Cosmos and History: The Journal of Natural and Social Philosophy, vol. 1, no. 1, 2005, p. 90-127.

SCIENTIFIC PARADIGMS AND URBAN DEVELOPMENT: ALTERNATIVE MODELS

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ABSTRACT: Urban sprawl's negative impacts have been amply demonstrated, starting as long as 30 years ago, and most North American urban plans have, somewhere, reference to sprawl as bad policy (or, perhaps, absence of policy). Yet North Americans continue to tolerate the construction of more and more suburban subdivisions. This paper suggests an answer to this paradox. We argue that sprawl's attractiveness—if one can call it that—is buried deep in North American cultural predispositions, which we trace to quite specific interpretations of the mechanistic worldview that emerged from 17th and 18th century revolutions in natural philosophy. North American culture is a scientific culture as well as a suburban one. If mechanistic science and its peculiar view of nature is so pervasive and if suburban sprawl is both pervasive and dysfunctional, then this particular form of science and its cultural roots need to be carefully examined. We do this from the perspective of the 21st century, when quantum physics and new discoveries in the ecological and biological sciences are suggesting that many commonly accepted assumptions about physical reality inherited from 17th and 18th century science are flawed.

KEYWORDS: Sprawl; Mechanistic Worldview; Suburbs; Epistemology

INTRODUCTION

Urban sprawl's negative impacts have been amply demonstrated, starting as long as 30 years ago, and most North American urban plans have, somewhere, reference to sprawl as bad policy (or, perhaps, absence of policy). Yet North Americans continue to tolerate the construction of more and more suburban subdivisions. Why? This paper suggests an answer to this question. Specifically, we posit links between scientific worldviews and models of urban and suburban development.

In the last few years, opposition to sprawl has grown somewhat stronger in the United States and Canada. On the one hand, businesses—at least those with some roots in a metropolitan area—are starting to realize how costly sprawl is to any sensible system of commerce (Leo et al. 1998; GTA Task Force 1996; Orlebeke 2002). In addition, research is exploding on other costs—from obesity and social dysfunctions to enormous amounts of air, water, and soil pollution (Bray et al. 2005; Gurin 2003). Some writers have warned that North America's style of suburban development is the most serious single threat to human survival (Register 2002, 106). On the other hand, a new generation of writers and architects has not only produced devastating critiques of

suburbanization, but also provided concrete examples of alternative ways of building (Duany, Playter-Zyberk, and Speck 2000; Kunstler 1996; Marshall 2000). These alternative developments have been popular with homebuyers and even some urban planners and politicians.

Nevertheless, the momentum of North America's sprawl has hardly slackened (Lopez and Hynes 2003). An enormous infrastructure is in place: hundreds of billions of dollars in highways, water, and sewer lines; and existing shopping malls, housing, and industrial parks. Furthermore, a financial and institutional infrastructure, including many generous and significant subsidies, which produced such development, is in place and operating smoothly (Winfield 2003; Savitch, 2002). It would be easy to blame corporate developers' political influence and monopolization of the market in new housing for this state of affairs; but these companies are clearly appealing to a responsive clientele.

In this paper we argue that sprawl's attractiveness—if one can call it that—is buried deep in North American cultural predispositions, which we trace to quite specific interpretations of the mechanistic worldview that emerged from 17th and 18th century revolutions in natural philosophy. These cultural forces were part of the collective psyche of the millions of Europeans who emigrated to the New World in the 17th, 18th, and 19th centuries, people who fashioned North America's non-aboriginal culture. By the close of the 19th century this culture had developed an abiding faith in mechanistic science and its promise of material progress. Furthermore, by the 1960s, this culture was also a suburban culture. Suburban sprawl is now a central defining feature of North America's politics, social life, and economics. We focus on this modern North American phenomenon, even though North American-style suburban development has invaded Western Europe as well as many Third World countries.

North American culture, then, is a scientific culture as well as a suburban one. If mechanistic science and its peculiar view of nature is so pervasive and if suburban sprawl is both pervasive and dysfunctional, then this particular form of science and its cultural roots need to be carefully examined. We do this from the perspective of the 21st century, when quantum physics and new discoveries in the ecological and biological sciences are suggesting that many commonly accepted assumptions about physical reality inherited from 17th and 18th century science are flawed. We argue that 21st century science's revision of those assumptions can be correlated with more sensible forms of development than North American sprawl. It must be stressed that we see mechanistic science itself as an outgrowth of early 17th century socio-cultural upheavals. A brief review of this point is appropriate.

THE GROWTH OF MECHANISTIC CULTURE

Science and society are interwoven profoundly at the start of the 21st century. Quite literally, contemporary societies are inconceivable without their massive scientific infrastructure. It is, therefore, easy for us to forget how recent this intense

interconnection is in terms of the long span of human history. The history of science in the ancient world (Egypt, India, and Mesopotamia), in the classical world (Greece and Rome), and in China, India, and Islam during the Middle Ages is a record of remarkable scientific achievements (Lindberg 1992; Bodde 1991; Butt 1991). But none of those cultures gave rise to what we term a modern scientific outlook or worldview (Huff 1993). It was only in Europe, roughly between 1500 and 1700, that a complex network of specific cultural, sociopolitical, economic, and religious forces produced a science whose theoretical and institutionalized structure**s** emerged as one of the key feature**s** of society (Seitz 1992). Scientific ideas and methodology permeated the thought of the 17th and 18th (Jacob 1988). Although 17th century science owed a great debt to classical and medieval achievements, it emphasized a mechanistic philosophy of nature—with important but increasingly marginalized residues of magical and mystical traditions (Martin 1992; Goodman and Russell 1991). Political, economic, and religious elites aggressively promoted the acceptance of, and ideological commitment to, the mechanistic philosophy, which was based on a search for certainty. This certainty was to be achieved by means of powerful scientific method and epistemology.

Associated with luminaries of the 17th century's Scientific Revolution[1] such as Francis Bacon, Galileo Galilee, Rene Descartes, and Isaac Newton, this epistemology provided the paradigm for a radically new approach to the understanding of nature and of humanity's relationship to its physical, metaphysical, and socio-cultural environments. This understanding was predicated upon a synthesis of the deductive (as exemplified by Descartes) and inductive/empirical (as exemplified by Bacon) approaches to the study of nature—a synthesis symbolised by the towering achievements of Newton. There is a vast literature on the symbiosis between the ideology of mechanism, the new scientific method, and their political and economic milieux in 17th and 18th century Europe (Dobbs and Jacob 1995; Golinski 1998; Shapin and Schaffer 1985). By the 19th century, the mutual interaction between science and the broader culture became a dominant feature of European societies. Indeed, by the 1870s it became common to speak of "a scientific culture, rather than science in culture" (Yeo 1993, 32).

Those developing the mechanistic worldview in the 17th century had the explicit ideological goal that it permeate all spheres of culture (Shapin 1996; Jacob 1988). In the 18th century, the European Enlightenment was a powerful intellectual institutionalization of this mechanistic philosophy.[2] The Enlightenment also set the

[1] Scholarship of the past two decades has undermined the notion of an unambiguously defined Scientific Revolution (Lindberg and Westman 1990).

[2] This was by no means an uncontested process. For an important account of several movements that posited powerful alternatives to the mechanistic paradigm see Reill 1999. Reill is especially useful for his account of "that loose group of thinkers, less frequently studied, though numerous, whom [he calls], for want of a better term, Enlightenment vitalists. Their inquiries usually centered on the fields of chemistry, geology, the life sciences and natural history. Unlike the [mechanists], they sought to reformulate the concept of matter, along with those of force, power and connection in their construction of a science that respected natural variety, dynamic change, and the epistemological consequences of skepticism" regarding

stage for the 19th century belief that this new science might afford humans the ability to modify and possibly control nature for the betterment of their species (although this had also been an important message of Bacon over a century earlier) (Greene 1992). The scope and impact of scientific activity grew dramatically in the 19th century, as did the effectiveness of the propagandists praising the virtues of (ostensible) objectivity and its contribution to empirical certainty. Our analysis will connect the phenomenon of sprawl to five specific cultural manifestations of this kind of science:

(1) science's professionalization, with its associated organizations and institutions;
(2) the equating of scientific with democratic ideals (most notably in the writings of the philosophers of the Enlightenment)[3];
(3) science's identification with the urban-industrial order;
(4) humans' increasing sense of separation from the rest of nature, since both individuals and societies were learning to live in a re-created physical environment controlled and refashioned by science and technology;
(5) the linkage of science to concepts of sociopolitical 'progress.'

These science/society interfaces were a major part of what has come to be called the scientific culture of Western Europe and North America of the last two centuries (Merchant 1980, Ravetz 1990).

