GROUNDS MAINTENANCE

TIME REQUIREMENTS

by

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ABSTRACT

If grounds managers are to reduce or hold down maintenance costs, they must utilize more objective techniques to determine time and other costs for specific maintenance activities. Personnel inadequacies, financial cutbacks, equipment breakdowns, and other problems require the manager to use this information to efficiently and effectively allocate men, money, and machinery.

In this thesis, Grounds Maintenance Time Requirements, are discussions of previous time studies and suggestions for the use of time study data by grounds managers for budgeting, planning, and evaluating maintenance programs. New information and data gathered from not-for-profit horticultural institutions are presented. An analysis and interpretation of this new data and recommendations for future studies are also included. Appendices include references for other sources of grounds maintenance time requirement data, and record-keeping and time studies information.

INTRODUCTION

Man has always been concerned with the amount of time needed to perform a particular task. No doubt the pharoahs in Egypt kept good records of the number of stone blocks laid each year to build their pyramids, and Chinese engineers knew how long it took to build each section of their Great Wall. It is part of man's basic curiosity, and need for control, to know these things. How long does it take? Can it be done any faster? Is there an easier way? These are questions asked countless times in nearly every occupation, both by laborers and by supervisors.

This study investigates time requirements for grounds maintenance activities, a topic neglected by most researchers for many reasons. I became aware of the need for additional information about grounds maintenance time requirements through my own experiences at Arnold Arboretum, Jamaica Plain, Massachusetts, and Fuller Gardens, North Hampton, New Hampshire, and suggestions from noted landscape maintenance professionals. It was felt that more time values were needed to substantiate published data and for comparing and evaluating unreported maintenance activities.

Chapter 1

HISTORICAL BACKGROUND

No discussion of time requirements should fail to mention the important early research done by Frederick W. Taylor. Known as the "Father of Scientific Management", Taylor did his first stopwatch time studies in 1883, at the height of the worldwide industrial revolution.(1) An inventor and engineer, he strove to improve the quality of industrial management by seeing it as an art based on scientific principles. He strongly advocated close observation of the individual worker to eliminate wasted motions, and thereby enhance the factory or shop's production efficiency.(2) This provoked resentment and opposition from workers when it was carried to extremes.

Although Frederick Taylor is frequently associated with the micro-motion technique of studying time and motion wastage, most of this work was done in the 1910's by his close associate, Frank B. Gilbreth.(3) By 1901, Taylor had postulated his five categories of managerial reform embodied in his book, Scientific Management. Advocating the use of unit times as the foundation of good management, he listed it as but one of his methods. The others included: improved purchase and storage methods, functional foremanship, production control (based on a specific planning department), and incentive wage

plans.(4) Although controversial in his day, Frederick Taylor was nevertheless responsible for many changes and improvements in production management techniques. It is interesting to note that Taylor spent his retirement years totally devoted to his estate, "Boxly", in the Chestnut Hill section of Philadelphia. Here he experimented constantly with gardening methods and patented numerous tools and techniques.(5)

Not surprisingly, John Surtees, a cost analyst from Connecticut, found in his work during the 1920's, 30's, and 40's, that the study of costs in the nursery and landscaping field was the most fascinating he had encountered.(6) His Service Charts on landscaping costs give numerous time requirement values for various landscape installation operations, and for a few maintenance activities. His individual task breakdowns show the relative efficiency of the various methods which facilitated cost comparisons and reductions.

Owen B. Schmidt, a nurseryman formerly with the old F.D. Moore and Sons Nursery of Narberth, Pennsylvania, produced time requirement values based on his experience in the 1940's and 50's.(7) The values recorded are mainly for digging, handling, and planting various sizes of trees, shrubs, and ground covers.

Time study analysis has been and is primarily focused on landscape construction. Some notable contributions include Gary Robinette's Off the Board/Into the Ground, James Griffin's Landscape Data Manual, the National Landscape Association's Landscape Designer

and Estimator's Guide, Kerr Associate's Cost Data for Landscape Construction, and The Center for Landscape Architectural Education and Research's A Guide to Estimating Landscape Costs. A listing of North American sources for both landscape construction and landscape maintenance time requirement data will be found in Appendix 1.

The landscape maintenance industry, as a whole, has been slow to adopt many modern management techniques, particularly those involving planning, scheduling, and cost control.(8) Only recently has there been any serious attempt to record the same type of time requirement values for landscape maintenance as for landscape construction. Perhaps this is due to the severe financial cutbacks felt by public gardens, parks, universities, and other institutions in the 1970's and 80's after the expansion period of the 1950's and 60's. Most of the work in this area has been done by David E. Lofgren through his Institute of Maintenance Research in Salt Lake City, Utah. His findings have been reported regularly in Grounds Maintenance magazine and publications of the Professional Grounds Management Society.

Additional significant studies in this field are in progress throughout the United States and Canada. Commercial landscape contractors and municipalities are the most active in gathering time estimates data. Perhaps this is because both need to closely monitor their labor expenses. Computer-aided data tabulation and forecasting is now a reality, and several organizations report using these systems. A complete listing of those reports dealing with grounds maintenance record keeping and time studies is included in Appendix 2.

Footnotes -- Chapter 1

[1]Daniel Nelson, Frederick W. Taylor and the Rise of Scientific Management (Madison, WI: University of Wisconsin Press, 1980), p. 36.

[2]_____, "Taylor, Frederick Winslow," Encyclopedia Britannica, 1984, XVIII, p. 1.

[3]Nelson, Frederick W. Taylor, p. 134.

[4]Ibid., p. 102.

[5]Ibid., p. 112.

[6]John Surtees, "Master Units of Landscaping," Service Charts No. 3 (Ridgefield, CT: John Surtees), p. 152.

[7]Owen B. Schmidt, "Labor Time Charts of Planting," (University of Delaware Short Course, 1955).

[8]E. Gray Payne, "Cost Control and Financial Management," Proceedings from the 1978 ALCA Landscape Maintenance Symposium (San Jose, CA: 1978), p. 43.

Chapter 2

USES FOR TIME REQUIREMENT DATA

Supervisors increasingly ask grounds managers to justify maintenance costs of outdoor spaces. Due to personnel problems, financial cutbacks, equipment breakdowns, and other reasons (discussed below), the wise manager should incorporate more scientific resource management techniques. The following are some ways in which time data and standards can be utilized as effective management tools.

A. Planning and Scheduling

A manager's success often depends on his knowledge of work requirements.(1) He needs planning expertise in managing budget, labor, equipment, and materials.(2) Labor accounts for 70% to 85% of most managers' budgets (3), so careful personnel scheduling is critical and most cost effective. Task time requirement approximations enable managers to more accurately schedule personnel where and when they are most needed. He must constantly compare the estimated workload with the available man-hours.(4)

Simple field observations of crew activity usually reveal staffing and productivity problems. The City of Wilmington, Delaware, made substantial personnel cost savings and improved park maintenance quality after a maintenance case study was made of its Parks and

Recreation Department by an outside consulting firm.(5) The San Joaquin County, California, Department of Parks and Recreation uses time and motion study as the basis of an ongoing analysis of staff productivity after an overstaffing problem was revealed.(6) These and other similar studies demonstrate that better task planning and scheduling leads to improved productivity.

B. Decision-Making

Managers need timely, accurate information to make sound decisions and to develop more efficient and effective methods.(7) Time studies will help determine the number and type of personnel needed, such as permanent or part-time, and skilled or unskilled. They may enable managers to determine the cost effectiveness of contracting particular jobs. The best maintenance technique may be determined through use of time study information. Managers need to know which is easier and more efficient: power tools or by hand, chemical weed control or mechanical control. An added benefit in making time studies is involving personnel in the process of determining the best method, thereby establishing a loyalty to the approach.

C. Budgeting

Budget preparation, forecasting, and justification are made much easier when the required quantities of manpower, materials, and equipment are known. Data in an easily usable form enables the manager to analyze job progress, productivity, and methods, and to project future costs. The impact and savings from cutbacks can be analyzed before they are made. High maintenance and under-maintained areas can

be pinpointed. Managers will better understand their resource utilization.(8) Wiser equipment purchase decisions can be made. A more expensive piece of equipment may prove more cost-effective in the long run. Properly kept records will help prove this. Park departments in several cities, including Ann Arbor (9) and Anaheim (10), found knowing the costs of maintaining various park areas enhanced their budgeting position with the city.

D. Priorities

Setting priorities is closely tied with budgeting. The manager must know where his resources should be spent. If cutbacks are necessary, he must decide how and where the cuts can be made to minimize the negative effects. The facts and figures will help determine relative priority of a task and allow administration's participation in the decision. They will also allow development of alternatives and strategies. At the Morton Arboretum (11), priorities are assigned to individual plants or groups of plants based on their relative value, landscape function, and ease of maintenance.

E. Formulating Standards

There is much controversy surrounding setting landscape operation time standards. It is generally felt there are too many variables to set precise time standards or averages for any situation. Time standards should be based on each manager's own particular situation, taking into account skill and motivation of workers, type of equipment, particulars of the environment, and maintenance requirements of specific plants. What is unarguable is that time standards

have been successful in aiding managers to allocate resources.

Standards may be defined in another sense as: "Guidelines specifying measurement of the quantitative and qualitative levels to which maintenance tasks should be accomplished."(12) Besides recording time to perform a maintenance task unit, there may be a qualifying statement detailing variables such as operating conditions, and/or plant maintenance levels. The results listed in Chapter 4 include such variables when supplied by the reporting institutions.

To determine these quantitative and qualitative standards, a manager must detail all of the individual component activities comprising an entire task, as well as the variables affecting these components. This can serve as an operations guide for gardeners. Studies in Ann Arbor (13) and Anaheim (14) demonstrated that standards provide uniformity of maintenance throughout their park systems.

