contrast to other, more recent and fashionable, metaphors that attempt to fuse together heterogeneous entities -- like networks, assemblages, rhizomes, collectives -- the former convey a sense of movement, flow, process, change,

transformation, and dynamism in addition to the 'inner-connectedness' suggested by the other 'tropes'. 'Metabolism' and 'Circulation' embody what modernity has been and will always be about, i.e. a series of interconnected heterogeneous and dynamic, but contested and contestable, processes of continuous quantitative and qualitative transformations. With its emphasis on movement, circulation, change, and process, and its insistence on the socially mobilised 'materiality' of life, historical-materialism has been among the first social theories to embrace and mobilise 'metabolism' and 'circulation' as entry-points in undertaking 'ontologies of the present that demand archaeologies of the future' (Jameson, 2002: 215). These ontologies and archaeologies are what we shall turn to next.

2. Historical-Geographical Materialism: Entering Metabolism and Circulation.

> 'Certainly we continue to have crickets and thunderstorms … and we continue to understand our psyches as driven by natural instincts and passions; but we have no nature in the sense that these forces and phenomena are no longer understood as outside, that is, they are not seen as original and independent from the civil order' (Hardt and Negri, 2000: 187).

Both 'Metabolism' and 'Circulation' have a long conceptual and material history. 'Circulation' gained wide currency after William Harvey's postulation of the double circulation of blood in the artery system of the body. Movement, flux and conduits became rapidly formative metaphors that would shape radically new visions of and practices of acting in the world. The concept of 'metabolism' arose in the early

19th century, particularly in relationship to the material exchanges in the body with respect to respiration. It became extended later to include material exchanges between organisms and the environment as well as the bio-physical processes within living (and non-living, i.e. decaying) entities. For example, in the writings of Jacob Moleschott (1857) and Justus von Liebig (1840; 1842), it denoted the exchange of energy and substances between organisms and the environment on the one hand and the totality of biochemical reactions in a living thing on the other. In fact, von Liebig's analysis turned organisms into living processes, gave them a history-as-process. Interestingly enough, von Liebig had taken the temporal/spatial separation of spaces of production and spaces of consumption through the emergence of long-distance trade on the one hand and the process of urbanisation on the other (what von Liebig called the 'metabolic rift') – as pivotal causes for affecting (negatively) the productivity of agricultural land on the one hand and the problematic accumulation of excrement, sewage and garbage in the city on the other (Page, 2004). This view would be effectively incorporated by Karl Marx in *Capital*:

> '… large landed property reduces the agricultural population to an ever decreasing minimum and confronts it with an ever growing industrial population crammed together in large towns; in this way it produces conditions that provoke an irreparable rift in the interdependent process of social metabolism, a metabolism prescribed by the natural laws of life itself. The result of this is a squandering of the vitality of the soil, which is carried by trade far beyond the bounds of a single country' (Marx, 1981: 949).

With this view of metabolism as ecological-historical process, and combined with the equally historical-metabolic views explored by Darwin for the biological world and Lyell for the geological reconstruction of the world, historical materialism would mobilise the concept of metabolism, neither as just an organic analogy to the social order (see Padovan, 2000) nor as a metaphor to be transposed onto society, but more importantly as the very foundation of and lasting condition for the social[1]. The mobilisation of 'metabolism' and 'circulation' in historical materialist throught is was we shall turn to next.

2.1. Historical Materialism and the remaking of environments

Materialism, as a coherent philosophical domain, emerged with the Epicurean tradition. Epicurus' dictum that nothing can be made out of nothing and that nothing that is distroyed can be returned to nothing (nothing is created, nothing is destroyed (Vaillancourt, 1996: 52) – or in Lucretius' words '*nil posse creare de nihilo'* (Lucretius 1994, 13-14) -- provided the fountainhead from which later historical materialist thought would emerge (Marx, 1970: 323). All of material life is inter-related and inter-dependent, so Epicurean philosophy argued, organized as ever-changing new arrangements of atoms that produce new realities as they are re-assembled in quantitatively and qualitatively new configurations.

In its most general sense, materialism asserts that both origin and development of what exists is dependent on nature and 'matter'. Or, in other words, a certain physical Reality exists that is prior to thought and to which thought must be related or interlinked (although it can never be identical to the Real) (Foster, 2000). As Roy Bhaskar argued, "neither thought nor language form a realm of their own, they are only manifestations of actual life" (Bhaskar, 1979: 100)[2]. For him, materialim as a

rational philosophical and complex view of the world combines (i) an *ontological* materialism that asserts the dependence of social upon physical being; (ii) an *epistemologial* materialism that asserts the independent existence and the transfactual activity of the things that scientific thought reflects upon; and (iii) a *practical* materialism that asserts the role of human and non-human tranformative agency (Bhaskar, 1983: 324; Foster, 2000: 2). Karl Marx's practical materialism was deeply inserted in both ontological and epistemological materialism. His historical materialism was, indeed, arguably the first coherent attempt to theorise the internal metabolic relationships that shape the transformations of the earth's surface and, through this, made and remade the social and physical world. In 'Grundrisse', in 'Capital' and, in particular, in 'The German Ideology', Marx insisted on the 'natural' foundations of social development (see also Hughes, 2000):

> 'The first premise of all human history is, of course, the existence of living human individuals. Thus the first fact to be established is the physical organisation of these individuals and their consequent relationship to the rest of nature… The writing of history must always set out from these natural bases and their modification in the course of history through the action of men … [M]en must be in a position to live in order to be able to 'make history'… The first historical act is thus the production of the means to satisfy these needs, the production of material life itself' (Marx, 1846 (1974): 42 and 48).

