Growing Sustainable Suburbs: An Incremental Strategy for Reconstructing Sprawl.

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Abstract: *A new way of understanding the growth of urban form leads to practical suggestions for reconstructing a more sustainable suburbia. Combining theoretical results with pragmatic experience — and combining "top-down" controls with "bottom-up" processes — we offer guidelines for implementing small-scale changes that eventually lead to large-scale improvements. The goal is a re-integration of the urban realm, resulting in a more humane and sustainable environment. Importantly, this can be achieved by a minimum of new investment applied all at once. Changes need to be implemented over time, and subsequent interventions will respond to the success of the preceding ones.*

INTRODUCTION.

Although attention tends to focus exclusively on the particular modern phenomenon called "sprawl", we must recognize that suburban expansion has existed since the beginning of cities. A city, whether planned or haphazard in its initial form, tends to grow organically as its population increases. Legal measures that check the possible overgrowth of the central urban fabric, diverting new growth to the urban periphery, go back to the beginnings of civilization. In its earliest form, a relatively sympathetic exurbia maintained strong organic and structural ties to the city. Outer growth often completed some of the insufficient functional and spatial requirements of the tightly-delimited historic city areas enclosed by natural or man-made barriers. Military and religious uses, for example, needed large open and flexible development spaces. Markets and business activities often found the ancient cities too restrictive for their activities.

These various activities and uses attracted a variety of other heterogeneous activities serving and supporting monasteries, cattle markets and fairs, military barracks, stores, travelers' inns and hostels, and later manufacturing and industrial installations. Houses, shops, restaurants, bars, and various services contributed to create suburbs with qualities similar to those one could find in the central cities. These benign suburbs conceived and built as mini-cities most often respected the scale, connectivity, hierarchies, and proportions found in the best urban centers, and they had a symbiotic complementarity with the cities they gathered around or grew out from. They respected pedestrian-scale

principles, with the result that they were walkable urban extensions characterized by relatively flexible, organic and vital urban structure. In today's terms, they were sustainable urban morphologies.

The first historic suburban explosion happened with the arrival of urban train and transit facilities, which allowed commuters to escape daily from the crowded city, and, for the first time, to combine living in a relatively rural landscape with working in the city. Of course, this solution was totally unsustainable. The rural character did not stay that way for very long, as successive waves of commuters leapfrogged one another to move further out to more peaceful environments. Beginning in Europe in the late 19th century and the USA in the early 20th, the periphery of large cities began to rapidly expand further and further away from the earlier city edges following the expansion of the railways patterns. This autocatalytic dynamic started to produce an enormous new suburban zone, with endless rows of houses and discontinuous urban sprawl along transit lines.

The second historic suburban expansion came about when the automobile became the engine of urban planning, helping to make mobility the principal and compulsive activity of individuals. It was not so much the formidable invention of the automobile itself — and its corollary, the historically exceptional age of fossil fuels — but rather the acceptance of automobile transportation as the essential and virtually exclusive connector of the various human needs. These now became dispersed by monofunctional zoning over larger territories and distances: so separated that an individual could no longer walk reasonably through this system. Automotive traffic became the indispensable tool needed to organize the connective system for the whole spectrum of human needs, from the daily domestic needs of the *res privata*, to the more refined and equally indispensable needs of the *res publica*.

Along with both of these historic waves — and in some cases accelerating them — has grown a body of political theory justifying and even celebrating the new development patterns. The Garden Cities movement, for example, sought to rationalize the new separated city, which meant the segregation of its functions within a low-density suburban hierarchy. The Radiant City of Le Corbusier glorified the new car-dominated suburbs, and made them a fashionable cornerstone of modernist planning and design. His vision was the basis for Norman Bel Geddes' 1938 World's Fair diorama exhibit, "Futurama", which in turn inspired a massive wave of freeway-based suburban expansion two decades later. Le Corbusier's wildly exuberant vision of a suburban utopia seems somewhat chilling in today's era of ecological and resource challenges.

Since that time, suburbia has variously been associated with ideas of liberation, freedom of choice, autonomy, connection to nature, space and health, priority of family over society, individual emancipation over collective regimentation, private integrity over public alienation, and many more worthy goals. On closer examination, however, the connection is more imagined than real. In any case, the appeal of modern suburbia is undeniably strong. Hardly anyone has been really obliged to move to the suburbs, but clearly many millions have elected to do so, for these and perhaps other reasons (notably economic factors; particularly land prices).

TRADEOFFS IN THE CONTEMPORARY SUBURB.

There are many negative tradeoffs that come with the evident benefits of suburban structure as it exists today. The future, it seems, will bring many more if we continue to misunderstand basic forces behind urban growth. Debate has raged about whether the contemporary suburb is a sustainable urban typology; whether it can survive coming ecological and resource challenges — particularly the increasing diseconomies of "peak oil" — or whether its weaknesses will become so compounded over time that it will have to be drastically modified. In any case, there is little disagreement about the following negative tradeoffs that already exist in today's ubiquitous suburb:

(i) *Severely restricted transport alternatives.* To the extent that travel is exclusively dependent upon the automobile, those who can't drive (children, the elderly, the infirm, the poor) are at a severe disadvantage in travel to daily activities and access to needs. Those who can drive (e.g. mothers) must often act as taxi drivers for others, and sacrifice significant time and expense of their own. Walking is severely restricted, negating its demonstrated benefits to physical, mental, and social health.

(ii) *Congestion-promoting geometry.* The hub-hierarchical system of roads (see Appendix I; Salingaros, 2005) characteristic of modern suburbs, and the compounded dispersal of destinations (more roads to get to more things requiring them to be ever further apart) creates increasing traffic congestion over time. This wastes resources and decreases work productivity, air quality, and respiratory health, while increasing fuel consumption, expense, noise, stress, and dependence on non-renewable and imported resources.

(iii) *Higher infrastructure burden.* The inefficient land-use pattern (segregated uses; hub-hierarchical roads; low density) tends to place an undue burden on the maintenance of a huge infrastructure. The tax collected per dwelling necessary to maintain aging suburban infrastructure increases over time. Increasing property taxes undermine efforts at densification, because they drive people ever further out beyond the suburban limits, which must then grow a new and vast infrastructure.

(iv) *Weak public realm.* Public spaces have become dispersed, poorly-populated, and expensive to manage. This is due to a failure to understand the human forces defining public space, and is responsible for a general decline of the public realm (Salingaros, 2005). This, in turn, has been shown to result in a decline of civic interactions. There is a growing trend toward private commercial spaces and gated enclaves, thus essentially privatizing the public realm and limiting its role as social and economic catalyst.

(v) *Decline of an authentic sense of place*. Contemporary suburbs pose a perhaps even more intractable set of challenges for reform, because they lack the identity of

place. Phony names like "Stafford Pointe" and a fountain on the feeder road don't connect residents with their non-neighborhood. These suburbs have scarce civic activities; they lack adaptable historic architecture; they have a highly dispersed, poorly-connected urban pattern. All these are absent as a result of the peculiar and pathological suburban geometry of post-war suburban growth. There is no *civitas* in suburbia.

(vi) ***Degradation of livability over time.*** These negative urban trends increasingly destroy the very qualities that suburbanites sought in the first instance. Cars take over the roads and curbs just as much as in the city core, and individual garages eventually become filled with consumer junk, forcing cars to park outside. The only alternative is to leapfrog to a new suburban site before it, too, destroys these qualities with its own self-induced pattern of growth. This leapfrogging mechanism is the essence of a self-destroying, unsustainable pattern.