F. Personnel Evaluation and Motivation

Many larger organizations have found standards valuable in personnel evaluation and motivation. In discussing effective performance evaluation, Dunlavey states "What is necessary are measurable job standards which must be set and adhered to. All employees should know what these are and how they measure up against them."(15) Many workers are anxious to know if they are improving; these figures give them that information. Park supervisors in Oakland (16) and Anaheim (17) use written work measurement standards for training and orientation, as well as for performance evaluation. For evaluation purposes

one should use standards developed at his own site and make sure everyone is comfortable with the production rate figures. If utilized properly, standards can foster better understanding between worker and supervisor, and help maintain or improve morale. Morale is improved by showing the employee how his/her activity contributes to the total maintenance project effort.(18) This increases the worker's sense of value to the organization.(19)

G. Design Considerations

"The future of any landscape project lies almost totally in the hands of the person who will be maintaining it."(20) This statement by Glenn Black, in the first issue of Grounds Maintenance, points out the desperate need for better communication between designers and grounds maintenance personnel. It is in the best interest of the landscape architect, as a professional, to insure that his design is well maintained.

> If the landscape designer is not able to convey to the maintenance personnel what he intends to accomplish through the design in terms of artistic configuration, color, form, and texture, the landscape will never reach its full potential and his design as originally conceived probably will fail. (21)

Landscape architects should realize the value in having accurate data on the cost of maintenance operations. The easier the maintenance of a project, the better the chances it will be properly installed and maintained to maturity as planned.(22) Maintenance cost information is valuable in selling clients cost-saving features such as mowing edges, automatic irrigation systems, mulches, etc.. The

data can also help to design easy maintenance landscapes that require less costly equipment, less materials, and fewer personnel. "Emphasis must, therefore, be placed on design that reduces maintenance costs at the outset, since capital funds are usually easier to obtain than adequate maintenance funds."(23)

H. Plant Evaluation

A project at California Institute of Technology in Pasadena, California has demonstrated how maintenance time requirement data can be used to evaluate maintenance costs for different kinds of plants. (24) It also identifies labor efficiencies that allow workers to more easily perform their jobs. Studies such as this provide a means for comparing plant material maintenance costs, a tremendous help in planning new or changing old landscapes.

Footnotes -- Chapter 2

[1]Robert E. Sternloff and Roger Warren, Park and Recreation Management (Boston: Holbrook Press, Inc., 1977), p. 42.

[2]Edgar Metcalf, "A Lot of Management Depends on Cause and Effect," 1982 Athletic Turf Management Annual (Appleton, WI: Madisen Publishing, 1982), p. 9.

[3]Park and Recreation Technical Services, Cost-Cutting Strategies for the Park and Recreation Agency (Washington, D.C.: U.S. Dept. of the Interior, 1981), p. 15.

[4]Sternloff and Warren, Park and Recreation Management, p. 45.

[5]Bruce A. Smith, "The City of Wilmington -- a case study," Grounds Maintenance 12 (May 1977): 56.

[6]Park and Recreation Technical Services, Cost-Cutting Strategies, p. 20.

[7]Richard W. Harris, "A Management Approach to Park Maintenance," Proceedings 1977 Park and Recreation Administrators Institute (Davis, CA: University of California Extension, 1978), p. 5.

[8]Ronald E. Pies, "Tempe, Arizona, Uses Computer for Maintenance Statistics," Park Maintenance 24 (April 1971): 18.

[9]George Owers, "Park Maintenance Plan: Ann Arbor pioneers an effective guideline," Park Maintenance 29 (September 1976): 11.

[10]Joel W. Carter, "Anaheim's Figures Sell a Budget," Grounds Maintenance 18 (January 1983): 22.

[11]David Barnett, "Special Care of the Morton Arboretum's Woody Plant Collections," The Morton Arboretum Quarterly 16 (Winter 1980): 61.

[12]Walter H. Bumgardner, "Developing Park Maintenance Standards," Park Maintenance 30 (May 1977): 6.

Footnotes -- Chapter 2 (continued)

[13]Owers, "Park Maintenance Plan," p. 11.

[14]Carter, "Anaheim's Figures," p. 22.

[15]Robert J. Dunlavey, Managing Personnel and Time (Appleton, WI: Madisen Publishing, 1981), p. 4.

[16]C. W. Weatherton, "The Work Management System: A Tool for Park Maintenance Managers," Park Maintenance 35 (December 1982): 10.

[17]Carter, "Anaheim's Figures," p. 22.

[18]John Van Dam, "Labor Requirement Analysis for Landscape Maintenance," Leaflet 21232 (University of California, Division of Agricultural Sciences: August 1981).

[19]Metcalf, "Cause and Effect," p. 9.

[20]Glenn Black, "The Broad View of Landscaping," Grounds Maintenance 1 (January 1966): 35.

[21]Philip D. Hatfield, "More Cooperation Needed Between Landscape Architects, Designers, and Grounds Managers," Grounds Maintenance 17 (February 1982): 1.

[22]Chris G. Moritz, "Good Design with Maintenance in Mind," Grounds Maintenance 1 (February 1966): 8.

[23]Walter F. Bruning, "Try a Minimum Maintenance Plan," Park Maintenance 18 (March 1965): 82.

[24]Van Dam, "Labor Requirement Analysis".

Chapter 3

SURVEY METHODS

In February, 1982, letters were sent to 159 botanic gardens, arboreta, public display gardens, university grounds departments, and municipal park departments in order to determine the existence of previously recorded grounds maintenance activity time requirement data, and the willingness of the institution contacted to collect additional data (Appendix 3). Ninety-six (96) institutions (60%) answered the initial letter, and of those answering, 65% (62 institutions) reported previously collected information to share, or willingness to collect new information.

A mailing in May, 1982, to the institutions offering cooperation explained the procedure for collecting information (Appendix 4). This mailing supplied each institution with a list of suggested grounds maintenance activities on which to report (Appendix 5) and a data reporting form devised by the author (Appendix 6). Additional copies of the form were supplied upon request.

The reporting form sought to record as much pertinent information as possible on each activity performed in order to show exactly how the activity was completed. Specifically, the author wished to

know what equipment was used, the skill level of the person performing the task, how long the task took to complete, and any other factors influencing the results.

Thirty-one (31) institutions and individuals supplied the requested grounds maintenance activity time requirement data and other information and suggestions to this study. Their names appear in Appendix 7. The data accumulated in this study appear in Chapter 4.

Chapter 4

SURVEY RESULTS

The figures recorded in this chapter represent results of landscape maintenance operations only. They are grouped into four major maintenance activities areas common to every horticultural institution. These major headings are: flowers and ground covers, drives and walks, shrubs, and turf. A separate subsection on roses was added to the shrub listings because of the large number of rose care entries received.

Within each major heading, entries are categorized by the particular activity involved, such as grooming, mulching, bed preparation, spraying, etc. The activities are divided further when tasks were done by several types or sizes of machinery, such as turf mowing or shrub spraying.

The equipment used for each activity is listed as supplied by the reporting institution. Except for basic hand tools, the type of equipment used for each activity may vary substantially. This fact should be taken into consideration when using the figures. With certain activities, such as turf mowing, there are many entries listing equipment of similar size and type, although not always the same make.

Only three categories of area or unit measurement are used. These are: (a) 1,000 square feet (ft.), (b) 100 linear feet (lin. ft.), and (c) per plant. This was done to simplify the results and make them easier to understand and compare. Should the reader wish the units broken down further, simply divide the time given in minutes, by 1000 to determine the time required for each square foot, or by 100 to determine the time required for each linear foot. A "per acre" figure is also supplied in certain instances when the values represent results from a very large mowing operation and were reported that way by the institution. In these few cases, a 1000 square feet figure is also supplied for standardization and comparison purposes.

Time values, the time required to complete one unit or area unit of activity, are supplied in minutes. Some raw data were supplied in a relatively rough form, such as taking eight hours to mulch two acres of paths. Other values, however, were supplied in more precise terms. For example, one institution reported 36 minutes to edge 268 feet 10 inches of turf. Time values listed within each activity appear in descending order.

Skill level refers to the qualifications of the person performing the maintenance task. These levels were reported on the basis of the relative scale supplied on the forms sent to each institution (Appendix 6). The letter A refers to personnel having extensive horticultural training and skills. Letter B refers to personnel with some horticultural training and skills. Letter C refers to personnel

having little or no previous horticultural training or skills.

The column for variables and comments includes notes supplied by the reporting institution. It describes in greater detail the activity being performed, the circumstances under which it was performed, and the plant material being maintained.

Sources of figures supplied are not given in the following charts. The reporting institutions were promised anonymity in regard to any connection between themselves and the figures published, and it is certainly not the purpose of this study to make judgements of an institution's performance based on the figures supplied.

