Treenet Proceedings of the 3rd National Street Tree Symposium: 5th and 6th September 2002
ISBN 0-9775084-2-0

REDUCING TREE HAZARDS IN URBAN HORTICULTURE

Phil Kenyon - Melbourne University Burnley College

"A stitch in time saves nine"
"Prune and shape early saves dollars and deaths later."

"Life Time" v "Tree Time"

The average Australian lives for about eighty years.

As a species we are conceited, we live on earth, believing we will be here forever, and that we are the most important event the world has witnessed. Most of us will be lucky if we have the honour of planting a tree and watching it grow through the various stages from a seedling, to a young tree to semi-mature to a mature fine specimen, admired by all, providing shade shelter and habitat.

Hang on! DO we see it Mature?

Will we be here long enough to see it mature? If it is an *Acacia confusa* maybe! But the average life of many tree species is one hundred years, two hundred is not uncommon, and in some cases many more years. As humans we want things to happen quickly. If a branch is to be removed, out comes the chainsaw, off goes the branch. If the tree 'decides' that a branch is no longer paying it's rent, the process of branch death and eventual expulsion may, and usually does, takes years.

We need to contemplate and further study trees, forests and the natural order of the forest environment. Time, and the concept of time is another important consideration with regard to trees. Trees are, in general, when compared to man, very long-lived. In many situations, tree failures develop slowly. A Red Gum may take twenty years to shed a branch; the changes can be very subtle. Twenty years in the life of a four hundred year old tree, is not a very long period.

We need to think in terms of **"Tree Time" not "Human Time"**

As arborists it is possible to locate faults and to predict tree failure, what is particularly difficult to predict is: 'When will the failure occur?'

If we are accurate to within a ten year period in predicting tree failure then in terms of tree time, that is pretty good.

Hazard abatement programs are usually based on inspections of mature and semi-mature trees. "Large, old trees are more likely to fail than are smaller or younger trees of the same species." [Harris, Clark, Matheny 1999]

Because of a poor understanding of the requirements for trees to have a well formed root system, a large percentage of the trees planted during the 1970's, have deformed root systems (Moore, 1987) (May, 1990).

Programs of reducing or preventing hazards by looking at 'whole tree management systems' may be much more cost effective long term, than hazard assessment and abatement of mature and senescent trees.

Such programs need to consider nursery systems, site planning, site preparation, planting techniques, through to pruning and shaping young and semi-mature trees. Poor nursery practices and resultant root deformities such as J roots, and root girdling have been shown to be the reason for many tree failures. Sometimes these root deformed trees fail within a five to ten year period, but other root deformed trees may not fail for twenty plus years. Root deformed trees are often stressed trees and are more susceptible to insect and pathogen attack. Many of the trees planted over the last thirty years have been planted with poorly developed root systems. These trees are a costly burden to maintain as they develop. Often to actually beat the vandals, the mowers, the engineers, the road construction workers, and the environment, parks departments struggle for years to maintain and grow root deformed trees. Unfortunately so much time effort and expense is wasted, as many of these root-deformed trees are unstable in the ground. Many of these trees are time bombs. It may be that an extremely wet winter, or severe windstorm, or an uncommon wind direction, either singly or in combination are the factors that contribute to the eventual failure. Trees with good anchorage and sound root systems are less likely to fail in these conditions.

Whole tree failures have the mass and potential force to cause far greater damage than branch failure. During hazard assessment greater care and more in-depth assessments need to be made of tree stability. There are very few references to techniques or methods to determine tree stability. ‘The Burnley Test’ for trees up to approximately 150mm is to rock the trunk at breast height and examine the root zone for root crown movement. The canopy of a tree has adapted to move and sway in the wind, tree trunks bend and flex, but how much should root crowns and systems move in the ground? Most landscape trees should firm up and be stable within five to six years after planting. After this time the trees should feel stable and not exhibit ‘excessive’ root crown movement. (What is excessive? At this stage it is difficult to define.) Further research is needed to investigate root crown movement and what is excessive!

