A Forest for Cars

A Strategy for the Elimination of Parking Lot Pollution

By Paul A. Olivier

Nothing could be more disagreeable on a hot summer day than a parking lot: the suffocating heat, the stench of gasoline and burning asphalt. Perhaps the only thing that constitutes a more destructive use of land is a landfill. While we may try to recycle and avoid creating landfills, it would appear that there is little we can do to avoid creating parking lots.

Ten per cent of the surface area of the average American city is parking lot, and this figure climbs to 20% and 30% as we reach the downtown area. Here the temperature of the asphalt, as well as the interior and exterior of automobiles, can reach as high as 170°F. At such temperatures, horrible things begin to happen.

Gas within fuel tanks, fuel lines and carbon canisters evaporates, and these hydrocarbon vapors make a substantial contribution to the formation of ground-level ozone. Ozone is not emitted directly into the air by vehicles but forms when nitrogen oxides and reactive organic gases (precursors of ozone) interact in the presence of heat and sunlight. Cars and other vehicles are "the largest source of ozone precursors,"[1] and surprisingly, more than 15% of the reactive organic gases from vehicles are not emitted while they are in operation, but while they are at rest in parking lots.[2] The parking lot incubates these gases into a toxic perfume laced with ozone and other pollutants.

At parking lot temperatures, paint, plastics and rubber deteriorate, and the value of the automobile depreciates accordingly. Similarly, asphalt melts and discharges more hydrocarbons into the atmosphere. As asphalt thermally decomposes, it eventually becomes friable and brittle and consequently loses a large part of its functional life. Objects left inside cars are often damaged and destroyed, and from time to time, we hear news reports about children and pets that do not survive the horrendous heat of the parking lot.

We all know that at parking lot temperatures, humans are negatively impacted in terms of health, comfort and cleanliness, but it is not easy to translate this into concrete numbers. Professor Devra Lee Davis of Pittsburgh recently estimated that more people are now being killed from the air pollution created by automobiles than from the accidental crashing of these automobiles.[3] Another study by the World Health Organization

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[1] "Ground-level ozone is created when certain pollutants, known as "ozone precursors," react in heat and sunlight to form ozone. Cars and other vehicles are the largest source of ozone precursors. See Smog – Who Does it Hurt? What You Need to Know About Ozone and Your Health at http://www.epa.gov/airnow/health/smog1.html

2"Motor vehicles are major sources of oxides of nitrogen (NOx) and Reactive Organic Gases (ROGs), precursors for ozone formation, a major source of air quality problems. While the bulk of vehicle ROG emissions are in the form of tailpipe exhaust, 15% or more can be in the form of evaporative emissions when vehicles are not operating." See http://wcufre.ucdavis.edu/air.htm

[3]"'It is our best estimate that more people are being killed by air pollution from traffic than from traffic crashes' said Devra Lee Davis, first author of the study appearing Friday in the journal Science. Davis, a professor at Carnegie Mellon University's Heinz School for Public Policy and Management in Pittsburgh,

estimates that "air pollution would cause about 8 million deaths worldwide by 2020."[4] A very large and deadly component of air pollution is ozone.

Ozone burns and destroys lung tissue immediately upon contact, causing inflammation and swelling.[5] Ozone reduces lung function. It hinders the ability of the lungs to fight infection and remove foreign particles. Those with asthma, emphysema, chronic bronchitis and other lung disorders are at risk even when exposed to low levels of ozone. Ozone increases sensitivity to allergens, it impairs cardiovascular functioning, it irritates the eyes, and it provokes nausea, dizziness and headache. Ozone even kills trees, damages crops, and causes the rapid deterioration of rubber products. It would be impossible to make a comprehensive list of the harm that ozone inflicts on humans and the environment, and without a doubt, it would be impossible to specify to the nearest 20 billion dollars the damage that it does each year to the US economy.

When we consider that cars and other vehicles are the largest source of ozone precursors, that a substantial amount of ozone precursors are produced by vehicles at rest in parking lots, that ozone formation is a chemical process driven by light and heat, and that parking lots are some of biggest generators of light and heat within an urban setting, do we not have here a problem that merits special attention? While we may spend huge sums of money each year to improve the safety and efficiency of our automobiles, and while, at the same time, we spend relatively nothing to improve the safety and efficiency of how we park them, have we not failed to form an integrated picture of the problem before us?