This environmental 'production' process is conceived in the broadest possible sense. It refers to the metabolic process that is energised through the fusion of the physical properties and creative capacities of humans with those of non-humans. For Marx,

this is what defines the act of ‘labouring’, i.e. the purposeful metabolic process intended to produce and reproduce (human) life. Production is an organic process in the first instance, similar (but not reducible or identical) to the act of producing things new by other organic and non-organic ‘actants’. What differentiates human actants from others is their organic capacity to wish differentially, to imagine different possible futures, to act differentially in ways driven and shaped by human drives, desires, and imaginations. This form of acting differentiates human acting from other active ‘moments’ in the production and transformation of ‘environments’.

Labouring is therefore nothing other than engaging the ‘natural’ physical and mental forces and capabilities of humans in a metabolic physical-material process with other human and non-human actants and conditions. It is through the process of ‘transposition of labour power into human organism’ (Marx, 1970: 323) that this metabolic process is mobilised. The products of transformed nature and embodied ‘dead’ labour take on a thing-like character, which, like any other actant, is enrolled again in subsequent assemblages. In fact, ‘[A]ny product can take on a ‘life’ of its own, and may come to dominate the living labour that makes it. The ‘nature of things’ is indeed to become non-human actors’ (Kirsch and Mitchell, 2004: 23). If the act of labouring, broadly conceived, constitutes a metabolic and circulatory socio-ecological process, then, the particular relational frame through which this labour is socially organised has to become an integral part of understanding the continuous (re-)making of what we can now discern as socio-natural entities (Castree 2002). The circulation of goods, or of entities, is evidently directly associated with the notion of metabolism, which involves exactly a process of transformation-in-movement. Or in other words, metabolic circulation fuses together physical dynamics with the social regulatory and

framing conditions set by the historically specific arrangement of the social relations of appropriation, production, and exchange or, in other words, the mode of production. The things with which labour works as past products always enter the metabolic processes as already configured assemblages, collectives, networks that, in turn, through socio-metabolic circulatory processes, mobilise new human and non-human 'actants' and produce new assemblages or collectives. As Timothy Luke (1999: 39) notes:

> '… Marx can be seen as an extended critique of Latour's sense of collectivization, inasmuch as he uses the notion of the commodity to describe the association of humans and nonhumans. Since Marx's examination of the commodity form under capitalism looks at ways in which human labor is mixed with nonhuman things to create value, much of his analysis is a careful study of who dominates whom in the process of such collectivization, with commodification leading to the endless 'co-modification' of human and nonhuman beings in both nature and culture. These ties now define coevolution.'

These 'collectives' are those proliferating objects that Donna Haraway calls 'cyborgs' (Harraway, 1991) or that Bruno Latour refers to as 'quasi-objects' (Latour, 1993); these hybrid, part social/part natural - yet deeply historical and thus produced - objects/subjects are intermediaries that embody and express nature and society and weave networks of infinite liminal spaces. These assemblages, like commodities, 'are simultaneously real, like nature, narrated, like discourse, and collective, like society' (Latour, 1993: 122). They take on cultural, social, and physical forms and enter social

and ecological processes in new and transformed manners. The city, in its parts and as a whole, is a caleidoscopic socio-physical accumulation of human/non-human imbroglios. In the production of these assemblages and entanglements, the figures of 'metabolism' and of 'circulcation' take centre stage in a materialist dialectical account. In the next section, we shall delve deeper into the origin and mobilisation of 'metabolism' and 'circulation' within historical materialism.

2.2. Metabolism as metaphor and practice.

Marx and Engels were indeed among the first to mobiles the term 'metabolism' to grapple with the dynamics of socio-environmental change and evolution (Fisher-Kowalski, 1998; 2003). In fact, 'Metabolism' is the central metaphor for Marx's definition of labour and for analysing the relationship between human and nature :

> 'Labour is, first of all, a process between man and nature, a process by which man, through his own actions, mediates, regulates, and controls the *metabolism* between himself and nature. He confronts the materials of nature as a force of nature. He sets in motion the natural forces which belong to his own body, his arms, legs, head, and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement he acts upon external nature and changes it, and in this way he simultaneously changes his own nature …. [labouring] is the purposeful activity aimed at the production of use-values. It is an appropriation of what exists in nature for the requirements of man. It is the universal condition for

> the metabolic interaction between man and nature, the ever-lasting nature-imposed condition of human existence, and it is therefore independent of every form of that existence, or rather it is common to all forms of society in which human beings live' (Marx 1867 (1971): 283 and 290).

