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Development of A Process Which Integrates Maintenance Considerations Into The Planning and Design of Parks

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都市公園에 있어서 維持管理를 고려한 計劃 및 設計 方法論 開發

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槪 要

都市公園의 合理的인 維持管理를 위해서는 計劃 및 設計단계에서 管理體系 및 費用의 주의깊은 分析이 요구된다. 公園의 維持管理문제를 計劃 및 設計단계에서 고려하여 처리할 수 있는 方法論이 開發되어짐으로써 보다 合理的인 計劃 및 設計가 이루어 짐과 동시에 理想的인 維持管理가 行해 질것으로 예상된다.

本 硏究에서는 Columbus市의 都市公園을 Sampling 하여 維持管理費用(maintenance cost)을 分析하고 計劃 및 設計단계에서 維持管理費用을 줄일수 있는 한 試圖로써 Simulation Model을 開發해 보았다. 앞으로 컴퓨터 情報交換體系(Interactive computer information system)를 적절히 活用한다면 都市公園計劃 및 維持管理에 보다큰 發展이 예상된다.

이와같은 硏究를 보다 發展시키기 위해 1)상세한 維持管理費用의 分析, 2)管理費用을 절감시킬수 있는 설계基準(Criteria)의 설정, 3)計劃·設計·管理를 연결시킬 수 있는 컴퓨터 情報交換體系 (Interactive computer Information system)의 開發등이 더욱 硏究되야 할 것으로 생각된다.

INTRODUCTION

The development of a park maintenance program usually comes after a park has been designed and constructed and often deals primarily with such physical aspects as plants, structures and equipment. Without proper consideration of maintenance, a park can not function properly. Maintenance of a park is not only prevents its deterioration but also serves as a means of improving and enhancing it. This is particularly true with regard to plant materials in a park

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which can deteriorate rapidly if not properly cared for. Therefore maintenance programs and their significance in park design will be analyzed in this study. The purpose of this research is to develop a method of park planning which research is to develop a method of park planning which incorporates consideration of maintenance needs and activities in the planning stage.

A decade ago the cost of maintenance was considered so insignificant that managers gave little attention to evaluation or control of such expenses (Mann 1980). Many believed that maintenance cost could not be measured, scheduled, planned, or controlled (Goode 1986). However, faced with increased budget constraints, park managers now recognize the need to determine the size and the nature of maintenance programs and to organize and control the personnel, equipment and supplies required to successfully carry out the maintenance programs (Kerry and Harris 1978).

Many park maintenance programs suffer from a lack of funds and properly trained staff to do the necessary work. Failure to consider maintenance in the planning stage usually results in long term maintenance problems. In view of these problems, it is essential to integrate conideration of maintenance problems into the planning and design or redesign of parks. For example, the life cycling cost analysis of maintenance equipment, and facilities and plant material in a park should be a part of the planning stage. A well organized and highly integrated planning and design process will consider maintenance programming and activites from the very first moment – it is an iterative and evolving process. A properly developed and efficient maintenance program can only evolve if maintenance considerations are integrated into design stages.

However, there have been very few documented attempts to integrate the consideration of maintenance into the various stages of park development, and when considered maintenance has been given a much lower priority than other pogram elements during planning, design and construction. Furthermore, there has been little study of maintenance systems for parks. Several studies have focused on plant maintenance but there are few overall studies of the maintenance systems. Omula (1978) pointed out that there is presently no clear concept of maintenance, and argued for the necessity of gathering data regarding ways of calculating the required amount of maintenance and effective maintenance. Furuya (1980) claimed that we need an overall understanding of maintenance which focuses on the plant maintenance. However, both of these assertions are only general statements and are not detailed studies of the relevant problems. Kim Yong-Soo (1981) studied park maintenance systems as a methodology for planning. In his study, he suggested the establishment of a "plan" which integrates maintenance considerations into the planning program.

In this study, incorporation of a "state of the art" technology into park planning and design will be examined. During the past decade, there has been a great revolution in computer hardware and software. Computer simulation, one part of that field, in park and landscape planning is relatively new but it is possible and has great potential. It may be a most effective way to cope with predicting future situations. The computer software used in this study are EXCEL and ERDAS(Earth Resource Data Analysis Systems). EXCEL is a spread sheet program and ERDAS is a Geographic Information System package. These systems were selected due to their availability in the Deparment of Landscape Architecture at the Ohio State University and their user friendly characteristics.