In combination with other heat-absorbing surfaces made by man, parking lots can elevate air temperatures in certain sections of a city by as much as 30° F relative to air temperatures in adjacent green areas.[6] This is not so hard to understand, since the temperature of an artificial surface such as an asphalted parking lot can be more than 70° F hotter than that of a vegetated surface. Furthermore, the highly conductive surface of the parking lot serves as a thermal battery, accumulating heat during the day and releasing it at night. Even five hours after sunset, the air temperature at one particular Alabama shopping center surveyed by NASA was some 12° F higher than at a nearby forest. As a result of the thermal properties of parking lots and other man-made surfaces, a dome of hot air may form over an entire city effectively raising its temperature by as much as 15° F. Even cities as small as 1,000 inhabitants are not excluded from this effect.[7]

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said ozone, particulates, carbon dioxide and other pollutants from the combustion of fossil fuels may affect the climate in coming decades. But she said her team found that they already are public health hazards." See Recer, P. Study Cites Air Pollution Deaths, The Associated Press, 16-Aug-01, p. 1.

4 Ibid., p. 2.

5 If you should have any doubt about how deadly ozone can be, please see Smog and Health at http://www.aqmd.gov/smog/inhealth.html

6 See http://wwwghcc.msfc.nasa.gov/land/heatisl.htm

7 "It was also determined from the urban heat island vs. population relationships defined by these data that at the lowest population value encountered, i.e., 1,000 inhabitants, there was already an urban heat island effect present on the order of 2 to 2.5°C." Oke, T.R. Urban Heat Islands of Small Towns at http://www.co2science.org/journal/2000/v3n32c1.htm

Some scientists estimate that every one-degree increase in temperature may result in a 2% increase in the demand for cooling power as well as a 3% increase in levels of smog.[8] If, for example, the temperature surrounding a shopping mall should rise by 30 F, this represents a 60% increase in the cost of air-conditioning as well as a 90% increase in levels of smog. Likewise, if the temperature within an entire city should rise by 15 F, then this represents a 30% increase in the cost of air-conditioning as well as a 45% increase in levels of smog. Since almost 17% of the energy produced in the United States is consumed for purposes of cooling, and since tens of billions of dollars are spent each year on ozone-related illnesses, then we must examine carefully any and all means to reduce what is called the "urban heat island" effect.

One promising approach is to coat dark surfaces with reflective paint. This alone can reduce the demand for cooling by as much as 40%.[9] Although this works quite well with respect to roof surfaces, it does not work well with respect to parking lots. The oil, grease, rubber and other compounds deposited by automobiles on the surface of the parking lot destroy the reflective properties of the coating. Moreover, a reflective coating on a parking lot would produce a lot of undesirable and dangerous glare that would surely blind any driver or pedestrian not equipped with sunglasses.

Even at mild temperatures, even in the absence of sunlight, parking lots inflict a lot of damage upon our environment. Since the ground underneath the parking lot can no longer absorb rainfall, the city and surrounding areas are subject to a much higher incidence of flooding. Generally a man-made surface will generate two to six times more runoff than a natural surface.[10] Storm water drainage systems are typically oversized at a considerable expense to handle the torrential flow of water along impervious surfaces. The effluent from parking lots (filled with lead, zinc, copper, hydrocarbons and other toxic substances) pollutes our streams and rivers.[11] Furthermore, since parking lots usually require security lighting for nighttime use, they make a significant contribution to urban light pollution.

What once was forest, prairie, desert or wetland can no longer breathe or drink. The land has died. It can no longer sequester carbon dioxide or purify in any other way the air we breathe. It can no longer retain, filter or transpire water. It has lost every one of these vital

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[8] See Adams, Eric. Urban Heat at http://www.architecturemag.com/jan99/tp/green/green.asp

[9] "Research conducted in Florida and California indicates that buildings with highly reflective roofs require up to 40% less energy for cooling than building covered with darker, less reflective roofs." Estes, M.G. et al. The Urban Heat Island Phenomenon and Potential Mitigation Strategies, p. 2 at http://www.asu.edu/caed/proceedings99/ESTES/ESTES.HTM. In addition to applying a reflective coating, we might store rainwater and drip it onto the surface of the roof.

