The Environmental Paradox of Cities:
Gridded in Manhattan vs. Gridless in Dubai

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Abstract

On the occasion of the Manhattan grid's bicentennial, this essay looks at New York City and Dubai through the lens of sustainability and their patterns of land use and street layout. It demonstrates that the virtues of the grid are based on the environmental paradox of cities: when humans inhabit dense urban space, they decrease their impact on the global environment faster than they increase their impact on the local environment; in other words, their ecological footprints per capita are smaller than in both low-density sprawl and cities of similar density with coarser, less permeable networks. Dubai, a modernist city of superhighways, superblocks and superhighrises, rapidly developed a disconnected pattern of homogenous enclaves that has served to limit physical accessibility, especially on public transit and foot, as well as to undermine the inherent vibrancy and sustainability of the compact, complex, connected, and complete urbanism of gridded Manhattan.

1. The Environmental Paradox of Cities

Dense, gridded cities are better for the environment than sprawling, disconnected suburbs. This can be expressed in a number of ways to different audiences. For the *regional planner*, it is no surprise that dense urban space that is mixed use, walkable, bikable and transit-served has less impact on global climate change than low-density sprawl oriented to motorized vehicles. More surprising is that it has less impact than urbanism of equal density that is not gridded. However, dense urbanism of any layout typically has greater impact than sprawl on local climate change, because of the "local heat island effect" caused by higher absorption and retention of solar energy and by waste heat from energy usage. Despite being hotter than surrounding suburban and rural areas (especially during the night), cities decrease their impact on global climate more than they increase their impact on the local climate. For the *environmental scientist*: the darker albedo/solar reflectivity of urban surfaces and materials, greater water and air pollution, lower level of

evapotranspiration from vegetation, and higher ambient air temperatures of the typical city are typically higher <u>per acre</u> than low-density urbanism or sprawl, but its average ecological footprint <u>per capita</u> of GHG/carbon, water and solid waste is smaller. Or, for the *economist*: measuring all of these factors per person rather than per acre is the more equitable metric in a global society with widely varying levels of land, wealth and population. Based on that metric, cities are more efficient in terms of land consumption, the construction and maintenance of infrastructure, and the mechanical heating and cooling of buildings, as well as transportation and communication. They also deliver higher personal and collective productivity and creativity with fewer externalities than less dense settlement patterns. Last, for the *average citizen*, the paradox can be expressed: suburbs may be "greener" per acre, but not per capita.

In short, the ecological footprint and environmental impacts of cities are larger than suburban sprawl per acre but smaller per capita; and the margin of benefit for gridded cities is even larger than non-gridded city.

This paradox is among the best news for a rapidly urbanizing humanity that is simultaneously facing some of the most severe and unprecedented challenges in its history. Increasing the size, density and mix of uses has related salutary effects, such as promoting walking, biking and transit, which often enhance the public realm and sense of community in today's increasingly diverse cities. And it offers more convenience, with fewer and shorter trips, especially by automobile. Productivity, wages and innovation (as measured in inventions and patents per capita) also rise, as does economic, cultural and social opportunity. Also, a compact city keeps the surrounding countryside more intact, whether it's agrarian or wild. In short, compact cities are good for nature – human nature and Mother Nature. Urbanism of course has its negatives: increased pollution, ambient noise, congestion, social friction, and communicable disease, as well as crime, overcrowding and mental illness if the urbanism is of low quality.

1.1 Dubai vs. Manhattan, a tale of urban growth

In its lighting-fast and audacious development, Dubai had a 60-year build-out of its footprint with a pace of development – adding about a million people - similar to that of Manhattan during its peak growth. Both booms were kick-started by big government action that triggered an immense amount of real estate development by the private sector, as well as the accumulation of great local wealth. Both cities were national centers of financial, academic, and cultural activity and were boosted by highly successful maritime ports and airports. The rivers' edges and the beaches played large recreational and natural roles in their respective cities, as did tourism.

Much to its credit, Dubai has got half the equation right: it's dense enough to begin to partake of the paradox. Its next challenge – not a small transformation - is to embrace the other half of the equation - *mixed use* - with lots of worthwhile destinations in walking distance of lots of people, supported by transit and a well-connected grid of streets and roads. Its low-rise residential areas are typically single-use and separated by an array of gates, walls, cul-de-sacs, and open land. And the

high-rise clusters are also often single-use and difficult to access by car, unlike the sidewalk-oriented tall buildings of New York.

