Why Do We Care?

- Personal safety
- Safety of crew
- Safety of citizens
- Recognizing load limitations for rigging
- Utility reliability
- Liability
Risk vs. Hazard

A HAZARD REQUIRES A TARGET

<table>
<thead>
<tr>
<th>HAZARD</th>
<th>THRESHOLD OF ACCEPTABLE RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPPER</td>
<td>LOWER</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>Frequency of Human Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Level of Acceptable Risk</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of Tree &amp; Severity of Defect</th>
<th>HAZARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Yellow</td>
</tr>
<tr>
<td>Medium</td>
<td>Orange</td>
</tr>
<tr>
<td>Large</td>
<td>Red</td>
</tr>
</tbody>
</table>
“Hazzard” Tree

Hazard = Defect + Target
Conflicts Can Cause Hazards

- Conflicts with utility lines
- Obstruction to traffic visibility
- Damage to hardscape
The Physics of Trees
Standing & Falling

• The physics behind wood failure is as easy as understanding that wood is heavy and gravity is a persistent force that pulls mass toward the ground. As long as the strength of the wood is sufficient to hold the weight of the wood in the air it will remain in place until the strength of the wood is weakened or a force exceeding the strength of the wood is exerted.
Opposing Forces: Gravity vs. Strength

• Gravity is constant
• Forces acting on the tree are variable
  – Wind
  – Snow and ice
  – Foliage
• The strength of the wood is variable
Signs & Symptoms

• There are signs (visual evidence of the causal agent) and symptoms (the effect of the pathogen on the host) that can be apparent in all of the components of a tree that signal loss of vigor or loss of wood strength.
Foliage and Twigs

Terminal leaf scars
The Branch Bark Ridge
Branch or Stem Attachment
Types of Branch Attachment

- Many times the primary factor contributing to weakness to external forces is the form of the branch structure, particularly the branch attachment.

- Wood screw
- Nail
- Suction cup
Strong Branch Attachment

- Overlapping wood tissue from the branch and the parent stem create a strong attachment.
Included Bark
Included Bark

- Look for tight “V”-shaped angles, especially with co-dominant leaders, and an absence of the branch bark ridge.
Included Bark
Included Bark
Included Bark
Co-Dominant Stems
Topped Trees Are Dangerous!
Topped Trees
“Zingers”
Lightning Spiral Seams
Internal Cracks From Lightning
Watch For Patterns In Bark
Trunk Taper

- The trunk taper should be appropriate for the openness or density of the site.
Roots and Root Collar

- The root flare should be well-formed.
- A trunk that enters the ground without a root flare may be an indication of fill soil.
Saturated Soils

- Soils that are saturated or have recently been subjected to flooding are generally less stable than well drained soils. Large trees are more susceptible to wind throw when soils are very wet.
Girdling Roots
Biomechanics: How do trees stand up?

- Trees are “self optimizing”, meaning that they take advantage of the conditions in which they exist and alter their form so that they can compete more successfully.
- Individual trees develop wood in response to the forces applied to them.
Reaction Wood

• Reaction wood (compression wood in conifers vs. tension wood in broadleaf trees)

Source: Shigo, *Above-ground anatomy (Pinus strobus)*
Reaction Wood

- Reaction wood (compression wood in conifers vs. tension wood in broadleaf trees)

Source: Jerry Bond, Davey Resource Group (Acer saccharinum)
Wood is stronger in tension than in compression so failure occurs first on the leeward side as the fibers are compressed.

As the load bends the stem, fibers in compressive stress buckle and eventually allow the stem to bend enough to cause the fibers on the opposite side of the stem (under tensile stress) to split apart axially.
Root Formation

- Because windward roots are held in tension during wind sway, they are the most important component of the root system with regard to anchorage.

- In wind tunnel tests, leeward roots grew thicker (to withstand compression), and windward roots grew with more branching.
Factors Affecting Strength Loss

- Biotic decay
  - Wood decay fungi
Branch Wounds As Ports Of Entry
Internal Factors Affecting Strength Loss

- **Biotic Decay**
  - Wood decay fungi

- **Biotic Destruction**
  - Wood chewing insects
  - Cavity dwelling animals
External Factors That Challenge Strength
Considering Weather Events

• When conducting risk assessment the arborist must be aware of the extreme weather conditions that occur in the region. The expected frequency of the weather events influences what level of risk is associated with a tree. Trees subjected to more frequent weather extremes might be considered a higher risk potential than a similar tree in an area without frequent weather extremes.

• Recognizing that hazardous conditions require both a tree and a target, the most effective method of reducing risk in some cases is to simply remove targets during times of weather events.
Before considering the health or structural integrity of a tree, the first step in risk assessment is to simply look at the size and height of the wood. Small twigs have little hazard potential and large branches have large hazard potential. Large branches lying on the ground have little hazard potential and large branches high in the air have great hazard potential.
Cavities
Determining The Extent Of Decay

- Resistograph
Tree Evaluation Forms

- Tree Hazard Evaluation Form
Tree Evaluation Forms

- Tree Inspection Forms
Risk Assessment In The Field

- Consider the season
- Evaluate the tree
  - Species
  - Height
  - Crown
  - Foliage
  - Twigs
  - Branches
  - Trunk
  - Root Collar
  - Roots
  - Maturity
Risk Assessment In The Field

- Evaluate the site
  - Soil
  - Hydrology
  - History
    - Soil compaction
    - Fill
    - Construction, digging or trenching activity
    - Removal of surrounding trees
    - Wind patterns
    - Precipitation patterns
    - Conflicts
Risk Assessment In The Field

- Evaluate the target
  - The frequency of human occupation
  - The value of non-human objects
Two Zones of Target Area

- Consider targets within drip line of tree
- Look also at area within tip-over zone
Hazard Tree Abatement

- If hazardous situation exists….
  - Move the target
  - Prune the tree
  - Remove the tree
  - Cabling and bracing???
  - Create a habitat tree
Thank You

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