[10] "As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff two to six times over what would occur on natural terrain." See The Hydrology of Floods at http://dc.water.usgs.gov/faq/floods.html

[11] "Degradation and water quality in urban and suburban watersheds is directly linked to the amount of impervious cover in a given area." See http://www.chesapeakebay/net/data/esdp/tool4.htm "Storm water runoff from urban areas is an extremely important source of oil pollution to receiving waters. These hydrocarbons tend to accumulate in bottom sediments where they persist for long periods of time." See A Sept. 1995 Pro-Act fact sheet on storm water pollution prevention at http://es.epa.gove/oeca/fedfac/fflexp2/proact16.html

functions. Air, water and light pollution all increase with the construction of each new shopping center and each new building requiring parking space. With the exception, perhaps, of a landfill or a toxic dump site, nothing represents a more brutal assault upon the natural world.

But since we cannot ban parking lots anymore than we can ban automobiles,[12] is there not some way to modify or transform the parking lot so that it can function as a forest? While the planting of trees along narrow streets makes sense, the planting of trees around or within a parking lot does not go far enough. Why should we settle for anything less than a rich, green canopy covering every square foot of parking space?

When we think of forests we generally think of trees. But with respect to parking lots, trees take too long to grow, and they occupy too much above- and below- ground space relative to the amount of shade they provide.[13] We need a fast-growing plant that has evolved to compete aggressively for every square inch of available sunlight. At the same time, we need a plant of a relatively small caliper that does little to diminish effective parking space and that does not require an elaborate and extensive root structure to stabilize itself. Every forest is filled, to a greater or lesser extent, not only with trees, shrubs, ferns and grasses, but also, as you may have guessed by now - with vines.

Few plants offer as many benefits in the forestation or reforestation of parking lots as vines.[14] Evergreen or deciduous, annual or perennial, flowering or non-flowering, fruiting or non-fruiting, scented or unscented, exotic or native, domestic or wild, nature presents us with thousands of species of vines.[15] Without a doubt, vines can quickly convert parking lots into some of the most wondrous displays of natural beauty ever seen within an urban setting. Instead of trying to hide or screen parking lots from public view,[16] municipalities and local businesses might feature and advertise them as tourist attractions. Imagine a parking lot in springtime adorned with thousands of clusters of sweetly scented wisteria blossoms. With vines, not only do we eliminate most of the

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[12] See Troy, May. "Ban on new parking lots among ideas for improving downtown" at http://centralohio.thesource.net/Files2/9601093.html

[13] "The standard rule of thumb is that the area of ground which should be left uncovered around the base of a tree be at least equal to the diameter of the branch area or crown at maturity." Dale, G. Parking Lot Design, p. 2 at http://www.plannersweb.com/articles/trans14.html

[14] See Ocone, Lynn. Versatile Vines at http://www.todayshomeowner.com/yard/19880609.feature.html

[15] See Cohoon, Sharon. Versatile Vines (vine growing tips) at http://www.findarticles.com/cf_0/m1216/4_202/54260355/print.jhtml

[16] "Given the visual prominence of parking lots, many jurisdictions seek to regulate their appearance and design. Probably the most common requirement is that parking areas be screened from public view. This is usually accomplished through the use of earthen mounds (known as "berms"), wood or masonry walls, trees and shrubbery, or any combination." Dale, G. Parking Lot Design, p. 1 at http://www.plannersweb.com/articles/trans14.html

undesirable features of parking lots, but we also create an elaborate and extensive home for birds, butterflies, bees and other indigenous creatures.

Since security lighting would be situated below the canopy of vines, the parking lot would not contribute to the light pollution of the sky at night. Instead of powerful floodlights creating simultaneously both glare and shadow, instead of tall floodlights indiscriminately illuminating adjacent properties, soft, well-distributed lighting could be suspended below the canopy structure.

Vines are not self-supporting, and this makes them versatile and adaptable to the structures we provide. Steel poles and cables are cheap and easy to erect above the entire parking area. Vines are easy to grow and require little ground space. Fast-growing vines readily exploit every square inch of arbor or trellis. With respect to parking lots, vines that are both perennial and deciduous are ideal. Perennial vines continue their growth from year to year, while deciduous vines drop their leaves in fall to let in light and warmth.

One of the best ways to decrease the size and cost of storm water management systems is to find an on-site use for the storm water.[17] It would be easy to store parking lot storm water in large underground pipes. After filtration to remove hydrocarbons and heavy metals, this water should be targeted directly to the root system of each vine. Drawn up through the vine by osmotic pressure, this water evaporates on the surface of leaf thereby transforming the parking lot into a gigantic evaporative cooler. On a hot summer day, this can drop the temperature of the tarmac by as much as 70° F. Not only would this reduce the cost of air-conditioning within a shopping center or urban area, but it would also reduce emissions from conventional power plants. The direct sequestration of carbon dioxide by vines, coupled with this negative production of carbon dioxide and other greenhouse gases by power plants, represents a very simple and cost-effective way to combat global warming.