The chorus line of high-rises along Sheik Zayed Road, like fanciful perfume bottles competing with each other for attention, is stunning at night. (Fig. 1) But these trophy towers often ignore their context on the ground, making urban space that can be alienating and scaleless. There are some wonderful exceptions, like the new development ironically called Old Town, with the elegant Burj Khalifa shimmering in the sky after the sun has set on the rest of the city. Its spreading triangular base anchors the half-mile-high silver spire to the ground and provides an awesome backdrop to a world-class public space. A plaza surrounding a powerful, spectacular fountain and a gigantic mall make it a latter-day Arab combination of Rockefeller Plaza and Times Square. Both "The Walk" at Dubai Marina and the Dubai Financial Center are also delightful on foot, the latter during the day and the former evenings and weekends.

As an architect, I could rant about the architectural excesses and superficialities, but I want to wear my other hat as an urban designer and planner and to focus on moving around in the city. Despite the new and impressive Metro system – a momentous step in the right direction – the city is still mired in the superblock/superhighway/supergrid transportation model. Like all such systems, it privileges *mobility* over *accessibility*, i.e., it's designed to move as many *vehicles* as fast as possible, rather than enabling as many *people* as possible to get to where they want or need to be. And the vaunted mobility is compromised by frequent traffic jams and pervasive 24/7-construction traffic, although both have slackened since the recession. It goes without saying that the roads and streets are inhospitable to pedestrians and bicyclists.

Figure 1: Stylized high-rises rise and shine on Sheik Zayed Road, Dubai's ultra-wide, ultra-long High Street. Unlike Manhattan, there is little if any functional or bulk zoning and the towers – many over 70 stories - neither taper with height nor space themselves for daylight and air. In this photo, nestling up to the skyscraper wall on the right is a low-rise subdivision of condos and villas on cul-de-sacs.

1.2 No left turn – the paradox of intersections and interruptions

The superblock pattern is a result of vast tracts of land granted by the Ruler (much like the English Crown sponsored development of London) to public or private developers to promote growth. With the relentless drive for fast build-out and no comprehensive regional plan, these large parcels have been typically developed as self-contained (if not gated) communities, creating an archipelago of independent neighborhoods and districts. Most of them act like large lakes that must be driven around, because, unlike Olmsted's Central Park, there are no cross connectors. The makes for a less permeable network of public roads, resulting in longer, less-direct trips, more traffic, increased gas consumption and greenhouse gas emissions. There simply aren't enough intersections; especially ones that allow left turns, which are the point of greatest friction and conflict - the Achilles Heel - of any vehicular network. A finer grid offers more places to turn left. These intersections allow vehicles to turn left by finding relatively frequent and sufficiently long gaps in the oncoming traffic to make the turn, without having to stop all the traffic with multi-phase traffic signals and dedicated left-turn lanes that require most traffic to stop in their tracks while a string of cars turns left (or while only one or two cars turn

left –– the bane of suburban driving). This means that the red lights not only *seem* longer, but actually *are* longer in places like Dubai than in Manhattan. (Near our neighborhood there was one 5-minute red light - underline twice as long as the longest in my hometown - that often drove me to the brink of road rage.) The fine-grained New York City grid also allows motorists to take alternate routes when they run into or are warned on the radio about heavy traffic or construction delays.

This geometric advantage applies to pedestrian movement as well, and here Manhattan is not much better than Dubai. So much of the island is gridded with very long blocks, often 800 feet. These elongated blocks fortunately run east-west, which is preferable to north-south for solar access, but they are too long for good walkability. A city like Portland, Oregon, is more walkable (and drivable), where the square blocks are only 200 feet on a side. It's very easy and pleasant to walk (and to drive), as the number of possible itineraries is exponentially larger than Manhattan. It adds to the variety and richness of moving around the city on foot. In Jane Jacobs' *The Death and Life of Great American Cities*, one of the very few drawings she includes is this diagram:
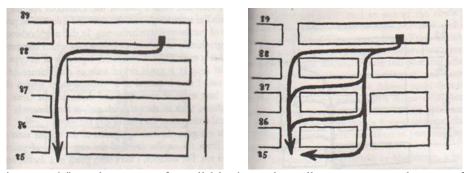

Figure 2: The advantage of small blocks – they allow more travel routes for both pedestrians and vehicles, which not only makes for a more varied array of itineraries but also allows easier changes to a route should there be any friction such as congestion, construction or an interest in variety. Manhattan's blocks are too long (and they lack services alleys common in other cities).

