

CORRELATING TREE DISTURBANCES, TREE WORK, AND TREE BUDGETS¹

by Eric Ulrich

Abstract. Tree-caused disturbances to electric facilities are the only reason utilities trim trees. The amount of tree work done by a utility as to what trees are maintained, what clearance is acquired, and how often the work must be repeated is directly related to the tree-caused interruptions experienced. Tree budgets are merely the funds required to obtain the amount of line clearance required to hold tree disturbances to a tolerable level. The purpose of this paper is to show how these basic criteria can be correlated to project accurate and meaningful budgets and measure the accomplishment toward that chosen objective.

Most utilities record their interruptions of electric service to customers. Many have developed some form of computerized interruption reports whereby as a part of the total data collected each disturbance is recorded as to cause, number of customers effected, and duration. At Met-Ed, our program is called the "Disturbance Reporting System."

Besides the many benefits of measuring the overall reliability of our utility, we have the ability to isolate specific causes as to what part of the problem they represent, and whether that is an increasing, stable, or decreasing part of the whole. Some causes such as lightning, load, etc. can be "fixed" on a permanent basis by line modifications. A tree caused interruption is never "fixed" permanently. At best, it is an estimate as to how long it can be held off until tree clearance must be acquired again or have the same interruption recur. Thus, tree caused interruptions at Met-Ed have been isolated and studied to see the effect of tree maintenance, or lack of it, on electric service reliability to our customers.

We have the ability to isolate the number of tree-caused disturbances, how many customers were affected and the total customer minutes (or hours) of service interruption. Either of the three could be used to measure the tree clearance "reliability" of a utility. Met-Ed chose customer-minutes in that it can be related to the "average customer" on an

annual basis and better reflect the degree of customer inconvenience as a part of the total reliability of electric service.

By comparing past history, we can determine if our tree disturbances are increasing, holding stable, or decreasing. When analyzing disturbances, a rolling average should be used to indicate trends without the spikes that are caused by "bad weather" years. Financial constraints at Met-Ed have had a deteriorating effect on our electric reliability to our customers, with tree caused interruptions the main culprit as shown in graph Dx T1.

The level of tree caused interruptions that a utility will consider "acceptable" or "tolerable" is the most difficult item to establish in a tree maintenance program. On distribution maintenance, which is the prime area of concern here, "zero" tree-caused interruptions is impossible. To try to approach this level of reliability would be "gold plating" or bucking the "Law of diminishing returns." To ascertain an acceptable or tolerable "level" of tree caused interruptions requires more information than any disturbance reporting system can provide. We must know how the amount of effort expended for tree maintenance (or some other measure of tree work completed) affects tree caused reliability.

Tree Work

This general term *tree work* can be used to include all the efforts ever put forward to count how much tree maintenance clearance is done. There are a few utilities that only count the dollars without knowing how much work was done. Most utilities count something, however, with the extremes being "loads of wood chips" at one end and "light, medium, or heavy trims on three-phase primary tree wire spacer cable" at the other extreme. Almost all utilities require labor hours to be