Most of the myths upon which suburbia has built its seductiveness have been exposed as false. Beyond its initial, impressive economies of scale, its increasing structural and functional failures are plainly evident. Legislation — and the special interests that it favors — helps to keep the current unsustainable model "locked in", preventing any competing model from implementation. There exists a built-in momentum of doing things a certain way, following unsustainable post-war typologies from the car-dependent landscape. The market already often rewards higher-density, walkable "neo-traditional" urban developments — but only where they are not made illegal by current suburban zoning! Meanwhile, residents find themselves having to pay increasingly for the growing social, cultural, economic, energy, and ecological costs of the modern suburb.

The lesson seems clear enough: the problems of older developments (including those of inner cities) are not always best served by fleeing to yet another outer undeveloped location. At some point, the optimal solution must necessarily be to turn back, reform the older development, and make it serve human needs more efficiently. This step rests on the recognition of value for a central place, and is fundamentally a process of regeneration rather than an unsustainable throwaway despoliation of our farmland. We propose reconstruction as the evident theory behind a successful new wave of inner-city and suburban redevelopment across the globe.

We do not treat here the social issues of the older suburbs, which is a major topic warranting a separate discussion. Rather, we present short-term pragmatics and policies for the reconstruction of the physical geography, and these will inevitably limit and shape the social life of the region. How this is addressed depends on who implements our proposals. The present social crisis is a most acute manifestation of everything unsustainable in suburbia: its self-consumption; its waste of time; its waste of energy; its erosion of social solidarity, self-organizational capacities, local creativity, imagination, and identity; its disorganization of human communities; its segregating mechanics and exclusions through its mono-functional and mono-social zonings, etc. Thus, we ultimately support social regeneration and healing by the measures we suggest. These will drastically improve social self-esteem, enable collaborative synergies and local

solidarities, help in rebuilding communities, as well as diversifying and enriching the social transect.

A PLAN FOR ACTION.

In the current urban and political environment, one must ask what is the most effective and realistic strategy (or series of strategies) capable of addressing the evident shortcomings of existing suburbs. These include their inefficient, hub-hierarchical, dispersed structure, the resulting over-dependence on the automobile, and other problems. To be effective and realistic means that such a strategy must not rely upon utopian conditions, astronomical sums of scarce taxpayer money, or radical opportunities to reengineer or rebuild. It means, very simply, a largely incremental approach driven by typical urban forces: redirecting the same forces that created today's unsustainable sprawl.

There is no need to restructure billions of acres of suburbia comprehensively and simultaneously — even if such a massive undertaking were economically feasible. The steps and priorities that we discuss here can be implemented on some vital parts within any suburban system. Developing such crucial focal points using our suggestions, we can then incrementally fix the networking and add missing links to the urban fabric. This will generate healing processes and self-regenerating dynamics that can eventually spread to a wider region of the urban fabric. For example, we can intervene just on the scale of a piazza design or new public building; or a building with mixed use in the right location.

We insist that there are possible short-term economic techniques to start the process of suburban reconstruction without either political revolutions, or high capital investments — in short, with an incremental, transformative approach. We believe the project of suburban reconstruction will be closely related to the emergence of a New Economy, with better accounting for sustainable features, and with more justified and more equitable resulting wealth. Its immediate social and economic benefits will include sustainable local job creation, and support for new professional skills. These will be developed and offered as an opportunity for rewarding careers in real estate and building trades.

Our proposals depend on a radical new conception of what a city is, and how it functions. We base our working assumptions on the latest scientific understandings in complexity theory, which invalidate most post-war planning models. Rules accepted as valid by well-meaning government planners and academics generated sprawl and degraded city centers to the point of almost total social collapse. A living city has to be both inhomogeneous and coherent: composed of distinct types of regions and functions, all working closely together. This implies simultaneous competition and cooperation between urban forces and functions. For example, commercial nodes are needed in the center of a suburban bedroom community to tie it together coherently. Such nodes need to connect both on the short (pedestrian) scale, and on the long (vehicular) scale, leading to a conflict that must be resolved by a very careful compromise in design. Once a commercial center becomes successful, legislation has to guarantee that it will not displace adjoining residences because of rising property values. As in a successful ecosystem, competing forces must be kept in a dynamic (not static) equilibrium.

This requires a different way of thinking about the relationship between conscious choices (like political decisions) and emergent trends (like aggregate economic processes), a combination of which has produced the modern suburb. These two extremes can be thought of as "top-down" and "bottom-up" processes. It is not a question of elevating one or the other, but of how they can be integrated, and managed more shrewdly. (In fact, the relationship between the two is very complex: for example, "top-down" political choices also have cumulative "bottom-up" effects, and cumulative economic trends also have at their heart "top-down" individual choices.) The radical conception of "the kind of problem a city is" (to use Jane Jacobs' apt phrase) must be joined by a radical new conception of how to manage such a complex structure more successfully for maximum human benefit.

The very notion of "control" must also undergo a change — one that has been said to be "less like carpentry, and more like gardening". Acting as responsible citizens and professionals, we must learn to manage and support bottom-up phenomena, such as market forces, without allowing them to descend to the lowest common denominator. We should also recognize the vital role as well as the limitations of top-down actions, beyond which they can be exceedingly dangerous. There are promising new strategies that combine the two aspects, particularly in the form of new kinds of "generative" urban codes.

We are proposing here in particular new "bottom-up" incremental changes and an associated method of working. This mode of planning and reconstruction encapsulates the central and radical method that we are proposing — an incremental approach based on a bottom-up methodology. It must be combined with top-down tools where appropriate and feasible, and the two approaches (bottom-up and top-down) can be coordinated into a larger whole through generative codes.

US URBANISM AND BEYOND.

Despite the unsustainability of the suburban model and the "tyranny of the private realm" it constitutes, the challenge cannot be dealt with without acknowledging the original purposes and ideals of suburban life. We are ready to evaluate positively some of the operational typologies and patterns developed in suburban city-building. Everyone can agree that the most extreme form of scale-less and amorphous urban sprawl has contributed very little value to urban culture. Yet, the history of suburban settlements cannot be reduced to its most caricatured examples. We take into account relatively successful examples like the early Garden Cities, *Siedlungen* in Germany, and early suburban developments in the USA. A strong case can be made, we believe, that such examples offer much more functional alternatives for a living urban tradition.

Although we utilize thinking and typologies from sprawl in the USA, our method is meant to apply universally. The degeneration of urban fabric in the USA is a special case, but it is neither isolated, nor exclusive. The same forces that produced it are crossing geographical and social distance into other cultures, and are influencing local neighborhoods the world over. This process is driven not only by the passion to copy all things American (even by the USA's political and ideological enemies), but also simply by the globalization of economic models that produced what they did in the USA. If

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nothing is done to actively counteract those trends, then the American variety of suburban sprawl is destined to become a global phenomenon.

Europe has its own particular suburbia, exhibiting far more national and local differentiations. For example, its urban landscape includes the terrifying violence-ridden French "Cités", the Eastern European prefabricated satellite towns, the residential middle-class low-density areas in many European countries, the English New Towns, decaying residential zones adjoining now dead industrial zones, etc. Despite the superficially distinct morphological character of these urban typologies, the European bureaucracy is ready to unleash its destructive potential throughout European territory, using the USA sprawl model as a template.