The filtration of water not only removes pollutants, but also safeguards the flow of water to each vine. A subsurface drip irrigation system has many advantages. There are no exposed irrigation tubes that can be damaged or vandalized by automobiles and pedestrians. According to the level of moisture in the soil as continually monitored by moisture gauges, the right amount of water can be metered very efficiently to the root zone of each vine. Any supplemental nutrients required by the vine can be added to the water. Subsurface drip irrigation systems may be relatively expensive with respect to agricultural applications (from $500 to $1200 per acre),[18] but with respect to a restricted landscaping application such as this, they cost far less.

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[17] "In many conventional developments, stormwater from rooftops are often piped into a storm drain which directly leads directly into an engineered stormwater management facility. One of the best ways to decrease the need for stormwater management systems is to manage Rooftop Runoff on site, instead of moving stormwater through a conveyance system. Redirecting rooftop runoff is a significant measure for reducing downstream impacts and can decrease annual runoff volumes by as much as 50% for medium and low density land uses." See http://www.chesapeakebay/net/data/esdp/tool4.htm

[18] Shock, C.C. An Introduction to Drip Irrigation, p. 2. See http://www.cropinfo.net/drip.htm

The maximum distance that vines have to cover within the parking lot is determined in large measure by stall and aisle dimensions. Typical stall dimensions in the United States are 8'10" (2.69m) wide and 18'8" (5.69m) long. To reduce the horizontal distance that vines have to travel, aisles should be one-way, and at a stall angle of 60 degrees,[19] aisle widths of approximately 16 feet (4.88m) are sufficient. If the canopy height is set at 12 feet (3.66m), then the total distance that a vine has to travel to cover both stalls and aisles is less than 40 feet (12.19m). Many species of vine are capable of covering this distance within the first two to three years of planting.

Vine support cables, spaced at intervals of one half the stall width, run perpendicular to the parking lot aisles. These vine support cables are suspended and held in place by means of steel poles. Within the parking lot, these poles stand upright. At the edge of the parking lot, they are angled outward to provide leverage. Anchor cables and screw anchors stabilize the entire structure. The material cost for the vines, for the cable structure to support the vines, and for the subsurface drip irrigation system, is less than $0.50 per square foot of parking lot. The money saved in not having to landscape the parking lot with trees and shrubs should cover a substantial portion of this cost.

If vine support cables are installed at intervals of one half the stall width (4' 5"), then the area that any one vine should cover is approximately 116 ft^2 (4'5"x 26'3").[20] One inch of rainfall over this area would generate approximately 72 gallons of water. If each vine requires an average of 4 gallons of water per day or 1,460 gallons of water per year, then approximately 20 inches of rainfall would be required for vine irrigation over a period of one year. In dry regions, it may be necessary to store additional rainwater from rooftops.

The amount of water that must be stored for irrigation depends on the average yearly rainfall and the distribution of this rainfall throughout the year. In regions of 20 inches of average rainfall per year or less, it would be necessary to store all available rainwater. In regions of abundant and well-distributed rainfall as in south Louisiana or Alabama, it might be necessary to store only 5 or 10 inches of rainfall.

A distinction is made within storm water management theory between *retention* and *detention*. When rainwater is *retained*, it is stored and slowly allowed to penetrate or infiltrate the soil. Since, in this case, most of the rainwater either evaporates or eventually reaches the water table, very little storm water leaves the site. However, when rainwater is *detained*, it is stored only as a means of temporarily restricting or interrupting it on its way to discharge. Detained water eventually exits the site as storm water and inevitably makes its contribution to the cost of storm water management within the urban area.

State and city codes specify the amount of storm water that must be detained in the event of intense rainfall. Generally this is calculated on the basis of a 10-year, 24-hour rainfall event. If we consult a Rainfall Frequency Atlas for the Eastern United States, we see that

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[19] "Depending on the parking lot dimensions, it has been shown that the optimum parking angle is 60 degrees." See http://orion.math.uwaterloo.ca/~hwolkowi/henry/teaching/f97/370.f97/stu…/background.html

[20] This also includes one half of the width of that part of the aisle that serves a particular stall.

every year in south Louisiana, there is a 1 in 10 chance that over 8 inches of rain will fall within a 24-hour period. If the owner of the parking lot is obliged by code to detain two-thirds of this amount, then the cost of storing water for purposes of vine irrigation should not be greater than the cost of storing water for purposes of detention. Just as the cost to landscape a parking lot with vines should not be much higher than the cost to landscape with trees and shrubs, so too, the cost to retain and irrigate should not be much higher than the cost to detain and drain.

