

BIO-ENGINEERING FOR THE URBAN ECOSYSTEM¹

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INTRODUCTION

The commonest cause of tree death in the city is the engineer. Environmental pockets are made by his design or his lack of it. Often they are not suitable for any plant life short of hardy weeds.

It is necessary to rethink the conventional platitudes of city tree planting. What works in the forest can not be expected to perform satisfactorily in the city. It is not enough to dig a hole and stuff in a tree, particularly in concrete.

Of the parameters of biomass production that affect survival and performance in the urbanizing landscape, water stress is the most serious problem. It supercedes good soil, special clones, insect and disease control and pollution.

Statistically, however, the most significant problem, is continuing construction and careless engineering. New roads, signs, lights, pipes, bus stops, cables, sewers, curbs, sidewalks, assault the root structure and growing medium (Fig. 1). More trees were lost in the Boston Common Park to construction in 1975 than in 3 years of epidemic Dutch elm disease. New paths carelessly planned, unnecessary sewers, and \$350,000 of new granite curbing were to blame.

Far more important than the actual physical damage to roots and trunks, is the permanent damage done in changing the microenvironment. When runoff water is piped into the sewer, the water table which nurtured the tree disappears. Water stress follows, with fungal infections close behind. Equally important, soil over the roots is compacted by machinery, and frequently covered with concrete or blacktop. Air exchange to the roots ceases.

In a survey of tree survival, it was found that most curbside trees on sidewalks do not live anywhere near a normal life span. The commonest cause of death is drought. The commonest injury auto damage. Statistically, vandalism is not a primary problem. Construction is a paramount problem.

¹ Metro. Tree Impr. Alliance (METRIA) Proc. 1:13-17,1978.

Bio-engineering is simply applying the parameters of biomass production in an organized fashion to plan the pockets where plant material must survive. It is more cost-effective than planting material in uninhabitable micro-environments, doomed to failure.

ENGINEERING AND TREE GROWTH

The city is a created landscape. It is not the forest. The rules and priorities of conventional silviculture do not always apply in an urban setting.

There is no humus, no seedlings to renew the urban forest and little soil, except in parks. The air is hot and dry. Excessive heat radiates from buildings, winter and summer. Searing winds are generated by the "canyon effect" of tall buildings. Even the climate is different, changed by the well-known "heat-island effect" of the city. Changes in rainfall patterns and air pollution inversions affect growth rates.

To further complicate this concrete landscape, microenvironments exist within the larger framework. The north sides of buildings may never have any sunlight, while south facing pockets will suffer the variations of temperature common to deserts. While it is true that there is a tree for each environmental pocket, it may be only a cactus. It is better to engineer planned environments that will support trees and plants. Educating engineers, though undeniably difficult in the field, is essential.

BIO-ENGINEERING FOR WATER STRESS

The parameters of biomass production are well-known. However, the relative importance of each is different in the man-made city. Water stress, the primary problem in cities, can be alleviated. Drainpipes should go through perforated pipes under tree pits. The water would be used by the trees. The overflow would still end up in the storm sewer, or better, percolate into the soil to recharge the underground aquifer. The same thinking can design irrigation with uncontaminated waste water. Storm sewers should be planned for re-use of light rainfalls, with overflow sewers for heavy rain only. Sewers in parks are unnecessary. They are destructive both in construction and in damage to the water table. Bringing the blind enthusiasm of engineering endeavor into parks destroys the few natural green oases that exist in the concrete city-scape.

The City of Boston just spent \$100,000 putting new sewers in its downtown park, to remove water from the paths. The needed water drains into the bay. During a drought in June, a crisis operation had to bring water with trucks and hoses.

POLLUTION DAMAGE

With the current sensitivity to the health hazards of pollution, it is popular to apply the same thinking to trees. Growth is compromised by air borne pollutants. Growth rates and disease susceptibility are affected. Leaf damage is seen. The most troublesome are auto fumes and particulate ash. Research has been sporadic about effects in vivo. Probably the total effect on survival rates is highly over-rated, when compared, statistically, to damage done by water stress and construction, as well as mechanical damage. Salt is the exception, damage from which is widespread. It can be avoided if planting pits are not adjacent to areas of pedestrian and auto use, and by the use of salt-resistant trees.