For Marx, this socio-natural metabolism is the foundation of and possibility for history, a socio-environmental history through which the natures of humans and non-humans alike are transformed (see also Godelier (1986)). To the extent that labour constitutes the universal premise for human metabolic interaction with nature, the particular social relations through whom this metabolism of nature is enacted shape its very form. Clearly, any materialist approach insists that 'nature' is an integral part of the 'metabolism' of social life. Social relations operate in and through metabolising the 'natural' environment and transform both society and nature. For historical-materialism, then, ecology is not so much a question of values, morals, or ethics, but rather a mode of 'understanding the evolving material interrelations (what Marx called "metabolic relations") between human beings and nature … From a consistent materialist standpoint, the question is … one of coevolution' (Foster, 2000: 10-11) (see also Norgaard, 1994). Foster (2000, 15-16) continues to argue that '[A] thouroughgoing ecological analysis requires a standpoint that is both materialist and dialectical … [A] materialist sees evolution as an open-ended process of natural history, governed by contingency, but open to rational explanation. A materialist viewpoint that is also dialectical in nature (that is, a non mechanistic materialism) sees this as a process of transmutation of forms in a context of interrelatedness that excludes all absolute distinctions …. A dialectical approach forces us to recognize that organisms in general do not simply adapt to their environment; they also affect

that environment in various ways by affecting change in it' (see also Levins and Lewontin 1985). In other words, non-human entities act in their metabolic exchange -- in their enrolment as Latour (1993) would call it -- with other human and non-human actants. This materialist view is decidedly 'constructionist' in the sense that it considers socio-natural processes as historically specific, produced, and contingent.

Marx undoubtedly borrowed the notion of 'metabolic interaction' from Justus von Liebig[3], the founding theoretician of modern agricultural chemistry. In contrast to other sociologists-avant-la-lettre, like Comte and Spencer, who used the concept of metabolism as an analogy for grappling with social metabolism and for whom 'nature offered the gnoseological structures to survey the workings of society' (Padovan, 2000: 7), Marx, Engels, or Adam Schäffle, mobilised 'metabolism' in an ontological manner in which human beings, like society, were an integral, yet particular and radically distinct, part of nature. The original German word for metabolism is 'stoffwechsel', which literally translates as 'change of matter'. This simultaneously implies circulation, exchange AND transformation of material elements. While matter moves, it becomes 'enrolled' in associational networks that produce qualitative changes and qualitatitively new assemblages. While the newly produced 'things' embody and reflect the processes of its making (though a process of internalisation of dialectical relations), they simultaneously differ radically from their constituent relational parts. For von Liebig, chemical metabolism was a process of 'creative destruction' in which the new irrevocably transformed the old. Metabolism as a bio-chemical process is a contradictory one, predicated upon fusion, tension, conflict, and ultimately transconfiguration, which, in turn, produces a series of new 'entities', often radically different from the constituting components, yet equally re-active. Metabolism (with a few rare exceptions), consequently, is a historical process, has a

time arrow. Labour (itself an organic metabolic procedure), then, becomes the organic activity through wich this metabolic process is mobilised in a human purposeful manner by means of enrolling heterogeneous things into specific metabolic interactions:

> ‘Actual labour is the appropriation of nature for the satisfaction of human needs, the activity through which the metabolism between man and nature is mediated’ (Marx, in Economic Manuscripts, 1861-1863).

While every metabolised thing embodies the complex processes and heterogeneous relations of its past making, it enters (or becomes enrolled), in its turn and its specific manner, into new assemblages of metabolic transformation. These dynamic heterogeneous assemblages form a circulatory process (although not necessarily closed) that, under conditions of generalised commodity production, takes on the form of circulation of commodities and the circulatory reverse flow of capital (as embodied dead labour in the form of past metabolic transformations). This processual metabolism is, according to Foster (2000), central to Marx’s political economy and is directly implicated in the circulation of commodities and, consequently, of money:

> ‘The economic circular flow then was closely bound up, in Marx’s analysis, with the material exchange (ecological circular flow) associated with the metabolic interaction between human beings and nature’ (Foster 2000: 157-158).

Indeed, under capitalist social relations, then, the metabolic production of use values operates in and through specific control and ownership relations and in the context of the mobilisation of both nature and labour to produce commodities (as forms of metabolised hybrid socio-natures) with an eye towards the realisation of the embodied exchange value. The circulation of capital as value in motion is, therefore, the combined metabolic transformations of socio-natures in and through the reverse circulation of money as capital under social relations that combine the mobilisation of capital, nature or dead labour, and labour power. New socio-natural forms, including the transformation of labour power as living labour, are continuously produced as moments and things in this metabolic process (see Grundman 1991; Benton 1989; 1996; Burkett 1999; Foster 2000). Whether we consider the production of dams, the re-engineering of rivers, the management of biodiversity hotspots, the transfiguration of DNA codes, the cultivation of potatoes (genetically modified or not) or the construction of a skyscraper, they all testify to the particular assocational relations through which socio-natural metabolisms are organised (in terms of property and ownership regimes, production or assemblaging activities, distributional arrangements and consumption patterns).