MECHANISTIC SCIENCE AND THE SUBURBAN LANDSCAPE

Our specific argument is that this culture's mechanistic worldview has been one key element in the emergence of the modern suburb's landscape. It is a landscape that is human-built, a product of human intentions and cultural conditioning. We are focusing on what our ancestors lived and thought as they were laying the foundations of this landscape, but we invite the reader to ponder how our descendants will respond to the landscape we are now creating (Cannadine 2002, 188-189). The meaning of this built techno-scientific landscape cannot be underestimated. While we hope to show that in some ways it is a legacy of mechanistic science, this landscape is also an influence on our behaviour, our sense of wellbeing, and the way we frame policy alternatives, particularly in North America (Fowler 1992). Before proceeding, however, it is worth noting that the mechanical worldview was formulated first by Europeans, only some of whom colonized the New World.

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mechanistic reductionism (Reill 1999, 365). The Enlightenment vitalists include such eminent figures as Johann Friedrich Blumenbach, Friedrich Schiller, G.L. Buffon, and Johann Wolfgang von Goethe. The critiques of the Enlightenment vitalists regarding the mechanistic paradigm influenced Romanticism, German *Naturphilosophie* and such twentieth century thinkers as Max Horkenheimer and T. Adorno.

[3] This generalization is subject to two important caveats: a) not all the philosophes were democratic (Voltaire was elitist in his political thought; Rousseau's conception of democracy was restrictive, e.g., women were given a lesser role in his ideal society); and b) insofar as the Enlightenment can be said to have been one of the major influences on the French Revolution, the politics of the Revolution—despite the slogan of egalitarianism—were often totalitarian or statist in practice (Outram 1995).

In fact, with respect to urban planning, there is a strong contrast between European and North American practices. It is clear that Europeans have self-consciously and vigorously resisted urban sprawl, even though they are inheritors of the same epistemological worldview. A partial answer to this apparent inconsistency has been provided by Louis Hartz and Gad Horowitz (Horowitz 1968). They argue that colonizers from Europe brought only a fragment of European culture with them—the worldview of liberalism that was emerging at the time—and then proceeded to evolve in their own way without the presence of the legacies of feudalism and of monarchism, which of course remained part of the physical and intellectual landscape of Europe. For example, Hartz and Horowitz explain the weakness of socialism in North America by the absence of feudalism's collective traditions.

European urban planning's aggressive stance against sprawl would never be accepted in liberal North America, where land ownership is considered far more sacrosanct (many immigrants had had their land taken out from under them by the enclosures, especially in Great Britain). This ideological stance was supported by an overwhelming abundance of raw land in the New World. Such open space was simply unavailable to Europeans. Limited access to fossil fuels also constrained any tendency to build car-oriented suburbs. We maintain that the mechanical worldview accompanying liberalism (Barber 1984), while still dominant in Europe after the 18th century, was nonetheless part of a much richer cultural mix. Combined with the scarcity of oil and land, this mix helps to explain that continent's different approach to urban development (Beatley 2000).[4] This approach has included the design of dense, mixed-use neighborhoods that include shops, a certain percentage of subsidized housing, public courtyards and squares, and generous amounts of green space. The result, according to Beatley, has been a broad array of lively and sustainable downtown districts all across Europe.

Our central thesis, then, is that we in North America are still living physically and epistemologically under the powerful spell of a mechanistic paradigm not just for science, but also for culture. Urban sprawl, as we shall see, is one of the most pervasive embodiments of this worldview. Within the context of North American suburban development, we shall point to cases where actors have used mechanistic science consciously to serve their own agendas but give other examples in which it is expressed as a broad cultural trait that is one of several influences on aggregate choice patterns.

Physics and biology have moved far from the 17th and 18th century focus on the application of Newtonian mechanics to the study of matter, plants, animals, and human society. The emergence of mechanistic science was in some ways only a transitional phase between Aristotelian epistemology on the one hand and quantum mechanics and the ecological sciences on the other. Nevertheless, even now, we in the West live our

[4] In contrast to writers such as Alexander (1972), Mumford (1961), and Beatley (2000), Jackson (1985) dismisses the cultural arguments and argues that economics was the only important factor: when Europe is rich enough, he writes, it will build sprawl. See pp. 239, 303. And, indeed, a recent commentator has pointed this out (Marshall 2000, 92-6). The case of Ireland seems to bear him out (Lynas 2004).

lives and interact with our environment in ways that in many respects follow the siren call of mechanistic science, even though its cultural underpinnings date to 1650 and earlier. Kuhn and others have shown that how scientists frame a question about Nature is conditioned by structures of thought peculiar to the era (Kuhn 2000; Shapin 1996; Berman 1981). These structures, according to Barber (1984) can be considered "pre-conceptual," since they make assumptions about the nature of reality and about human relations to it in ways that reflect deep cultural trends and precede theory and analysis. We shall focus on three preconceptual assumptions (obviously not exhaustive) that underlie mechanistic science, and therefore its culture: (1) the assumption of objectivity; (2) the pre-eminent importance of the search for a new kind of certainty and security, especially by means of quantitative methods and predictive models; and (3) materialism's postulate of reductionism, with its corollary that bits of matter are discrete and cannot interpenetrate each other (an 'either/or' as opposed to a 'both/and' perspective). (For a more sophisticated list, see Merchant 1992.)

These assumptions will be used to structure the linking of 19th century scientific culture to North America's sprawl culture in the late 20th century. There is nothing sacrosanct, of course, about mechanistic science's pre-conceptual assumptions. In fact, scientific research during the last century, as mentioned, has made them questionable. The corollary of this point is that other, more inclusive pre-conceptual assumptions would leave us free to explore more sensible forms of human settlement than sprawl.

I. OBJECTIVITY AND PARTICIPATION

A fundamental axiom of mechanistic science is objectivity. We use the term axiom literally: i.e., a precondition/principle for doing/thinking 'mechanistically', which is assumed rather than proven. The assumption of objectivity says, in part, that we can observe objects and phenomena without affecting them.

The roots of the objectivity debate, both in terms of the content of scientific knowledge and the role of the individual scientist in constructing that content, date back at least as early as the 16th and 17th centuries. However, it was during the 18th century Enlightenment that the contours of the debate assumed their modern form. The twin symbols of 'reason' and 'nature' dominated Enlightenment attempts to establish what were grandly hoped to be 'objective' sciences of humanity and society, as well as physics, astronomy, chemistry, and biology. Led by a group of brilliant individuals known as the *philosophes*, including Denis Diderot, Jean Lerond D'Alembert, Francois Marie Arouet de Voltaire, David Hume, and the Marquis de Condorcet, the Enlightenment epitomized the explicit effort to propagandize on behalf of the scientific outlook (Hankins 1985; Outram 1995, 47-62). A key ingredient in the philosophes' campaign was that social progress would automatically issue from an increased satisfaction of material needs, which in turn would be a direct consequence of liberating the intellect from traditional superstition and irrationality.[5] And, indeed, since the start

[5] The precise degree to which such progress would necessitate major democratic reforms in government or

of the 19th century there is no doubt that Westerners have seen themselves as using science and technology to transform dramatically both physical and social environments.

Debates over the desirability of such a transformation continued to heat up during the 19th century—a testimony to the power of the Enlightenment's vision (Hulme and Jordanova 1990). These debates took on a new character after the 1860s, however, when the *scientific naturalists*, led by Thomas H. Huxley and his allies—including John Tyndall, Leslie Stephen, and John Morley, as well as Herbert Spencer and Francis Galton—embarked on a vigorous campaign to persuade all levels of the public that science was objective and ideologically neutral. If science were accepted as an objective quest, then its conclusions would carry an almost invincible authority. Scientific pronouncements could then be taken as definitive in cultural as well as technical matters (Butts 1993, 313-7; Yeo 1993; Fichman 1984; Fichman 2002, 66,70,182). Influential utopian planners such as Frank Lloyd Wright and Le Corbusier argued that their proposals' power came from those proposals' transcendent expression of a common good for all citizens, regardless of their politics (Fishman 1977).

The scientific naturalists helped to create a largely secular climate of opinion in which the theories and metaphors of modern science penetrated the institutions of education, industry, and government (Turner 1993, 131-32, 179, 196-7). The successful establishment of this community and its authority tended with certain exceptions to exclude participation by anyone other than the formally trained scientific elite in the propagation and dissemination of knowledge. This was integral to the process of professionalization.

This new scientific ethos of the late nineteenth century was enthusiastically embraced in the United States. The Smithsonian Institution was founded in 1846 as a government center for research and publication in science. The establishment and development of the Smithsonian has been crucial to the evolution of federally supported science in America. There was also a growing interaction between scientific research and technological/industrial innovation that continues to shape the policies and politics of the United States and other 'have' nations (Seitz 1992, 45-46).

To summarize, by the close of the 19th century, the 17th century assumption of objectivity had become a cult, a dominant ideological as well as practical force in European and North American culture. Twinned to an ethos of increasing scientific professionalism, this cult served to discourage laypersons from significant participation in devising the economic**,** sociopolitical, and philosophical frameworks that would shape emerging twentieth-century culture.[6]

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could be made compatible with varying degrees of reform within traditional monarchist states is a subject of vigorous historical investigation and controversy. What is clear, however, is that Enlightenment propaganda imbued the subjects of different countries with new aspirations and new expectations for change and reform (Outram 1995, 112-113).