Traffic roundabouts – much more common in Dubai than Manhattan - have reduced the friction inherent in the left turn. However, widening them to three or four lanes has proved very dangerous for drivers, and impossible for pedestrians. The lack of intersections that allowed left turns extended my daily commute home – 5 km as the crow flies – to 18 km! (Fig. 2) Fortunately, for cars other than many Porsches or Ferraris, this ridiculous route could be cut in half by illegally cutting across several hundred meters of sand. The paradox here is that more intersections increase *accessibility* by shortening routes and travel times, even though turning vehicles slow the speed of traffic. Network underline connectivity and its fraternal twin underline proximity, are usually of greater value in driving around cities than high travel speeds on the road. As exemplified in New York, a network is better than a tree; accessibility trumps mobility; continuity beats interruption.

Figure 3: The lack of places to turn left tripled the distance of my evening commute home. The morning commute was 1/3 as long, because of more opportunities to turn right. With a grid many times coarser than Manhattan, everyone lives, works and shops on large islands surrounded by a ring of asphalt and sea of sand. Although this Google photo depicts a largely low-rise area, there are in fact a number of 40-70 story buildings along the Gulf's edge in Dubai Marina.

And then there's the superhighway supergrid, the American model on hormones, not unlike Robert Moses' realized and unrealized dreams in New York City. With up to six or even seven lanes in either direction and the world's largest and most baroque interchanges, it can be hair-raising to drive and hair-pulling to navigate. If you miss your exit, you might well miss your meeting. It can take 15 – 30 minutes to recover, and that's only if you have a co-pilot or GPS; and neither map nor electronics can quite keep up with the changing roads and construction detours.

1.3 More roads, not wider ones with more lanes and bigger interchanges

Let's hope the Roads and Transport Authority's (RTA) plan to carpet the entire Emirate with this supergrid is no longer on the table. (Fig. 3) The hubris and absurdity of this vision is enough to make Los Angeles or Houston, maybe even Robert Moses, blush. And the automatic policy of adding more *lanes* to decongest *roads* needs to give way to adding more roads, especially the missing links in a grid that is too coarse and too incomplete. And those empty 12 lane bypass roads, which feel like a future whose time has passed, should give way to investment in the UAE's proposed national rail system, like New York did a century or more ago.
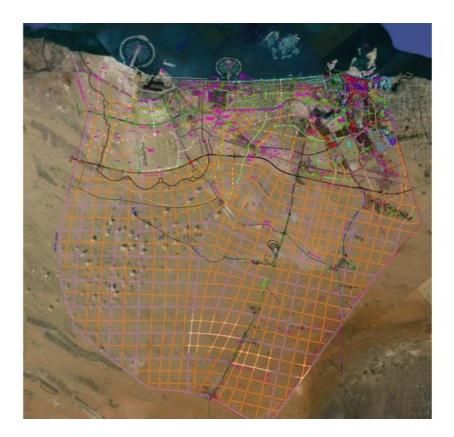
Fig. 4 – An official plan to carpet the entire Emirate with a supergrid of superhighways is over-the-top and hopefully over its shelf-life. A supergrid is not an urban grid: less a Corbusian "machine for living" and more a machine for moving machines that move.

There are other smaller discontinuities in the road network, most notably the cul-de-sac, which contribute traffic to the network without providing additional capacity to it. People living on these dead ends may enjoy their quiet privacy, but they are transportation parasites within the larger network. Low traffic on cul-de-sacs means more traffic elsewhere. A city has two basic options: like New York, to *spread out* its traffic across a close-grained, distributed network of many streets to equitably share the traffic burden, or to *channel* it on a more hierarchical network of cul-de-sacs, collector, arterials and highways (which typically spares the wealthy neighborhoods). (Fig. 4) The former strategy favors accessibility and the latter mobility (as long as the major roads are not overloaded with traffic). In fact, the connected grid has greater capacity per lane mile, because, as noted above, the many intersections allow turning left by slipping between oncoming cars.