Analysis of Parks And Recreation Systems

1. Columbus city parks summary

City parks are administered by the City of Columbus Department parks and recreation department. The classification system of Columbus city parks is catergorized into functional use groups that reflect the purposes they serve, the recreation needs they fulfill and the service areas

TABLE 1. Columbus City Parkland Summary of 1988

Parks	Number	Acres	Acre/1000
City Property			
Developed Parkland			
Neighborhood parks	101	749	1.3
Community and District	24	1357	2.3
Special Use and Facilities	44	1118	1.1
Subtotal	169	3224	5.4
Golf Courses	6	796	1.3
Reservoir Parks	3	1465	2.5
Undeveloped Parkland			
Park Reserve Sites	28	945	1.6
Watercourse/Conservation	19	179	0.3
Operations	4	77	0.1
Other City Property			
Street Islands	77	33	0.1
Street Easement	7	40	0.1
Lots	9	4	–
Median Strips	38	28	0.1
Subtotal	131	105	0.2
Easements			
Scenic and Conservation Area	44	164	0.3
Total Park Land and Properties	404	6955	11.7

Note : Acres per 1000 population figures are calculated using 1986 City of Columbus population of 593, 146
Source : Columbus Recreation and Parks Department, Park Facilities Guide of 1986.

to they cater to. The parkland summary of Columbus is shown in table 1.

The total area of parkland and properties is 6955 acres. The Columbus Park and Recreation Department is also managing the reservoir and other water areas which are comprised 5035 acres. The total acreage of parkland can be used as critical data for planning future management. In park planning the quantification of park supply has typically been given as a ratio of acres of park per 1000 people. The 6955 acres of Department equals to 11.7 acres per 1000 people.

Among the various categories of parkland in Columbus, developed parkland represent the highest percentage of acres and numbers. This means that developed parks serve as the most important element in the park system. The developed parklands are further classified into smaller units or groups such as neighborhood parks, community and district parks, and special use facility parks.

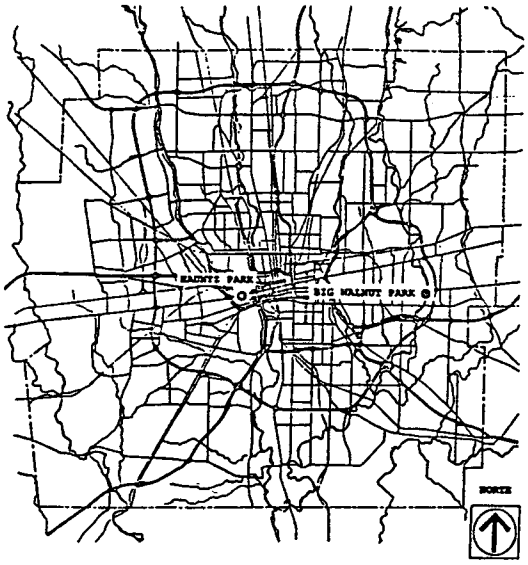
2. Sampling of Selected Parks

Parks were selected for analysis in this study in accordance with the following criteria.

a) The site was managed as a part of a developed parkland.
b) Precisely estimated maintenance expenses are available for the site.
c) Some maintenance problems have been identified on the park.

Based on these criteria Hauntz park (Neighborhood) and Big Walnut park (Community and District) were selected for further study. A special use park was not selected because this type of facilities is not managed by the Columbus Parks and Recreation Department. The location of parks selected for further analysis are shown in Figure 1.

The facilities located in each park are shown in Table 2. The recreational activities offered in each park have a close relationship to their facilities. Big Walnut park has more facilities and serves a wider range of recreational activities than Hauntz park.



Source : Columbus Recreation and Parks Department, Park Facilities Guide of 1986.