[6] The cult of objectivity has a history that is replete with subtle and not so subtle claims. See, e.g., Daston 1992; Porter 1992.

20th Century Physics Challenges the Assumption of Objectivity

Not being able to meet the assumption of objectivity would invalidate most contemporary scientific research, yet physicists studying subatomic particles have found that the observation process does indeed interact with experimental findings. A notable example of this phenomenon involves light, which behaves like a particle when experimentally observed one way, but like a wave when observed in another. "The quantum world," writes Kosso

> is one of essential uncertainties and irresolvable probabilities… Things exist somehow as waves and particles and yet as neither, an ambiguity that is resolved only by our intervention in the act of observation. Definitive properties such as being a wave or a particle, even being in any particular place, seem to be created by the observer. (Kosso 1998, 3)

Quantum mechanics (and relativity theory) have forced a radical rethinking of some of our most basic concepts of "reality", including the crucial relationship between experiment and hypothesis in the validation of scientific theory. During experiments, scientists are always manipulating matter to extract its secrets (Caspary 2000, 50-1; Galison 1987). But the basic assumption of most practicing scientists—especially those working in fields other than theoretical physics—remains that this intervention will not affect the validity of the experiments' outcomes, or the experiments would not be worth conducting.

How, then, are the notions of "objectivity" and "participation" affected by the 20th century revolutions in physics? Though its claims are firmly rooted in experiment, quantum theory describes the world "in terms that do not apply (at first glance) to anything we actually experience in nature…. In the world we observe, everything is definitely here or there, moving at one speed or another…Bohr had quantum mechanics in mind when he excused physics from the **task of reality**" (Kosso 1998, 151). Does this mean that science does not provide a valuable avenue for comprehending nature, ourselves included? Hardly. It simply means that certain results of quantum mechanics appear bizarre and do present a challenge to our understanding and credulity. "The quantum world is someplace weird, but that does not mean that it does not exist…In general, modern physics describes the world in terms that challenge our imagination and intuition" (Kosso 1998, 175-76). It bears repeating that certain important elements of our imagination and intuition are still rooted in 17th century culture.

Many contemporary scientists maintain that, in spite of observational conundrums at the particle level, in most contexts rigorous techniques allow us to make observations and to conduct experiments that enable us to understand and predict the workings of Nature better and better. Others insist that we are participating in what we observe, and that our findings are always contaminated by our intentions or techniques in one way or another. The issue is far from settled (Goldstein 1996, 119-125). It would be rash to say that the mechanistic paradigm is totally repudiated by quantum mechanics.

A number of contemporary philosophers of science, such as Cartwright, have argued, however, against a vision of a uniform world completely ordered by a single elegant and deterministic theory. Instead, Cartwright claims that the laws of science are not absolute or final, and that an ideological belief in that absolutist view is misplaced. The laws of science are more a patchwork than a monolithic unity. Accordingly, the laws of science are "dappled" and a broader range of connections between scientific paradigms and actual cultural realities is possible (Cartwright 1999, 34-50). "It's not the end of the world. It's not even the end of our knowledge of the world. It's just the end of the world as we know it," writes Kosso (1998, 186). We suggest that if quantum mechanics spells the end of the world as we know it, then embracing a quantum view of reality will have implications for sprawl's appeal.

It seems as if the human mind, or perhaps human consciousness, is able to separate itself from the rest of nature, contemplate it, analyze it, and even predict it. Brian Swimme has suggested, though, the absurdity of assuming our separateness from nature, even in the act of contemplating her. Whatever position one may take on the philosophical controversies over the relationship between body and mind, our brains and our thoughts all emerge from the dirt we stand on (and pave), by the food we eat, by the air we breathe, by our parents' bodies and our parents' love, and ultimately by the sun's energy, without which nothing would happen on Earth. Thus, in a real sense, humans are an example—probably not the only one—of the universe contemplating itself (Berry and Swimme 1992; Berman 1981). Objectivity in the strict sense is impossible. We are participants, whether we like it or not.

It may well be, as Shimon Malin recently put it, that future historians will describe adherence to 'the principle of objectivation—whereby a living universe is treated as a vast collection of chunks of dead matter—as a transitional aberration.' We admit, along with Einstein, that 'possibly [we] did use that line of reasoning, but it is nonsense all the same.' (2001, 241)

However, Malin notes,

> [S]cience is based not only on the principle of objectivation but on human experiences as well. Since experiences are subjective and, as experiences, cannot be objectivized, the very basis of the scientific endeavor is excluded from the domain of scientific inquiry…This need not be a limitation of science per se. It may well merely be a characteristic of science as it is currently practiced. It is possible that the integration of the objective and subjective domains within the context of the scientific endeavor will be the next decisive step in the evolution of science (Malin 2001, 230).

This integration not only challenges a basic assumption of mechanistic science. It also openly acknowledges that we are a part of what we build and that what we build shapes our behavior. We are thus forced to consider more critically not only the epistemic claims of mechanistic science but also some of its technological offspring, such as transportation technology and city building.

We have shown that by the 19th century the general public could no longer fully understand the increasingly complex theories of mechanistic science, nor could it enter meaningfully into debates about the direction scientific and technological developments should take. Our argument is that this nonparticipation in the scientific enterprise was part of a more general, nonparticipatory state of mind engendered by the assumption of objectivity.

We underline that we are using "participation" in a broad, cross-disciplinary sense, participation not only in a particular form of science but also in the political system, the economics of housing, and nature itself. Notwithstanding its many manifestations, we argue that participation always carries a political meaning, since it refers to the power or energy contributed by an individual to a collectivity of which she or he is a part. Defining participation in this way also enlarges the scope of what is traditionally considered political—i.e., elections and the policies and structures of government. For example, we have shown that 19th century political life in Western Europe and North America was altered by the rise of a powerful scientific establishment. Furthermore, participation in the activities and organizations of this establishment was increasingly limited to those with professional credentials. In this system, the non-specialist became politically disempowered. Other examples of this process will be suggested below.

Objectivity, Professionalization, and Urban Reform Government

Lack of participation turns out to be central to the culture of sprawl—its environmental destructiveness, its government, and its planning.

The sense that we humans are somehow separate from nature lies at the base of the nonparticipatory worldview. "Nature" is something over there and is assigned contradictory attributes such as cruelty, beneficence, unpredictability, and grandeur. The suburbs have been desired—and marketed—as a way of "getting closer to nature" than the polluted and paved central city. In fact, suburban development has done far more violence to the biosphere than the 19th century industrial city, by bulldozing millions of hectares of prime farmland, by requiring egregious amounts of energy to service, and by promoting explosive growth in the use of trucks and automobiles. The car, in fact, is one of the single greatest contributors to the air pollution that kills thousands of North Americans every year (Fowler and Layton 2002). This fact is surely the clearest possible indicator of our disregard for the rest of nature. Mike Davis has graphically illustrated this disregard with specific respect to the building of Los Angeles's suburbs, an enterprise which has totally ignored the region's long term history of catastrophic seismic and meteorological upheavals (Davis 1998). The irony should not be missed: in our efforts to get closer to what we see as nature, we end up polluting and spoiling our nest beyond recognition.

There is no doubt, of course, that certain 19th century American pioneers in suburban development were genuinely trying to capture some of nature's wildness in

their design (Jackson 1985, ch.4). But it is highly misleading to call artificially winding streets and acres of lawns more organic and "natural" than what one finds in downtown neighborhoods. Neither environment has much "wild" nature left in it, except by accident. It is also misleading to suppose that we as a part of nature can somehow make something more or less 'natural.' This faulty supposition stems in part from the mechanistic worldview that posits an external 'nature' that humans can objectively study and manipulate.

The genesis of urban sprawl's government and politics also illustrates the nonparticipatory worldview. As cities' populations exploded in the 19th century, municipal governments struggled to keep up with demands for housing, social services, and physical infrastructure. Local politicians developed effective *ad hoc* organizations that tried to meet the needs of millions of immigrants from the rural countryside and from Europe. These organizations often turned into party machines with a hammerlock on local government that lasted for decades in cities such as New York and Chicago (Banfield 1969, Parts III and IV; Yates 1977, 44; Weaver 1977, 55-73). To give them their due, these machines staffed police and public works departments, and built impressive networks of roads, sewers, streetcar lines, waterworks, and electric and gas lines (Haywood Sanders, as reported in Bridges 1997, 172-3). The loyalty of immigrants who obtained work from these projects was expressed as rock solid majorities for the machines at election time.

While there was plenty of money to be made by individual businessmen under the rule of these political machines, the business community as a whole was not pleased at having its fortunes tied to an organization with unpredictable and temperamental bosses and with a power base that rested on an immigrant working class. A reform movement sprang up to challenge the party machines' hegemony. Although the movement's origins and aims were political, it presented itself as ideologically neutral—just as the scientific naturalists did. The reforms were designed, in fact, to de-politicize municipal government. The argument of the reformers was that municipalities, incorporated as they were by provinces and states, were basically business enterprises, whose efficient operation depended on objective management principles and technical expertise (White, 271-4; Tindal and Tindal, 57-60; Anderson 1979; Harrigan 1993; Banfield and Wilson 1963, Ch. 11 and 12). There was no Republican or socialist way to pave a street, it was pointed out.