FLOWERS AND GROUNDCOVERS (*Skill Level; **minutes)

Activity / Equipment	Area/Unit	SL*	Time**	Variables and Comments
Bed Preparation:				
Sod lifter, rototiller	1,000 ft^2	C	1600.0	Making new beds; required removing sod
Howard rototiller, spade, rake	1,000 ft^2	B	686.0	Incorporated manure, peat, fertilizer; rake, grade, and firm
Rake	1,000 ft^2	B	520.0	Shallow cultivation of perennial beds
Shovels, rakes, wheelbarrow	1,000 ft^2	C	400.0	Task done every 3-4 months
Rototiller	1,000 ft^2	B	392.0	Several very narrow beds
Rototiller	1,000 ft^2	B	120.0	
Rototiller, shovels	1,000 ft^2	C	120.0	Includes fertilizer and lime incorporation
Rake	1,000 ft^2	B	60.0	Light raking to level beds
Rototiller (rear-end tines)	1,000 ft^2	B	24.0	Soil in excellent condition; 20 small areas required much turning around
Fall Clean-Up:				
Rakes, shovels	1,000 ft^2	B	800.0	Includes waste removal
Shovels	1,000 ft^2	C	320.0	Pulling out annuals
Cultivator	1,000 ft^2	C	300.0	Cultivating perennials
Wheelbarrows, dumptruck	1,000 ft^2	B	230.0	
Hedge shears, pruners	1,000 ft^2	B-C	140.0	Cutting back perennials in fall
Rake, leaf blower	1,000 ft^2	B	49.0	Leaves blown from beds and raked onto tarp; dumped into truck; 3 persons
Spading fork, rake	per plant	B	1.1	Remove annuals, turn over beds
Shovels, truck	per plant	B	0.25	Removing annuals into truck; 2 persons

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
					(*Skill Level; **minutes)
Fertilizing:					
	Hose, HOZON attachment	1,000 ft^2	B-C	150.0	Includes watering first, mixing and clean-up
	Hose with HOZON applicator	1,000 ft^2	C	120.0	Liquid feeding of groundcover
	Hose, HOZON attachment	1,000 ft^2	C	114.0	15-30-15
	Drop-spreader	1,000 ft^2	B	110.5	Many small, very narrow beds
	Spading forks	1,000 ft^2	C	100.0	Organic matter worked in with a fork
	By hand	1,000 ft^2	B	60.0	Side-dress
	Drop-spreader	1,000 ft^2	B	25.4	
	Hand rotary spreader	1,000 ft^2	B	20.0	
	By hand	1,000 ft^2	B	10.0	10-10-10 used; very careful feeding
Grooming:					
	Pruners, rake	1,000 ft^2	A-B	55.9	General grooming of perennials
	Wheelbarrow	1,000 ft^2	C	48.5	Dead-heading marigolds
	Pruners, rake	1,000 ft^2	B	36.0	General grooming of perennials, daily
	Stake, string, knife	per plant	B	3.8	Installing stake and tie-up dahlias
	Peony hoops	per plant	B	3.6	Installing peony hoops on perennials
	Pruners	per plant	A	2.4	Grooming dahlias
	Handshears	per plant	B	0.8	Dead-heading dusty miller; 2 persons
	By hand	per plant	B	0.7	Dead-heading *Salvia splendens*; in bad need of attention
	By hand	per plant	B	0.39	Dead-heading geraniums
	Felco handshears	per plant	B	0.36	Dead-heading astilbe
	By hand	per plant	A	0.3	Pinching chrysanthemums

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
Mulching:					
	By hand	1,000 ft^2	C	160.0	Installing black plastic; includes cutting holes for planting
	Garden Way cart; shovel	1,000 ft^2	C	160.0	300 feet from mulch pile to beds
	Truck,wheelbarrow,pitchfork	1,000 ft^2	B	61.0	Mulching perennials; 3 persons
	Shovels	cu.yd.mulch	B	60.0	Cocoa bean mulch on perennials
Planting:					
	Stakes, string, trowels	1,000 ft^2	A	6900.0	Layout and planting of carpet beds
	6" earth auger attachment on chainsaw; trowels	1,000 ft^2	B	834.0	Planting 7 different groundcovers on streambanks; 1 pint to 1 gallon containers
	Handtools	1,000 ft^2	C	720.0	Planting perennials
	Handtools	1,000 ft^2	B	686.0	Planting annuals
	Trowels	1,000 ft^2	B	640.0	Planting bulbs every 10 inches
	Handtools	1,000 ft^2	B	610.0	Planting annuals every 10 inches
	Trowels	1,000 ft^2	C	360.0	Plant bulbs; unskilled labor
	Cultivator,hoe,rake,trowel	1,000 ft^2		160.0	Planting annuals; 3 persons
	Handtools	1,000 ft^2	A	109.0	Planting perennials
	Trowel, cart	1,000 ft^2	A	80.0	Plants carried 1,000' by cart
	Paper, drafting equipment	1,000 ft^2	A	57.0	Carpet bedding design and layout; includes staking out
	Shovel	per plant	B	8.6	Plant chrysanthemums; includes removal of annuals prior to planting
	Trowels	per plant	A	7.5	Layout and plant annuals; includes watering in and clean-up

(*Skill Level; **minutes)

Activity / Equipment	Area/Unit	SL*	Time**	Variables and Comments
Planting (continued):				
Shovels	per plant	B	4.80	Large perennial divisions
Shovel and trowel	per plant	B	2.6	Planting daylilies from 2-quart containers; 4 persons
Shovels	per plant	A	2.55	Layout and plant large perennial divisions; beds on islands, difficult to work on
Shovel and trowel	per plant	B	2.0	Planting *Liriope* from 1-quart containers; 4 pers.
Hand tools	per plant	A	1.44	Planting perennials
Trowels	per bulb	B	1.0	Planting daffodils; 2 persons
Hand tools	per plant	A-B	0.88	Planting annuals; includes watering in
Stakes, string, trowels	per plant	A	0.84	Layout and planting of carpet beds
Trowel	per bulb	B	0.48	Planting bluebells
Trowel	per plant	A	0.38	Planting *Pachysandra*
Trowel	per bulb		0.24	Planting bulbs; unskilled labor
Trowel	per bulb	A	0.08	Planting tulips; bulbs laid out before planting; soil in excellent condition
Spraying:				
3 gallon hand sprayer	1,000 ft^2	B	225.0	Spray seedling in flats; incl. mixing & clean-up
Hand sprayer	1,000 ft^2	B	200.0	Spraying annuals; incl. mixing & clean-up
2 gallon watering can	1,000 ft^2	B-C	62.0	Drenching beds with fungicide; incl. mix & cleanup
Info. not supplied	1,000 ft^2	A	60.0	Treating perennials with herbicide (Treflan)
Hose	1,000 ft^2	C	28.6	Watering annuals, average over entire season

(*Skill Level; **minutes)

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
Spring Clean-Up:					
	Rake, pitchfork	1,000 ft^2	C	109.0	Remove straw, leaves from perennials
	Rake	1,000 ft^2	C	17.0	Raking leaves from perennials
Weeding:					
	Hand tools	1,000 ft^2		1220.0	Weeding 5 different groundcovers; planting on sloping stream banks; seasonal average
	Hoe	1,000 ft^2	C	667.0	Weed perennials, very heavy infestation
	Hand tools	1,000 ft^2	C	560.0	Weed annuals, heavy weed infestation
	Hand tools	1,000 ft^2	C	316.0	Weed annuals
	By hand	1,000 ft^2	C	80.0	Weed annuals, no mulch present
	Hand tools	1,000 ft^2	C	114.0	Weeding annual beds
	By hand	1,000 ft^2	C	93.5	Pulling weeds from annual beds
	Hand tools	1,000 ft^2		68.0	Weed annuals
	By hand	1,000 ft^2	C	68.0	Weeding annual beds
	Dandelion digger	1,000 ft^2	B	60.0	Weed groundcover (*Euonymus fortunei*); 4 persons
	Hoe	1,000 ft^2	B	56.0	Weed perennials; light infestation

(*Skill Level; **minutes)

DRIVES AND WALKS

Activity	Equipment	Area/Unit	Skill Level	Time (Minutes)	Variables and Comments
Gravel Paths & Drives					
Raking:	Rake	1,000 ft^2	A	36.0	Grooming gravel paths
Weeding:	Hand tools	1,000 ft^2	C	115.0	Weeds light to moderately heavy
Spreading Stone:	Shovel, rake, truck	1,000 ft^2	C	153.0	Includes loading truck and spreading by hand
Hard-Surfaced Areas					
Sweeping:	Broom, shovel	1,000 ft^2	C	120.0	Leaves very wet
	Push broom, shovel	1,000 ft^2		45.0	Sweeping roads and gutters; 4 persons
	Broom, shovel	1,000 ft^2	C	36.0	
	Parker sweeper	1,000 ft^2	B	17.0	Debris heavy from rain
	Backpack blower	1,000 ft^2		5.6	Sweeping sidewalks
	FMC sweeper	1,000 ft^2		0.52	Sweeping sidewalks; includes emptying hopper
	Wayne sweeper	100 lin.ft.		0.89	Sweeping roads and gutters

SHRUBS

Activity / Equipment	Area/Unit	SL*	Time**	Variables and Comments
Fertilizing:				
By hand	1,000 ft^2	B	17.0	Hand broadcasting
Pick-up mounted rotomist	1,000 ft^2		14.7	Foliar feeding of iron chelate; includes mixing and clean-up; 2 persons
By hand	per plant	B	3.0	Hand broadcasting small trees and shrubs
Hedge Trimming:				
Loppers, handpruners	100 lin.ft.	B	800.0	Renovation pruning of old privet hedge; stems up to 1½" diameter and 12' high; includes removing rotten stumps
16" & 30" electric shears	100 lin.ft.	B	670.0	Trimming tall (8') and very wide (8') Taxus hedge
Electric shears	100 lin.ft.	B	500.0	Trimming 6' high maintained privet hedge
Info. not supplied	100 lin.ft.	A	383.0	Trimming Taxus hedge
Electric and hand shears	100 lin.ft.		303.0	Trimming 44 different hedges in good to excellent condition; 40" high x 57" wide x 23' long average. Average over 2 growing seasons in northern U.S.
16" hand shears	100 lin.ft.		276.0	Trimming boxwood hedge 30" high x 22" wide; includes clean-up
30" electric shears	100 lin.ft.		84.0	Trimming boxwood hedge 30" high x 22" wide; includes clean-up
Electric and hand shears	per plant	A	86.0	Trimming formal tree hedge; 84 trees -- 16' high x 12' wide; includes moving staging and clean-up; 3 persons

(*Skill Level; **minutes)