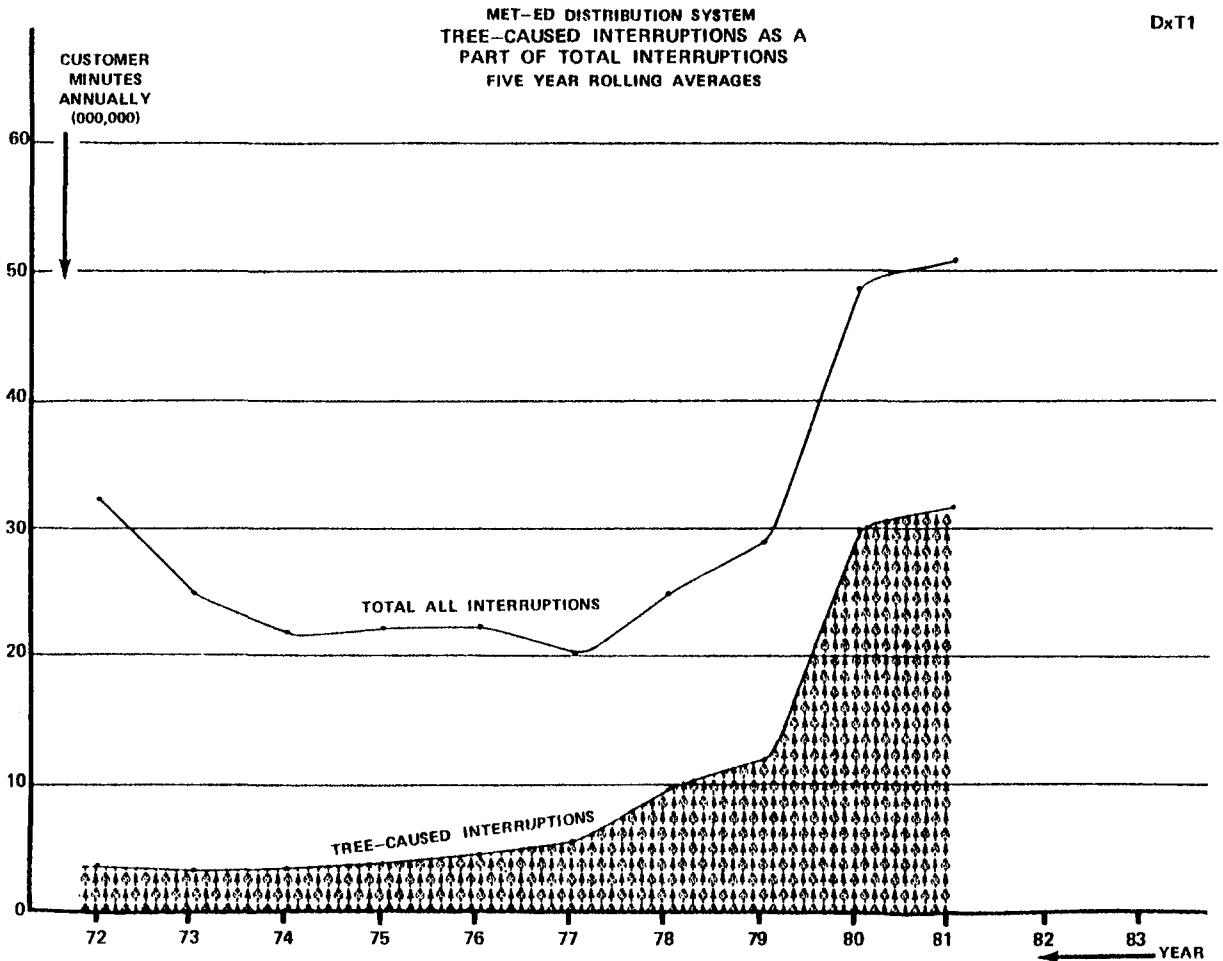
¹Presented at the annual conference of the International Society of Arboriculture in Louisville, Kentucky in August 1982.

counted. Whatever "work units per labor hour" are counted thereafter, a common reference is established that does not inflate with dollar values.

At Met-Ed, we record trees trimmed, trees removed, area cut, area treated, and others. All of these work units have labor hours and appropriate equipment and materials associated to the work units completed. We thereby monitor the efficiency and economy of work units completed, such as labor hours per tree trimmed, cost per tree trimmed, and so forth. These work units are excellent for internal supervisory control of our work force, but are difficult to associate to the whole maintenance picture. A constant reference is still needed to establish how much must be done to do "all" of the work required, or one maintenance

cycle.