FIGURE 1. The Location of Sampled Parks

TABLE 2. Properties and Facilities of Sample Parks

	Hauntz park	Big Walnut park
Acreage	5.7 acres	142.8 acres
Classification	Neighborhood	Community & District
Recreation center	–	*
Restrooms	*	*
Playground	*	*
Softball	*	*
Baseball	–	*
Football	–	*
Soccer	–	*
Tennis courts	–	*
Basketball courts	*	*
Picnic area	*	*
Reservable shelter	–	*
Bikeway	–	*
Pond and lakes	–	*
Wooded scenic area	–	*

Note : Symbol * : present, – : not present
Source : Columbus Recreation and Parks Depatment, Park Facilities Guide of 1986.

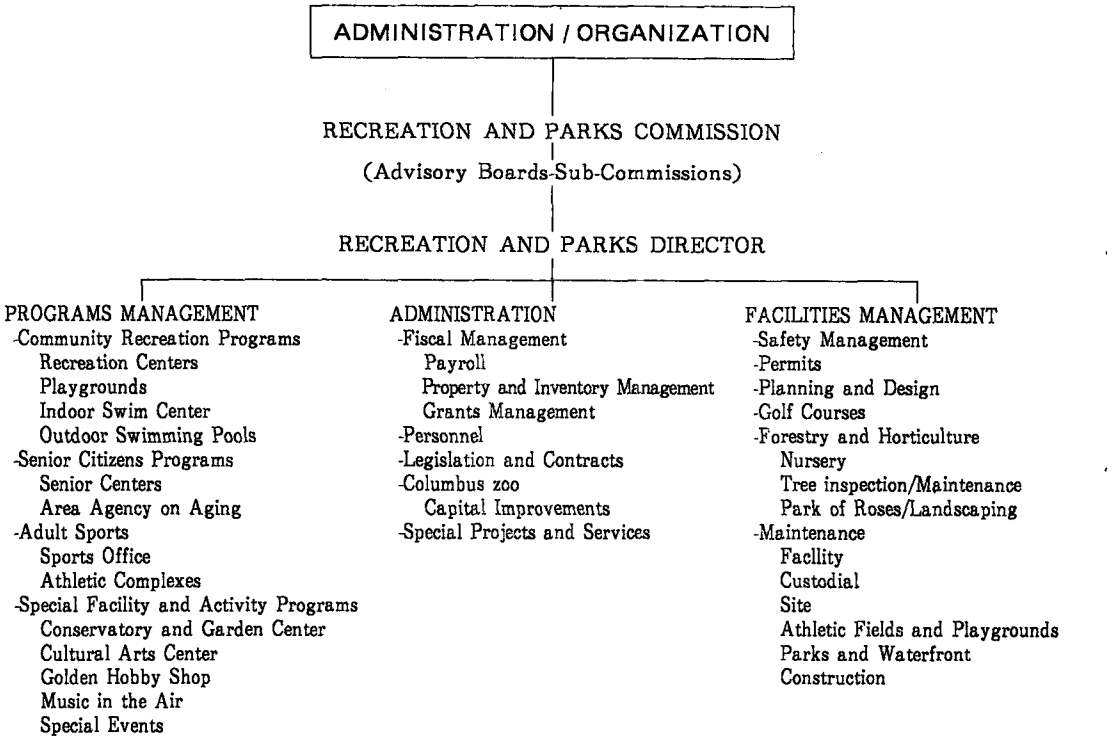
Park Maintenance system Analysis

1. Administration Organization

The successful management of park service depends on the role of the administrative and supervisory (Moses and Crawford 1977) professionals responsible for planning and carrying out recreation and park operations. Generally, an organizational chart shows how the major administrative responsibilities and functions such as program development and supervision, fiscal management, facilities planning, design, and maintenance, and administrative services – are assigned to separate divisions.

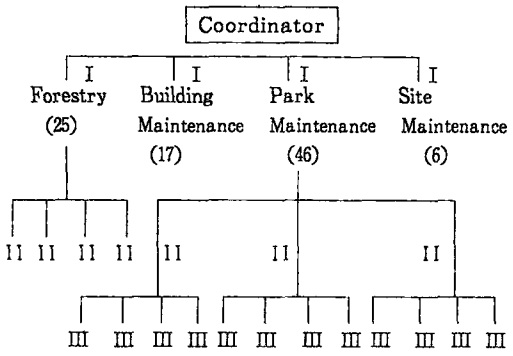
The Columbus Department of Recreation and Park is divided into three major sections : Program Management, Administration, and Facilities Management. The organizational chart (Figure 2) developed by the city of Columbus demonstrates the range of functions is responsible for administrative section, The Administration is responsible for the overall management and coordination of all departmental operations and activities, programs, facilities and other services. Program Management is charged with various recreation program development. Facilities Management is concerned with safety management, permits, planning and design, and maintenance of forests, parks, golf courses, and other facilities.