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
Mulching:					
	Wheelbarrow & pitchfork	1,000 ft^2	C	400.0	Mulch shrubs; unskilled labor
	Wheelbarrow, pitchfork, dumptruck	1,000 ft^2	B	380.0	Mulching shrub beds; 7 persons
	Truck; forks	1,000 ft^2	C	300.0	Mulching
	Wheelbarrow & pitchfork	1,000 ft^2	C	250.0	Evergreen needles on heath beds; carried 50' to site; mulch 2" deep
	Wheelbarrow & pitchfork	1,000 ft^2	B	134.0	Mulching shrub beds; does not include loading and transporting; 3 persons
	Forks	per plant	C	21.0	Mulching young trees; hand carry mulch 300' from pile to trees; unskilled labor
	Pitchforks, dumptruck	per plant	B	2.6	Mulching trees; mulch taken directly from truck; 2 persons
Pruning:					
	Loppers, saw, hand pruners	1,000 ft^2	A	25.0	*Viburnum* rejuvenation
	Hand shears	per plant		108.0	Cloud pruning 12' *Chamaecyparis pisifera*
	Hand shears	per plant	A	30.0	Annual shrub pruning; shrubs 4-5' high
	Hand shears	per plant	B	4.8	Annual shrub pruning; includes clean-up
	30" electric shears	per plant	B	2.9	Annual shrub pruning of *Taxus*; 4' high x 4' wide
Shrub Removal:					
	Shovel, mattock	per plant	C	40.0	Removing large shrubs; including debris clean-up

(*Skill Level; **minutes)

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
Spraying:					
	Hand held rotary granule applicator	1,000 ft^2	B	51.0	Herbicide application in shrub areas; including watering in
	3 gallon backpack sprayer	1,000 ft^2	B	17.0	Herbicide application in shrub beds
	Pick-up mounted rotomist	1,000 ft^2		14.0	Spraying insecticide on shrubs; including mixing and clean-up; 2 persons
	3 gallon handsprayer	1,000 ft^2		3.0	Spray herbicide in shrub beds; done twice a year
	3 gallon backpack sprayer	100 lin.ft.	B	400.0	Spraying 10' high hemlock hedge; including mixing and clean-up
	300 gallon Bean sprayer	per plant	B	0.19	Spraying rhododendron collection spread out on rough terrain; including mixing and clean-up
	Meyers 50 gallon sprayer	per plant	B	1.8	Spray trees for bag worm; including mixing and clean-up
Weeding:					
	Hoe	1,000 ft^2	C	400.0	Weeding moderately infested shrub bed
	Hand tools	1,000 ft^2	B	253.0	Weeding under 30 trees with mulched beds 3½ to 16 feet in diameter, 2-5" thick
	Cultivators	1,000 ft^2	C	50.0	Weeding older shrub plantings
	Dandelion diggers	per plant	C	0.29	Weeding mulched azalea bed; 6 persons
Staking:					
	Stakes, twine	per plant	C	5.5	Tying up shrubs for winter protection
	Stakes, fasteners	per plant	C	4.0	Staking small new trees

(*Skill Level; **minutes)

ROSES (*Skill Level; **minutes)

Activity Equipment	Area/Unit	SL*	Time**	Variables and Comments
Fertilizing:				
Cultivator	per plant	B	1.75	Feeding roses; pull back mulch, side-dress and cultivate in
Cultivator	per plant	A-B	1.25	Feeding roses; side-dress and cultivate in
By hand	1,000 ft^2	A	31.0	Side-dress
Grooming:				
Hand pruners	per plant	A	1.1	Dead-heading
Hand pruners	per plant	A	0.5	Dead-heading
Hand pruners, basket	per plant	B	0.19	Dead-heading, removing yellow leaves and weeding; performed daily
Hand pruners	per plant	B	0.12	Dead-heading
Hand pruners, wheelbarrow	1,000 ft^2	B	300.0	Dead-heading
Mulching:				
Shovel; wheelbarrow	per plant	B	0.5	Apply cocoa bean mulch
Planting:				
Shovel	per plant	A-B	7.5	Planting rose bushes
Pruning:				
Ladder; hand pruners	per plant		34.0	First spring pruning of climbing roses
Hand pruners; loppers	per plant	A	2.4	Heavy summer pruning of floribundas
Hand pruners; loppers	per plant	A	2.2	Spring pruning
Hand pruners; loppers	per plant	A	1.25	Light spring pruning and clean-up
Hand pruners; loppers	per plant	A	1.2	Heavy summer pruning of grandifloras

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
Roses Spraying:					
	300 gallon Bean sprayer	per plant	A	1.6	2 persons -- 1 driver, 1 sprayer
	300 gallon sprayer	per plant	B	0.9	Includes mixing and clean-up
	30 gallon hydraulic sprayer	per plant	B	0.3	
	22 gallon sprayer mounted on Cushman	per plant	B	0.24	Several different locations; does not include preparation time
	50 gallon hydraulic sprayer	per plant	B	0.12	Sprayer pulled by hand
	SOLO backmounted mist sprayer	per plant	A	0.09	Includes mixing and clean-up
	30 gallon Bean sprayer	1,000 ft^2	C	40.0	Includes mixing and clean-up
Winter Preparation:					
	Shovel, wheelbarrow, tractor	per plant	C	6.5	Cover roses with 8-10" soil; includes cutting back
	Twine, shovel, wheelbarrow	per plant	B	1.72 2.04] 3.76	Tie up canes Cover roses with 12-16" soil
	Shovel, wheelbarrow	per plant	C	0.72	Cover roses with soil

(*Skill Level; **minutes)

Activity Equipment	Area/Unit	SL*	Time**	Variables and Comments
Edging:				
Hand edger	100 lin.ft.	B	48.0	Edge along crushed stone path
Spades, fork, truck	100 lin.ft.	B	30.0	Edging shrub beds, fill cut edge with wood chips
Power edger, broom, shovel, wheelbarrow	100 lin.ft.	B	18.0	
Power edger, FMC sweeper, broom	100 lin.ft.		14.0	Edging sidewalks
Gas-powered edger, brooms	100 lin.ft.	B	13.4	3 persons -- 1 to edge, 2 to sweep
Gas-powered edger, string trimmer	100 lin.ft.	B	4.0	
String trimmer	100 lin.ft.	C	18.4	Edging walks, moderately overgrown
Echo trimmer SRM 302A	100 lin.ft.	B	4.1	String trimming against concrete block wall
Fertilizing:				
Drop spreader	1,000 ft^2	B	4.2	Includes filling time
Scotts rotary spreader (8' swath)	1,000 ft^2	B	3.5	8 lb. fertilizer/1000 ft^2
Push rotary spreader	1,000 ft^2	B	2.7	10-6-4 applied @ 1 lb.N/1,000 ft^2
Rotary spreader	1,000 ft^2	A	2.4	Flat area
Rotary spreader	1,000 ft^2	B	1.9	8-8-8 fertilizer used
Rotary spreader	1,000 ft^2 or per acre	B	1.4 60.0	Large area fed with urea (45-0-0)
Model B Cyclone manual spreader (6-8' broadcast width)	1,000 ft^2		1.0	8 lb. fertilizer/1,000 ft^2; smaller areas

(*Skill Level; **minutes)

Activity Equipment	Area/Unit	SL*	Time**	Variables and Comments
Fertilizing (continued):				
Tractor-powered Miadem spreader with 20' broadcast width	1,000 ft^2		0.2	4.6 lb. fertilizer/1,000 ft^2; includes refilling hopper from 50 lb. bags
Leaf & Clipping Removal:				
Rake, wheelbarrow	1,000 ft^2	C	150.0	Bamboo leaves in small areas
Rake	1,000 ft^2		120.0	Leaf raking
Rake	1,000 ft^2	C	44.0	Leaf raking
Vacuum on riding rotary, rake	1,000 ft^2	B	28.9	Includes hand raking under occasional tree or shrub
Rake	1,000 ft^2		13.0	Leaf raking
Rake	1,000 ft^2	C	9.6	Leaf raking; includes loading
Rake	1,000 ft^2	C	7.2	Remove lawn clippings
Rake	1,000 ft^2	C	6.0	Remove lawn clippings
3 HP rider-type turf vacuum	1,000 ft^2		1.2	
Mowing:				
19" rotary set at 3" height	1,000 ft^2	B	87.2	Mowing moderate creekside slopes; grass 20-50" high -- usually damp; involved some trimming near shrubs
Push rotary	1,000 ft^2	C	60.0	Long narrow strips with trees & shrubs
20" self-propelled rotary	1,000 ft^2	B	27.8	
Push rotary	1,000 ft^2	C	21.7	Mowing small enclosed areas with some trees

(*Skill Level; **minutes)

Activity Equipment	Area/Unit	SL*	Time**	Variables and Comments
Mowing (continued):				
19" rotary modified to cut 4-8" high	1,000 ft^2	B	18.1	Mowing creek banks in 16 different areas; slope ranged 0% to 50%; grass dry to wet; spikes worn on shoes
20" Jacobsen Commercial Rotary	1,000 ft^2	B	16.0	Many small plots; many turns
18" push rotary	1,000 ft^2	C	13.4	
20" push rotary	1,000 ft^2		7.4	
20" push rotary	1,000 ft^2	C	5.9	Open area; no obstacles
48" Hesston Front Runner	1,000 ft^2	A	5.2	Detail mowing in and around mulched beds of large shrubs; level to rolling terrain; grass 6" high -- cut to 4"
48" John Deere rotary	1,000 ft^2	B	3.3	Very irregular area
48" riding rotary	1,000 ft^2	B	3.0	Open area with few trees or shrubs
48" riding mower	1,000 ft^2	A-B	1.6	
48" John Deere rotary	1,000 ft^2	B	1.25	Open area with some obstacles
60" rotary riding mower	1,000 ft^2 or per acre	A-B	2.6 112.5	Several separate areas with trees; includes travel time
72" Cushman rotary	1,000 ft^2 or per acre	B	3.1 133.0	
72" riding mower	1,000 ft^2	C	1.3	Area planted with trees and shrubs
John Deere 1030 and PTO rotary mower	1,000 ft^2		5.0	Undeveloped area