Municipal Reform and the Erosion of Political Participation

The late 19th century business-led wave of urban reform thus paid homage to objective science and in particular to the mechanistic worldview (though there is a well-documented link between business and this science that goes back to the 17th century) (Jacob 1988; Ravetz 1990, 120-121; Pyenson and Sheets-Pyenson 1999, 251-258; Cohen 1994, 153-203; Merton 1970). The practical impact of this link was to legitimate

any agenda by appeals to science and statistics:

> More and more, the reformers placed their final trust in the bureaucratic method …a radically new approach to society and problem-solving. At the theoretical level, it was founded upon the burgeoning science of statistics. This science … seemed able to rationalize the complex and mysterious world created by the new urban-industrial order. (Rutherford 1984, 444-5)

This urban-industrial order included not just poverty and homelessness but also massive new public works, labyrinthine public accounts, and large for-profit corporations. The city itself was seen as a giant machine, which would work smoothly only if its problems were handled objectively and at arms' length by scientifically trained experts—hence the call for independent specialized commissions. These commissions, as well as the main municipal bureaucracy, were to be staffed by professionals who were neutral, objective, and not motivated by any political interests. From 1880 until well into the 20th century, municipalities embarked on a far-reaching program to professionalize their large and growing administrations (Yates 1977, 44-67), ostensibly to take advantage of the powerful new insights into the real world provided by the scientific method.[7] Not coincidentally, civil service reform greatly decreased the number of jobs available to hand out to friends of political machines.

Whereas the scientific naturalists used the apparent neutrality of science to underpin the authority of science itself, urban reformers used that neutrality to underpin their political legitimacy.

"Scientific" governments' discouragement of widespread participation in public life in the 1890s became reflected in the particular urban environment those governments began to build in the 20th century—an environment that was increasingly accommodating to the automobile. While urban reformers were everywhere, their legacy is more evident in the US Southwest, the Canadian West, and in smaller cities, especially the late 20th century suburbs. The older industrial cities of the East and Northeast, whose downtowns were less car-friendly, were less affected by the movement (Bridges 1997, 3-12). There are quite a few large cities in the American Southwest with nonpartisan elections and city managers, but the consensus of urban government scholars is that "reform-style city government is most likely to be found in suburban cities" (Harrigan 1993, 115; Banfield and Wilson 1963, 140). One may also observe that San Diego, Houston, and Phoenix are examples of what happens when cities are built entirely on the suburban pattern. All these jurisdictions tended to have an ethos that encouraged management by experts as opposed to participation by citizens.

One of the salient characteristics of "reformed" cities with nonpartisan elections and city manager systems (which also tend to have weak mayors) is low turnout in municipal elections (Bridges 1997; Lineberry and Fowler 1968). Thus, it is not surprising that the nonparticipatory worldview is a political fact of life in many North American suburbs. Voter turnouts should be higher there because suburbanites tend to

[7] This professionalization of the civil service clearly drew on 19th century French bureaucratic reforms.

be better educated and to have higher incomes than people who live elsewhere. Despite this fact, the growing suburban dominance over North American politics (Dale 1999) has proceeded apace with steadily dropping voter participation. Voter turnout in municipal elections and participation in local issues is notoriously low in the suburbs (Alford and Lee 1968; Fowler 1992, 120).

Nonparticipatory Citybuilding and the Politics of North America

Voting is only part of the story, however. As Mumford puts it,

> Suburbia offers poor facilities for meeting, conversation, collective debate and common action—it favors silent conformity, not rebellion or counter-attack. So suburbia has become the favored home of a new kind of absolutism: invisible but all-powerful. (1961, 513)

Although newer urban and suburban development in North America often includes semi-public spaces of some sort—some in malls, some carefully integrated into a complex of office buildings—these spaces, argues Kostoff, are too programmed to invite informal, unpredictable contact (1992, 182). John Sewell notes that there are no truly public squares for civic gatherings of any sort in the suburbs, no places of sufficient urban intensity to invite marches or protests (Fowler 1992, 130). Robert Putnam (2000, ch.12) has found considerable evidence that American suburbanites have retreated into the privacy of their homes and are participating less and less in local organizations. Part of the reason is that these people are spending more time in their cars, driving alone around the ever-expanding city. Finally, Lowi (1979, 267) sees the suburbs as an escape from political responsibility for the social and economic challenges faced by central cities, challenges that are not unrelated to the growth of the suburbs themselves (Rusk 1993).[8]

Thus, although the nonparticipatory principles of reform government were laid down at the end of the 19th century, they were most warmly embraced by 20th century city regions charged with managing the sprawling wastelands built for cars. These placeless places are incapable of supporting a vibrant civic life, which requires frequent face-to-face contact on city streets. When someone needs the car for even the smallest errand, it is difficult to nurture casual acquaintances with neighbors in the area. As insignificant as these acquaintanceships might seem at the time, they are the bedrock for effective collective action when the need arises. They also enrich the civic life of the entire city in unexpected ways (Jacobs 1961; Fowler 1992). The suburban landscape can rarely support the organic growth of such relationships.

At a less obvious level, it is worth noting that the houses and malls of suburbia are all built by large developers for shoppers and residents. Their scale and design require them to be planned from above. Until quite recently in human history, people built

[8] But see Sies, esp. 326-7. Early in the 20th century many middle class suburbanites in the Philadelphia area were active in the affairs of their central city. However, they were rail commuters.

their own houses. Even in the early part of the 20th century, workers all over North America were building their own suburban houses, room by room (Harris 1996). By now, however, we are thoroughly used to having everything constructed for us. We have explained above why we feel lack of participation in the mechanistic scientific establishment was politically disempowering. The same point can be made about lack of participation in building our own dwellings or planning our neighborhoods.

Participatory Citybuilding: Cohousing and the New Urbanism

Those who participate in citybuilding embody a worldview that transcends mechanism. They see themselves not as passive recipients of the fruits of scientific enterprise but as co-creators of their own social and built environments—at the interface between the objective and subjective domains, as Malin would say.

Most examples of this phenomenon, significantly, come from inner cities. One case is Cedar-Riverside, not far from downtown Minneapolis, where a developer had plans to "level the entire area and construct … a massive complex of twenty high-rise apartment towers including 12,500 units." (Nozick 1992, 130) Local activists, with the help of a favorable court decision and some tax increment[9] fund money, have been developing the neighborhood with affordable housing, a grocery co-op, a People's Community Center, and the Riverside Co-op Café.

Cedar-Riverside is a working class community. Similar examples are rare—Dudley Street in Boston (Medoff and Sklar 1994) is one and Banana Kelly in the Bronx (Gratz 1989) is another.

Middle class initiatives are more common. Cohousing is an example of mostly middle class people who are determined to design and even to build their own housing around a community center, usually in groups of ten to twenty families. While this housing is often in the country or the suburbs—hardly a deterrent to urban sprawl—sometimes it is downtown, reconfiguring existing houses or even old warehouses (Hester 2005; McCamant and Durrett 1988). The main point is that these user-designed pockets of the city are the antithesis of the nonparticipatory worldview. Cohousers have become their own housing professionals.

One of the strongest voices against sprawl and simultaneously in favor of participatory development comes from a group of architects and planners who call themselves New Urbanists. Explicitly rejecting the dominance of specialized professionals such as zoning lawyers and civil engineers, New Urbanites involve every stakeholder in the planning of a neighborhood, via no-holds-barred brainstorming sessions ("charettes") that emerge with practical, physical designs (Kunstler 1996, 135-6, 147-8). The Charter of New Urbanism states, "We are committed to reestablishing the relationship between the art of building and the making of community, through

[9] The 'increment' was additional taxes generated by new development. This money was used by the community to leverage locally driven development.

citizen-based participatory planning and design" (Duany et al. 2000, 261). Andres Duany, one of New Urbanism's central figures, argues, "Many successful neighbourhood improvements can trace their origins back to the kitchen tables of concerned citizens…. Their common sense is often the only bulwark against the short-sightedness of conventional developers…."(Davis 2003).[10]

A post-sprawl North America can be characterized by people who participate actively in the design and building of their neighborhoods, which will reflect diverse personalities. By definition they will not be part of a homogeneous subdivision. When small groups of people collectively design their own settlement the result is compact, in order to reinforce the chances for social contact (Alexander 1985; Fowler 1991). The settlements almost always include plans for ecologically sensible waste re-use, "soft" energy, and more plants and greenery—even in dense areas of the city (Fowler 1991). Human symbiosis with, not detachment from, the rest of nature is openly celebrated.