A constant reference is relatively simple on a transmission system. For instance, if a utility has 10,000 acres of wooded right-of-way and it completes 2,000 acres of maintenance annually, it can accurately project (and budget for) a five-year maintenance cycle. A constant reference on a distribution system is far more difficult in that the work units are diverse and inconsistent from one area to the next. Two possibilities that are available to most utilities as a constant reference are the pole miles of line completed or the maps completed. Met-Ed has chosen pole miles of line completed as a reference since we schedule and complete tree maintenance on our facilities by electrical operating circuits rather than geographic

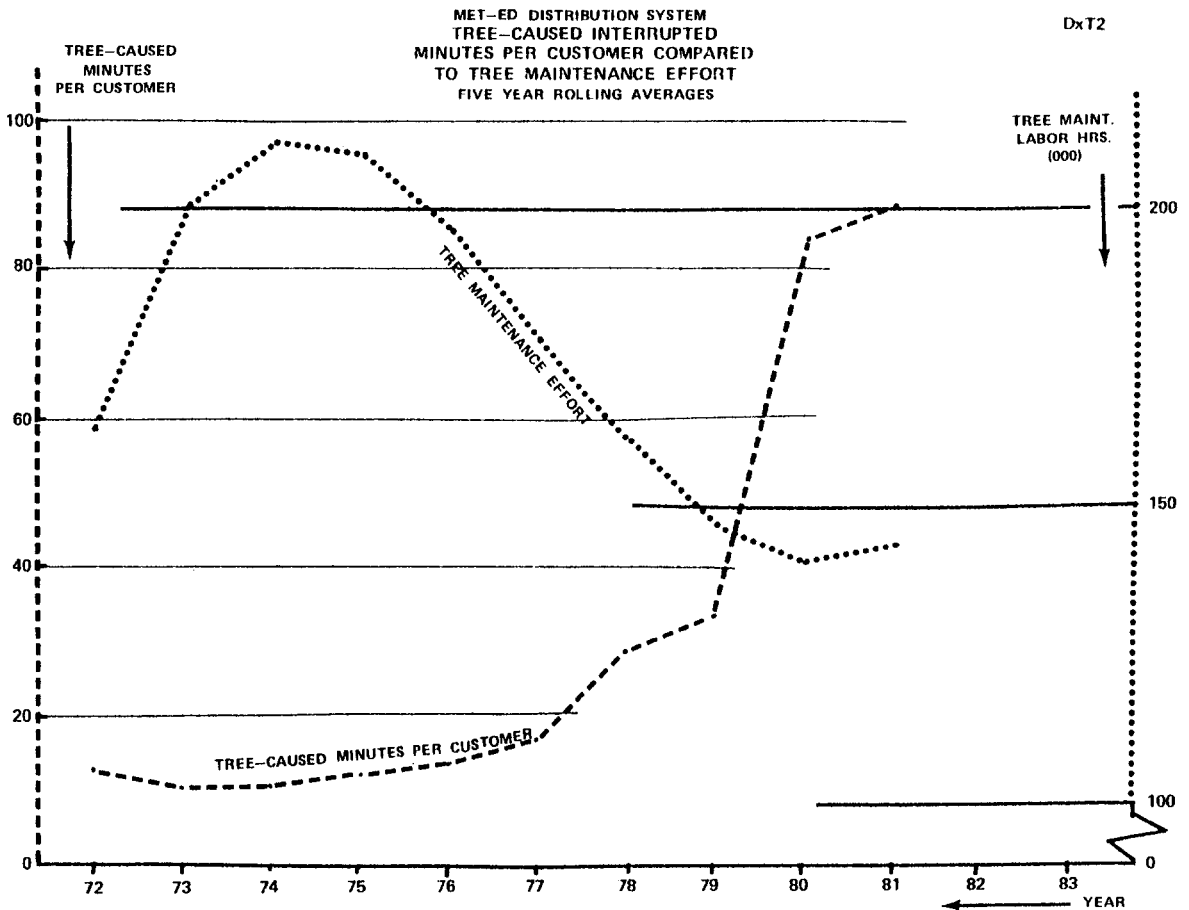


maps. Pole miles are also more useful in that work units per mile or labor hours per mile can more accurately be used for measuring work density and for allocating budget requirements per operating area (division, district, etc.).