The reason behind this potentially disastrous mistake is that the sprawl typology is plugged into most European countries' mentality and corporate/government aspirations. Those entities are only waiting for their chance to act, having long ago decided that traditional European urbanism must be erased in the name of progress. In doing so, they betray a fundamental misunderstanding of the evolutionary nature of human environments, and the highly pertinent aggregated information in these older urban places. Planners put far too great a faith on a naive conception of the enduring "modernity" of relatively primitive industrial technology. Thus they exclude large areas of highly pertinent solution-space, for no other reason than the outmoded dictates of fashion.

The developing world presents yet another set of challenges. In many places one sees, side by side with American-style sprawl developments, "informal settlements": squatter villages and slums. These communities present challenges, but also opportunities. They are severely deficient in standards of sanitation, access to basic resources like clean water, access to transportation, adequate space and ventilation. Yet they feature characteristics of self-organization that can result in remarkably high-quality urban morphology. A strategy to combine their highly networked, highly efficient urban structure with the advanced sanitation and other amenities of the adjacent suburbs offers an ideal combination of properties — in the developing world, and in the developed world as well.

Our model of reconstruction is essentially about connectivity and not about geometrical typologies *per se* (that is, we are not excluding connective typologies as they embody connective structures in patterns, but we don't impose any specific geometry, either). It can work on informal settlements to make them into more humane urban environments. There is no need to bulldoze them and replace them either with high-rise towers, or with American-style sprawl, yet this is what government agencies are waiting to do when they have enough funds. We can use what is already there, instead of rejecting it outright. Much work remains to be done to achieve this optimum, and the efforts must necessarily be tailored to each culture and political system. Each community will have to develop its own adaptive combination of political action, professional expertise and market process.

FIVE PRIORITIES FOR SUSTAINABLE SUBURBS.

Many authors have proposed reasonable and incremental changes for urban and suburban morphology, but implementation has been haphazard and largely unsuccessful. The reason is that urban morphology is the result of deeper generative processes, which must also be changed. The configuration of buildings is driven by the physical communications network: the street pattern and infrastructure such as the networks for sewage utilities that are normally buried underground. The networks determine to a large extent how the visible, aboveground built structure is configured, and that is not going to change until the geometry of the network changes. The network, in turn, is determined by current social, political, and industrial practices in transportation and energy use and availability. Building a subway to connect low-density sprawl makes little economic sense if the transportation patterns generating sprawl remain in place; such a high-capacity heavy rail system should be reserved for a medium-to-high density city.

Dynamic processes drive a city to function as a network, and it is essential to grasp them. A new understanding comes as a result of the recent application of scientific methods to urban structure, which are not generally known to the majority of practitioners. Key concepts and results were developed by the authors and our friends (see Appendix II). We have drawn on morphogenesis, as developed in biology, and on the science of networks. Christopher Alexander has shown how complex form is coherent or not, depending upon the process by which it evolves, and this relies on the sequence of steps that are allowed (Alexander, 2004). Healthy urban evolution can thus be guided by a relatively simple set of codes. Conversely, the wrong codes will grow a monster, regardless of the measures taken later to impose a particular form. Such changes, we believe, can be made in piecemeal fashion, much as living organisms grow new blood vessels to organs as those develop. This will require a different management approach, and a radically different urban strategy.

The network model of cities reveals that urban forces are very different from the physical form that we usually see. Every piece of healthy urban fabric is characterized by a coherent, robust network structure. The properties that make it robust are precisely those that minimize network breakdown from random cuts (studied extensively by the US military in reference to the internet and the electronic communications networks). Our method is to identify the urban network, then to channel its growth so as to make it as robust as possible. Then, any perturbation is much less likely to lead to a catastrophic collapse. Our results translated into physical form lead us to propose a geometrically complex urban fabric, which is inhomogeneous and extensively connected. We can only provide the barest outline here of what is an entirely new understanding of urban structure.

Below, we outline a five-part incremental strategy, combining elements of bottom-up and top-down processes. This strategy relies upon conscious interventions and choices at three levels simultaneously: at the democratic level, wherein the shared public realm is collectively managed; at the professional level, wherein scientifically informed judgments are responsibly applied; and at the level of market exchange, wherein complex processes achieve emergent results. In any effective strategy, these three realms must be seen as elements of a complex morphogenetic process, and managed accordingly.

We should emphasize that specific cases have to be studied in detail, and solutions

tailored to the location. Still, we feel that these guidelines give at least a first appreciation of this methodology, and may be instantly implemented even by those who do not wish to delve any deeper into the theoretical aspects. Technical terms used below will be explained later in the appendices given at the end of this paper. More advanced work is under way, working with our research colleagues to develop a new generation of codes for the different zones in the reconstructed city.

Some Notes on the Methodology:

1. A suburban area will be examined with particular attention paid to its overall size, geometry, connective network structure, and existing physical boundaries. If it meets the maximal pedestrian catchment size of being walkable in its longest dimension in 30 minutes, then we can proceed to step 2 (see Appendix III). If either its largest dimension, or its area, is too large, then the region needs to be subdivided into one or more pedestrian catchment regions. This is achieved by a variety of means helping to physically enhance and articulate clearly-identifiable limits. Such geographical solutions include boundaries, divisions, and a semi-permeable system of neighborhood enclosure. It is essential to provide an encompassing and unambiguous understanding of neighborhood edge. Articulations can be features of natural landscape like canals, lakes, parks, gardens, forest or hedges, often developed from existing site potentials, or created from scratch in derelict or neutral urban edges. Otherwise, they can be urban constructs, like planted avenues and boulevards, urban service strips, and complex thresholds of new public spaces alternating with sophisticated park strips and parkway systems. Boundaries can eventually be accentuated with the building of a substantial but permeable wall that will separate the catchment regions. This wall does not have to be a literal and uniform continuous wall construction, but should consist of a series of connected buildings articulating public spaces, enclosed courtyards and gardens, sections of walls, gates, and monuments. This edge will create an enclosing complex sequence of architectural and urban events supporting the concept of neighborhood boundary.

2. Houses that adjoin the outer boundary (whether physical boundary patterns or wall system patterns) will define the outer, lowest-density region of the suburb. This outer region (envisioned more as a ribbon than a disk) is going to be no more than a few houses in width, and will partially encircle the rest of the suburban region. As American suburbs use a block size of two houses width, this means that the outer region will contain at most several blocks (i.e., it should not continue outwards indefinitely). The vehicular roads should reinforce the encircling geometry as much as possible. The outer region will follow a zoning that is similar to Duany-Plater-Zyberk Smart Code for Zone T3 (see Appendix IV). While the density here looks the same as the typical suburb, the connectivity is drastically increased, and the traffic patterns become pedestrian-friendly.

3. The regional center will be the approximate geographical center of the pedestrian catchment region (Appendix III). New zoning codes will permit mixed-use buildings up

to a maximum of three to five stories high, depending on the situation. We could have a commercial ground floor, a possible mezzanine with commercial or office space, and the rest of the building devoted to housing. Present setback and closeness restrictions will be immediately abandoned, and new zoning for an urban center will be adopted. The central region will be limited to very roughly 20% of the total suburban region, or less, and its outer edge will be strictly marked and maintained. Some such limitation is necessary to prevent the regional center from taking over the intermediate-density portion of the catchment region (because of higher commercial value), and this also follows because traditional good and efficient cities are organized this way.