In these ways the mechanistic traditions of objectivity and professionalism have been superseded in certain instances by the actions of people who embrace the inevitability of constant participation by humans in all of physical and cultural reality. Acknowledgement of this participation characterizes the 21st century scientific fields of quantum physics and the ecological sciences (Capra 1982; Zohar and Marshall 1994). People who design and build their own neighborhoods have not only integrated the objective and subjective domains (to use Malin's words); they have also regained political power taken from them by nonparticipatory mechanistic social and economic institutions.

While the mechanical worldview grew out of its own era's culture, its physical and epistemological legacy is still with us 300 years later. But that legacy was also political: objectivity forbade us from participating in nature, and professionalism forbade all but the properly indoctrinated to practise science, or even (now) to build houses. There was, however, a lurking contradiction. On the one hand, at some level we are all collaborating ("participating") to support the social, technological, and epistemic structures we now have. On the other hand, we tend to ignore this fact—mechanical science is perhaps the new opiate of the masses—and retain a faith in the objectivity assumption. This syndrome has given us a nonparticipatory worldview that continues to reinforce itself. Given our democratic ideology, these observations should give us pause.

II. CERTAINTY AND SECURITY

Mechanistic science can be seen as an attempt to find some certainty in the tumultuous times of the 17th century (Toulmin 1992). Descartes, Newton, and many of the other scientists of the era were trying to formulate a method that would enable them to discover *reliable* truths about nature. We have already noted that these attempts

[10] See, however, Marshall (2000). He argues that New Urbanists insist 'on putting the developer in the driver's seat in shaping places…' (146)

were supported, financially and institutionally, by the political and clerical elites at the time, who were seeking to bolster their legitimacy—and their power—by championing the new science (Jacob 1988; Dobbs and Jacob 1995). Later, new elites, including those of professional science, sought to bolster *their* legitimacy and power to articulate and provide the bases for security by appeal to science's achievements and potential. What many historians have termed the *cult of science*—with its core belief that science afforded an avenue for achieving a sense of security in a rapidly changing industrial world—emerged among certain thinkers of the Enlightenment, but it reached a crescendo in the Victorian era (Turner 1993).

The Industrial Revolution and "Control" of Nature

To understand the full impact of the cult of science, it is necessary to grasp the temper of the Victorian age. The world of the mid-nineteenth century witnessed dramatic advances in science. But 'science' meant only partly the empirical approach to nature. More tangibly, science became identified with its results: the products of technology. During the long reign of Queen Victoria, the science and technology of the Industrial Revolution transformed many of the conditions of people's lives. The first railroad was built in England in 1825, when Victoria was a little girl. Before that, the maximum speed of land travel was, for up-to-date Englishmen as it had been for Caesars and Pharaohs, the speed of the horse. But before the Queen and Empress died, at the century's close, almost all of Great Britain's railroads had been built. The technology of mechanistic science, driven by the culture of entrepreneurial capitalism, had begun that liberation of humans from animal muscle, that acceleration toward (then) inconceivable velocities, which became characteristic of the twentieth century (Briggs 2000).

Mechanistic technology was also impressive because it made things *work*. The practical, empirical British (and European and North American) mind was fascinated (Briggs 1989). So were the profit-seekers. While Victoria occupied the throne, transatlantic steamship service was begun, power-driven machines revolutionized industry, the telegraph and telephone were developed, and the electric lamp and the automobile were invented. City planning was being refashioned into a scientific enterprise although developers were still the economic engines of urban development. The dazzling new inventions promoted a tendency to see technology not as a product of a scientific culture but as a determinant of social and economic choices, inexorably driving human progress. Evolution (particularly those versions that incorporated the concept of progress) became a watchword to the late Victorians despite the notorious controversies surrounding that theory (Fichman 2002). This was because evolutionary metaphors seemed to make sense of a wide range of human social relations, including humanity's relationship to both its social and physical environments (Cooter and Pumfrey 1994; Winter 1998). Significantly, evolution appeared to justify to many

Victorians that Europeans, as claimants to the highest rung of the ladder of "civilization", had the right, indeed duty, to "civilize" and dominate the rest of the world. As traditional political, economic, religious, and philosophical verities withered in the bracing air of the cult of science and technology, both elite and popular segments of society sought new sources of intellectual and spiritual certainty. Evolutionary and other scientific theories appeared to provide it in domains as diverse as economics, politics, gender relations, Eurocentrism and racism, imperialism, science popularization, and the visualization, instrumentation, and interpretation of the scientific enterprise itself (Lightman, ed. 1997, pp. 72-142, 179-235, 283-289, 312-353, 378-474).

The secularization and modernization of European and North American culture accelerated during the course of the nineteenth century. The consequences and effects of that transformation are felt world wide today.[11] Faith in an all-knowing and all-powerful God has, for many, been replaced by, or incorporated with, faith in a scientific understanding of natural forces, human history, and evolution, and in the promises of progress made by the technological juggernaut of industrial capitalism. By the close of the nineteenth century, it seemed as if this understanding assured human domination over other species and the environment (as if we humans were not inescapably part of that environment) and our apparent control over health and disease. Mechanistic science was a key ingredient in the cult of progress that the Victorian era bequeathed to the twentieth century (Turner 1993, 35-37, 71-72, 119-120, 126-127).

Events of the late twentieth and early twenty-first centuries have shown what an ill-conceived notion "control of nature" is (Capra 2002, 1982). The presumed triumph of secular science over traditional religious and other cultural authorities is also in question. The contemporary dialectic between science and the broader culture is manifested in legal and ethical controversies over scientific creationism, reproductive technologies, global warming, and depletion of bio-diversity (Appignanesi 2002; Fichman 1997, 2002).

Certainty in the Social Sciences: Comte and Positivism

However, despite these significant controversies, and their 19th century precursors, the champions of mechanistic science succeeded in persuading society that they were offering certainty in the form of a more controlled physical environment. Scientists

[11]But the transformation was anything but inevitable, unproblematic, or systematically steady. Victorian science, religion, politics, and societal and institutional structures were complex and dynamically interacting and changing aspects of the human condition. Only when this is recognized does it become possible to understand Victorian culture—and the crucial role of science within that culture—as a pluralistic and shifting landscape. The relationship between science and Victorian culture was thus a two-way street. There was a veritable traffic in ideas and practices in the nineteenth century (Lightman 1997, 9, 15). Those debates were puzzling, often traumatic, to the society of that age.

themselves sought certainty within the scientific establishment by defining increasingly specialized niches (Secord 1986; Wise 1995; Van Helden and Hankins 1994). In addition, some disciplines such as history, psychology, sociology, and economics sought to divest themselves of aspects of their philosophical past and acquire the legitimizing aura of science. In the processes of specializing and insulating themselves from their pre-Newtonian past, professionals and career scientists built up a secure intellectual fortress from whose ramparts they could make objective pronouncements about the proper direction of public policy as well as social and technological development (Friedman 1987, 87-223).

Although the debate on the precise relationship between the social sciences and the natural sciences continues to our own day, the Enlightenment ideal of a *socially* legitimate scientific model for all explanation exercised a profound allure for influential thinkers as diverse as Jeremy Bentham and Karl Marx (Gordon 1991; Cohen 1994). One of the most significant exponents of this aspect of the Enlightenment was Auguste Comte (1798—1857). His elaborate systematization of the links between the various sciences is known as *positivism.*

Comte's overarching goal was to apply scientific methods to the study of human societies and place the knowledge of human institutions on as secure a footing as the laws of the inorganic world. Positivism was instrumental in the development of sociology as a distinct scientific discipline. Comte's ideal of science was modeled on the mechanistic Newtonianism of Laplace and Lagrange. Insofar as Comte identified himself as a natural scientist, it was mathematics that he knew best. Tellingly, he first called his approach to the science of society "social physics"—before changing that to "sociology" after 1840. To be sure, as Comte refined his ideas on the social sciences, he necessarily had to massage his mechanistic reductionism to deal with the complexities of the sociopolitical world. But Comte never wavered from his unambiguous assertion that the 'aim of science is prediction', with the corollary that "the aim of prediction is control" (Laudan, pp. 376-377, 378).[12] Comtean positivism was particularly influential in the genesis of systems of control such as technocracy, social engineering, "scientific management", and industrial psychology (Coleman 1978; Waites 1989; Pickering 1993; Brown 1997; Kent 1978). For Comte, scientific formulation was inextricably tied to a social goal: philosophy had to be realized in politics (Pickering 1993, 570-574; Scharff 1995, 102-105), and planners were legitimate only as implementers of immutable laws established by science (Friedman 1987, 71). Comte and the urban planners influenced by him believed that prediction and control were the cornerstones of social planning.

[12] Comte's famous aphorism first appeared as "Science, d'ou prevoyance; prevoyance, d'ou action" ["From Science comes Prevision; From Prevision comes Action"], in his *Cours de Philosophie Positive* (Comte 1830, tome I, p. 52).