Of course, the ambition of classical Marxism was broader than reconstructing the dialectics of historical socio-natural transformations and their contradictions. It also insisted on the ideological notion of ‘nature’ and of ‘society’ in bourgeois science and society (Schmidt 1971; Smith 1984; Benton 1989). In other words, much of historical materialism questioned and critiqued the process of purification, separation, and binarisation that, in Latour’s vocabulary, produced the modern ‘constitution’ and derailed the project of becoming ‘modern’ (while, in the process, filling this symbolic void with all manner of socio-natural imbroglios). Historical-geographical

materialism as a dialectical (that is non-teleological) evolutionary (that is as actively produced history) organicism (that is the unity of the heterogeneous social and the heterogeneous natural) not only addresses the cultural, discursive, 'ideological', moral/ethical constructions of nature that were as prevalent in the 19th century as they are today, but offered a view of the world that unified the natural and the social while critiquing radically the 'modern' separation of 'society' from 'nature'[4]. In fact, the clarion call of Bruno Latour to re-connect the two poles that have been severed by modernity, is already pre-figured by Marx in 'Grundrisse':

> 'It is not the unity of living and active humanity the natural, inorganic conditions of their metabolic exchange with nature, and hence their appropriation of nature, which requires explanation, or is the result of a historic process, but rather the separation between these inorganic conditions of human existence and this active existence, a separation which is completely posited only in the relation of wage labour and capital' (Marx 1858 (1973): 489).

However, by concentrating on the labour process as mere social process (as was and is the case for most of modern sociology, including marxist sociology), some Marxist analysis – particularly during the 20th century – tended to replicate the very problem it meant to criticise. By relegating nature to the substratum for the unfolding of social relations, in particular labour relations, 'socialised' marxism maintained the material basis for social life while relegating 'natural processes' to a realm outside the social. This opened up a 'void' that became silenced rather than problematised, was ingnored rather than taken as the 'space' for politics, for struggle, for pre-figuring

possible radical socio-ecological transformation, and realising alternative socio-natural relations. In other words, while mainstream economics equally forgot the natural foundations of economic life[5] (only to rediscover this recently under the guise of environmental economics), much of marxist theory became an exclusive 'social' theory rather than a socio-ecological one. Put simply, the over-emphasis on the social relations under capitalism that characterised much of Marxist (and other) social analysis tended to abstract away from or ignore the material and socio-physical metabolic relationships and their fantastasmagoric representations and symbolic ordering, and resulted in a partial blindless in 20th century social sciences to questions of political-ecology and socio-ecological metabolisms.

Some recent approaches to the society-nature problematic, such as Actor Network Theory or (political-) ecological theories of a variety of kinds, have provided a new grammatical apparatus that has 'profoundly revitalized empirical studies of human-nature-technology relations …. But … it remains important that we incessantly raise the question … why are "things as such" produced in the way they are – and to whose potential benefit' (Kirsch and Mitchell, 2004). While a historical-materialist mobilisation of metabolism might begin to shed light on the production of socio-natural entities, this has to be fused together with another, equally central metaphor and material condition, one that is closely related to metabolism, namely circulation.

2.1 The invention of circulation.

> 'Enlightened planners wanted the city in its very design to function like a healthy body, freely flowing as well as possessed of clear skin. Since the beginnings of the Baroque era, urban planners had thought

> about making cities in terms of efficient circulation of the people on the city's main streets. The medical imagery of life-giving circulation gave a new meaning to the Baroque emphasis of motion. Instead of planning streets for the sake of ceremonies of movement toward an object, as did the Baroque planner, the Enlightenment planner made motion an end in itself' (Sennett, 1994: 263-264).
>
> 'In fact, there was no "industrial revolution", but only a "dromocratic revolution"; there is no democracy, only dromocracy, there is no strategy, only dromology. Thus, the related logic of knowing power, or power-knowledge, is eliminated to the benefit of moving-power - in other words the study of tendencies, of flows (Virilio, 1986: 47).

Alongside the emergence of the notion of 'metabolism' in the natural and social sciences (an emergence not wholly disassociated with the rising 'metabolic rift' caused by industrialisation and urbanisation), the notion of 'circulation' began to gain greater and wider currency. For example, the idea of 'water circulation', that water piped into the city must leave the city by its sewers is not older than the 19th century (in the West). Circulating water, following a given path and finally returning to its source, remained foreign to western urban imaginations, spatial representations and engineering systems until then. Modern urbanization, highly dependent on the mastering of circulating flows, is linked with the representation of cities as consisting of and functioning through complex networks of circulatory system (Kaika and Swyngedouw, 1999). Before the 'discovery' of circulatory systems, the movement of water was seen merely as evaporation: the separation of the 'spirit' from the 'water'

(Goubert, 1989). This view of things to happen, to appear, or to disappear through 'extraction' was widely held before circulatory views began to replace them. In chemistry, for example, Phlogiston theory rested on the basis of extractionist views until Lavoisier's chemistry postulated chemical reactions as (metabolic) transfigurations or re-arrangements of components that, in the process, produced qualitative new configurations, but in which nothing was lost or disappeared. Together with phlogiston theory, the representation of the respiratory system, plant growth, the Physiocratic view of the production of material wealth from the given natural conditions of the soil, even the Malthusian one-directional flow of matter, they all indicate the incapacity of renaissance people to conceive of 'circulation' as an infinite circular and occasionally cyclical process.