4. The intermediate ring — a region between the outer low-density region and the regional center — will be opened up to mixed use, and zoning will be changed to allow, but not require, closely-built two and three-storey buildings. This region will follow a specific zoning code intermediate between the outer region and the urban center (similar to the Duany-Plater-Zyberk Smart Code for region T4). This is meant to grow into a separate entity that has its own unique characteristics — neither low-density, nor central region, but a relaxed mixed-use urban fabric reminiscent of traditional small towns. We suggest that a wider typological variety be encouraged, allowing for diverse budget categories of inhabitants. The necessary inclusion of public housing (spread carefully, and in a small percentage mix) distributed throughout the whole area can prevent ghetto-like apartment blocks or segregated regions that nowadays mark our cities. Streets can be narrowed, and setback restrictions abandoned to allow denser urban fabric.

5. The only major restructuring that is necessarily carried out by government agencies directly will be on the road structure. Everything else can be left to commercial forces. The outer region will mostly be left alone. The intermediate ring will have to be connected with the central region via radial roads: no more than two of them need be introduced, if not already there. Incremental steps will then begin to reconfigure the connections. At present, vehicular roads are straight and wide, opening up to substantial and broad parking lots. Pedestrian paths, if they exist at all, are narrow, tortuous, and fragmented. These characteristics must be reversed. New direct pedestrian paths will link pedestrian open plazas (some taken over from existing parking lots), in a continuous network. New vehicular roads will guarantee car access to many smaller and narrower parking lots, connected in a roundabout manner (Alexander, 2004; Salingaros, 2006). Most suburbs don't have this geometry, so the city must decide to open several narrow roads and close some wide roads around the regional center. These are distinct from the feeder road that now connects to the exterior of the suburb itself. Internal roads need not be as wide as the excessively broad streets in existing suburbs, so they can be built between houses, or by combining empty lots. Access for emergency vehicles will be guaranteed by pedestrian paths that can handle an occasional ambulance or fire truck.

A word on our choice of terminology: the intermediate "ring" could have any overall geometry. All we mean is that it roughly encloses a regional center with distinct characteristics, and is itself enclosed by a loosely surrounding outer region. We have no

intention of imposing a definite simplistic geometry on the urban fabric. A fixation with pure geometry has been the downfall of urbanism of the past several decades. A particular complex geometrical network will evolve as the fabric becomes alive with human activity, and that involves internal connectivity, not overall shapes. Our aim is strictly to re-make a region that is now homogeneous and disconnected on the short scale, into a strongly-connected, inhomogeneous and complex system (described later in this paper).

BEING PREPARED FOR THE PROSPECT OF DRASTIC CHANGE.

Our task as urbanists has to deal with evolving alternative scenarios for the future. We cannot predict what will actually happen, but change often comes unexpectedly. Even though thinkers may predict coming change decades ahead, those in a position to implement changes invariably ignore evolving conditions until a crisis arrives. Then, there is a scramble to react to a crisis situation. At such a time, it is highly probable that unworkable short-term expedients are adopted out of panic, as opposed to carefully thought-out longer-term solutions. We are convinced that the present government/commercial/industrial system that builds suburbia is going to continue to do things the same way out of inertia, thus leading to catastrophic change at some point in the future. When gradual evolutionary change is thwarted, change comes all at once.

Suburban development is heavily dominated by the protocols of major national retail and development corporations, which focus on the bottom line of profits (so that their stock can survive in the stock market). They have a stated policy of risk-aversion that will not allow even a minor change in current procedure, in case profits dip in any way. Customer surveys indicate that people still yearn for the utopian 1950s house in the green suburb, so builders continue to provide it (albeit in a dreary, isolated new sprawl development rather than out in the real countryside). Massive advertising campaigns project the desirable image of the same 1950s house in the green suburb, so, really, the customer surveys just give back the industry's advertised unsustainable image that is fed to consumers by the media. This is a self-feeding deception. Our discussions with major developers find many willing new urbanists in their employ who have been unable to convince central headquarters to try sustainable solutions in practice. The reason given is a possible (imagined but not actually verified) short-term risk in profits.

Nor is it necessarily true that climbing energy prices will force developers to rethink their unsustainable typologies, at least in the short term. For example, there has been discussion of a concept to insert a developer-owned gasoline station at the entrance of each new suburban development, and sell subsidized gasoline to residents. This would of course be a major selling point for new suburban sprawl developments, as long as developers can continue to subsidize the gasoline. Of course, developers walk away from older developments, so those residents will have to buy their gasoline at market price, whatever that is going to be. We have here a mechanism favoring the abandonment of older urban fabric for the newest sprawl development, which is of course in the interest of developers. The increased profits may well overcome losses in this particular gasoline subsidy, until there is finally a catastrophic collapse at the point beyond which the subsidy can no longer be maintained.

Needless to say, the conventional thinking of governments and developers has not yet come to terms with the scope of changes needed, and the more sustainable geometries needed are not being incorporated sufficiently into current projects. This attitude will make it more difficult to retrofit existing suburbs that have all their infrastructure planned for unsustainable sprawl. First, there is tremendous reluctance to change the position of a street, even if its location and size lead to serious problems. Second, the below-ground infrastructure — and the legal boundaries that it must follow — is there to stay. As we found out after natural disasters that wipe out the built urban fabric, a city is forced for economic reasons to reuse the below-ground infrastructure. This severely limits the possibilities for sustainable redevelopment, by limiting the possible built geometry above ground. When sufficient pressure comes from societal forces to affect a major change, the economics of an urban crisis situation will frustrate the needed revisions in the infrastructure. For that reason, it is essential to be thinking ahead nowadays to a more flexible, more "dynamic" approach, when building the road pattern and infrastructure.

This essay addresses the reconstruction of residential suburban regions. One component of the proposed solution is to insert commercial nodes in an organic manner. The opposite problem of taming the regions of purely commercial sprawl is a separate issue, which is discussed in more detail elsewhere (Salingaros, 2005). Nevertheless, the two problems are tied. Today, the commercial sector has developed building and urban typologies that are designed almost exclusively for automobile access within a sprawl geometry. Even if encouraged to insert commercial nodes into previously residential urban fabric, the easiest expedient for them is simply to transplant the same typology into the suburb. That destroys whatever urban fabric exists there, and prevents new urban fabric from forming around the transplanted node. The geometry is simply non-connective on the proper scales.

The majority of commercial buildings are commissioned by large national and multinational corporations, which have developed a "one-size-fits-all" typology geared to the car-dependent landscape. Those businesses that are genuinely local tend to copy the prototypes built by the large chains, so the effect is the same. Local contractors get used to building the same model over and over. Given the locked-in economics, no-one wants to face the harsh reality that car-dependent geometries kill the city. A restaurant, office building, or store embodying the sprawl geometry destabilizes a wide region around its parking lot. It is for this reason that we have to be extremely careful to apply new typologies appropriate to the mixed (pedestrian plus vehicular) urban fabric that is our primary goal. Simply continuing to apply the present templates for commercial nodes will not improve suburbia, but will only lead to more traffic congestion, making the present unsustainable situation even worse.

THE SMALL-SCALE APPROACH.