Disturbances and tree work. Tree-caused disturbances may be correlated to the volume of tree work performed in various ways. The more trees that are trimmed, the fewer tree-caused disturbances a utility should expect to experience. At Met-Ed, we have chosen labor hours, in that whatever volume or mix of tree maintenance must be performed (mostly trimming, half trimming-half removal, etc) labor-hours will best reflect the total tree clearance requirements. Since the state of tree clearance maintenance and

tree-caused disturbances at any point in time is the cumulative effect of previous years' maintenance, a rolling average should be used to indicate that cumulative effect or trend. When tree-caused disturbances are compared to labor-hours, it logically follows that more effort should reduce disturbances and less effort will cause disturbances to increase. This assumption is generally true on the graphic comparison of tree caused interruptions and tree maintenance labor hours, graph DX T2.

Elimination of all tree-caused interruptions on a distribution system is impossible. Realistic limits or a tolerable range of tree-caused disturbances will vary considerably with different utilities. Utilities that have 1/3 or more of their geographical service



Note: 72, 73, 74, & 75 are one, two, three, & four year rolling averages respectively for tree-caused disturbances.

area in forested land use, will have higher levels of tolerable tree-caused interruptions. Since tree-caused disturbances are but a part of the overall electric reliability to customers, the tree-caused tolerable level will be a sliding scale in relation to all other causes as a part of the whole.

It is my professional opinion that below some level of tree labor effort, tree conditions will have deteriorated to the point whereby the control of how many interruptions are likely to occur is lost to the whims of weather and what portion of the service area is affected by adverse weather conditions. Major weather patterns with wind, wet snow, or ice will require significant line crew efforts to restore service to interrupted customers. In addition, repetitive interruptions of the same customers (aggravating customer relations) will occur and hold up the average for those customers who are not interrupted. From Graph Dx T2, it appears that a five-year rolling average of at least 200,000 labor hours is required on our system to achieve a tolerable level of tree caused disturbances without divergent trends.

Tree Work and Budgets

At Met-Ed, 200,000 labor hours will be the bottom level of an effective range of labor effort that is required to keep trees maintained to a tolerable disturbance level. The top of that range must be determined by management prerogative in relation to overall reliability. Simple arithmetic using the average cost per labor hour will give us a minimum dollar budget requirement. How the money is split (A) among the operating areas and what is to be measured (B) to determine the "pace" of required work completion are two items that should be addressed.

A. Budget splits at Met-Ed are designed by a formula that includes: 1) the volume of trees that must be maintained (50%), 2) the volume of tree-caused interruptions (40%), and 3) the volume of pole-miles of line that must be maintained (10%)

Regardless of what level of budget expenditure is actually forecast by a utility, it is important that it be split or apportioned in a fair manner according to the actual or measured tree work requirements and tree-caused disturbances. The actual tree work (1) and pole-miles of line (3) that must be done is properly apportioned by the percentiles established in Table 1. Incidentally, the average trees per pole-mile is indicative of tree density among the various divisions of our service area.

The volume of tree-caused disturbances is the second part of the formula and reflects the need for tree maintenance by actual experience.

1972-1981; Tree caused interruptions

	Total	(2) % by Division
Central	4,127	29.6%
Lebanon	751	5.4%
Eastern	2,537	18.2%
Western	6,526	46.8%
Company	13,941	100.0%

When the three components are assembled, we have percentile spreads that are based on actual tree work required, actual experienced tree interruptions, and actual length of line where the work must be done and tree interruptions can occur (Table 2).