In order to take care of various park maintenance jobs, the Columbus Department of Recreation and Parks developed, in the Facilities Management section, divisions with specialized responsibilities and levels of authority and power. In order to better understand the sections of organization and the activities of its maintenane personnel, the Columbus Department of Recreation and Parks Maintenance Division chart of organization (Fig. 2) was restructured as shown in Figure 3. These are ; (1)the top managerial level (2)the supervisory or middle-managed level and (3)the direct-service level. The manager who holds the supervisory ; position must have those specific knowledge and skills which underlie park maintenance jobs. A coordinator works together with four managers to increase effectiveness. Direct supervision of maintenance jobs is done by a middle-management supervisory position.



Source : Columbus Recreation and Parks Department, Annual Report of 1986.

FIGURE 2. The Organization Chart of Columbus City



Note : I-Manager, II-Supervisor, III-Direct worker
(Number)-Total number of employees

FIGURE 3. Park Maintenance Organization Chart

Staffing levels in the park maintenance division include of 94 full-time employees, approximately 60 part-time summer employees and 5 other part-time employees in 1988. The park maintenance program is organized into 12 zones, each of which is covered by a mobile maintenance team. Under the fairly new approach, maintenance jobs are carried out by a highly mechanized system. The conventional methodology of assingning one or two maintenance workers to playground or a park is less efficient than a mobile team methodology (Moses and Crawford 1977). The mobile team in the Columbus park maintenance program consists of a supervisor and from two to four maintenance workers.

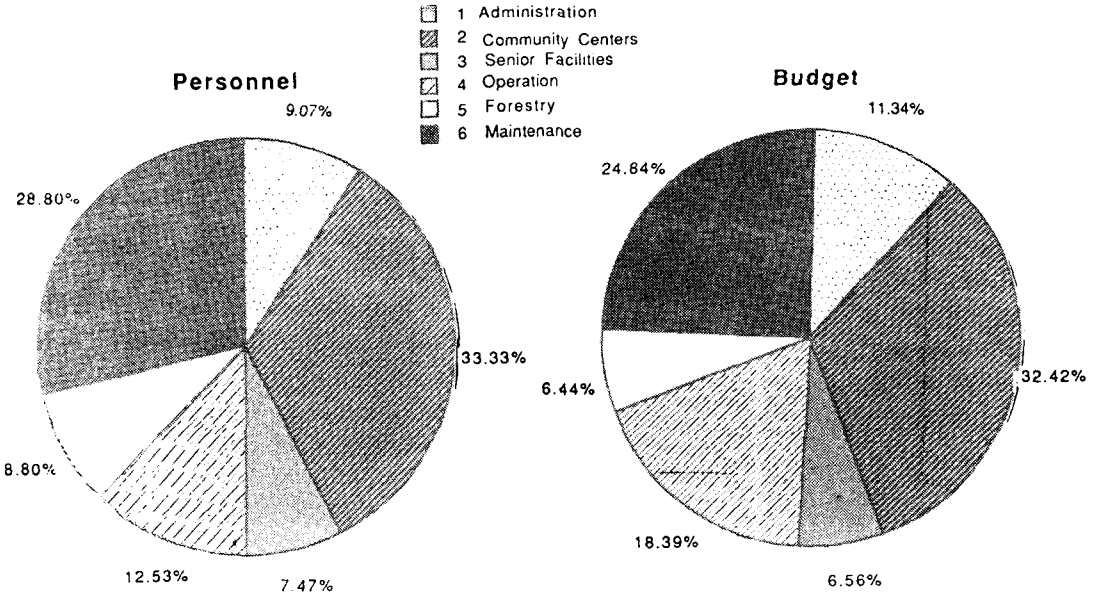
2. Budget Analysis

Columbus Recreation and Park Department manages a diverse range of facilities including parks, community recreation centers, senior citizen centers, athletic complexes, swimming pools and indoor swimming centers, and golf courses. All maintenance and operation budgets are funded through the recreation and park operation fund. This fund is composed of funds transferred from the cities general fund and revenues generated