We need to acknowledge the sheer size of suburban real estate and recognize that to reform its shortcomings is a hugely massive task. This vast structure, accommodating over half of all urban dwellers in the USA and Europe, was not created overnight — and its repair will not occur overnight. Rather than seeking massive top-down reconstruction

projects (which have so often failed in the past anyway) we suggest that a more powerful and more effective strategy is to make piecemeal changes. These are to be effected both in physical projects, and in what may be called the suburban "operating system": i.e., the system of codes, regulations, and economic incentives. It is this legislated code structure that produced suburban morphology in the first place. We must provide tools that exploit small points of incremental change, which serve to re-connect the present fragmented structure into a more coherent, more functional urban system. Like gardeners planting seeds, and pruning or weeding a bit here and there, we must seek to induce organic processes of regeneration and reconstruction.

Following is a more detailed proposal of how to achieve such an incremental process of transformation. All of these suggestions need to be initiated by an immediate change in the zoning and construction codes, so our first task is a legislative one, not an architectural or urban one. Cognizant of the immense difficulties of changing codes, we have devoted the final section of this paper to this problem. These necessary changes are not necessarily in order of implementation, as a number of these changes must be done in tandem, or in a back-and-forth iteration.

PRIORITY ONE: Define new neighborhood structures of centers and boundaries.

We need to redirect the existing suburban systems towards a networked pattern of neighborhoods with public centers and boundaries. Often these are emergent or latent structures already in place, perhaps around an existing civic or retail amenity. A town center will be defined as the geographical center of a roughly bounded urban region. Every neighborhood needs a clearly-defined public space, well connected to the neighborhood street network, and enclosed by mixed-use buildings and public buildings. These urban typologies have been avoided in post-war urbanism as being reminiscent of the past, but their need has been picked up by the commercial sector, which has reconstructed them (to great profit) in private shopping areas.

Here it is necessary to reverse the misguided ideology of placing the region's heart on the geographical edge, in an attempt to draw in car traffic to commercial nodes from as far away as possible. That measure only served to disconnect a commercial node from its immediate neighbors, leaving an urban region without a heart, and encouraging the proliferation of disconnected commercial strips all over the landscape. This dead geometry was the price paid for giving parking an exaggerated visibility, and sacrificing everything else to this absolute priority. There was never any need for such a drastic and ultimately disastrous geometrical reorganization. A rehabilitation can easily work now, with parking very carefully thought out so that it is convenient, sufficient, but unobtrusive.

Healthy urban fabric is supported by many permeable boundaries. These were either eliminated, or replaced with impermeable boundaries: both anti-urban measures. The neighborhood needs to have a clearly understandable boundary which can be an avenue, planted alley, a natural feature, or a landscaped system. This is a distinct idea from an isolating, impermeable boundary, such as a wall around a gated community. We are referring to the need for a psychological boundary, which enables the network geometry to take place, and not so much to a restrictive physical boundary that cuts connections.

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Typically, the regional center will offer opportunities for more elaborate, denser typologies, whereas the edge of the neighborhood can offer larger lots and different functional activities like light industry, larger institutional buildings, and suburban villa typologies with larger gardens. In this way, many of the choices of a low-density lifestyle that motivated suburban growth in the first instance can be maintained, but within a system that preserves walkability and integration. The key is to break up the present homogenous low-density geometry into regions of distinct density. Homogeneous sprawl is weighed down by its size, and becomes unwieldy and eventually dysfunctional, whereas heterogeneous adjacent regions can be made to support each other.

PRIORITY TWO: *Network the existing infrastructure.*

The transport infrastructure of suburbia lacks several efficient levels of network connectivity. The existing hub-hierarchy network kills local connections, and must be reversed by connecting on the same, small scale. Healthy urban fabric requires better networking, nodes, and pedestrian pathways. More pathways and pedestrian routes, as well as connecting residential alleys and streets, need to be created to irrigate the suburban areas. An easy step is to switch the roles of road and alley: direct car traffic into the alley, and protect part of the main road as a continuation of the pedestrian network. Since active paths form only between complementary urban nodes, however, a prerequisite for suburban connectivity is the introduction of mixed use. This means an immediate legislative opening of commercial use within existing suburban subdivisions. Concerns of noise and pollution (part of the original reason for functional segregation) can be maintained by restricting what can be allowed into formerly purely residential zones — for example, nothing that requires vast parking needs, or that generates excessive noise and pollution.

With that in mind, suburbs need to create short, walkable new streets as an opportunity of progressively densifying, and opening the process of importing new mixed use typologies. We should create new pedestrian and bicycle connections on existing streets and with additional short path and lanes. This implies a radically new connective geometry (although one to be achieved with very modest means). We will also develop a fully connective pedestrian and mixed-mode vehicular network. Dangerous, isolated or unpleasant segments (where pedestrians feel threatened by vehicles) will be identified and repaired.

We need to liberalize road standards to allow skinny streets, irregular geometries, the incursion of shop-front activities, boulevard layouts, and other more pedestrian-friendly street and path patterns. The principle of the walking citizen is an indispensable measure as a tool for all of these additional connections. Through a reasonable number of phases, new connections should cut through all the scales of the street armature and dimension of both the distances between the intersections and nodes, and also simultaneously reduce the size of suburban blocks and lots.

PRIORITY THREE: *Insert monumental connections, screens, and vistas.*

Once the smaller pathways and streets have been increased and the connections multiplied and enriched, stronger interventions are required at a larger scale in order to create connections between main centers, monumental structures, and social and cultural attractors. Key elements of this can be done quickly, as Haussmann did so successfully with the boulevards of Paris in the mid-nineteenth century. But in any case, the elements should be identified, and a plan for their progressive implementation should be adopted. Opening radial connections will have to sacrifice some built structures (as occurred in Paris), and this is an essential step to increasing connectivity. Massive rebuilding is not necessary, nor is it necessary to do everything at once.

We need to identify and build monumental connection points and terminating vistas. These don't exist in today's homogeneous sprawl, and will have to be built anew. Commerce entering a dormitory suburb will be encouraged to build so as to create a visual landmark (and be severely penalized if they try to continue the present alienating practice of isolating themselves with vast parking lots). The goal is to identify and reinforce a network of larger avenues, boulevards, parkways and planted alleys forming a monumental network, with a comfortable section integrating bike and pedestrian lanes, transit lines, and reasonably efficient automobile traffic. Along these avenues, alleys and boulevards, the codes will encourage the construction of a coherent street-wall frontage with mixed use urban typologies between 2 minimum and 5 maximum floors, with progressive setbacks for upper stories (see Priority 5 for more on this).

The perspective intersections and street terminations should be reserved for public buildings, monuments, sculptural elements, or larger landscape arrangements. The underlying planning principle is to use pedestrian visual feedback to anchor the urban spaces, rather than prioritizing vehicular traffic from looking at a plan, as is done nowadays (in a process that totally ignores the pedestrian experience).

PRIORITY FOUR: *Divide oversized blocks into urban blocks (the scissors technique).*

This technique, developed by Léon Krier (1984), rationally reorganizes larger mega-structures into their organic components, divided by a pattern of convivial public urban spaces. In many cities, post-war planning merged small urban blocks to create super-blocks, and this mistake was copied as a template for the suburbs. We now have to do the opposite. The process begins by cutting pathways and streets into larger urbanization blocks. Their excessive present size opposes natural pedestrian connections and forces purely automobile transportation.