Water can be stored either above or below ground. Aboveground storage is relatively cheap, but it would occupy a lot of space, and its visibility might compromise the aesthetics of the parking lot. It would appear logical, therefore, to store water in the vast area underneath the parking lot.

One of the most economical ways to store water underground is in large corrugated high-density polyethylene (HDPE) pipes (see adjacent picture). Strong enough to support the weight of an automobile, these pipes may be discretely buried underneath the parking lot.

Instead of detaining parking lot water for release into the watershed, would it not make more sense to retain it for vine irrigation? Instead of wasting this precious resource, would it not make more sense put it to beneficial use on site and thereby eliminate the need to manage it further down the watershed? Like fractals, watershed patterns are self-repeating on a multiplicity of levels, and any refusal to solve the problem locally at its point of origin may eventually give rise to disastrous levels of large-scale flooding.

Every parcel of undeveloped land has a natural capacity to retain and detain rainwater. Regardless of the intensity, duration and frequency of rainfall, land after development should be able to retain and detain the same amount of water as it did before development. With respect to parking lots, most city codes and ordinances focus mainly on detention. Very little is specified with respect to retention.

But has the owner of a parking lot fulfilled his or her responsibility with respect to the environment simply by restricting the flow of storm water from the site? The land after development should be able to retain and thereby *utilize* as much water after development as it did in its original state when *fully covered* with grass or trees. Since a parking lot cannot support a large amount of grass and trees and at the same time function efficiently as a parking lot, it would appear that city planners have had no other choice than to formulate codes only in terms of detention.

But since vines fulfill all of the vital functions of grass, trees and other predevelopment vegetation, should city codes and ordinances regarding storm water management not go far beyond the goal of simple detention? Since parking lots inflict a lot more damage on our environment than dumping all at once large quantities of toxic effluent into urban drainage systems, should city codes not also specify the amount of post-development vegetation? The primary focus in urban planning should be the *amount of vegetation per square foot of parking space*. The amount of storm water to be managed is quite simply the amount of water needed to sustain this vegetation under normal conditions of growth.

But when we define all in terms of retention and on site irrigation, have we not overlooked a basic and minimal need for detention? What happens when the irrigation pipes underneath the parking lot are full, and the parking lot is subjected to intense rainfall? Obviously it no longer has the ability to retain. But is this not what happens in a pre-development setting when, after heavy and prolonged rainfall, the ground can no longer absorb and retain water? All excess water simply drains away forming our streams, rivers, bayous and lakes.

But in a post-development setting, it is not the drainage but the speed of drainage that is so critical. Even though pre-development ground may be saturated with water, its vegetation provides it with a relatively large surface area that hinders and impedes the rapid flow of water from the site. A tree, for example, is a complex three-dimensional structure, and each one of its leaves and branches can hold and detain water. Likewise, a mature vine forms a complex tangle of sub-vines and leaves measuring several feet in depth. Since a canopy of vines has a surface area several hundred times greater than that of the parking lot, it has a fairly substantial ability to intercept water even when the storage pipes underneath the parking lot are completely full.

Nonetheless, urban planning officials might argue that this is not enough, especially if the prospect of additional intense rainfall is highly immanent. They might force the owner of the parking lot to discharge vine irrigation water to storm water drains in anticipation of additional rainfall. However, if this rainfall does not occur, and if the owner of the parking lot is eventually obliged to buy water from the city to replace the water he uselessly discharged, then the city might sell irrigation water to the owner of the parking lot at a discounted price. In the end, a debate may easily arise among urban planning officials, one side stressing the importance of interception and detention, the other side stressing the importance of irrigation and retention.