The Rise of Statistical Thinking

Concurrent with the rise of positivism was the increased authority given to *quantitative* methods and models in the professionalizing disciplines (Smith 1998; Harman 1982). The sophistication and extension of quantitative analysis lent greater authority and certainty to the findings of the so-called exact sciences. The growth of statistical reasoning was crucial to the rise in the cultural authority of science during the 19th century. It became apparent that improvements on classical probability theory were necessary to analyse an increasingly dynamic and perhaps unstable mass society. Statistics appealed to practitioners and theorists as a reliable method of searching for the regularity that characterized the seeming randomness of individual and singular events. Scientific determinism—though it had many critics—seemed as achievable in the social as it was (apparently) in the physical and biological sciences. The great improvement in accuracy of demographic, economic, anthropometric, and social records early in the 19th century permitted statistics to become perceived by many in Europe and North America as the "numerical science of society". Statistics thus joined the ranks of the other ostensibly objective sciences in so far as its practitioners were seen as being loath to go beyond the 'facts.' Adolphe Quetelet was one of the most famous and able of those who sought to erect compelling statistical analyses not only of public affairs but also of the psychology and behavior of individuals within society (Porter 1995).

The ascendancy of quantitative and statistical reasoning was not an uncontested path. Charles Dickens surely spoke for many of his contemporaries in his bitterly anti-statistical novel *Hard Times* (1854). Many readers were repelled by Thomas Gradgrind's [patriarch of Coketown] command to the schoolmaster that he teach "these boys and girls nothing but Facts. Facts alone are wanted in life. Plant nothing else, and root out everything else. You can only form the minds of reasoning animals upon Facts; nothing else will ever be of any service to them" (Dickens 1854, 1). Indeed, the belief in the legitimacy of numbers, or of knowledge in any form, is a social and moral problem as much as it is a scientific one. Statistical reasoning, nonetheless, won the allegiance of sufficient numbers of those in power, as well as of many segments of the population, to emerge as a major handmaiden to mechanistic science during the Victorian era. In the end, the security that numbers afforded seemed to banish most doubts and fears of those living in an emerging techno-scientific age (Porter 1995, 3-86, 217-231; Gigerenzer, Daston, et al. 1989, 1-69, 235-292).

Scientific Certainty and Models of Suburban Development

The mechanistic worldview, then, was an attempt to find some certainty in the turbulent times of the 17th century and in fact served a similar function in the 19th century. This search for certainty relates to cities and suburbs in several ways, again

illuminated by dominant schools of urban planners of the late 19th century.

Starting in the 14th century, landowners—mostly nobles—in continental Europe as well as in England took over ("enclosed") land traditionally used by peasants for their crops and livestock. This process accelerated in the 17th and 18th centuries, displacing tens of thousands of people, not only physically but also emotionally (McQuaig 2001; Polanyi 1957). Refugees from these enclosures poured into the growing industrial cities of North America and Europe, cities that seemed to be growing uglier and more anarchic. They became dangerous places, and those who could afford it sought the certainty of ordered suburban tranquillity. Suburbs were seen as the way to cut themselves off from the rough-and-tumble sidewalks of downtown, where the air and streets were dirty and where anything could happen.

The design of these pre-20th century suburbs was qualitatively different, of course, from the car-driven sprawl of today. The former were enclaves for the privileged few and had almost none of the political, social, and ecological consequences of contemporary suburbs. We argue, however that the most important similarity between the older and newer suburbs—the unbroken thread to focus on—is the motive to escape the central city, in the quest for security.

Those people who experienced 19th and 20th century cities as unpredictable and dangerous and who sought security in the suburbs were not, to be sure, conscious agents of the 17th century mechanistic worldview. But elements of this worldview can be discerned in the language used by developers to attract these people to their expansive new communities on the urban fringe. Ironically, Ebenezer Howard, who developed plans for worker-run self-sufficient cities in the late 19th century, used such language. Totally at odds with Howard's ideology, however, numerous entrepreneurs used his label of Garden City for their suburban developments, describing them as places where residents could be closer to "nature", as we have already seen. However, the developers' pre-planned subdivisions were examples, as well, of the prediction and control dimensions of mechanism (Jackson 1985; Hall 1988). Home buyers were being offered an ordered refuge from the chaos of the city.

Thus, the suburbs fulfilled a need for certainty by being a predictable environment. The ultimate remedy for the disorderly city was in planned subdivisions[13] where houses all looked the same, and where residential uses were strictly segregated from commercial and especially industrial uses. The tool of zoning was used to ensure that areas were uniformly covered either with thousands of houses, immense shopping malls, or industrial "parks" (Fowler, 1992). Specialized land use was the mirror of specialized science.

The developers' blandishments were, in fact, appealing to widespread cultural values rooted in the Enlightenment. The *philosophes* had made a convincing case that human well-being could be achieved by scientifically-informed control of nature, and planned suburbs seemed to confirm that proposition.

[13] See Harris (1996) for a disapproving description of *unplanned* working class suburbs, however.

The Paradoxes of Homeownership

As cities grew crowded, and land became more expensive, newcomers were compelled to rent. Here was another source of uncertainty. Tenants were always in danger of having their rents doubled or of being evicted. In Europe, the political system stepped in to protect tenants, while North Americans showed less concern for ensuring a roof over everyone's head (Beatley 2000; Jackson 1985, 102).

In North America, uncertainty about shelter led to a search for security in the form of a single family home, owner-occupied—one of the hallmarks of sprawl. Security was found less in territorial communities than in the abstract, placeless reassurances of legal ownership of property. The guarantees of legal ownership were enormously appealing to the descendants of those who had been chased off feudal land by the Enclosures. This was especially true of those who were not so well off. In 1900, in some cities, the middle class rented in the suburbs, while the working class underwent considerable privations to own their own houses, because it made them feel economically more secure (Harris 1996; Sies 2001).

But the suburban formula for certainty came at a heavy economic and political cost. Homeowners became trapped in a network of dependencies such as mortgages, traffic-clogged streets, and those ubiquitous malls with identical stores. Ironically, escaping to homeownership in the suburbs was a way of giving away one's power—to the banks, to the traffic engineers, and to the developers of subdivisions and malls (Dale 1999; Zukin 1991, 11). In exchange for protection from the ugly and anarchic city, the suburbs have in fact become a new regime with its own forms of authoritarianism, as Mumford suggests: "In escaping the complex cooperations of the city Suburbia recovers the original vices of overspecialization and rigid control" (509). The overspecialization refers to land use separation, which will be considered below. The control, on the other hand, is not just in the building process. Mumford, with his usual prescience, wrote in 1961,

> Each member of Suburbia becomes imprisoned by the very separation that he has prized: he is fed through a narrow opening: a telephone line, a radio band, a television circuit. This is not … the result of a conscious conspiracy by a cunning minority: it is an organic by-product of an economy that sacrifices human development to mechanical processing. (512-3) (See also 542)

As with everything else, it is easier to see others' enslavement than our own. Daily behavior becomes so much a part of personality that we do not notice the chains we have fashioned for ourselves in the search for security. Critiques such as Mumford's have become scarcer as most North Americans become inured to the landscape of suburbia.

This landscape is not just residential. It also includes technological artifacts—bridges, factories, highways, skyscrapers, malls, and so forth—that have become part of modern 'nature'. Viewed thus, landscape refers to the scientific, economic, and political contours of society as well as to the physical environment (Schama 1995, 10-18;

Golinski 1998, 103-132; Shukin 2001). The suburbs themselves were seen as a version of techno-scientific progress in the 19th century, especially as an example of the miracles of transportation and construction technology (Jackson 1985, ch.2 and 7). It was this techno-scientific landscape, planned by and built with large scale capital**,** which, from the 19th century on, promised North Americans a security that could not be found in what was seen as a chaotic central city.

City Planning as Mechanistic Ideology

One of the players in the search for suburban security was the planning movement, specifically through its role in the homogenization of land use. We have noted Comte's central role in developing the idea that scientific planning should be a powerful tool for social reform. Although always distrusted as incipient enemies of the inherently beneficial market economy, planners and their ideas covered the full ideological spectrum from left to right (Friedman 1987, 55). Urban planning became important towards the end of the 19th century as part of the urban reform movement in both the US and Canada (Rutherford 1984; Scott 1971, ch.2 and 3). Planners were often hired by chambers of commerce seeking to regain some sense of order in an era of explosive urban growth (Lindstrom 2002; Moore 1979). Planning was a clear example of how professions were establishing themselves as specialties legitimized by their use of quantitative scientific methods. "The belief of city planners [early in the 20th century] in efficiency and science was intense" (Gunton 1979, 181).

Nevertheless, in most cities, staff planners tend to be facilitators of a complex process of building development rather than shapers of the city (Fowler 1992; Leo 2002). On the other hand, a small group of writers on urban planning—such as Frank Lloyd Wright, Le Corbusier, and Ebenezer Howard—have influenced the kinds of developments that get proposed. Many of these larger developments are the results of public/private development partnerships, which illustrate North Americans' ambivalent (hypocritical?) attitude towards keeping government separate from the private sector. Perhaps urban planning is all right as long as businessmen are in control of the process, which often seems to be the case (Lorimer 1972; Leo 2002; Squires 1989).