For trees over 150 mm at breast height it may be necessary to establish a line into the crown to test for stability of the root crown. The line may be used to gently set up a sway or rocking motion in time with the natural frequency of sway motion of the tree. Whilst this is occurring the root crown may be examined for excessive movement. This test must be used carefully if there is real concern that the tree may not be stable in the ground. On two occasions trees have actually failed and commenced to fall over when subjected to this test by the author.

When Testing Trees over 150mm trunk Calliper at Breast Height

Care should be taken not to pull the tree over during testing!
Beware of dead wood and hanging branches in then crown.
Watch the root crown at ground level for movement.
Watch for ground heave. Cracks in the soil opening and closing.

Another method is to use an air knife to remove some soil from the root crown and visually inspect the root crown for decay or deformities such as root girdling.

The latest method is to attach a load cell and an inclinometer to the tree and actually pull the tree with a winch. The winch is anchored and the tree is pulled from approximately 6 m up the trunk. The tree is pulled in four directions, an equal amount of force is exerted each time the tree is pulled and the movement of the tree in the ground is measured using the inclinometer. Ken James (Burnley College) is currently working on this system to further refine it .The advantage of this method is that some actual numbers are given to indicate the strength of the trees stability by comparing pulls on each of the four compass points. In two recent tests visual assessment suggested that each tree was moving excessively in the ground, but when the load cell and inclinometer test was undertaken the arborists present were confident that the tree stability was not an immediate problem.

Whole nursery systems need to be reviewed to reduce the incidence of root deformed trees. Specifications for the supply of trees should demand and ensure that only trees with quality root systems will be accepted.

Tree planting site preparation and planting pit design are also responsible for many tree failures. Inadequate, effective anchor root zones, waterlogged planting pits, incorrectly shaped planting holes are all factors which have contributed to many tree failures. Many tree species have evolved in a forest situation where the root systems are inter-woven and interdependent. Each tree provides wind buffering and increased stability to it’s neighbour. Trees share mycorrhiza and much of the soil flora and fauna. There is a lot of interaction between trees. We have taken these trees out of the forest and asked them to grow in a stressful, often solitary environment. To reduce hazardous failures we need to ensure that each municipal tree is propagated, grown and established to “ Best practice” utilising all the technological advances of the year 2002.

Old, and stressed trees, are more likely to have potential for failure. Because of the number of root deformed trees planted, there is the potential for an epidemic of tree failure. Australia, along with the rest of the world, is becoming increasingly litigious. As managers of this tree resource, it is our responsibility to manage our resources to minimise the hazards associated with trees.

"A tree is hazardous if it has both a structural defect that predisposes it to failure, and a target that would be struck if it were to fail" (Smiley and Fraedrich). The target can be any object of value, whether this be fixed, such as a house or mobile, such as people, animals and vehicles. The situation is a little more complex than this. There are obviously levels of tree failure or hazards, and there are levels of target value and exposure. All trees have the potential to be hazardous, and it could be argued that as a tree ages, it inevitably would become hazardous. A four hundred year old *Eucalyptus camaldulensis*, a species that is an acknowledged large limb shedder, growing in the middle of a paddock at Epping, Victoria would normally pose little threat to man or his assets, the risk of an accident is very remote. If the paddock is stocked with a large number of stud cattle, then the possibility of loss is increased. Stock will often seek shade and shelter in both hot weather and stormy weather. If a house was constructed under the canopy of this tree, then it is really only a matter of time before major damage may result from branch failure.

Hazard assessment is a very difficult area for any tree manager to quantify. There are many variables, and many areas that need to be considered. The following is a list of possible considerations:

Potential for tree failure.
Presence of a target.
Target value.
Target risk time.
Potential of tree to cause damage.
Tree value.

If each of these factors could be rated, it may be possible to develop a formula to assist in decision making when faced with difficult decisions

The potential for a tree to actually fail can be extremely difficult to predict. In order to determine the potential for tree failure, the arboriculturalist needs to have an intimate knowledge of tree physiology, tree structure, tree disorders or stress factors, how certain species respond to stress, characteristics of particular species as forest trees, and as isolated urban trees. This knowledge, combined with information on many other factors including; history of the site, normal weather patterns, drought, rainfall, wind, incidence of severe storms, soil type, how the soil reacts when saturated, how the soil reacts when it dries out, are among some of the factors that an arboriculturalist would consider. A qualified arboriculturalist, with years of experience in a particular area, working with a limited number of species, cannot be expected to predict all potential failures. Only qualified and experienced arboriculturalists should assess trees for potential failure. A systematic approach to the inspection of trees for hazard potential should reduce the risk of overlooking possible failures. The following lists may be useful guides in assessing trees for potential failure.