MECHANICAL ABUSE BY PEOPLE

Auto damage and vandalism are the two serious causes of mechanical damage to city trees. They are too frequent to be dismissed lightly. Autos cause the disproportionate share. Few large trees bear no scars of damage. Young trees are seriously compromised because of their tender bark. Auto damage may occur on 81% of sidewalk trees in a business area. 30-50s is not uncommon elsewhere. The closer the tree to the curb, the higher the incidence. Trees set back far enough to avoid car doors and parking, are less affected. Barriers help. Tree stakes do not. Often they are damaged by cars to the point where they actually are hanging on, not holding up, the trees (Fig. 2). Much of the fungus decay (that eventually claims the trees' lives) starts as auto wounds.

Vandalism is highly over-rated except in areas of high child use, such as playgrounds; or near pubs and bars. On the streets, approximately 10% are gouged or cut. About 15% have broken branches, although many of these are from being hit by trucks. Wrapping helps protect them when first planted. Torn lower branches are helped by simply having the canopy of branches begin above six feet. Nurseries should train shade trees when young to a high canopy, especially varieties like linden, Callery pears and flowering species.

An interesting observation was that trees with flowers planted around their bases were rarely vandalized.

STAKING

An observation that flies in the face of all conventional planting data was borne out in a statistical analysis. Staking in the city is a losing battle. 80% of the stakes end up damaging the trees (Fig. 3). Except in windy areas, stakes are not really necessary to help a tree get established. Survival rates are not markedly different between staked and unstaked trees.

MAINTENANCE

Another reality of the city is the fact of poor maintenance. Trees should be planted, and expected to survive with no follow-up care. It is one of the inescapable realities of the urban ecosystem. Correct engineering of the microenvironment can produce a planting pocket that is self-sustaining.

THE RESULT

The result of city environmental parameters is that trees adopt the growth habit of desert plants. They grow slowly, mature over-early, have small leaves and huge crops of seeds. They conserve their energy to remain alive, rather than becoming the expected giants of the woodland.

SURVIVAL RATES

Longevity is not what is genetically expected. In surveys done on street trees in Boston, only 15% were over 12 inches in diameter. Extensive planting was done at the turn of the century, but few large trees remain. On Beacon Street, in 1911, about 350 lindens were planted. Sixty years later they should be in their prime, yet only 81 have survived, only 55 of these in healthy condition.

Survival of young trees is poor too. On another street, 116 honeylocust, plane and maple were planted 6 years ago. Today 31% are healthy, 33% in poor condition, and 36% dying, dead or gone. One year survival rates depend largely on contractor competence, and regular water. In one year, in Boston, 4 contractors had loss rates of 35%, 12%, 9% and 2% respectively. Good planting techniques and special acclimatizing make the difference.

The survival statistics point up one more parameter...a political one. City bids go to the low bidder. It is difficult to weed out poor performers. The realities of city politics, bidding procedures, entrenched hierarchies and neighborhood neglect and abuse must be reckoned with.

THE FOURTH DIMENSION-TIME

The landscape is a &dimensional discipline. Trees grow. Their sizes change. Too often, engineers and architects overlook this obvious fact. Even city foresters do...and plant maples under electric wires.

With proper bio-engineering, attention to growth parameters will pre-tailor trees to grow the right size in the right place, with little additional care. In preparing a matrix, factors to include in the urban scale would be; sun, shade, soil, wind, water, cars, insects, diseases, people, animals, pollution, macro-and micro-environment, construction, politics, as well as aesthetic qualities and uses.

CONCLUSIONS

Bio-engineering means planning for optimal survival and health, environments to support temperate trees and shrubs. Construction and tree planting need more coordination. Protection from autos, salt and drought can be designed in. Monocultures must be avoided, so that no one disease can decimate a whole street or area, as Dutch elm disease has in places.

Since trees don't live very long in concrete anyway, fast growing varieties can be used. Staking should be eliminated, except in special circumstances. Water has to be provided for, either as runoff directed into the pit or simple irrigation with runoff from buildings.

Most interestingly, studies suggest that sidewalks are not the best place for trees. They should be planted' inside the pavement, rather than at the curb side. Ideally they should be planted in plantations, squares and parks. They survive better and suffer less vandalism. The ground should be unpaved beneath them.

In the urbanizing landscape, the parameters of tree growth have to be viewed as part of the total environment. Most urban forestation starts at the wrong end. If plant material is to survive--and possibly thrive--bio-engineering and total planning procedures have to be applied early-on.