(*Skill Level; **minutes)

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
Mowing (continued):					
	Brush hog	1,000 ft^2 or per acre	B	0.7 30.0	Rough field area
	Kubota I rear-mount rotary 59" cut	1,000 ft^2 or per acre	B	0.7 30.6	All figures supplied by one large arboretum. Averages for all equipment listed: 0.83 min./1,000 ft^2 or 36.31 min./acre
	Kubota II belly-slung rotary 59" cut	1,000 ft^2 or per acre	B	0.72 31.5	
	Kubota I & II (each with 59" cut)	1,000 ft^2 or per acre	B	0.87 38.0	
	Kubota I & International 200	1,000 ft^2 or per acre	B	1.4 61.6	
	Kubota II & International 200	1,000 ft^2 or per acre	B	1.4 61.7	
	Kubota I & II and International 200	1,000 ft^2 or per acre	B	0.92 39.9	
	International 200 (59" cut)	1,000 ft^2 or per acre	B	0.61 26.5	
	International 464 "brush hog" 72" cut	1,000 ft^2 or per acre	B	0.65 28.4	
	22" Jacobson reel	100 lin.ft.		3.6	Weekly trimming beside sidewalks
	3-reel riding mower	1,000 ft^2	B	2.7	
	One 3-gang 84" span reel mower & 2 30" reel mowers	1,000 ft^2		1.4	3 persons
	National Triplex reel mower (15' span)	1,000 ft^2		1.3	Open and accessible tree covered area

(*Skill Level; **minutes)

Activity	Equipment	Area/Unit	SL*	Time**	Variables and Comments
Weed Control:					
	24" drop spreader	1,000 ft^2	A	14.4	Herbicide application
	Hand sprayer	1,000 ft^2	A	4.8	Spot control
	Ferguson tractor and spray tank	1,000 ft^2		0.41	Spraying herbicide; includes mixing and clean-up
	5-gallon hand sprayer	1,000 ft^2		0.3	2 persons

(*Skill Level; **minutes)

Chapter 5

ANALYSIS AND RECOMMENDATIONS

The following can be said of the figures and information supplied in the charts of Chapter 4:

1. The data represent information collected from thirty-one different sources ranging in size from a two acre estate garden to a several-thousand-acre arboretum. These same thirty-one sources utilize annual grounds maintenance budgets ranging from under $20,000 to over $1,000,000. Their staffs include untrained CETA workers, newly trained college interns, and seasoned professional horticulturists.

2. Twenty-one per cent (21%) of the figures represent activities performed several times over the course of a growing season by the same person, using the same equipment; or they are averages of an activity performed once each year but recorded for several years. The remaining 79% of the figures are from activities performed and recorded only once.

3. Except for basic hand tools, the type of equipment used for each activity varied substantially and should be taken into consideration when using the figures. With certain activities, such as turf mowing, there are many entries listing equipment of similar size and type, although not always of the same make.

4. Of the 210 activities reported, 193 (92%) involved only one person in the operation. Where two or more people performed the task, it is so noted in the Variables and Comments column, and the figures then represent the rate for the appropriate number of persons.

5. Eighty-three per cent (83%) of the institutions represented in Chapter 4 supplied a Skill Level Rating for their employees performing the reported activities. This information was sought to give data users a clearer picture of how the task was performed.

Some of those reporting the information misinterpreted the skill level rating, so no firm conclusions can be drawn. While the author sought the Skill Level of the person performing the task, some reported the Skill Level they thought should be required for the activity. Some institutions' data were supplied by the employee performing the activity, thereby jeopardizing the rating's accuracy.

Better defined guidelines concerning skill levels are needed in future studies. Most cooperators ranked raking, weeding, and mulching in the lowest Skill Level (Rating C) and pruning, planting, fertilizing, and chemical weed control in the highest skill level (Rating A).

This study recorded information on a wide range of grounds maintenance activities from various institutions throughout North America. Variations in equipment, worker performance, working conditions, plants, and desired levels of maintenance make precise comparison of the results impractical. Reporting of results varied as well.

Some of the institutions chose square footage or linear footage as their measurement unit, while others recorded the number and size of plants. Future studies could focus on a limited selection of activities and more fully document the conditions under which each task is performed.

Improvements in future studies could be gained by using a person of known job skills to repeatedly perform the same task over uniform terrain and plant material. This would standardize the time value for each task. Once the value is reviewed and accepted by the grounds maintenance profession, further studies could be conducted. These investigations might study variables such as equipment type, personnel skill level, plant species and size, or maintenance method. In studying the effects of these changes on the standard value, one might develop "factors of variability" or "coefficients." These "factors of variability" would be whole numbers or fractions of whole numbers to be multiplied by the previously established standard value. This would result in a reliable prediction of the task's completion time using a variety of equipment, plants, skill levels, or operating conditions.

The following example illustrates how this may work: Let us assume the accepted turf mowing standard using a John Deere 214 riding mower with a 48-inch deck is 1.50 minutes per 1,000 square feet. This standard assumes no refueling stops, a level lawn, and no obstacles. If the mowing deck is changed to one that cuts a 60" swath, the efficiency of the mowing operation may be increased by let us say, 20%.

A 20% increase in efficiency translates into a variability factor of 0.8. This variability factor may be calculated by the equation: Variability Factor (or Coefficient) = (Present rate of efficiency) minus (Change in rate of efficiency) divided by 100. [For this example: 100-(+20)/100 = 100-20/100 = 80/100 = 0.8]. 0.8 multiplied by the original 1.50 minutes per 1,000 square feet equals 1.20 minutes (0.8 x 1.50) per 1,000 square feet, the new standard for a John Deere 214 riding mower with 60-inch deck.

This technique for determining variability factors or coefficients is commonly used with farm machinery. Please see in the accompanying Sources Consulted listing the reference to work done by Elms Renoll at the Alabama Agricultural Experiment Station.

It is no surprise that some time values produced by my study vary significantly for a particular activity. The size and make of equipment varies in all but a few maintenance activities. There are certainly no quantitative or qualitative guidelines available for such terms as "moderate weed infestation", "rough terrain", or "very narrow beds". Each institution has its own set of operational circumstances. Few institutions' maintenance departments receive high priority and an appropriate funding level. Institutions responding to the February 1982 letter (Appendix 3) could not assist or were constrained because of limited budget resources.

The results reported in this study should not be used literally as standards, as each institution's situation varies. The time

requirement values found in this study have usually taken into account the great variations in operating conditions, equipment, and productivity levels.

Using the following worksheet, adapted from one developed by David Lofgren and published by the Professional Grounds Management Society in Grounds Maintenance Estimating Guidelines, I will show how the study's results can be used. Data presented in this study for mowing range from 1.25 to 5.20 minutes per 1,000 square feet for cutting with a riding mower equipped with a 48-inch deck; spring rose pruning figures vary from 1.2 to 2.4 minutes per plant; or feeding annual beds with a Hozon applicator takes 114 to 150 minutes per 1,000 square feet. These figures may be placed into the following worksheet (Figure 1) under column C, and using an institution's own particular figures for Column B (Numbers and Unit of Measure) and Column E (Frequencies), one sees that ranges are produced (Column G) for the expected time for each operation during a year.

In producing a series of ranges of this type, a grounds manager is better able to evaluate the performance of his staff, equipment, and scheduling. Should the actual total time to complete a task per year be near or below the low end of the established range, the manager may wish to question the worker's thoroughness or, if appropriate, reward the worker for an expedient job. It may also be that a new piece of equipment was in fact a wise purchase, or that ideal working conditions prevailed.

Figure 1

A	B	C	D	E	F	G
Activity	Numbers and Unit of Measure	Time to Complete Unit of Measure	Total Time for Item or Area (once) BxC	Frequency by Month J F M A M J J A S O N D	Total Frequency Per Year (Total of E)	Total Time Per Year (DxF)
Mowing - Lawn tractor with 48" deck	20,000 ft^2	1.25 min/ 1,000 ft^2	25 minutes	1 5 4 4 4 5 4 1	28	700 minutes
	20,000 ft^2	5.20 min/ 1,000 ft^2	104 minutes	1 5 4 4 4 5 4 1	28	2,912 minutes
Rose Pruning: (Spring)	100 plants	1.2 min/ plant	120 minutes	1	1	120 minutes
	100 plants	2.4 min/ plant	240 minutes	1	1	240 minutes
Fertilizing:						
Feeding annuals with HOZON applicator	1,500 ft^2	114 min/ 1,000 ft^2	171 minutes	2 2 1 1	6	1,026 minutes
	1,500 ft^2	150 min/ 1,000 ft^2	225 minutes	2 2 1 1	6	1,350 minutes

On the other hand, should the total time per year be near or above the high end of the established range, the manager may need to search for unforeseen time-consuming variables such as inefficient scheduling or bad weather. If appropriate, the manager can adjust schedules, consider new equipment, or if necessary admonish the crew member for taking too long.

By comparing the established ranges with his own man-hour availability, a manager can then adjust his budget accordingly or, if necessary, contract out part of the year's maintenance tasks. If maintenance department budget cuts are made, he can also use the ranges to better envision potential effects the cuts may have. Furthermore, the comparison will show the manager where he may need to work with his crew to motivate them or improve their work techniques.

The grounds maintenance activities time requirement values accumulated by my study will provide a starting point and/or will permit comparisons. With these values as guidelines, managers can bracket their own individual circumstances. This will enable them to produce their own set of in-house standards.

Appendix 1

SOURCES OF TIME REQUIREMENT DATA FOR LANDSCAPE OPERATIONS

Carter, Joel W. "Anaheim's Figures Sell a Budget." Grounds Maintenance, January 1983, p. 22.