B. The "pace" of work completion at Met-Ed is measured on a cyclic basis. A cycle is the rate at which we are completing work and then projected

Table 1. 1973-1981; Actual tree-work completed projected to all tree-work to be done

Div.	Trees maintained	Pole-miles maintained	Ave. trees per pole-mile	Total pole-mile	(3) Percent of pole-miles by division	Total trees to be maintained	(1) Percent of tree-work by division
Central	261,364	2,237	117	2,952	27.0%	345,384	26.5%
Lebanon	127,881	2,335	55	1,505	13.8%	82,775	6.4%
Eastern	245,841	1,397	176	2,384	21.7%	419,584	32.2%
Western	371,406	3,355	111	4,096	37.5%	454,656	34.9%
Company	1,006,492	9,324	108	10,937	100.0%	(1,302,399)	100.0%

as the amount of time needed to do all of the work required. For instance, if a utility has 10,000 pole-miles and maintains 2,000 pole miles annually, it's completion cycle would be projected as five years. In order to calculate cycles, Table 3 is provided to show the correlation between labor-hours

and pole-miles maintained.

By multiplying our nine year average of 150 labor hours per pole-mile times any fractional portion of our total pole miles we can graph the labor effort required to provide for any given cycle. Graph Dx T3 shows this array of possible cycles.

Table 2. Budget split percentiles

	(1) Percent of tree-work (X.5) +	(2) Percent of interruptions (X.4) +	(3) Percent of tree miles (X.1) =	Applied percentile for budget split
Central	26.5%	29.6%	27.0%	27.8%
Lebanon	6.4%	5.4%	13.8%	6.8%
Eastern	32.2%	18.2%	21.7%	25.6%
Western	34.9%	46.8%	37.5%	39.8%
Company	100.0%	100.0%	100.0%	100.0%

**MET-ED DISTRIBUTION SYSTEM
LABOR HOURS REQUIRED TO PROVIDE
CYCLIC TREE MAINTENANCE
ACTUAL EXPERIENCE INSET ON THEORETICAL AVERAGES**