SYSTEM CAPACITY

Figure 5: A dense network of roads/streets (on left) has greater capacity than the tree-like hierarchy of the superhighway and superblock arterials with collectors and cul-de-sacs (on right). Travel distances and times are shorter with a network, while moving more vehicles on an equivalent amount of roadway, which also means less pavement to install and maintain, plus less land use, less storm water run-off, and less heat gain for the same capacity and travel time). (This doesn't mean grids can't be very congested and slow; they will back up if their capacity is overloaded.) Manhattan has a more rectilinear grid than shown, as well as being far more complete than the Dubai pattern, which is more accurately portrayed by the left diagram, although some of its superblocks are larger.

In Manhattan, speeding is more or less kept in check by the short distances between intersections and traffic signals, as well as congestion. In Dubai, the preferred traffic-calming device is the speed bump. They are more than a constant pest – they shorten the life of your vehicle's suspension system and the length of your cervical spine, and can be a literal pain in the neck. (There were several dozen speed bumps on my daily commute.) Sometimes they are placed sensibly on neighborhood streets, to warn the driver of an upcoming pedestrian crosswalk or intersection. But too often they are used on arterials and even highways, to simply slow down drivers, who are all assumed to be speeders if unchecked. This assumption may be true for many of us, but there are less tyrannical ways to put the brakes on fast drivers. Research has shown that driving speed is determined more by street and lane width than by posted speed limits. Narrower roads not only slow traffic, they cut the consumption of land, asphalt and energy, as well as reduce run-off, road maintenance, and the flooding and erosion that often follows rainstorms. Why build wide roads that are engineered for high speed, and then impede that

speed with jarring bumps? It's like putting one foot on the gas pedal and the other on the brake pedal at the same time.

1.3 The Transit grid – public and private, steel and asphalt

A network of steel also connects Manhattan and much of the rest of New York City: it has one of the first and largest rail grids, including subway, passenger rail and freight rail. Like many large cities, it has this parallel transportation system, which is untethered from the surface grid when it tunnels underground and relatively aligned when on or above grade. The intermodal connections usually are strategically located and often anchor intensified real estate development and/or commercial, institutional and government centers, which tend to congregate in nodes. The term TOD is pretty useless in Manhattan, where so much of the population is so well served by public transit. The island is one mega-TOD, and the city's huge fleet of taxis and vans, plus public buses, tends to distribute themselves everywhere, although they often ply the same arterials and connect at the same nodes and intersections. And at a few key landings, water-borne ferries, tourist boats and ships link into the grid. The airports, by nature, tend to be huge and irregular superblocks that defy subjugation to the surface grid, and their aircraft fly independently above it all.

Dubai has made surprisingly significant progress in public transit in city and culture so enamored of and devoted to the automobile. For several years now, it has been operating the first line of the world's largest automated Metro. The elevated line runs along the spine of the linear city stretching along the coast, more or less paralleling Sheik Zayed Road until it weaves around and dives under the older, tighter parts of the city near Dubai Creek. (Fig. 5) It connects the very busy airport with the historic center of the city, which started as a creek side pearling and fishing village and trading port, and now runs over ten miles to the world's largest manmade port at Jebel Ali at the western end of the city, near the border with neighboring Emirate, Abu Dhabi. The aerial guideway slowly dances up and down, sometimes flying over cross streets, sometimes ducking under highway overpasses. All in all, it reflects and respects the broken, coarse grid of the city. Dubai also operates a growing fleet of modern single and double-decker buses. There are even gleaming air-conditioned bus shelters, energy hogs that are nonetheless welcome for the half of the year that is intensely hot and humid.