Caskey, Alan R. "Landscape Work Simplification, Measurement, and Performance Guide." Grounds Maintenance, September 1970, p. 25.

_____. "The Elmhurst Park District -- a Maintenance Case Study." Grounds Maintenance, February 1977, p. 92.

Center for Landscape Architectural Education and Research. A Guide to Estimating Landscape Costs. Reston, VA: Environmental Design Press, 1979.

Copley, Kathy. "How to Estimate the Job." Grounds Maintenance, January 1983, p. 10.

_____, and Lofgren, David. "Estimating." Grounds Maintenance, February 1983, p. 18.

Ellison, C. Donald, ed. Park Maintenance Management Manual. Harrisburg, PA: Bureau of Recreation and Conservation, 1979.

Godfrey, Robert S., ed. Building Construction Cost Data 1977. Duxbury, MA: Robert S. Means Co., Inc., 1977.

Graham, Andrew W. "Independence National Historical Park Management Plan." Philadelphia: Morris Arboretum of the University of Pennsylvania, 1980.

Griffin, James M. Landscape Data Manual. Los Angeles: Building News, Inc., 1972.

"Grounds Maintenance Guide to: Work Simplification, Measurement, Performance." Grounds Maintenance, February 1976, p. 30.

Kerr Associates. Cost Data for Landscape Construction. Minneapolis: Kerr Associates, 1982.

Lofgren, David E. "Calculating Maintenance Time Requirements." Grounds Maintenance, June 1981, p. 52.

Appendix 1 (continued)

_____. "Mowing Time Requirements Based on Travel Speed and Width of Cut." Grounds Maintenance, August 1981, p. 80.

_____. "Work Simplification, Measurement, Performance." Grounds Maintenance, February 1976, p. 30.

National Landscape Association. Landscape Designer and Estimator's Guide. Washington, D.C.: National Landscape Association, 1971.

"1968 Landscape Job Estimating Guide." Grounds Maintenance, January 1968, p. 21.

Pedersen, Bradley W. Management Planning: Projecting Costs and Tasks. Appleton, WI: National Institute on Park and Grounds Management, 1982.

Professional Grounds Management Society. Grounds Maintenance Estimating Guidelines. Pikeville, MD: Professional Grounds Management Society, 1984.

Robinette, Gary O. Off the Board/Into the Ground. Dubuque, IA: Kendall/Hunt Publishing Co., 1968.

Schmidt, Owen B. "Labor Time Charts of Planting." University of Delaware Short Course, 1955.

Surtees, John. Service Charts No. 3. Ridgefield, CT: John Surtees.

"Trimming around Monuments Creates Maintenance Challenge." Grounds Maintenance, August 1980, p. 14.

Van Dam, John. "Labor Requirement Analysis for Landscape Maintenance," Leaflet 21232. University of California: Division of Agricultural Sciences, 1981.

Appendix 2

REFERENCES: GROUNDS MAINTENANCE RECORD-KEEPING AND TIME STUDIES

Anderson, Robert D. "Better Parks Management: Planning and Results." Park Maintenance, December 1978, p. 10.

Baumgardt, Dr. John P. "Formal Flower Bed Construction Guide." Grounds Maintenance, April 1970, p. 34.

Bumgardner, Walter H. "Developing Park Maintenance Standards." Park Maintenance, May 1977, p. 6.

Carter, Joel W. "Anaheim's Figures Sell a Budget." Grounds Maintenance, January 1983, p. 22.

Caskey, Alan R. "The Elmhurst Park District -- A Maintenance Case Study." Grounds Maintenance, February 1977, p. 92.

_____. "What You Should Know about Bidding, Contracting." Grounds Maintenance, September 1971, p. 11.

Copley, Kathy. "How to Estimate the Job." Grounds Maintenance, January 1983, p. 10.

_____, and Lofgren, David. "Estimating." Grounds Maintenance, February 1983, p. 18.

Ehly, Jean. "New Methods Save Time, Money for Amarillo Parks." Park Maintenance, March 1970, p. 26.

Goldapp, A. Allen. "Work Scheduling Works." Grounds Maintenance, February 1983, p. 9.

"Good Records Help in Handling Maintenance Budget Cutbacks." Park Maintenance, August 1971, p. 16.

Graham, Andrew W. "Independence National Historical Park Management Plan." Philadelphia: Morris Arboretum of the University of Pennsylvania, 1980.

"Grounds Maintenance Guide to: Work Simplification, Measurement, Performance." Grounds Maintenance, February 1976, p. 30.

Appendix 2 (continued)

Harris, Richard W., ed. Proceedings 1977 Park and Recreation Administrators Institute. Davis, CA: University of California Extension, 1978.

Hazle, William. "Mowing Tips Which Will Save You Time and Money." Park Maintenance, April 1973, p. 14.

Huey, Dr. Philip. "Plant Cost per Color Day." Grounds Maintenance, February 1969, p. 66.

Lofgren, David E. "Activity-oriented Time Cards." Grounds Maintenance, January 1978, p. 39.

_____. "Budgeting for Turf Care." Grounds Maintenance, November 1978, p. 34.

_____. "How to Cost Equipment Use." Grounds Maintenance, May 1977, p. 30.

_____. "How to Figure Your Actual Landscape Costs." Grounds Maintenance, April 1975, p. 20.

_____. "Landscape Maintenance Inventory." Grounds Maintenance, November 1969, p. 14.

_____. "Landscape Maintenance Time-Demand Schedules." Grounds Maintenance, August 1978, p. 24.

_____. "Scheduling Work Projects." Grounds Maintenance, April 1970, p. 20.

_____. "Staffing Charts and Manning Tables." Grounds Maintenance, May 1978, p. 42.

_____. "Time Schedules for Turf Management." Grounds Maintenance, January 1979, p. 48.

_____. "Work Schedules for Improved Control." Grounds Maintenance, March 1974, p. 68.

_____. "Work Simplification, Measurement, Performance." Grounds Maintenance, February 1976, p. 30.

_____. "Writing Specifications for Maintenance Work." Grounds Maintenance, September 1969, p. 29.

Matecki, James. "Here's How One Department Justifies Budget Requests." Park Maintenance, July 1980, p. 14.

Appendix 2 (continued)

"1968 Landscape Job Estimating Guide." Grounds Maintenance, January 1968, p. 21.

Olsen, Norma J. "Bidding and Estimating the Landscape Job." Grounds Maintenance, June 1966, p. 4.

O'Rourke, F. L. S. "A Guide to Landscape Job Estimating." Grounds Maintenance, June 1967, p. 21.

Owers, George. "Park Maintenance Plan: Ann Arbor Pioneers an Effective Guideline." Park Maintenance, September 1976, p. 11.

Pedersen, Bradley W. Management Planning: Projecting Costs and Tasks. Appleton, WI: National Institute on Park and Grounds Management, 1982.

Pies, Ronald E. "Tempe, Arizona Uses Computer for Maintenance Statistics." Park Maintenance, April 1971, p. 8.

Renoll, Elms. "Predicting Machine Performance Rates for Specific Field and Operating Conditions," Circular 258. Auburn University, AL: Alabama Agricultural Experiment Station, December 1981.

Schaefer, Theodore H. "You CAN Analyze Operation and Maintenance Costs by Using the Data Collection Method." Park Maintenance, November 1973, p. 8.

Staley, James G. "Planning and Scheduling." Grounds Maintenance, March 1977, p. 20.

Starr, Michael. "Data Processing Pays Off for Medford Parks Department." Park Maintenance, April 1972, p. 8.

Surtees, John. Services Charts No. 3. Ridgefield, CT: John Surtees.

Thomas, John S. "How Some Departments Cope with Adversity." Park Maintenance, January 1980, p. 8.

Urbano, Cynthia C. "SLICE -- a Computer System for Landscapes." American Nurseryman, September 1984, p. 92.

Van Dam, John. "Labor Requirement Analysis for Landscape Maintenance," Leaflet 21232. University of California: Division of Agricultural Sciences, 1981.

Watson, J. R., and Williams, Steve. "Calculate the REAL Cost." Grounds Maintenance, January 1983, p. 60.

Appendix 3. Initial Letter Requesting Information

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

LONGWOOD PROGRAM IN ORNAMENTAL HORTICULTURE
157 AGRICULTURAL HALL
(302) 738 2517

February 24, 1982

Richard Mahone, Director of Landscape
Colonial Williamsburg
P.O. Box C
Williamsburg, VA 23185

Dear Dick:

As grounds managers are increasingly being asked to reduce the costs of maintaining the areas under their control, there is a need to incorporate more scientific techniques to accurately determine the time and cost requirements for specific activities. This information is also essential to more effectively plan work schedules, and may be used to measure gains in efficiency.

I am currently involved in thesis research relating to grounds maintenance. In particular, I aim to produce a more reliable base of data concerning time requirements for performing grounds maintenance tasks. To date, few figures have been published, and those that have, need to be confirmed with other findings. In addition, I hope to standardize to some extent the many variables involved in performing these activities.

At this stage, I wish to know who has gathered such data in the past, and what general types of information have been recorded. I also wish to determine if you, at Colonial Williamsburg would be willing to participate in collecting data in 1982 to aid in my thesis work.

Please fill out and return the enclosed card. I would appreciate your prompt reply, and will be contacting you at a later date should your reply be favorable.

Thanks for your cooperation.