Our proposed outer suburban region should not be misunderstood as being composed of vast narrow housing or commercial blocks, as is often the case today within sprawl. We mean for every region to be crosscut with roads, paths, and connections, otherwise it becomes an anti-urban typology. Whenever an overall urban geometry is impermeable, both pedestrian and vehicular traffic are diverted to the region's edge, so that internal connectivity suffers. The connectivity should become multiple (i.e., composed of overlapping networks), so that it is not exclusively dictated by the vehicular roads.

We need to continue the pattern of connectivity at smaller scales, with passageways,

internal courtyards and gardens, covered passages and galleries, etc. Any sacrifice of private property will be compensated with the creation of new urbanizable land and potentially valuable real estate on new public spaces. Note that connectivity need not apply simultaneously for all transport modes: where a new road does not fit, a bike trail and footpath improve the situation. Healthy urban fabric requires the superposition of distinct connective networks, consisting of footpaths, bicycle paths, mixed pedestrian/car roads, and regular streets for traffic. The one-size-fits-all approach to traffic, mistakenly applied in the post-war years, has left us with a dismal overall urban connectivity.

PRIORITY FIVE: Change the "operating system" of suburbia to facilitate further incremental reform.

We need to reform the zoning for any new development, and for incremental infill. New zoning codes must allow the construction of mixed-use New Towns with dense centers — well integrated into the transport system, having coherent, pedestrian-friendly street geometries, and having environmentally low-impact qualities. We need to end the coded bias toward monofunctional, mono-social, homogeneous, and mono-typological patterns of development.

Disincentives should be created against urban expansion into new (virgin or agricultural) areas, including a shifted burden onto permit applicants to demonstrate that market demand cannot be met within existing suburbs, and cannot be developed by infill, densification, and reconstruction of derelict areas. The way to achieve this is to charge steep development impact fees for those projects that do not meet this burden. The market will eventually take care of this, once a major subsidy in food production is phased out. Increased energy prices will make close-by farmland extremely valuable, as the low transportation costs which currently subsidize long-distance agricultural production will cease.

Legislation will create incentives for high-density new development (focusing on filling in the central core region), and disincentives for maintaining low density throughout within existing suburbs. Our model sets forth a specific notion of heterogeneous urban fabric, in which low density has its place but cannot spread throughout a region. We need to encourage densification of existing low-density building with financial and tax incentives structured to generate regions of decreasing density around a central core. Restrictive setbacks and onerous use restrictions will be liberalized. Building low density on larger lots outside a well-defined outer ribbon will be discouraged.

We need to work to reform other sprawl-promoting practices such as (in the USA) mortgage redlining, Federal highway incentives, FNMA ("Fannie Mae") mortgage restrictions on mixed use, and the like. Banks will play an increasingly decisive role, by refusing to lend money for an obviously urban-destroying project. Growing public awareness of the new connective geometry of sustainable urban fabric puts lending institutions in the spotlight as principal players in this urban game.

PUTTING IT ALL TOGETHER INTO THE FRACTAL CITY.

We have summarized our working methods as a blueprint for suburban reconstruction. The main idea is to use existing suburbs with as little intervention as necessary, but with a change in zoning and planning codes as promptly as possible, to encourage sustainable urban growth from this time onwards. "Bottom-up" commercial forces, in concert with shrewd "top-down" adjustments, will then take care of the reconstruction. We indicate the direction for reconstruction by providing codes, and exploit normal urban forces to take care of the process at their own pace. We are also optimistic that, with the correct legislation in place, the commercial sector will fund a significant portion of the reconstruction, not out of any ideological desire for a better urbanism, but simply as a smart process to do better business.

In the particular implementation methodology we offer, each suburb will be analyzed according to a technique we have developed, and for which details and implementation are available from *Katarxis Urban Workshops* (Appendix II). Here we only presented an outline to indicate the utility of this method. Different regions and localities will need individual study and recommendations, and that will necessitate a site analysis and report from our team. The theoretical concept of "fractal city" at the base of our method is explained further in (Salingaros, 2005) (see Appendix V).

Our initial conceptualization leads us to subdivide an existing homogeneous suburb into regions of different density and mixture of uses. These regions will have a geometry that initially depends on the site and existing conditions. As the urban fabric grows, however, regions of distinct urban character will develop a noticeable geometrical similarity, a process which we denote as "fractalizing the suburb" (see Appendix V). This appearance will have nothing to do with basic geometric shapes (rectangles, circles, hexagons) that urbanists have traditionally imposed on a plan. The new urban geometry instead refers to network connectivity, a much more advanced scientific concept than simplistic geometrical figures taken from a schoolbook. Living urban fabric will grow to resemble an electronic circuit-board or microchip, where every node is connected, and where any geometrical regularity has been sacrificed to establishing network connectivity. True urban geometry is far removed from the shapes that were thought to define urban morphology during the past several decades (Salingaros, 2005).

Exactly the same problem occurs in suburban regions, whose geometry impedes urban connectivity (see Appendix VI). Because in many cases, suburban geometry consists of amorphous blobs and ribbons (superficially copying the plans of picturesque traditional settlements), it was thought that this would permit a liveliness denied by a rectangular grid. That is a misunderstanding. Amorphous suburban geometry is presently disconnected — it is totally rigid. Both a blob-and-ribbon geometry (found in high-income suburbs and in the poorest favelas) and a rectangular plan (found in rigidly planned urbanism) can evolve into living urban fabric by the reconnective processes we describe. They must be allowed to do so by the codes in place. Neither initial geometry is "better", nor does either geometry guarantee a living urban fabric. During its evolution into living urban fabric, a rectangular geometry will deform and become more complex on the small scale; whereas an amorphous geometry will straighten out on the large scale (a very successful "top-down" example of the latter being the straightening out of Medieval Paris by Haussmann).

Since there is no specific recommended urban geometry, the shape of distinct urban

regions is dependent upon the site. Initially the whole suburban region is encouraged to evolve into distinct urban regions in an approximate sequence of connected pieces. Forces that act on different scale hierarchies will not be suppressed to maintain the homogeneous or segregated geometry, as is done nowadays, but will be guided to grow the network. The evolution of the network determines the urban morphology, and not vice-versa. The overall coherent geometry must be supported by the road grid. If existing roads contradict or impede the evolution of urban fabric towards a circuit-board geometry, then some roads will need to be changed before that particular region can be regenerated. In most cases, the vehicular road grid itself can survive mostly unchanged, although road widths and curb radii will probably have to be adjusted.

A circuit-board has to handle many connections of entirely different character, some needing the shortest path, and others accommodated by less direct couplings. Healthy urban fabric establishes fragile pedestrian connections (which require straight paths, and reinforcement by surrounding built structures), and also the much more elastic vehicular connections. Cars and trucks can drive on a looped path without any problem, as long as the roads are easy to navigate. Also, cars and trucks need not drive fast within a moderately complex urban fabric. The key to connectivity and movement is access, not speed, thus reversing the priorities of several generations of planners. It is necessary to accommodate two distinct networks having mutually exclusive characteristics: pedestrian paths connecting urban spaces, on the one hand; and vehicular roads connecting parking lots, on the other. These two networks must interface, cross each other, and occasionally run in parallel. The second must not be allowed to erase the first. Most important, we must not confuse the totally distinct characteristics of these two networks and apply them to the wrong one.