To those who think that retention and on-site use are not so very important, it might be helpful to point out that the urban heat island effect actually modifies patterns of rainfall. When we look, for example, at the city of Mobile, we see that in those areas of the city with large concentrations of malls and parking lots, there has actually been an increase in the amount of annual rainfall. As Michael Taylor explains:

> During the early 1980's, Mobile entered an expansion period that is continuing today. Thousands of trees have fallen victim to this expansion and concrete has taken their place. All of which has provided much more heat in the summer time. This expanding urban heat island has had direct effects on the sea breeze that forms every day in the summertime. The sea breeze front that provides those quick intense downpours in the summer time may be intensifying due to the urban heat island. In areas of northeast Mobile, near the concentration of pavement associated with the malls, annual rainfall amounts can be 10 to 12 inches higher than measurements taken at Bates Field. While

> rainfall has increased over the heat island, cropland in the southern part of the county has suffered. The extent of the affects on the sea breeze front is not fully understood, however with a continued growth of urbanization in the city, the climate of Mobile may forever be altered (Petit 1995).[21]

Due to the urban heat island effect, it would appear that the annual amount of rainfall within certain parts of the city of Mobile has increased dramatically, and at the same time, it has created conditions of drought within neighboring farmland. Taylor also points out that, since development, there has been a definite increase in intense rainfall events within the city.[22] Many other studies confirm what has happened in Mobile, that as temperatures rise, the probability of both intense rainfall and prolonged drought increases significantly.

If we do not take steps to retain and use rainwater on site as an essential and critical means of combating the warming of our cities, then our detention systems may never be large enough to handle the ever-increasing volumes of rainfall that confront us. Just as we cannot solve the problem of a runny nose with bigger and better handkerchiefs, we cannot solve the problem of the urban heat island effect with bigger and better storm water detention systems. We might think that the planting of trees and shrubs within the parking lot is a step in the right direction, but what is the value of a beauty that does little more than hide the ugliness and destructiveness of the parking lot? A beauty that distracts us from seeing the innate ugliness of this manipulation and distortion of nature is ultimately deceptive, superficial, cosmetic, and cheap.

Only by going to the heart of the problem, that is, only by creating a rich canopy of vegetation above the entire parking lot can we eliminate in a definitive and comprehensive manner all of the air, water and light pollution that it generates.

Imagine flying over a parking lot in an airplane and not seeing a single automobile. Imagine shopping in summer time and not having to contend with the heat and discomfort of a conventional parking lot. Imagine the delight of walking under a cool and sweetly scented canopy of leaves and blossoms. Imagine the savings in air-conditioning as temperatures drop within urban areas, and as a consequence, the number of power stations that need never be built. Imagine the huge reduction in levels of ozone, and as a consequence, the reduced incidence of asthma, heart disease and lung disorders. Imagine a parking lot that serves as a major tourist attraction, or a vineyard that doubles as a parking lot. Imagine hummingbirds and

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[21] Taylor, Michael. 1999. Intense Rainfall Events, p. 3, at http://www.southalabama.edu/geography/fearn/480page/99Taylor/Taylor.htm

[22] Ibid., p. 2.

butterflies, bluejays and mockingbirds. So many wonderful things spring to mind when we imagine a forest for cars.

Is there a cheaper and more effective way of reversing the urban heat island effect and eliminating all aspects of parking lot pollution? Perhaps there is. But why wait for some futuristic and stupendous breakthrough in science when nature has already given us all that we need? Often we buy into the myth that the problems created by science require the big solutions that only science could provide, and when we have a very simple and obvious solution that involves very little science, we refuse to take it seriously. Even though our problem might be totally solved, insofar as the solution does not conform to our cultural expectation of what that solution should be, we do nothing at all.

If this solution to parking lot pollution involved a significant increase in the cost of constructing a parking lot, we might dismiss it as unrealistic. But in many municipalities, if existing ordinances regarding parking lots were strictly enforced, the conventional parking lot with trees and shrubs would cost a lot more than the totally forested parking lot we are proposing here.[23] Let us be quite clear: *money is not the central issue*. Businesses would gladly spend a bit more in the construction of parking lots if they could reduce air conditioning bills and, at the same time, extend a greater degree of comfort to their clients. The health and environmental benefit to the nation would translate into tens of billions of dollars each year. The central issue is not money but the uncertainty associated with change.

In the final analysis, we must ask ourselves if there is some ingenious way of stepping outside of convention without incurring risk. Surely there is not. But when we realize that we incur a much greater risk by doing nothing at all, perhaps we will find the courage and enthusiasm to do something new.

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[23] "Parking lots have been recognized as thermal 'hot-spots' and many California cities have implemented ordinances that require shading of 50 percent of paved areas by trees." See McPherson, E.G., Simpson, J.R. and Scott, K.I. Actualizing Microclimate and Air Quality Benefits with Parking Lot Shade Ordinances at http://wcufre.ucdavis.edu/actualizing.html