When William Harvey (1628) promulgated his ideas of the double circulation of blood in the vascular system of the human body in 1628, a revolutionary insight came into being which would begin to permeate and dominate, both metaphorically and materially, every day life, engineering and academic practice for the centuries to come[6]. By the end of the century, medical practice had accepted the idea of the circulatory (metabolic) system, leading, among others, to a profound re-definition of the body. In the 19th century, the metabolic circulation of chemical substances and organic matter (see von Liebig's contribution above) became increasingly accepted and would form the basis of modern ecology. The 'circulation' and the 'metabolism' of matter became fused together as the two central metaphors trough which to capture processes of socio-natural change.

Indeed, the use of the word 'circulation' to refer to the movement of money within a national economy established itself within a generation of William Harvey's claim (Harvey A.D., 1999). Thomas Hobbes, in Leviathan (1651), for example, had

already compared the problems of a government that was unable to raise sufficient tax revenue to ‘an ague; wherein, the fleshy parts being congealed, or by venomous matter obstructed, the veins which by their natural course empty themselves into the heart, are not, as they ought to be, supplied from the artery, whereby there succeedeth at first a cold contraction, and trembling of the limbs; and afterwards a hot, and strong endeavour of the heart, to force the passage of the blood’ (cited in Harvey A.D., 1999). Francis Bacon, in his essay ‘Of Empire’, wrote that merchants ‘are vena porta; and if they flourish not, a kingdom may have good limbs, but will have empty veins, and nourish little’ (cited in Harvey A.D., 1999).

At the beginning of the 18th century, the term ‘circulation’ had become established in many sciences, from the flow of saps in plants to the circulation of matter in chemical reactions (Teich, 1982). ‘Circulation’ becomes a dominant metaphor after the French Revolution: ideas, newspapers, gossip and -- after 1880 -- traffic, air, and power ‘circulate’. From about 1750, wealth and money begin to ‘circulate’ and are spoken of as though they were liquids, flowing incessantly to nourish a process of accumulation and growth. Society becomes to be imagined as a system of conduits (Sennett, 1994). Montesquie in *Lettres Persanes* (p. 117) speaks of ‘[T]he more “circulation” the more wealth’ and in *l'Esprit des Lois* of ‘[M]ultiply wealth by increasing “circulation”’. Rousseau (1766) refers to ‘[T]his useful and fecund circulation that enlivens all society's labour’ and to ‘a “circulation of labour” as one speaks of the circulation of the money’ (cited in Illich, 1986). Intricate mechanical contraptions were constructed to mimic national economic dynamics as circuits of conduits, valves, and connections through which money and goods flowed incessantly. Of course, by the mid-19th century, The flâneur -- dandy, artist, detective, and stroller, the favourite literary characters of Baudelaire and, later, of Walter

Benjamin, of the *passages* -- has been well represented and theorized as an object of circulation within urban space. Of course, in the process, ‘circulation’ became less and less identified with closed circular movement, but identified with change, growth, and accumulation. Similar to the way von Liebig discovered the mechanisms of metabolism through considering the ‘metabolic rift’, ‘circulation’ acquired greater explanatory power exactly when it was seen as an integral part of a process of change and transformation.

Adam Smith and, in particular, Karl Marx conceived a capitalist economy as a metabolic system of circulating money and commodities, carried by and structured through social interactions and relations. Accumulation is dependent on the swiftness by which money circulates through society. Each hick-up, stagnation or interruption of circulation may unleash the infernal forces of devaluation, crisis and chaos. Society's wealth and the relationships of power on which wealth is constructed is seen as intrinsically bound up with and expressed by the ‘circulation speed’ of money in all its forms (capital, labour, commodities). Later, David Harvey (1985) would analyse the circulation of capital and its urbanization as a perpetuum mobile channelled through a myriad of ever-changing production, communication, and consumption networks. The development and consolidation of circulating money as the basis of material life and the relations of domination and exclusion through which the circulation of money is organized and maintained shapes this ‘urbanization of capital’.

By the mid 19th century some British Architects also begin to speak of the inner city mobilising the metaphor of circulation. Sir Edwin Chadwick formulated the ideology of circulating waters effectively for the first time in 1842. He presented a report on the sanitary conditions of the labouring population of Great Britain. Lewis Mumford (1961) has called it ‘the classic summary of paleo-technic horrors’. In his