Pathological portions of any urban region will reveal themselves after several small-scale interventions fail to bring that region to life. Everyone recognizes shops and restaurants whose successive operators repeatedly fail; parks and playgrounds that are gloomy and thus unused; open plazas that feel deadly — it has something to do with their geometry, although citizens find it difficult to pinpoint exactly what the flaw is. It could be that the geometry of built structures is simply not salvageable: it has the wrong shape, orientation, position, etc., which frustrates connectivity to the urban fabric. A dead geometry cannot be resurrected. An anti-urban (intentionally disconnecting) geometry was imprinted in the minds of architects and planners after the Second World War, and thus countless buildings erected since codify it. In that case one has to decide to act in a top-down manner and replace what is there. To do otherwise would be to waste resources on "Band-Aid" solutions, where a more drastic solution is needed. We repeat, however, that such a large-scale intervention is recommended only as a last resort, and not as a general approach.

For this method to be applied, the city or municipality to which the suburb in question belongs must be ready to promptly change its zoning codes to enable our connecting process to take effect. Communities who refuse to change their anti-urban and unsustainable zoning codes must be left to suffer the eventual consequences of dysfunctionality in the future. That is an evolutionary law of nature: entities that do not adapt to changing circumstances are condemned to become redundant or unusable as conditions evolve. Again, we believe that this process will be market-driven, in the best sense (which certainly does not include industry advertising urging people to support an

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unsustainable product through intentional misinformation). The choices that consumers make in the market will thus be linked more closely to policy choices they make as citizens in a democracy, informed by responsible professionals. Thus responsible citizens will soon learn to invest solely in those communities that have adopted these forward-looking planning codes, which will at the same time improve the civic quality of their home cities, and guarantee their real-estate investment for the decades to come.

LEGISLATION PREVENTS OR ENCOURAGES RECONSTRUCTION.

There are presently in place neighborhood review boards, homeowners' associations, etc. that have some influence on new building and rebuilding of the urban fabric. These oversight entities should begin to use our prescriptions for the regeneration of that suburb or region (abandoning their present guidelines, most of which lead away from a sustainable urban fabric). This concept should work no less in any conventional suburb than in a downtown, where a process of approval is now taken for granted. The idea is to implement all these proposed guidelines in practical form.

We certainly take the view that urbanists should not get mired in endless legal wrangling, possibly getting "shot down" by some hierarchical authority. But often it is impossible to make the kinds of design changes needed without at least suspending the present requirements. That may be a particularly bad problem in the USA, where Le Corbusier style segregated zoning and unbelievably large building setbacks, wide roads, low densities, etc. have such a stranglehold because they are legislated into codes. Unfortunately, this post-war US planning model is still being embraced by other countries who seek to achieve US-style prosperity, and who are not yet aware of the model's growing disadvantages. But here, too, we need an incremental strategy. Our recommendation is that urbanists take whatever steps they can based on the local conditions and the local political will, and not waste time tilting at windmills.

In the above Section entitled "The Small Scale Approach" we prioritize Coding and Legal Action. Regarding previous arguments about top-down and bottom-up strategies, immediate short-term interventions (as well as the possibility to impact the larger context with smaller economic interventions, etc.), there exists a definite dilemma here. Political work and legal strategies are often tedious, long, and depend upon triggering top-down effects. Also, the relationship between legal action, coding, and their implementation is an enormously time-consuming process, involving a lot of lobbying and long-term strategies. That's the reason why we do not insist on a definite sequence for the stages of urban action. Sometimes, the coding could be a priority; for example, the coding could be a limited project that depends on coding only. At other times, there could be a larger coding effort on the regional scale like the Traditional Neighborhood Codes developed by Duany-Plater-Zyberk (see Appendix IV).

Physical urban and architectural changes can even happen without necessarily introducing new codes, or they can take advantage of legal ambiguities. Interestingly, most projects need to be accompanied by a written document including legal and code aspects, but one wouldn't say that the coding was the most essential. It is rather the integration of didactic physical design and subtle and integrated coding that empowers the project. We definitely agree with the incredible emergency and need for a full and

comprehensive legal revision and re-coding strategy. In the context of this paper, however, we clearly stress feasible, short-term, tangible policies and actions. We balance these goals within a larger context of more thorough political and legal objectives to be aimed at. We are more supportive of efforts on an intermediate time frame. It will be the combined actions at various scales and levels which will constitute an overwhelming challenge to the obsoleteness of legal planning inertia, and will finally accelerate massive and drastic overhaul.

That said, the problem of this bureaucratic stranglehold is very serious. Sometimes it is not even the local zoning that prevents suburban reconstruction. For example, we and our associates have recently experienced enormous problems in Mississippi (following the devastation by hurricane Katrina) from onerous regulations. For example, the Department of Transportation refuses to budge on its wide-road protocols, including enormous building setbacks. The only way out of this impasse was achieved by New Urbanists marshalling the Governor and other forces to come in and neutralize the stranglehold of the Department of Transportation. The US Federal Emergency Management Agency (FEMA) has also required draconian building forms in order to get flood insurance: no street-level activities; everything up on stilts; all garages below, etc. If so much as ONE resident in a community builds their house in a non-conforming way, the ENTIRE community gets denied flood insurance. This effectively means that they get denied mortgages!

Based on these practical examples, we don't see how we can avoid the political and legal realm. Even so, we need to try and stick to the incremental approach: " to do what you can when you can". At the same time, we offer our strategy in a flexible enough way to allow people to sequence things in the optimal manner that their local requirements allow. This is what is meant by our phrase "change the operating system". Some of these legislated restrictions and impositions (relatively dry topics by themselves, but extremely dangerous) are like bits of malicious software, viruses even, that determine all kinds of unpleasant outcomes for the urban fabric, and prevent their remedies.

CONCLUSION.

The evidence already shows that the modern suburb in its current disintegrated form (sprawl) is not a sustainable form of development, and needs to be reformed. This problem is particularly important as the developing world looks to the developed world for leadership in its own new, unavoidable suburban development. But this reform need not take away the characteristics that drove suburban expansion in the first place: a greener and more rural livable environment, access to larger homes on larger properties, use of the automobile as an option (and not as a necessity), and so on. Instead, reform needs to be aimed at creating a richer and more connected structure, allowing alternative modes of transport, greater ranges and locations for activities, and greater coverage of property. In this sense, the reforms presented here are less about limiting choice, and more about expanding choice and diversity.

Along with these reforms must go a reform in our thinking about cities, and what Jane Jacobs termed "the kind of problem a city is". We must cease to assume that

changes can only happen with massive, expensive, "top-down" solutions.

Indeed, we do not believe that a massive, top-down approach will even succeed in addressing the connective failures of modern suburbia, assuming that one was even feasible in this age of growing pressure on public revenues. Rather, a new kind of strategic and iterative mix of top-down and bottom-up approaches will be necessary. Strategic reform of the "operating system" that generates suburbia will result in emerging changes in the existing structure. Relatively small economic management tools, such as shifts in tax policy, can be powerful bottom-up tools. (One powerful economic change may already be happening: a drastic escalation in energy costs, which may well trigger major suburban reconstruction.) Relatively small pilot projects and incremental connective elements can act as catalysts for more growth.

To be sure, some top-down tools are useful, if carefully applied. Occasionally, new infrastructure can be a very useful intervention — new light rail lines, for example. We value the lessons provided by the best urban reconstructions of the past, including Haussmann's transformations of Paris, Burnham's work in Chicago, and others. Key changes were made in strategic areas, while large areas between them were kept mostly intact. Those successful approaches were highly selective: changing a minimum of the geometry to make a maximum of difference to the functioning of the whole.

