

separate those with potential from those with little or no potential for success. Concepts were then subjected to a decision analysis which tested each concept for its practical contribution to program objectives. Only nine, of more than 40 ideas for new tools and equipment that merited screening, were worthy of complete analysis.

### Conclusions and Recommendations

After the decision analysis and study of adverse consequences, five concepts emerged (Figure 4) as potential improvements on line clearance equipment:

- Pantograph-Type Linkage — support for powered pole saws and pruners.
- Mobile Platform Lift — similar to those used in the orchard industry.
- Boom-Mounted Tool — replacement of the bucket on existing lift trucks.
- Servo-Assisted Pole Saw — for trimming from the ground in backlot locations.
- Cut/Bundle/Chip Vehicle — mechanized vehicle for continuous operations of tree trimming.

The estimated development cost, benefit/cost

ratio, and savings to an average size utility for these concepts are shown below.

The pantograph concept, in conjunction with higher horsepower pole tools, is recommended for short-term development. The adaptation of this concept to existing lift trucks insures a high probability of success.

An engineering study should precede development of other recommended concepts to substantiate their benefits to utilities throughout the United States.

There are unknowns in all development programs such as market demand, operating costs, and actual productivity of the concept after development. Regardless of the unknowns, the economic analysis supports the belief that the development of equipment for tree trimming has the potential for high return on investment.

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## ABSTRACT

Shigo, A.L. 1982. **Cabling and bracing: how to minimize internal injury.** *Arbor Age* 2(1): 16-20.

Cabling and bracing, like injections, implants, cavity fillings, and pruning, can be very beneficial for trees but only when done properly! When done improperly, these treatments will cause a great deal of injury to the tree. In professional tree work, many factors must be considered to do a proper job. Proper cabling and bracing requires not only a high degree of skill in working with types and placement of hardware, but also a sound working knowledge of how a tree is constructed and how defects develop in trees. When a screw, rod, or bolt is inserted into healthy wood, the injured wood surrounding the metal will be walled off by the tree. In healthy wood, the column of discolored wood associated with the injury will be no wider than the diameter of the hole. The column of discolored wood may extend above or below the hole, but the length of the column will differ in different tree species, and with individuals within a species. The discolored wood may be caused by the tree's response to the injury. This is a normal response to injury and infection. Cabling and bracing cause wounds. But the injury caused by a wound must be weighed against the added time that the tree will remain safe, attractive, and healthy. There always will be times when the rules must be bent because of many other factors. But it is always best to know the rules before bending them. The more you know about the basics, the more you will be able to help trees.