report, Chadwick imagined the new city as ‘a social body through which water must incessantly circulate, leaving it again as dirty sewage’. Without interruption, water ought to ‘circulate’ trough the city to wash it of sweats and excrements and wastes. The brisker this flow, the fewer stagnant pockets that breed congenital pestilence there are and the healthier the city will be (Vigarello 1988). Unless water constantly circulates through the city, pumped in and channelled out, the interior space imagined by Chadwick can only stagnate and rot. This representation of urban space as constructed in and through perpetually circulating flows of water is conspicuously similar to imagining the city as a vast reservoir of perpetually circulating money. Viollet-le-Duc introduced circulation as a bodily metaphor for the organization of the urban villa. In fact, Chadwick's papers were published under the title ‘The Health of Nations’ during the centenary commemoration for Adam Smith (Chadwick, 1887). Like the individual body and bourgeois society, the city was now also described as a network of pipes and conduits. The brisker the flow, the greater the wealth, the health and hygiene of the city would be (Gandy 2004). Just as Harvey redefined the body postulating the circulation of blood, so Chadwick redefined the city by 'discovering' its needs to be constantly washed (Illich, 1986:45). New principles of city planning and policing were emerging based upon the medical metaphors of ‘circulation’ and ‘flow’. The health of the body became the comparison against which the greatness of cities and states would be measured. The ‘veins’ and ‘arteries’ of the new urban design were to be freed from all sources of possible blockage (Sennett, 1994: 262-265; Corbin, 1994).

With circulation as a metabolic process firmly established as practice and as solid representation of the process of socio-ecological change, attention quickly moved from metabolism and circulation to ‘speed’ or, in other words, to the

'movement of movement'. Metabolic circulation of the kind analysed by Marx, and now firmly rooted in generalised commodity production, exchange, and consumption, is increasingly subject to the socially constituted dynamics of a capitalist market economy in which the alpha and omega of the metabolic circulation of socio-ecological assemblages is the desire to circulate money as capital (Douglas 2004). The creation of urban space as space of movement of people, commodities, and information radically altered the choreography of the city. Places and spaces became less and less shared, motion devalues or threatens to devalue place; connections are lost, identities reconfigured, and attachments broken down. Yet, at the same time, the accumulation of movement and of capital also signalled an intensified and accelerated accumulation of new urbanised natures, metabolised through the metabolic vehicles that spun intricate networks and conduits. While the urbanisation of nature led to a spiralling accumulation of unstable socio-natural assemblages, the components of these assemblages became radically disassociated from their geographical origin as speed, movement and mobility ironically rendered the fields of vision and connections more opaque, transient, and partial. Although the city turned into a metabolic vehicle, the rift between the social and the nature became in fact rather deeper than ever engrained in the urban or modern imagination.

3. (Hybrid) Natures and (Cyborg) Cities

> 'The metabolic requirements of a city can be defined as the materials and commodities needed to sustain the city's inhabitants at home, at work and at play …. The metabolic cycle is not completed until wastes and residues of daily life

> have been removed and disposed of with a minimum of nuisance and hazard' (Wolman, 1965: 179)

> 'A barrel of crude oil sold for about $13 in 1998. The same quantity of whole blood, in its "crude" state, would sell for more than $20,000 (in Manhattan, NY)' (Starr, 1998).

When mobilising the twin vehicles of 'metabolism' and 'circulation' from a historical-materialist epistemological perspective, the modernist tropes of 'nature' and 'society' radically disappear. Or in other words, modernity's bifurcation, separation, and binarisation of the categories of 'nature' and 'society' is recognised by historical materialism as exactly what it is, an image, a metaphor, a trope; one that can be and is mobilised for all manner of cultural, social, or political projects. A dialectical approach recognises both the radical non-identity of actants (human and non-human) enrolled in socio-metabolic processes within an assemblage while recognising the social, cultural, and political power relations embodied relationally in these socio-natural imbroglios. The production of (entangled) things through metabolic circulation is necessarily a process of fusion, of the making of 'heterogeneous assemblages', of constructing longer or shorter networks. In fact, both the notions of Hybridity or Cyborg are misleading if not radically reproducing the underlying binary representation of the world. Hence, the bracketing of 'Hybrid' and 'Cyborg' in the title of this section refers exactly to the 'excess of meaning' inscribed in coding the city as either 'hybrid' or 'cyborg'. While intuitively attractive, they nevertheless still suggest a process of 'dirty' mixing, an ambiguous fusion of things that can be ontologically separated and 'purified'. Natures and cities are always already

heterogeneously constituted, the product of actants in metabolic circulatory processes. Metabolic circulation, then, is the socially mediated process of environmental, including technological, transformation and trans-configuration, through which all manner of 'agents' are mobilised, attached, collectivised, and networked. The heterogeneous assemblages that emerge, as moments in the accelerating and intensifying circuitry of metabolic vehicles, are central to a historical-geographical materialist ontology:

> 'As plants, animals, minerals, air, light, etc., in theory form a part of human consciousness, partly as objects of natural science, partly as objects of art … so they also form in practice a part of human life and human activity. Man lives physically only by those products of nature; they may appear in the form of food, heat, clothing, housing, etc. The universality of man appears in practice as the universality which makes the whole of nature his inorganic body: (1) as a direct means of life, and (2) as the matter, object, and instrument of his life activity. Nature is the inorganic body of man, that is nature insofar it is not the human body. Man lives by nature. This means that nature is his body with which he must remain in perpetual process in order not to die' (Marx, Economic and philosophic manuscripts, selected writings, p 63).