DxT3

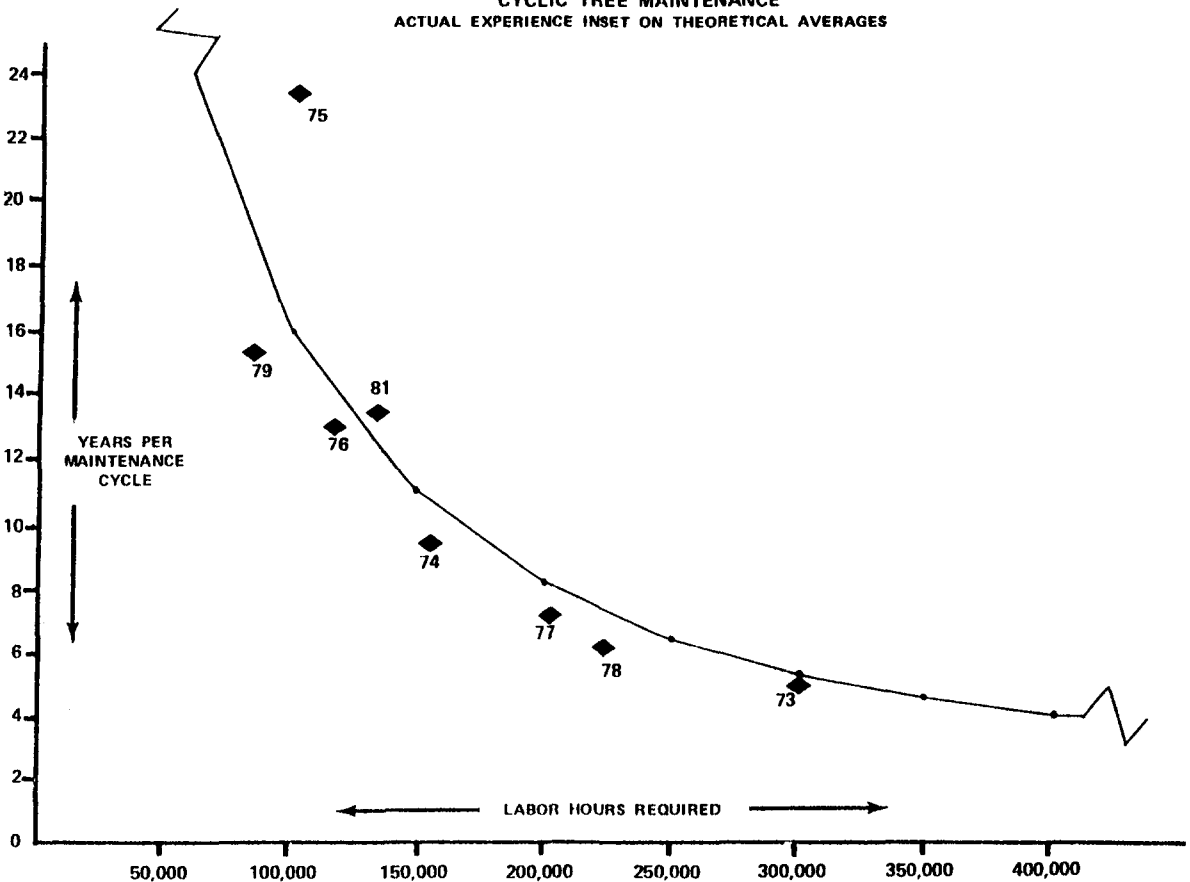


Table 3. 1973-1981; Tree-work labor-hours in relation to pole miles completed

	<i>Total labor-hours</i>	<i>Pole-miles maintained</i>	<i>Labor-hours per pole-mile</i>
Central	372,042	2,237	166
Lebanon	175,534	2,335	75
Eastern	350,497	1,397	251
Western	500,858	3,355	149
Company	1,398,931	9,324	150

By using average labor-hours per mile and calculating pole-miles per year to project cycles, we have a "normal curve" graph. Our years per cycle that we calculate annually by using actual miles completed are very close to the theoretical graph.

Maintenance cycles less than 4 or 5 years are probably unnecessary and certainly expensive for the respective incremental shortening of cycles achievable (very similar to tree-caused interruptions). Likewise, maintenance cycles greater than 8 years are probably unrealistic with regard to customer service reliability and professional ethics of utility management.

Correlation Summary

Tree-caused disturbances are recorded and counted in a manner that will provide meaningful statistics for the different operating areas. The tree disturbances are then correlated to measured tree work units, or tree work effort to determine the effect of the tree maintenance performed. The tree work units and tree work effort are then correlated to pole-miles, an electrically acceptable "exposure" reference, to determine the tree work density of the different operating areas. Tree budgets are thereafter fairly apportioned to provide the labor effort resources necessary to accomplish the prescribed tree work volume required to maintain a tolerable and objective level of tree-caused disturbances.

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ABSTRACT

Struve, D.K. 1982. **Breeding for tree improvement requires industry cooperation.** *Am. Nurseryman* 156(1): 179-181.

After a species is chosen, three basic tree improvement steps should follow. First, the amount and cause of variation that exists in the traits of interest are determined. Second, the variation is "packaged" or reproduced, and third, the variation is mass-produced and made available for operational use. Variation is the key to success in any breeding program. Range-wide sampling indicates the amount of variation present in the traits of interest. An educated guess can be made as to whether the variation is under environmental or genetic control using these data. Genetically controlled variation, that which is inherited, is the only type available to a breeder. Alternatively, provenance tests can be established to determine the amount and cause of variation. But it may take years before this information is available. Generally, most species have enough genetically controlled variation to justify a breeding program. Breeding for fast growth, wide adaptability, and resistance to disease and insect pests holds great promise for ornamental plants. Trees might be bred to tolerate or perhaps flourish under harsh urban environments. Although it is more difficult, trees might be bred for resistance to combinations of air pollutants, or trees could be bred that perform well over climatically diverse areas.