Sincerely yours,

Mark Zelonis
Longwood Program Fellow

Appendix 3 (continued). Return Postcard Accompanying Request for Information

I have gathered grounds maintenance time requirement data at my institution. ____Yes ____No

If Yes, the general types of activities recorded were:

I'm willing to participate in collecting data in 1982 to aid in your thesis project.___Yes ____No

Name, Title _____

Institution _____

Address _____

_____

Telephone _____

United States 13c

MARK ZELONIS
LONGWOOD PROGRAM IN [illegible]
157 AGRICULTURE HALL U OF D
NEWARK, DELAWARE 19711

Appendix 4. Follow-up Letter Explaining Data Collection Methods

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

LONGWOOD PROGRAM IN ORNAMENTAL HORTICULTURE
157 AGRICULTURAL HALL
(302) 738-2517

May 25, 1982

Kevin Marshall
American Rose Society
P.O. Box 30,000
Shreveport, LA

Dear Mr. Marshall:

Thanks for your offer to help me in my thesis work on grounds maintenance. I've devised a form that includes the basic information I'm looking for and have enclosed several copies for your use, as well as a sample form filled out. If you'd like more, just let me know.

I've enclosed as suggestions a list of activities you might be performing at A.R.S. You needn't report on everything - nobody has time for that. But if you could perhaps supply good data on a few select areas or tasks, that would be great! The time you record should include minor delays if they occur, but not time to and from the site.

Should you have any questions, feel free to contact me.

Sincerely yours,

Mark Zelonis

Mark Zelonis

Appendix 5

LIST OF SUGGESTED MAINTENANCE ACTIVITIES ON WHICH TO REPORT

AREA	ACTIVITIES	
Lawns	Mowing --	push mower power mower (push & self-propelled) rider mower tractor
	Feeding --	rotary or drop spreader
	Weed control --	hand sprayer pull or dig by hand power sprayer
	Sweeping --	hand raking power rake
	Leaf removal --	hand raking blower vacuum
	Edging --	hand and power edger
	Trimming --	string trimmer chemically hand trim
Shrubs	Feeding --	by hand liquid feed
	Pruning --	hand & power equipment
	Weed control --	pull or dig by hand hand hoe spray chemically granular herbicide
	Mulch --	organic material vs. plastic depth
	Pest control --	spray or dust systemic
Flower Beds	Prepare --	dig, level
	Plant --	density
	Cultivate --	by hand or rototiller

Appendix 5 (continued)

AREA	ACTIVITIES
Flower Beds	Feeding -- granular vs. liquid
	Mulch -- organic material vs. plastic
	Weeding -- no mulch mulch pre-emergence chemicals
	Clean-up -- dead-heading staking, tying
	Pest control -- hand sprayer power sprayer
Paved Areas	Sweep -- hand vs. machine
	Vacuum -- push or self-propelled

Appendix 6 -- GROUNDS MAINTENANCE ACTIVITY REPORTING FORM

Date	Area	Activity (including equipment)	Size of Area or # of Plants	Skill Level	Time Required	Variables (or comments)

MZ 5/82

SKILL LEVELS: A -- Highly skilled (extensive training required)
B -- Moderately skilled (some training required)
C -- Relatively unskilled (little or no training required)

Appendix 7

COOPERATING INSTITUTIONS AND INDIVIDUALS

Bayard Cutting Arboretum
Oakdale, New York

Bickelhaupt Arboretum
Clinton, Iowa

Blithewold Gardens and Arboretum
Bristol, Rhode Island

The Bloedel Reserve
Bainbridge Island, Washington

Bowman's Hill State Wild Flower Preserve
Washington Crossing, Pennsylvania

Brigham Young University
Provo, Utah

Chanticleer
Wayne, Pennsylvania

Clark Garden of the Brooklyn Botanic Garden
Albertson, New York

Coker Arboretum
Chapel Hill, North Carolina

Cornell Plantations
Ithaca, New York

Dawes Arboretum
Newark, Ohio

Desert Botanical Garden
Phoenix, Arizona

Sarah P. Duke Gardens
Durham, North Carolina

Dumbarton Oaks
Washington, D.C.

Appendix 7 (continued)

Fuller Gardens
North Hampton, New Hampshire

The Tyler Arboretum
Lima, Pennsylvania

Holden Arboretum
Mento, Ohio

College of the Holy Cross
Worcester, Massachusetts

Dr. Richard W. Lighty
Kennett Square, Pennsylvania

Longue Vue Gardens
New Orleans, Louisiana

Mr. John Masengarb
The Morton Arboretum

Matthaei Botanical Gardens
Ann Arbor, Michigan

Mitchell Park Horticultural Conservatory
Milwaukee, Wisconsin

Montreal Botanical Garden
Montreal, Quebec, Canada

Morris Arboretum
Philadelphia, Pennsylvania

Morton Arboretum
Lisle, Illinois

Parks and Recreation Department
City of Newark, Delaware

New York Botanical Garden
Bronx, New York

North Carolina Botanical Garden
Chapel Hill, North Carolina

Old Westbury Gardens
Old Westbury, New York

Sherman Library and Gardens
Corona del Mar, California

SOURCES CONSULTED

Alsip, James L. "Increase Management Efficiency." Grounds Maintenance, April 1972, p. 15.

American Landscape Contractors Association. Proceedings from the 1978 ALCA Landscape Maintenance Symposium. San Jose, CA, 1978.

Anderson, Robert D. "Better Parks Management: Planning and Results." Park Maintenance, December 1978, p. 10.

Barnett, David. "Special Care of the Morton Arboretum's Woody Plant Collections." The Morton Arboretum Quarterly 16 (Winter 1980): 61.

Baumgardt, Dr. John P. "Formal Flower Bed Construction Guide." Grounds Maintenance, April 1970, p. 34.

_____. "1969 Plant Maintenance Schedule Guide." Grounds Maintenance, January 1969, p. 29.

Bethel, Gerald. "A Systems Approach to Management of Park Maintenance." Park Maintenance, April 1971, p. 12.

Black, Glenn. "The Broad View of Landscaping." Grounds Maintenance, January 1966, p. 10.

Brickman, Dick. "Analyze Operations to Make Landscape Maintenance Cost-effective." Grounds Maintenance, September 1978, p. 64.

Bruning, Walter F. "Low Maintenance for Park Areas." Park Maintenance, April 1970, p. 10.

_____. "Try a Minimum Maintenance Plan." Park Maintenance, March 1965, p. 82.

Bumgardner, Walter H. "Developing Park Maintenance Standards." Park Maintenance, May 1977, p. 6.

Carter, Joel W. "Anaheim's Figures Sell a Budget." Grounds Maintenance, January 1983, p. 22.

Caskey, Alan R. "Budgeting for Maintenance." Grounds Maintenance, February 1971, p. 13.

_____. "Guide to Managing Individual Jobs." Grounds Maintenance, January 1971, p. 25.

_____. "Landscape Work Simplification, Measurement, and Performance Guide." Grounds Maintenance, September 1970, p. 25.

_____. "The Elmhurst Park District -- a Maintenance Case Study." Grounds Maintenance, February 1977, p. 92.

_____. "Total Maintenance Plan Guide." Grounds Maintenance, October 1970, p. 21.

_____. "What You Should Know About Bidding, Contracting." Grounds Maintenance, September 1971, p. 11.

Center for Landscape Architectural Education and Research. A Guide to Estimating Landscape Costs. Reston, VA: Environmental Design Press, 1979.

_____. Manual of Site Management. Reston, VA: Environmental Design Press, 1978.

Colbert, Richard A. "Low Maintenance Landscaping in Median Strips." Paper presented to annual meeting of the American Association of Botanical Gardens and Arboreta. Vassar College, June 1982.

Community Planning and Management and the Department of Parks and Recreation. Ann Arbor Park Maintenance Plan. City of Ann Arbor, MI, 1981.

Copley, Frank B. Frederick W. Taylor, Father of Scientific Management. New York: Harper and Bros., 1923.

Copley, Kathy. "How to Estimate the Job." Grounds Maintenance, January 1983, p. 10.

_____, and Lofgren, David. "Estimating." Grounds Maintenance, February 1983, p. 18.

Davis, Stephen. "Performance Appraisal: Tool for Improving Employee Morale." Park Maintenance, December 1980, p. 6.

Division of State Planning and Technical Assistance (Pacific Southwest Regional Office). Maintenance Impact Statement Handbook. Washington, D.C.: Heritage Conservation and Recreation Service, 1980.

Dunlavey, Robert J. Managing Personnel and Time. Appleton, WI: National Institute on Park and Grounds Management, 1981.

Edmonton Parks and Recreation Department. Technical Standards Manual. Edmonton, Alberta: Parks and Recreation Department, 1982.

Ehly, Jean. "New Methods Save Time, Money for Amarillo Parks." Park Maintenance, March 1970, p. 26.

Ellison, C. Donald, ed. Park Maintenance Management Manual. Harrisburg, PA: Bureau of Recreation and Conservation, 1979.

Gilbreth, Frank B. Motion Study. New York: D. Van Nostrand Co., 1911.

Glenn, Jerry. "25% Saving through Maintenance Analysis and Controls in Los Angeles." Park Maintenance, January 1968, p. 22.

Godfrey, Robert S., ed. Building Construction Cost Data 1977. Duxbury, MA: Robert S. Means Co., Inc., 1977.

Goldapp, A. Allen. "Work Scheduling Works." Grounds Maintenance, February 1983, p. 9.

"Good Records Help in Handling Maintenance Budget Cutbacks." Park Maintenance, August 1971, p. 16.

Graham, Andrew W. "Independence National Historical Park Management Plan." Philadelphia: Morris Arboretum of the University of Pennsylvania, 1980.

Griffin, James M. Landscape Data Manual. Los Angeles: Building News, Inc., 1972.

"Grounds Maintenance Guide to: Work Simplification, Measurement, Performance." Grounds Maintenance, February 1976, p. 30.

Hannebaum, Leroy G. Landscape Operations Management, Methods, and Materials. Reston, VA: Reston Publishing Co., Inc., 1980.

Harris, Richard W., ed. Proceedings 1977 Park and Recreation Administrators Institute. Davis, CA: University of California Extension, 1978.