Institutionalized planning experienced a renaissance after World War II in North America, when there was a need for hundreds of thousands of new homes, fast—for returning soldiers and for those whose housing needs had been postponed during the war. "Members of the professional class … returned from the war with a whole new approach to accomplishing large-scale tasks, centered on the twin acts of classifying and counting. … Town planning became a technical profession based upon numbers. As a result, the American city was reduced into the simplistic categories and quantities of sprawl." (Duany et al. 2001, 11; Banfield and Wilson 1963, 191)

Planning, by definition, must be seen as a tool for achieving some kind of certainty, and, as such, control. There is an unwillingness to trust the Invisible Hand of the market place (Bookchin 1974, 100). Modern planning arose in North America when big developers, responding to dramatic urban growth in the late 19th and early 20th centuries, started to build hundreds and then thousands of houses at one time. Development of this scale needed regulation, and, just as important, needed planning to organize its own large scale operations (Gilpin 1986). Planning regulated the expansion of suburban housing in North America—it didn't prevent it.

North Americans, jealous of private property rights, put their faith in market forces. The market is touted by its supporters as a democratic way to make decisions, including those about urban form; but there is reason to doubt this belief (McQuaig 2001). A more accurate picture is that even when no formal urban planning principles are being applied—which is often—sprawl has still been shaped by government-funded systems of transportation and communication, and by market regulation and subsidization (Franklin 1990; Marshall 2000), including mortgages on single family homes and other developments on the fringes of cities (Fowler 1992; Savitch 2002). Like many infrastructure policies these were not decided on democratically (Franklin 1990). They were the product of heavy lobbying by the construction industries in both the US and Canada, even though the results were politically popular in some quarters (which was the intent)(Fowler 1992). As Richard Register puts it,

> …[M]ost people were personally compromised, bought off. By the mid-1950s tens of millions worked for the auto/sprawl/freeway/oil industrial complex, or were in debt to it or hooked on its products. This made them blind to the pitfalls and contradictions of the development patterns enveloping them. (Register 2000, 108)

Once again, many North Americans are seen as unaware of their own enslavement.

Within the parameters of these non-market forces, many of the most important planning decisions are taken by large developers and by CEOs of large corporations seeking to build—or to close—offices, warehouses, factories, or subdivisions (Ray and Roberge 1981; Smith 1979). Market apologists might argue that house-buyers and other consumers can influence the big companies by a series of individual decisions; but those decisions are extremely susceptible to highly effective advertisements that manipulate our values and preferences, starting from an early age (Klein 2000). One plausible explanation of why North Americans in search of security have flocked to suburbs whose benefits are so questionable is that they have been bombarded since the cradle with persuasive images of the suburban dream (Mies 2001, 330; Jackson 1985, 102). The primary sources of those images of planned communities have been the large developers, for over a century. We would argue, though, as refugees from the Enclosures, many North Americans were even more drawn to the suburban ideal. Alexander (1972) has shown that Americans are more attracted to single-family homes centered in larger lots than Viennese, except neurotic ones.

The planning component of suburban sprawl can thus be traced in various ways to 17th century society's quest for certainty and to the epistemology that embodied that quest. For Europeans, it has taken the form of government planning initiatives. On the other side of the Atlantic the search is to own a single family home, in the arena of an unpredictable and relatively placeless housing market. Urban planning is a place-based arbiter between homebuyers and developers or other large corporations, whose lobbyists and advertisements shape individual as well as collective choices.

Living With Uncertainty—Evolutionary Urban Growth

Scientists in the 20th and 21st centuries have determined that nature is far from random, but that humans are deluded if they believe that nature can always be reliably predicted (Capra 1996; Zohar and Marshall 1994). Heisenberg discovered that the mass and location of quantum particles could never be known simultaneously—knowing the mass precluded being certain about its position, and vice versa (Heisenberg 1971).

Quantum mechanics puts into question some of the more deterministic aspirations of science, thus potentially undermining the positivist rationale behind planning for progress. Reformist planners have seen themselves for decades as agents of progress (Friedman 1987; Register 2000). But if there is one thing that seems clear, it is that progress as such is difficult to plan, though it often exhibits identifiable patterns. Gratz describes a South Bronx neighborhood that illustrates this principle. She relates how, starting with a single family, residents of one street slowly but with great perseverance gained possession of buildings that were going to be demolished because absentee owners were behind in their property taxes. The family, some neighbors, social workers, and a few other helpers offered "to take the buildings off the city's hands and renovate them. They were willing to … provide some unpaid labor. They wanted to build low-cost cooperative housing that would not be a permanent burden on taxpayers, as was massive subsidized new construction… " (Gratz 1989, 113-4).

While the housing proposal was being worked out, these residents started a community garden, organized a food cooperative, and started recycling paper and glass.

> Dozens of young residents learned the skills needed in carpentry and construction for the renovation process. As new residents filled up the apartments, local merchants stopped going out of business and new stores opened. All this happened rather gradually, over a period of ten or more years. (Fowler 2004, 50)

When the successes in this neighborhood became known at City Hall, policymakers immediately wanted to apply this 'model' to other derelict areas. As Gratz notes, this completely misses the point that urban evolution comes out of creativity defined by the genius of a particular place. It cannot be planned from above—a conceit inherited from

mechanistic science.

Examples already referred to illustrate how small-scale, user-designed areas of the city develop organically, without an endpoint in view (although some cohousing projects do seem that way). Some of the most vital city districts are those that have somehow slipped through conventional development frameworks and escaped the ministrations of city planners and large developers. McKnight (1995, 84-6) gives the example of a group of working class people in Chicago who learned that fresh fruit and vegetables could help their significant respiratory problems. Instead of trying to figure out how to buy all this, they had the idea of building a greenhouse on the roof of a two-story apartment. Their extra produce earned them some money and used otherwise wasted energy leaking through the poorly insulated roof. Senior citizens were attracted to the greenhouse, worked in it, and developed new friendships and energy—they felt excited and empowered.

None of all this was planned, none of it *could* have been planned. In each case, in fact, whether it was cohousing or greenhousing, the project was a leap into the unknown. Uncertainty marked every step of the way.

The New Urbanists, mentioned above, clearly approve of planning. They have produced a draft plan framework, although it is highly flexible. They propose that planning be pro-active and highly participatory instead of simply reactive to developers' proposals (Duany et al. 2000, 224-8; Leo 2002). The result is often a disorderly scrap (Kunstler 1996, 190) so the outcome, once again, is always uncertain.

It is natural for our mechanistic minds to be uncomfortable with uncertainty implied by no plans (or leaders). Yet North American sprawl illustrates what happens if we cling to the illusion of certainty. Using mechanistic principles to plan suburban development has ended up producing chaos, while parts of some downtowns are being rebuilt from below, restoring a sense of order (Marshall 2000). Gratz and Mint have shown that these rebuildings grow like a garden, with participating citizens acting like husbandmen (1998). Planned projects that assume a finished product deny the organic nature of truly urban places—a house, a neighborhood, a city is always evolving (Lerup 1977). If humans need a pattern language as an intelligent guide to urban husbandry, the language can eventually be dropped, says Alexander, because it only "reminds us of what we know already" (1979, xv). These writers are not anarchists, but they suggest that relaxing the determinism of mechanistic science will help humans fit their settlements more gracefully into what is, after all, an ecosystem, not a piece of machinery.

III. REDUCTIONISM TRUMPED BY AN EITHER/OR UNIVERSE

One of the key tenets of Newtonian physics is that two objects cannot occupy the same place at the same time. This is because objects are seen to be made of irreducible, impenetrable matter—mechanistic physics was materialistic. Mutual exclusivity has fostered a tendency in our culture to separate things into discrete, pure categories.

Mutual exclusivity is also essential to reductionism, which asserts that entities of a given kind are collections or combinations of entities of a simpler or more basic kind. Further, such entities are definable in terms of expressions denoting the more basic entities. Thus, the ideas that physical bodies are collections of atoms or that thoughts are combinations of sense impressions are forms of reductionism. Though by no means universally accepted, the reductionist paradigm has been enormously influential (Jones 2000). There is a basic appeal to the idea that, in order to find out how something works, we need to examine its separate parts.

Starting in the late 17th century and continuing into the 19th century, scientists have divided their study into increasingly specialized areas, in keeping with the ethos of reductionism. Just as observers distanced themselves from the observed, and observed phenomena from each other, so these observers separated *themselves* from each other. As we have previously demonstrated, the specialization of science (including the social sciences) was the Siamese twin of professionalization in the 19th century. And while these twins could not be surgically—or institutionally or epistemologically—separated, the "objects" studied by mechanistic science could be. By the start of the 20th century, the tendency to separate and isolate previously integrated aspects of culture had become an obsession. Of course, certain developments in contemporary science—notably in quantum physics, relativity theory, ecology, and the quest for "organizing principles" in developmental biology and genetics (Capra 1996)—are forcing a broad rethinking of many of the basic assumptions of mechanistic/reductionist science. But the reductionist paradigm, with its roots in the transformation of scientific thought and methodology in the 17th and 18th centuries, remains a potent epistemological and cultural metaphor.