The seldom-discussed transportation backstory, however, is *private transit*. I mean some 20,000 private vans, mini-buses, and buses that ferry workers to and from their workplaces (mainly construction sites but also commercial and institutional employment centers) and their often remote, segregated, sometimes un-air-conditioned, and very crowded living quarters (8 men or 8 women to a room!). They are everywhere, mostly vans, but over 10,000 light and heavy buses – 10 times the number of public buses. It's rarely acknowledged, but it's this private transit that is doing the lion's share of moving workers around the city. This system results in much lower vehicle miles traveled (VMT) and tailpipe emissions (although some of these buses are old and polluting) than if the workers were commuting in private cars, or even in public buses, which are not usually as packed as the company buses. The poorly-paid, over-worked armies of construction laborers are the unsung

transportation heroes of Dubai. There is no subaltern transportation mode of this size or complexity in Manhattan, which has a far smaller proportion of underclass, non-native residents and international workers and servants (who are not eligible for citizenship in Dubai).

Figure 6: Cars, taxis, vans, buses, trucks and Metro stream and sometimes scream by the world's tallest building, which stands higher than the Empire State and Chrysler Buildings stacked one atop the other.

It's no secret that Dubai's traffic fatality rate, especially for pedestrians, is among the highest in the world. It's often blamed on poor drivers who hail from many different countries and cultures. But surely, the excessive width of the local roads and number of high-speed roadways contribute. Other fallouts of Dubai's automobile-dependent lifestyles are the lack of physical exercise and the fast-food culture of roadside eateries. Both factors contribute to the native Emeratis' exorbitant rate of obesity and diabetes, probably the highest in the world. But Dubai's worst stigma is the planet's highest per capita ecological footprint, pumped up by the high vehicle usage (as well as by a diesel-driven "construction economy," which continues despite the economic downturn, albeit at much slower pace). As David Owen so eloquently and definitively showed in his now famous article in *The New Yorker*, Manhattanites have a smaller ecological footprint than not only the Emiratis, but also the suburbanites in surrounding counties and states. This margin primarily results from greater use of transit, greater walkability (and recently bikability), more compact and efficient infrastructure and buildings, the latter being more efficient to heat, cool and sometimes to maintain.

1.4 Other grids, from bicycle paths to diagonals to underground truck lines

The most conspicuous new grid in Manhattan is the growing network for bicyclists, along with roller-bladers, runners, golf-carters and strollers. It is both a system for utilitarian mobility as well as a recreational venue. It tends to follow the street grid, with distinctive diversions into pools of public spaces and sometimes spectacular eddies into the larger parks with hills to climb and descend. And like all the rights-of-way that hug the islands' shoreline, the path or carriageway can become sinuous and even romantically landscaped to provide leafy sanctuary and shade. The City is to be lauded for its aggressive addition of bike lanes, paths and street closings and plazas, and for its extensive, soon-to-be-opened bike sharing system. The geometric, pixellated grid meeting the more natural and curvilinear water's edge is an old urban delight, going back to the one of the first ever urban gridirons, in the ancient Greek city of Miletus in Anatolia, where the grid was even more contrapuntal because of more dramatic terrain. Indeed, regular gridirons are subject to the relief of the exception, especially the diagonal. No diagonal is more famous and more enriching than Broadway, which, to its credit, is not an urban planning trope, but is based on a genuine historical circumstance. It's not just that it was a Native American trail, but that it was so completely surrounded by consistently gridded streets for most of its length. Unlike most cites, which have numerous radials and diagonals, mid- and up-town Manhattan plays a relentlessly cardinal and cadastral field to Broadway's figure.

Speaking of cardinal directions, the fact that Manhattan's grid is typically on the four points of the compass is beneficial. Unlike the random web of lower part of the island, or the rotated grid of the Law of the Indies, this regularity lends itself to good and equitable access to sunlight. No grid can increase the total <u>amount</u> of direct or diffuse solar radiation on a given piece of land, but it can facilitate <u>more equitable</u> access to whatever light and heat that is available by avoiding the black holes in the center of large, fat blocks. It is true, on the other hand, that the high-rises of both Manhattan and Dubai, tend to skew the distribution of light, as well as of air, with tall buildings that grab more than their share of each, while blocking others to the north or downwind. They can also hog the good views. Here's where Manhattan's early and sophisticated zoning codes beat Dubai's free-for-all, although there is far more sun to go around in the desert, where shade from neighbors is usually welcome.