We need also to keep in mind what can go horribly wrong with a heavy-handed top-down approach. Unfortunately the utopian architect Le Corbusier offers us perhaps the most cautionary tale here, as his legacy was implemented disastrously in many cities, including New York under Robert Moses, and Algiers under the post-war French colonial government. (Thankfully, Le Corbusier's horrific Voisin Plan for Paris was not implemented, although the suburbs of Paris were built in this image, and their recent eruption in riots cannot entirely be dissociated from their urban form).

All of these lessons remind us of the power of change over time — the power of emergent processes, and "game theory" dynamics — and the need to make interventions very carefully, intelligently and sensitively. We believe this can be accomplished with a new toolbox of the sort outlined here. Much more work needs to be done to develop detailed strategies for such tools in varying contexts, and to document their likely results. However, we do believe that with such an improved understanding, we can act on a complex system like a contemporary suburb and, with the right diagnosis, in effect, heal it, much like a doctor heals a sick patient without major surgery. Or, to return to the gardening metaphor, it may not be necessary or even desirable to clear the old weedy garden; we may find that a bit of pruning and weeding, and a few seeds strategically planted, can, with a bit of time, produce a very nice garden indeed.

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APPENDIX I: Hierarchies and Connectivity.

Hierarchy plays a central role in understanding urban structure. A hierarchy is simply a collection of similar objects (such as roads, or buildings) of different size and capacity. A natural hierarchy contains representatives of different sizes, and not only one size. All cities are formed of multiple hierarchies. The crucial difference is how those hierarchies are connected. A hub-hierarchy requires that each movement go to the top of the hierarchy before coming down to a lower level. We take the word from its use in airline routes, where all connections have to go through a central hub. That is analogous to having to take the expressway simply to buy a gallon of milk. Thus, all connections are forced to constantly go up and down the hierarchy. A multiply-connected-hierarchy, on the other hand, allows one to connect to equal low levels in the hierarchy directly. This important point was first clarified by Christopher Alexander (1965) in a seminal essay, who used the mathematical terms "tree" for a hub-hierarchy, and "semilattice" for a multiply-connected-hierarchy.

APPENDIX II: Katarxis Urban Workshops.

Katarxis Urban Workshops is an international nonprofit organization established to spearhead the urban reconstruction necessary for a sustainable future. Based in Luxembourg City, it is a consultant to governments, commercial developers, and academic institutions seeking to implement sustainable urban solutions. Periodic teaching seminars train participants in new, scientific techniques of urban regeneration. Katarxis Urban Workshops publishes "Katarxis", the highly acclaimed online publication, which relates new traditional architecture with the latest scientific advances in understanding complex architectural and urban form. President Lucien Steil is an

internationally-known Traditional Architect and educator, and founding member of C.E.U. (Council for European Urbanism). Vice-President Nikos Salingaros is Professor of Mathematics, author of three seminal books on architecture and urbanism, and a contributor to the "New Athens Charter". Secretary Michael Mehaffy is a project consultant and educator, and co-founder with Christopher Alexander of the Centre for Environmental Structure — Europe, which conducts research on new kinds of urban coding. Steil and Mehaffy were founding contributors to the "Viseu Declaration on Architectural Education".

APPENDIX III: Pedestrian Catchment Region.

This is based on the old idea of a traditional walking neighborhood. Every house must be connected by a footpath to the region's geographical center in a way that a person takes from 10 to 15 minutes to walk from a residence to the center. That means that the entire region could be walked across its largest dimension in 20 to 30 minutes. Specific figures depend upon climate, locality, and culture, and are being studied by the Katarxis research team. We refer back to the concept of central place theory of Chrystaller, which is verified by every student of urbanism seeing how central places develop out of randomness. Nevertheless, we do not seek to impose Chrystaller's original hexagonal geometry (which we consider artificial and restrictive). Rather, we use these ideas to support the New Urbanist practice of providing footpaths crisscrossing a neighborhood. Contrary to some recent claims that were later proven wrong, pedestrian movement reduces crime.

APPENDIX IV: Duany-Plater-Zyberk Smart Code.

This is a new kind of detailed zoning code that applies to most situations which concern us here (see Duany et. al., 2005; Duany & Plater-Zyberk, 2000). In contrast to conventional "segregated use" zoning, the Smart Code identifies patterns of mixed-use configuration, organized according to a Transect gradient from urban to rural. But the system need not be linear or continuous; indeed, it is intended to achieve the more complex organic structures of traditional cities. In summary, T3 codes the Sub-Urban Zone (very different from what is usually understood as *suburban*) of isolated residences on large lots, but with much more housing diversity, walkability, and connectivity than what exists today. The T3 height limit is three storeys. T4 represents the denser Urban General Zone, with houses closer to each other and to the sidewalk. Mixed use is permitted, with corner stores and restaurants within walking distance of most houses. The T4 height limit is four storeys. Transect Zone T5 is the Urban Center Zone, mixing commercial uses with housing. This is analogous to the neighborhood center or small-town Main Street in early twentieth-century America, as well as the traditional European village. The T5 height limit is six storeys. Important zoning details will gradually transform the road network, since implementation of sharp curb radii and narrower streets help to calm traffic.

APPENDIX V: The Fractal City.

A fractal is a complex object that displays some structure on every scale of magnification. Its opposite is a non-fractal object that exists on one or two scales only. Today's suburbs exist primarily on two scales: the scale of the houses, and the overall scale of the entire development. More seriously lacking is the scale of connections: all houses in a suburban development connect to nodes outside that development, thus setting an extremely high minimum size for the distribution of pathlengths in the connective hierarchy. As argued in Salingaros (2005), unless a complex system can interact on a hierarchy of different scales, from the very large to the very small, it is pathological. Thus, the process of "fractalizing the suburb" involves the creation of many new connections on the intermediate and smaller scales. The smallest possible connections are pedestrian ones to the immediate neighborhood — and these are entirely missing from sprawl. At the same time, commercial nodes adjoining residential nodes are now intentionally disconnected by zoning and physical barriers, thus isolating functions and contributing to a gross departure from fractal structure.

APPENDIX VI: A note on "sprawl" versus "organic" development.

A number of terms used in this field are too often used imprecisely, or may have multiple definitions. Two of the most notorious are also two key terms in this discussion: "organic" growth, and "sprawl". Following are the precise definitions we use.

ORGANIC: Systemic in character, consisting of parts whose relationships are co-adaptive, co-evolutionary, and mutually influential. These characteristics are objective and measurable — although they may be exceedingly complex. Organic urban fabric is connected on many different scales, and this has nothing to do with superficial appearance. Suburban developments that use curved streets for visual effect do not achieve any organic qualities, even as they may resemble organic forms when seen from the air.

SPRAWL: Outer areas of an existing urban system, which are poorly differentiated, poorly inter-connected, and highly segregated by use and type. This is also called by some authors "Conventional Sprawl Development" or "CSD". Its defining characteristic is that its components do not interact to work as a system. Instead, urban growth invades the land without connecting to it. This type of development is highly inorganic, in the sense used above.

SUBURBIA: The outer areas of an existing urban system, which have differentiated in structure away from the urban core. Healthy suburban regions are connected internally, as well as to the urban core, on which they are dependent. There is absolutely no reason for suburban growth to follow the geometrical characteristics of sprawl — it just happened to do so after the Second World War for reasons we discuss here.

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