Urban Trees Can Prolong the Life of Things Manufactured and Built

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Many of the things we make to support our lives deteriorate with age (good wine and fine musical instruments potentially to the contrary). Common examples are all around us - our cars, our homes, our streets, our kitchen and workshop tools, our boats, our garden furniture, our computers - the list goes on and on. Sometimes the deterioration comes from use - the sharp right angles of a slot-head screwdriver tip eventually get worn off so we either have to grind the tip, replace the screwdriver (using the old one perhaps for prying off paint-can lids!), or become increasingly frustrated as the screwdriver slips more and more when driving screws.

The deterioration of interest in this article is caused by the sun. Of course, we couldn't live here on Earth without the sun. It provides the energy to keep the earth's surface warm enough for us but also drives photosynthesis in green plants - the foundation of our food supply. But sunlight comes at a cost. Most of us are aware of the need to protect our skin from direct sunlight in summer because of the risk of getting skin cancer. What about all the things we build and the effect of direct sunlight on them?

We frequently speak of "the elements" when things we make are put outdoors and hopefully last a good long time. The big four of these elements are direct sun, precipitation, wind, and temperature. Trees can influence all of these for the built things that are under or near their crowns. When in leaf, they cast a shade, intercept both wind and rain, and moderate the temperature. In essence, trees take the harshness off the raw elements. Let's look a little deeper at ultraviolet (UV) light or radiation and see how trees may take the harshness off that driver of material deterioration. The materials we will examine are asphalt and wood.

Asphalt is a mixture of a highly viscous petroleum-based binder and aggregate (gravel). Anyone who has walked by a paving crew in action will know the smell of fresh hot asphalt. What we smell are the volatile organic compounds (VOCs) escaping from the binder. The rate of their escape from the roadways (and rooftops, where lots of asphalt materials are used) depends on many things, including the age of the material installed, the temperature, and the amount of UV light. The temperature is a function of both the air temperature and the incident sunlight (direct sunlight makes dark surfaces hotter than if they were white). The other issue with direct sunlight is the photo-oxidation that results from UV light hitting the binder materials and causing a chemical breakdown.

Two recent studies are of interest here. In California, McPherson and Muchnick (2005) studied the asphalt-pavement longevity of unshaded and shaded urban streets. They found that tree shade was at least partially responsible for the reduced deterioration rate of street pavement. This means at least two things: (a) lower rates of air pollution from VOCs from the pavement; and (b) extended pavement life and therefore reduced rates of maintenance costs. Just last month, using lab-based experiments, Khare et al. (2020) reported substantially higher rates of VOC emissions from asphalt binders under even moderately higher temperatures. They pointed out that the

average American city has nearly 45% of its land area covered with asphalt roadways, driveways, and parking lots, and another 20% covered by rooftops most of which are topped with asphalt materials.

The upshot of this discussion is that tree shade is good for asphalt longevity. Besides lowering maintenance costs for roadways and roofs, shade lowers asphalt temperatures (compared to those in direct sunlight) and therefore reduces the rate of air pollution from the asphalt. Finally, shade reduces the UV load on asphalt and therefore the rate of deterioration from photo-oxidation.

One of my favourite examples of tree shade on streets is from Powell River in BC. The residential streets of the town were established about a hundred years ago. Oak St. (pictured below) still has the oak trees planted there and they provide some shade over the entire street. Poplar St. (also pictured), on the other hand, no longer has trees, so the asphalt suffers the continual onslaught of direct sun.

When it comes to wood, UV radiation is again the culprit. UV light denatures lignin, the main structural component of wood. We first might see discolouration but in outdoor situations, that can eventually lead to weakening of the wood as well as cracking. In our Halifax clime, with substantial rainfall each year, the UV light and water work together to hasten wood deterioration. Keeping direct sunlight off one's deck is helpful to wood longevity, and what better way to do that with woody plants (i.e., trees)!

The story is not all rosy when it comes to trees shading infrastructure. The shade is fine, but what about various materials that drop from trees to the surface below? I can't find any literature on the effects of leaf and insect exudates on asphalt, but I know from personal experience that those drippings are rather unpleasant to have on your car. Some people find that fallen leaves stain their car's paint. Finally, I also know from personal experience that while I cherish the tall elm tree that stands next to and over my house, the annual pilgrimage to the roof and gutters for leaf cleaning is an increasingly less-pleasant undertaking.

In closing, my opinion is that it is better to have trees above asphalt surfaces than not. The trees - particularly their foliage - represent a far superior surface, environmentally speaking, to receive sunlight compared to asphalt, and, who knows, the benefits to the infrastructure may also be saving us money in the long run.

References

American Flexible Products. 2019. How UV Rays Can Harm Your Materials. https://americanflexible.com/uv-can-harm-materials/

Khare, P., J. Machesky, R. Soto, M. He, A.A. Presto, and D.R. Gentner. 2020. Asphalt-related emissions are a major missing nontraditional source of secondary organic aerosol precursors. Science Advances 6: eabb9785

McPherson, E.G. and J. Mucnick. 2005. Effects of street tree shade on asphalt concrete pavement performance. Journal of Arboriculture 31(6):303-310.