Hatfield, Philip D. "More Cooperation Needed between Landscape Architects, Designers, and Ground Managers." Grounds Maintenance, February 1982, p. 1.

Hazle, William. "Mowing Tips Which Will Save You Time and Money." Park Maintenance, April 1973, p. 14.

"Higher Mowing Better." Park Maintenance, May 1979, p. 8.

Huey, Dr. Philip. "Plant Cost per Color Day." Grounds Maintenance, February 1969, p. 66.

International Sanitary Supply Association. Your Guide to Programmed Maintenance. Chicago: International Sanitary Supply Association, 1982.

Kerr Associates. Cost Data for Landscape Construction. Minneapolis: Kerr Associates, 1982.

Kitchen, James W. "Assessing Maintenance Efficiency." Grounds Maintenance, February 1967, p. 34.

Kumlien, Wade T. "Cost Accounting for Grounds Maintenance." Park Maintenance, May 1976, p. 9.

Linderman, Ann. "Maintenance Problems Cut by Classification of Park System." Park Maintenance, May 1974, p. 25.

Lofgren, David E. "Activity-oriented Time Cards." Grounds Maintenance, January 1978, p. 39.

_____. "Budgeting for Turf Care." Grounds Maintenance, November 1978, p. 34.

_____. "Budgets: A Tool, Not a Master." Grounds Maintenance, July 1978, p. 16.

_____. "Building Maintenance into the Design." Grounds Maintenance, April 1968, p. 10.

_____. "Calculating Maintenance Time Requirements." Grounds Maintenance, June 1981, p. 52.

_____. "Design Changes to Cut Costs." Grounds Maintenance, February 1970, p. 18.

_____. "Establishing Maintenance Priorities." Grounds Maintenance, April 1980, p. 66.

_____. "Evaluating, Equating a Grounds Inventory." Grounds Maintenance, February 1972, p. 35.

_____. "Formulas Become Reality." Grounds Maintenance, January 1972, p. 37.

_____. "How to Cost Equipment Use." Grounds Maintenance, May 1977, p. 30.

_____. "How to Figure Your Actual Landscape Costs." Grounds Maintenance, April 1975, p. 20.

_____. "Inventory Control: A Management Tool." Grounds Maintenance, March 1978, p. 85.

_____. Landscape First-Aid: A Caretaker's Manual. Salt Lake City: The Church of Jesus Christ of Latter-Day Saints, 1967.

_____. "Landscape Maintenance Chart of Accounts." Grounds Maintenance, March 1977, p. 74.

_____. "Landscape Maintenance Costs." Grounds Maintenance, July 1971, p. 36.

_____. "Landscape Maintenance Inventory." Grounds Maintenance, November 1969, p. 14.

_____. "Landscape Maintenance Time-demand Schedules." Grounds Maintenance, August 1978, p. 24.

_____. "Landscape Quality Design Evaluation." Grounds Maintenance, August 1971, p. 31.

_____. "Making a Maintenance Program Happen." Grounds Maintenance, March 1972, p. 73.

_____. "Mowing Time Requirements Based on Travel Speed and Width of Cut." Grounds Maintenance, August 1981, p. 80.

_____. "Scheduling Work Projects." Grounds Maintenance, April 1970, p. 20.

_____. "Site Planning for Efficiency." Grounds Maintenance, May 1971, p. 16.

_____. "Staffing Charts and Manning Tables." Grounds Maintenance, May 1978, p. 42.

_____. "Timesavers in the Landscape." Grounds Maintenance, September 1974, p. 10.

_____. "Time Schedules for Turf Management." Grounds Maintenance, January 1979, p. 48.

_____. Training Work Book II -- Maintenance Management. St. George, UT: The NAHRO Workshop, 1981.

_____. "27 Ways to Reduce Maintenance Time, Increase Efficiency." Grounds Maintenance, October 1973, p. 14.

_____. "Work Schedules for Improved Control." Grounds Maintenance, March 1974, p. 68.

_____. "Work Simplification, Measurement, Performance." Grounds Maintenance, February 1976, p. 30.

_____. "Writing Specifications for Maintenance Work." Grounds Maintenance, September 1969, p. 29.

Lowry, Stewart M.; Maynard, Harold B.; and Stegemerton, G. J. Time and Motion Study. New York: McGraw-Hill Book Co., 1932.

Luckham, W. R., and Reynolds, R. K. Business Management Techniques for the Professional Grounds Manager. Blacksburg, VA: Virginia Tech Extension, 1982.

Madisen, Erik. "The Crisis in Maintenance. Part II: The Department's Obligation." Park Maintenance, December 1971, p. 6.

Matecki, James. "Here's How One Department Justifies Budget Requests." Park Maintenance, July 1980, p. 14.

_____. "Prepare to Substantiate Budget Requests." Grounds Maintenance, February 1979, p. 18.

Metcalf, Edgar. "A Lot of Management Depends on Cause and Effect." 1982 Athletic Turf Management Annual. Appleton, WI: Madisen Publishing, 1982.

Millen, J. Michael. "Designing for Maintenance." Landscape and Turf, May/June 1982, p. 18.

Moritz, Chris G. "Good Design with Maintenance in Mind." Grounds Maintenance, February 1966, p. 8.

National Landscape Association. Landscape Designer and Estimator's Guide. Washington, D.C.: National Landscape Association, 1971.

Nelson, Daniel. Frederick W. Taylor and the Rise of Scientific Management. Madison, WI: The University of Wisconsin Press, 1980.

Newcomb, Duane G. "Upgrading Maintenance Traits." Grounds Maintenance, July 1966, p. 20.

"1968 Landscape Job Estimating Guide." Grounds Maintenance, January 1968, p. 21.

Olsen, Norma J. "Bidding and Estimating the Landscape Job." Grounds Maintenance, June 1966, p. 4.

O'Rourke, F. L. S. "A Guide to Landscape Job Estimating." Grounds Maintenance, June 1967, p. 21.

Owers, George. "Park Maintenance Plan: Ann Arbor Pioneers an Effective Guideline." Park Maintenance, September 1976, p. 11.

Park and Recreation Technical Services. Cost-Cutting Strategies for the Park and Recreation Agency. Washington, D.C.: U.S. Department of the Interior, 1981.

Pedersen, Bradley W. Management Planning: Projecting Costs and Tasks. Appleton, WI: National Institute on Park and Grounds Management, 1982.

Pies, Ronald E. "Tempe, Arizona Uses Computer for Maintenance Statistics." Park Maintenance, April 1971, p. 8.

Ponti, Michael. "Planning, Organization Make Maintenance Crews Efficient at Georgetown University." Park Maintenance, January 1982, p. 10.

Professional Grounds Management Society. Grounds Maintenance Estimating Guidelines. Pikeville, MD: Professional Grounds Management Society, 1984.

Renoll, Elms. "Predicting Machine Performance Rates for Specific Field and Operating Conditions," Circular 258. Auburn University, AL: Alabama Agricultural Experiment Station, December 1981.

Robinette, Gary O. Off the Board/Into the Ground. Dubuque, IA: Kendall/Hunt Publishing Co., 1968.

Rubinstein, Marion. "A Slice Out of the Maintenance Budget." Grounds Maintenance, February 1968, p. 32.

Schaefer, Theodore H. "You CAN Analyze Operation and Maintenance Costs by Using the Data Collection Method." Park Maintenance, November 1973, p. 8.

Schmidt, Owen B. "Labor Time Charts of Planting." University of Delaware Short Course, 1955.

Scholz, Olive. "Cut Maintenance through Good Design." Park Maintenance, December 1981, p. 6.

Shank, Bruce F. "Mower Efficiency." Weeds, Trees, and Turf, April 1983, p. 65.

Smith, Bruce A. "The City of Wilmington -- a Maintenance Case Study." Grounds Maintenance, May 1977, p. 56.

Staley, James G. "Planning and Scheduling." Grounds Maintenance, March 1977, p. 20.

Starr, Michael. "Data Processing Pays Off for Medford Parks Department." Park Maintenance, April 1972, p. 8.

Sternloff, Robert E., and Warren, Roger. Park and Recreation Maintenance Management. Boston: Holbrook Press, Inc., 1977.

Surtees, John. Service Charts No. 3. Ridgefield, CT: John Surtees.

Taylor, Frederick W. Scientific Management. Westport, CT: Greenwood Press, 1947.

Thomas, John S. "How Some Departments Cope with Adversity." Park Maintenance, January 1980, p. 8.

Totemeier, Carl. AABGA Northeast Regional Meeting announcement, June 5, 1981.

"Trimming Around Monuments Creates Maintenance Challenge." Grounds Maintenance, August 1980, p. 14.

Urbano, Cynthia C. "SLICE -- a Computer System for Landscapes." American Nurseryman, September 1984, p. 92.

Van Dam, John. "Labor Requirement Analysis for Landscape Maintenance," Leaflet 21232. University of California: Division of Agricultural Sciences, 1981.

Van Vorst, John. "Match Equipment to the Chore." Grounds Maintenance, August 1979, p. 29.

Watson, J. R., and Williams, Steve. "Calculate the REAL Cost." Grounds Maintenance, January 1983, p. 60.

Weatherton, C. W. "The Work Management System: A Tool for Park Maintenance Managers." Park Maintenance, December 1982, p. 10.

Weeks, Max C. "Maintenance Costs -- Neighborhood vs. Large Parks." Park Maintenance, January 1967, p. 24.

White, Sherrill. "High Level Maintenance with Low Level Budget." Park Maintenance, November 1980, p. 10.

Wilkinson, John J. "How to Manage Maintenance." Harvard Business Review, March-April 1968, p. 100.

Willis, Robert P. "Herbicides Can Cut Your Maintenance Costs." Park Maintenance, June 1978, p. 9.