As Luke (1999: 43) argues, the conditions of associating humans and nonhumans in ancient, Asiatic, feudal, or capitalist relations of collectivization can thus be used to understand how power, knowledge, and conflict co-modified people and their things in any given society'. These assemblages of humans and non-humans, of dead labour and inert materials, are reminiscient of the 'hybrids' and the 'cyborgs'

of respectively Bruno Latour and Dona Haraway. However, while Haraway asks penetrating questions as to why 'Cyborgs' are produced the way they are and the relations of power inscribed in these imbroglios, this question remains silent in Latour's work. For him, the key issue centres on transforming the 'constitutional' arrangements through which human and non-human actants become mobilised or enrolled (Latour, 2004). In sum, while Latour defends a democratic republic of heterogeneous associations, Haraway maintains a perspective that emerges from a radically different ontological position. In other words, a deep ontological divide opens here. As Benedikte Zitouni (Zitouni, 2004) convincingly argues:

> 'Haraway views any entity as an *embodiment* of relations, an *implosion*, the threads of which should be teased apart in order to understand it. Whereas Latour views any entity as *a piece of matter* that is continuously affected and that contracts links with a larger networks *that allows it to live, to be*. On the one hand, the entity *crystallizes* the network; on the other hand the entity is *supported* by the network. Haraway studies the network in order to define the entity; Latour studies that same network in order to define the entity's consistency and persistence. … Dialectics, congealment, crystals, prisms, representations are not possible tools any longer for urban studies but instead we view pieces of matter, of any kind, that act, react and interact with one another, that gain there consistency, persistence and existence or lose them through the affects and links to other agents. Power differences and inequality can no longer be stated as such, as a departure point into the city but have to be explained through the many actions and relations between objects, humans and non humans. There is nothing *behind* any space or agent, only attachments

aside of it that make it stronger or weaker, allow it to exist or lead it to perish' (Zitouni 2004).

It is in this latter sense that we wish to see the city as a metabolic circulatory process that materialises as an implosion of socio-natural relations organised through socially articulated networks and conduits whose origin, movement, and position is articulated through complex political, social, economic, and cultural relations. These relations are invariably infused with myriad configurations of power that saturate material practices, symbolic ordering, and imaginary (or imagined) visions.

While studies on urban metabolism have often uncritically pursued the standard industrial ecology perspective that is based on some input-output model of the flow of 'things' (see table 1 on London's metabolism), such analysis merely poses the issue, but fails to theorise the making of the urban as a socio-environmental metabolism (see, for example, Weisz, *et al*., 2001). While insightful in terms of quantifying the urbanisation of nature, it fails to theorise the process of urbanisation as a social process of transforming and reconfiguring nature. It would not be too much of an exaggeration to state that most processes of transformation of nature are intimately linked to the process of urbanisation and to the urbanisation of nature. From this perspective, it is surely strange to note that relatively little empirical or theoretical work has been undertaken that explicitly attempts to theorise environmental change and urban change as fundamentally interconnected processes.

Insert Table 1 about here

Yet, little attention has been paid so far to the urban as a flow or a process of socio-ecological *change*[7]. Or in other words, the view that a city is a process of environmental production, sustained by particular sets of socio-metabolic interactions that shape the urban in distinct, historically contingent ways -- a socio-environmental process that is deeply caught up with socio-metabolic processes operating elsewhere -- rarely grabs the headlines. Of course, 'environmental' issues have been central to urban change, culture, and urban politics for at least a century if not more. Visionaries of all sorts lamented the 'unsustainable' character of early modern cities and proposed solutions and plans that would remedy the antinomies of urban life and produce a healthy 'wholesome' urban living. The 'Hygienic City' of the 19th century (Gandy 2004) celebrated the making of the city as a system of circulatory conduits that would render the metabolism of the city rhyme in concert with the bio-chemical metabolisms associated with a sanitised urban life. Hausman's opening up of Paris, King Leopold's sanitation of Brussels, the visionary construction of Vienna's Ringstrasse, and London's slum clearances point to these combined processes of political-ecological transformation and socio-cultural reconstruction, not to mention Kropotkin's or Elisee Reclus's ecological anarchism or the various attempts at creating socially or ecologically harmonious 'utopian' cities, dreams pursued with equal fervour by anarchists, socialists, liberals, and fascists.

4. The Urbanisation of Nature: A Political Ecological Manifesto

In a different context, we have tried to bring together in a somewhat systematic manner the foundations for a historical materialist political ecology of the city and of the urbanisation process (Swyngedouw, *et al*., 2003). By way of

conclusion, I thought it would be useful to recapitulate these principles, which simultaneously set out a research agenda for urban political ecology, but also insists on the contested and contestable nature of the organisation of the urban as a circulatory metabolic process. In other words, socio-ecological metabolisms are inherently part-political processes and, consequently, constitute an integral part of any political or social project. Political visions are, therefore, necessarily also ecological visions; any political project must, of necessity, also be an environmental project (and vice versa).