A SYSTEMATIC APPROACH TO HAZARD TREE INSPECTION

- Tree Stability (root system)
- Trunk Failure, Trunk Integrity
- Major Scaffold Limb Failure
- Branch Failure
- Fruit Fall (Small number of species)

Visual Tree Assessment Hazard Indicators

TREE STABILITY	TRUNK INTEGRITY	BRANCH INTEGRITY
Buttressing absent	Co-dominant stems	History of branch shedding
Existence and location of major roots	Cracks, vertical, horizontal.	Unusual, excessive Branch Collar formation
Trunk lean	Discoloured or dead sections of bark.	Dead wood
Excessive growth on one side	Fungal fruiting bodies	Defoliation
Trunk movement at ground level (Test)	Trunk deformities	Ant nests
Fine cracks in soil	Hollows, cavities	Burls, deformities
Root tension, opposite side to lean.	Flush cuts on trunk	Epicormic shoots
Ground heave	Exudates	Cracks
Fungal fruiting bodies	Decay	Delamination
Level changes	Wire, foreign objects	Included bark
Severed roots	Sound the tree?	Branches bending down
Root plate hollow	Drill	Very long branches
Major change (trenching, clearing)	Resistograph/ PIRM/ SM 80	Lack of branch taper
Dead or deformed trunk sections at ground level	Acoustic devices (Tomograph)	Signs of branch stress
Dead tree	X-ray	Dead areas or sections of branch or bark

REFERENCES

Barley, R. (1991), *Hazardous Trees : Managing Your Risk.* AAA Seminar. VCAH Burnley, Richmond, Victoria.

Bethge, K., Mattheck, C. & Hunger, E., (1996), *Equipment for detection and evaluation of incipient decay in trees, Arboricultural Journal*, Vol. 20, pp. 13 – 37.

Cutler, D. F., Gasson, P. E. (1988), *Wind Blown Trees. Research at the Jodrell Laboratory, Kew. Journal of Arboriculture*. 12(03)pp. :231-236. AB Academic Publishers, England.

Dunster, J. A., (1996), *Hazard tree assessments: developing a species profile for Western Hemlock, Journal of Arboriculture,* Vol. 22, No 1., pp 51 – 57,

Harris, R. W. (1992), *Arboriculture : Integrated Management of Landscape Trees, Shrubs and Vines (Second Edition)*, Prentice-Hall, Englewood Cliffs, New Jersey.

Mattheck, C. (1991), *Trees. The Mechanical Design*. Springer-Verlag, Berlin, Heidelberg, New York.

Mattheck, C., Bethge, K. (1991), *Failure of Trees Induced by Delamination. Journal of Arboriculture*. 15(03)pp. :243-254. AB Academic Publishers, England.

Matheny, N. P. & Clark, J. R., (1994), *Evaluation of hazard trees in urban areas,* International Society of Arboriculture, Savoy, Illinois, USA.

Paine, L. A. (1971), *Accident Hazard Evaluation and Control Decisions on Forested Recreation Sites*, U.S. for Serv. Res. Ppr. PSW-68 (Berkeley, CA).

Shigo, A. L. (1991), *Modern Arboriculture. Touch Trees*. Shigo and Trees, Associates, Durham, New Hampshire, U.S.A.

Smiley, E. T. and Fraedrich, B. R. (July, 1992), *Determining Strength Loss from Decay, Journal of Arboriculture*, Vol. 18, No. 4, pp 201 - 204

Vogel, S. (1996), *Blowing in the wind: storm –resisting features of the design of trees, Journal of Aboriculture,* Vol. 22, No 2.

Young, T. P.& Perkocha, V., (1994), *Treefalls, crown , and buttresses, Journal of Ecology,* Vol. 82, pp. 319 – 324