Of special import to our study is the appeal of reductionism to students of society. During the Enlightenment, various visions of a more perfect social order were rooted in the conviction that science—especially in its mechanistic mode—would provide the fundamental laws that govern humanity's proper actions. It was Turgot, his brilliant protégé the Marquis de Condorcet (1743-1794), and their circle who first coined the term social sciences. The term itself is highly significant. For these individuals believed that it would be a *science* of society—based on the scientific method's combination of reason and experiment, and using reductive and quantitative methods whenever possible—which should and would replace the various systems of tradition and authority that had previously governed human history. As society was broken down into its material components of population, resources, industry, and so on, the reduction of human beings to autonomous social atoms became a more common theoretical device (Johannisson 1990, 361; Cohen 1994). We have already seen that "scientific" urban reform at the end of the 19th century proposed rule by experts over their special areas of municipal policy—such as police, health, and transit—as a way of solving urban problems.

Social and Physical Monocultures

Although modern science has discovered that Nature's secrets are not so easily disentangled as Turgot and his coterie believed, the North American social and physical environment still reflects the 17th and 18th century fixation on separation and reduction. On our industrialized farms, single crops are planted in huge fields to accommodate the demands of petro-chemical agriculture and its machines. We divide our schedules into work time and play time and assume the two cannot overlap. In the 19th century, in the United States, there was a widespread movement to purify the home as a haven of domesticity, presided over by women, while the workplace was imagined as the equally exclusive domain of the man (Jackson 1985, 47-52; Hayden 1984). Cities and suburbs have been divided into large areas of single uses—residential, commercial, and industrial—partly because of the growth in the scale of enterprises, starting in the 19th century (Katznelson 1981). This land use segregation reflected the growing tendency to separate work from other parts of our lives. The suburbs express separation perfectly, since they were created to avoid industrial pollution and commercial density found in the central city. As we have noted, land use was from the start separated throughout the suburbs. Everything—from standardized housing to the same chain stores in malls—became homogenized. Monoculture was social as well as physical, because suburbs were explicitly marketed as havens from the central city's mix of incomes, nationalities, and races. Jackson reports that "in 1960 not a single one of the Long Island Levittown's 82,000 residents was black" (1985, 241). Suburbs became socially and racially more heterogeneous starting in the 1960s, but some analysts maintain that the segregating tendencies of suburban culture remains (Gottdiener 1994; Dreier et al. 2001).

From the very beginning, of course, cities have been segregated into sub-areas. Spiro Kostoff (1992) has summarised some of the dozens of different criteria for dividing up the city in pre-industrial times—religious, commercial, governmental, and residential districts, for example, to say nothing of ethnic and class divisions. While the viability of governmental and religious districts was connected to scale—they were functional only up to a certain size—the commercial and residential components of the city have been far more elastic. This is because of the commodification of land, which blossomed dramatically in the 17th and 18th centuries in Europe and North America (Polanyi 1957). Once most urban land was being sold to the highest bidder, uses sorted themselves out according to what they could afford, from office buildings (which could pay enormous rents), to stores, factories, and residences, whose abilities to pay for space varied within as well as between categories of use (Hurst 1975, 92-8). The explosion of cities in the 19th century enshrined these uses in concrete. The size and extent of homogeneous land use was related to the cost of land, which was only marginally sensitive to the scale of development or, interestingly, to the workability of a city district. (Fowler 1992, 145; Jacobs 1961, ch.13) One of the most important factors in producing the huge, dysfunctional subdivisions we have in North America was the

abundance of relatively low cost land, which made single family homes that much more accessible to working class people (Jackson 1985).

Buying and selling land is an illustration of the mechanistic worldview's materialism (Barber 1984). First, the land market needs the concept of private property, which by definition excludes everyone but the owner from the property. Combined with the separation of uses by rent, private property upholds materialism's axiom: no two uses or owners can occupy the same place at the same time. Second, the land market also reflects a profound separation from the land, which is treated as a commodity—an illusion, since humans cannot create land (Polanyi 1957, Ch. 6). Affection for a place goes unrecognized, subordinated, repressed. This affection is attenuated both when single use areas are created and when we relate to land as an instrument (notice the prevalence of the term "land *use*".)

Functional segregation and emotional separation have produced more and more places with little meaning to people who "use" them. Not places with no meaning at all, but places without the richness of history or of a mixture of activities and energies (Stefanovic 2000). Indeed, these places have lost so much of their meaning that many writers have noted that they seem placeless. "There is no there, there," said Gertrude Stein of Oakland's suburbs.

In the 1920s, a second generation of urban planners developed regional planning, which stressed the inter-relatedness of cities and their hinterlands (Hall 1988, Ch. 5). However, contemporary city and suburb building is never done with an eye to how the whole fits together, because in true mechanistic tradition the whole city is seen as nothing more than the sum of its parts (Marshall 2000, 108-9). This might be why little effective regional planning—including features such as Urban Growth Boundaries—exists in North America (Anthony 2004).

Building with Multiple Uses—Either/Or versus Both/And

Modern physics and the study of ecology—to say nothing of numerous poets, novelists, and visual artists—see places as multi-dimensional. In a real sense, place cannot be separated from time (Sheldrake 1995). At the micro-level, the location of a particle has to be expressed in terms of probability unless the observer wants to pin it down to a particular place at a particular time, in which case other information about the particle is lost. Atoms, their sub-particles, and their energy waves interpenetrate each other in a way that contradicts the Newtonian assumption that two things cannot be in the same place at the same time. Photons and electrons can be observed as particles, but they are simultaneously waves of energy. The world of quantum physics, Zohar and Marshall have argued, is a world of "both/and" (Berman 1981; Zohar and Marshall 1994). Space cannot be separated from time, for instance—there is a space time continuum. Cultural anthropologists have found many cultures in which this is a perfectly understandable concept, because place is still of the utmost importance to

them (Abram 1996).

Many urban areas illustrate the possibilities of both/and building. At the most prosaic level, the New Urbanism Code explicitly calls for mixed land use (Duany et al. 2000, 260-3). The most vibrant and successful city districts have close-grained mixed land use. (Keep in mind that, if one includes within one's scope enough land, its uses will always be mixed.) Small scale shops, offices, and residences all jumbled together might seem messy, but these uses acquire their own harmony, their own history, and, indeed, their own way of inspiring affection for the neighborhood. Jane Jacobs (1961) demonstrated this truth over forty years ago, and she was widely praised for her insights into the city. Systematic research has supported her insights (Fowler 1987). The examples already given show how easily one grass roots initiative in a particular place turns into a multitude of different projects, such as the greenhouse in Chicago that turned into energy savings, economic development, and a healthy focus for seniors. The Cedar-Riverside neighborhood, in addition to its numerous affordable housing units and business enterprises, ended up with six performing arts theatres, a system of child-care homes, and classes in entrepreneurial skills offered by the area's community development corporation.

These examples of both/and development can only be expressed in a neighborhood *over time*. A mechanistic snapshot of the processes could never capture the reality of urban dynamism that they represent.

CONCLUSION

Our paper began with the question of why suburban sprawl continues despite decades of books, articles, and policy papers clearly demonstrating its economic waste, environmental devastation, and social and political dysfunctions. We have argued that sprawl's attraction in North America stems can be traced in part to the 17th century mechanistic worldview and the upheavals that put it in place. This worldview is still ingrained in our 21st century psyches, which is why the large corporations and governments that subsidize them and give them life (through charters) are so powerful. As powerful as they are, it is as much a mistake to blame these institutions as the primary sources of suburbanization as it would be to blame a quarterback for losing a football game. We are all implicated. Our argument has been that the economic and political forces that came together to build North American suburbs cannot be separated meaningfully from the mechanistic worldview of the men and women who direct those forces.

The overwhelming physical dominance of large scale, segregated development has political implications. That is, it shapes North Americans' views of what is normal, of what is possible, and therefore of what land use policy could be. In this way, the physical environment helps to set the political agenda of North American governments —at all levels. Large subdivisions of housing, shopping malls, and office towers need to be built by large developers and planned for by big governments. Once in place, these

formidable institutions consolidated their considerable political power over land development and even over the formulation of alternative public policies (Fowler 1992, 121-8). We do not discount the powerful incentives provided by these public policies that subsidize highways and cars, single family dwellings, and other features of urban sprawl. We insist, however, that these policies are symptoms of the prior cultural conditioning we have tried to describe.

Cohousers, the residents of Cedar Riverside, and Chicagoans who build greenhouses on their roofs are evincing, in a visceral way, a scientific worldview that includes mechanistic science but is far broader. Clues to the shape of future cities can be found by noticing the organic, unplanned activities of city-dwellers sprouting like weeds in the formal gardens planted by Descartes and Newton. These activities are playing out the newest phase of the history of the co-evolution of science and social structures. Sprawl, whose appeal is related to earlier phases, is an extremely costly and even dangerous form of development. We have given a number of examples of creative citybuilding that challenge sprawl. These examples epitomize the link between scientific paradigms and urban development.

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