1. Processes of socio-environmental metabolic circulation transform socio-physical environments and produce socio-physical milieus (such as cities) with new and distinct qualities.
2. There is nothing a-priory unnatural about produced environments like cities, genetically modified organisms, dammed rivers, or irrigated fields (Harvey, 1996). Produced environments are specific historical results of socio-environmental processes.
3. All socio-spatial processes are invariably also predicated upon the circulation and metabolism of physical, chemical, or biological components.
4. These metabolisms produce a series of both enabling and disabling socio-environmental conditions. Indeed, these produced milieus often embody contradictory tendencies.
5. Processes of metabolic change are, therefore, never socially or ecologically neutral
6. Social power geometries shape the particular social and political configurations as well as the environments in which we live. Lefebvre's 'Right to the

City' (1972) also invariably implies a 'Right to Metabolism' and to 'Metabolic vehicles'.

7. Questions of socio-environmental production become hereby fundamentally political questions. Political-ecology attempts to tease out who gains from and who pays for, who benefits from and who suffers (and in what ways) from particular processes of metabolic circulatory change.

8. The political program, then, of political-ecology is to enhance the democratic content of socio-environmental construction by means of identifying the strategies through which a more equitable distribution of social power and a more inclusive mode of producing natures (of producing metabolic circulatory processes) can be achieved.

Such perspective permits all manner of new insight into the urban problematic and opens myriad avenues for re-centering the urban as the pivotal terrain for eco-political action. 'Urbanising' the environment, therefore, is a project of environmental construction that actively produces the urban (and other) environments that we wish to inhabit now. Being modern, as Rimbaud captured it, is exactly about active creation of situations and events, and through doing so, participating in the production of our natures. Modernity as a particular set of processes of metabolic transformation promises exactly the possibility of the active creation of the environments we wish to inhabit. In this sense, modernity is not over; it has not yet begun.

ENDNOTES

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Table 1: The Metabolism of Greater London

THE METABOLISM OF GREATER LONDON (7,000,000 inhabitants)

INPUTS	**TONNES PER YEAR**
Fuel (oil equivalent)	20,000,000
Oxygen	40,000,000
Water	1,002,000,000
Food	2,400,000
Timber	1,200,000
Paper	2,200,000
Plastics	2,100,000
Glass	360,000
Cement	1,940,000
Bricks, blocks, sand, tarmac	6,000,000
Metals	1,200,000

WASTES	**TONNES PER YEAR**
Industry and demolition	11,400,000
Houshold, civic & commercial	3,900,000
Wet digested sewage sludge	7,500,000
Carbon dioxide gas	60,000,000
Sulfur dioxide gas	400,000
Nitrogen oxide gas	280,000

Source: www.global-vision.org/city/metabolism.html

[1] Ernst Haeckel, who coined the term ecology (1866), mobilised organic metaphors to describe social conditions, and started a long lineage of human ecological analysis, one that would ultimately drive a wedge between natural sciences and social sciences as the legitimacy of such unmediated trans-formulations was increasingly questioned. Human ecology would subsequently bifurcate into a de-naturalised social ecology, primarily through the Chicago School, on the one hand and industrial ecology on the

other. The latter, moving increasingly in the direction a variety of types of commodity chain or goods-flow analysis would increasingly distance itself from relational social theory (Fisher-Kowalski, 1998; 2003; Fisher-Kowalski and Hüttler, 1999; Newcombe, 1977)

[2] This statement, of course, does not mean that thought or languages are simply the epiphenomenon of 'material' relations. On the contrary, very complex dialectical arrangements infuse the articulation of the real, the symbolic, and the imaginary (for different ways of exploring these articulations, see, for example Žižek (Žižek and Daly, 2003) or Lefebvre (1991) in the construction of the real.

[3] Although Schmidt (1971) and Fisher-Kowalski (1998) maintain that Moleschott (1857) provided the influential insights, this is convincingly rebuked by Foster (2000), who maintained that von Liebig and Mayer (1845) were of central importance. In any case, the use of 'metabolism' was widespread in the emerging social sciences at the time and both Marx and Engels were familiar with the then ongoing scientific debates in biology.

[4] This has become engrained in social theory since its founding fathers Durkheim, Weber, and a 'socialised' Marx.

[5] While the Physiocrats were radically and correctly critiqued, the rational kernel of their mythical theorisation was equally radically dismissed.

[6] The first person apparently to suggest the circulation of blood in the arterial system was Ibn-al-Nnafiz (physician, born in Baghdad and died in Cairo in 1288) (Illich, 1986: 40). The idea of circulation remained alien to the imagination of 16th century Europeans. Two 16th century scientists suspected what Harvey would later discover: Servetus (a Spanish genius and heretic burnt by Calvin -- he also edited Ptolemy's geography in Lyon -- and student of Vesalius in Paris) and Realdus Colombus of Padua (also student of Vesalius). Harvey was a student of Vesalius in 1603.

[7] Among those who address this issue are: Blowers (1993), Haughton and Hunter (1994), or, for a more critical perspective, Burgess, *et al.* (1997), Baeten (2000), Davis (1998), Desfor and Keil (2004); Gandy (2002); Keil and Graham (1998); Swyngedouw (1999; 2004).