Regarding cadastral advantages, there is no doubt that a gridded city like Manhattan and parts of other boroughs, is more efficient for land division and ownership than more randomly and irregularly laid-out Dubai. The Euclidean geometry allows for easier real estate surveying, assessing and sales, as well as for more consistent spatial packing of buildings. Rectangular lots are easier to build on, as most construction systems like or even demand square corners. There tends to be less leftover, unbuildable land, and therefore higher densities, on top of clearer circulation. This physical consistency enables more effective urban design and planning, because there's more predictability to future development than in Dubai, where it's more a matter of the Ruler's fancy or the government's dictation, especially from the alpha regional transportation agency.

There are less obvious urban grids, some intentionally hidden to the eye, ear and nose by being underground and some so sparse as to be invisible to the eye. Electric utility, telecommunication, water and sewer lines often follow the grid of the streets above, for easier installation and repair. Like the streets, they ultimately connect to and/or cross the rivers, not unlike the much more famous bridges and tunnels. The sparse grids are the pixels of schools, libraries, fire houses, police stations, medical facilities, community centers, and places of worship, all of which tend to space themselves out more or less evenly with the residential communities and neighborhoods (with some exceptional civic and cultural centers). The grid connects the dots in NYC better than in Dubai, where these land uses tend to be more randomly located.

1.5 The missing fabric and links

Dubai, having built an extensive infrastructure and many high-density areas, is now in a position to get the second half of the urban paradox right. It can infill existing development, and build more mixed use, walkable urbanism on the open urban land that it has vaulted over, as well as add the missing links in the transportation network. Just as important as connecting the dots, the existing single use areas need to be transformed into more complete and complex districts and neighborhoods. New and retrofit development is best located near Metro stations, with the highest densities within a quarter mile radius. To be fair, this type of infill is exactly what many U.S. cities also need to do, if they are to overcome the equally unsustainable imprint of single use zoning and the leapfrog development of endless suburbs. In many cases, they are currently re-densifying in this welcome and time-tested pattern.

If these mixed use places are well designed, interesting, humane environments, people will live, work, shop and recreate there not only because of proximity, but because they want to be there. They will enjoy being footloose pedestrians on pleasant days and evenings, just as they now flock to The Walk in Dubai Marina or mob the dancing fountain at Dubai Mall. Walking is the healthiest, greenest, safest, cheapest, friendliest and most enjoyable way to move around a city, with biking a close second. Walking is also a primary mode of mobility in Manhattan, with its incredibly rich mix of uses that is well served by a highly interconnected circulatory network for vehicles and pedestrians, including a safe, pedestrian-scaled environment with wide sidewalks. As Jane Jacobs, New York's patron saint of sidewalks and mixed use, presciently illuminated over four decades ago, walking will flourish 24/7, even in less-than-perfect weather. It is also essential that there be destinations worth walking to, as well as a high concentration of people to frequent and support them. And transit, which always starts and ends with a walking leg, enables the pedestrian to get around the whole city.

A city without mixed use and a connected grid or network is simply dense, high-rise sprawl, which is typically the worst of both worlds: it offers neither the stimulating life of cities nor the quiet privacy and greenery of suburbs. If suburban sprawl is boring to Gen-Xers and Gen-Yers, dense sprawl is not only boring but noisy and crowded to boot. Monocultures, like over-specialized species and ecosystems, are inherently less sustainable. In social, economic and environmental

terms, they are less resilient, less able to adapt and co-evolve with changing conditions. Nor are they as culturally vibrant, architecturally rich, or spatially interesting. In the end, it may even be more basic than physical urbanism. The grid is arguably the natural and inevitable pattern for a democracy, especially one connected to market economics. In a very basic, almost subliminal way, it makes everyone and every place equal. And it encourages and facilitates commerce, both economic and social, in its ongoing, extensive, multi-valent possibilities and its flexible routes, adaptable itineraries and easy wayfinding. The relentlessness occasionally opens up into the marketplace, the civic center, the institutional campus or the park that so wonderfully and clearly declare themselves to be the exception to the rule. (And, importantly for a democratic polis like New York City, it's the rule of law, not people, whereas in Dubai it's essentially a monarchy, which tends toward more monumental layouts.) The grid is ideologically and operationally American in its egalitarian, pragmatic accessibility, rid of the hierarchical space of imperial capitals or the royal precincts of Dubai. That's our founding proposition - one worth preserving, even fighting for as it is continually threatened. The grid makes that vigilance easier, both physically and culturally.