TABLE 3. Program Description and Budget Distribution

Program Description	Budget(%)	Personnel
Administration : Management and coordination of all operations. Long range planning and project design and land acquisition.	$ 2,277,151 (11.3)	34
Community Centers/Playgrounds : Management of recreation centers, playground, shelterhouses, tennis courts, Indian Village camps, and the Cultural Arts Center.	$ 6,509,926 (32.4)	125
Senior Citizen Facilities : Management of arts and crafts program, educationcal activities, and social events.	$ 1,316,927 (6.6)	28
Operation and Extension : Revenue producing facilities and programs such as golf courses, adult sports leagues, and swimming pools.	$ 3,693,197 (18.4)	47
Forestry and Horticulture : Maintenance of city trees and landscaping.	$ 1,293,259 (6.5)	33
Maintenance & Repair : Maintenance of all department facilities and parkland.	$ 4,987,141 (24.8)	108
Total	$ 20,077,601(100)	375

Source : Columbus Recreation and Park Department, Program Summary of 1989.



Source : Columbus Recreation and Park Department, Program Summary of 1989.

FIGURE 4. Program Summary Of 1989

from recreation services (Columbus Recreation and Park Department 1988). The description of program and budget distribution in 1989 is shown in Table 3 and Figure 4.

From Figure 4, it can be seen that parkland maintenance comprises approximately 25% of the total budget. Most of the maintenance budget is used for the payment of employees. The repair and replacement of maintenance equipment is budgeted at a maximum of $ 300,000 or 6% of the total maintenance budget. Other supplies such as fertilizer and plants are intended to cost from $ 25,000 to $ 50,000 or about 1% of maintenance budget.

However, the department has not developed a systematic budget analysis for maintenance operations. Therefore, it is suggested that the cost analysis of principle maintenance jobs will assist in evaluating employee work output, assigning work tasks or planning budgets.

3. Maintenance Job Analysis

In order to examine the cost of maintaining sampled parks, a preliminary study of a general park maintenance manual was conducted. The general purpose of these manuals is to provied information on how various maintenance functions should be carried out. These manuals usually include precise statements of maintenance responsibility at all levels, operations calendars, suggested work plans and work sheets, lists of supplies and equipment, inventories of tools, inspection forms and checklists, and detailed statements as to how specific tasks are to be carried out (Moses and Crawford 1977).

Generally in park maintenance manuals, a variety of tasks should be considered (Gilcrest and Holland 1978). However, in the city of Columbus, only common maintenance work such as trash clean up, turf mowing and trimming, and tree pruning is carried out on a regular basis. This means that the maintenance division can adopt its own procedures depending on what they consider significant. The four basic maintenance tasks identified in the city of Columbus are very fundamental aspects of park maintenance and the performance of which will affect the physical characteristics of the park site.

These fundamental jobs are carried out in all the city of Columbus parks on the same schedule. Trash clean up is done two times every week (three times in the downtown area) throughout the year. Turf mowing and trimming is done during the growing season (14 times a year : between April and October). Tree pruning is performed once a year. Other maintenance jobs such as fertilization, disease and insect were required. The maintenance of facilities such as benches, picnic tables, trash cans, and play ground are done on a case by case as needed basis when a work order form is submitted by the maintenance staff.

4. Maintenance Cost Analysis

The objective of this section is to develop a systematic approach to anticipating maintenance cost using quantitative analysis. This method will establish the relationship between the park maintenance system and planning.

In the Division of Columbus Recreation and Park Department, a manager utilizes a time-and-motion schedule of each maintenance assignment of specify the duration of the proposed task. This information is very important for the quantitative analysis of maintenance cost. The maintenance cost analysis data was obtained by interviewing a manager of the Park Maintenance Division at Columbus Department of Recreation and Parks.

Table 4 illustrates an example of a systematic methodology for quantitatively presenting maintenance expenses. The total labor cost is calculated by multiplying the total unit(hours) of specific maintenance labor by labor wage (dollar/hours). Then the total cost of implementing each maintenance task can be calculated by combining the expense of machine fuel and depreciation. By multiplying this cost by the frequency of task execution, the total yearly expense is acquired. From this approach, it can be seen the duration of labor units such as hous or days is the most important factors in determining maintenance expenses. Life cycle cost analysis of maintenance equipment can start from an economic replacement concept. In order to estimate the cost of machinery replacement, the information on life expectancy, average daily use, original purchase price and the replacement cost per unit time was obtained by interviewing a manager of Park Maintenance division at the Columbus Department of Recreation and Parks.

Table 5 shows the equipment required by the Columbus Park Maintenance Division to perform major maintenance jobs such as cleaning turf mowing and trimming, and tree pruning. By dividing the original price of equipment by the

TABLE 4. Systematic Maintenance Cost Analysis

Items	Labor Hours (Hr)	Labour Cost ($)	Machine Fuel ($)	Repla. Cost ($)	Sub-total ($)	Frequency (Times/Year)	Yearly Total ($)
Hauntz Park							
Trash Clean Up	3	30	0	0	30	104/yr	3120
Turf Mowing	4	40	6	6.1	52.1	14/yr	730
Turf Trimming	6	60	4.5	12.3	76.9	14/yr	1075
Tree Pruning	160	1600	0	8	1608	1/yr	1608
						Total	6533
Big Walnut Park							
Trash Clean Up	4	40	0	0	40	104/yr	4160
Turf Mowing	48	480	36	8.1	524.1	14/yr	7338
Turf Trimming	72	720	27	147.8	894.8	14/yr	12528
Tree Pruning	48	480	0	2.4	482.4	1/yr	482
						Total	24508

Note : Repla, cost refers to the funds which must be set aside to permit replacing equipment of the end of its useful life.

TABLE 5. Maintenance Equipment

Types of Machinery	Primary Use	Price[1] ($)	Expected Service Life(Yrs)[2]	Replacement Cost ($/Hour)[3]
Tractor Mower	Mowing	16000	10	2.85
Dump Truck	Clean up	14800	10	2.64
Pick Up Truck-Tractor	Trimming	13000	10	2.32
Turf Trimmer 60"	Trimming	640	60	0.01
Weed Eater	Trimming	240	30	0.01
Chain Saw	Pruning	450	12	0.05

Note : 1 ; The price of machinery was assumed from 1988 purchase price at the Columbus Recreation and Park Department. 2 ; The expected service life of machinery was estimated by a manager of the Columbus Recreation and Park Maintenance Division. 3 ; By assuming the average weekly use (40 hours per week) and yearly frequency of machinery, replacement cost was calculated (i.e. 2.85−16000 / (10*14*40)).

estimated time of maximum use (this data is acquired by multiplying the life expectancy and the average daily use) of the equipment, the replacment cost per unit time (hour) can be calculated. By applying this data and the labor duration, the cost analysis of equipment replacement is possible. By comparing the labor cost and equipment replacement per the unit time (hour), the significance of these factors can be determined (Refer Table 6 of Maintenance Equipment). Labor cost is much higher than equipment cost. Thus, it is suggested more intensive use of equipment instead of human labor can lead to move economical maintenance.

Development of a Methodology which includes a Maintenance Program

1. The Establishment of criteria

Modern park design requires that a park facility fulfill 1)functional, 2)aesthetic, and 3) maintenance cost reduction or containment criteria(Donahue 1977). The ideal design will meet standards set for all three criteria. However there has been a tendency among planners and designers to consider the functional and aesthetic characteristics of parks more than maintenance concerns. Needless to say, aesthetic and functional organization of parkland are prime ingredients that govern the intensity of usage. However, increased use of parks during a period of limited or restricted budgets demands a more businesslike

approach to park maintenance and may eventually require development of methods to reduce maintenance costs.

During the design process, planners and designers also consider many other park and recreation resource design issues. However, they focus overwhelmingly on design and construction issues during the planning and design stage. Recreation and park resources designed for public use are not complete at the end of the construction phase but only become more or less complete (if successful) completed in the maintenance stage. The functional aspect of parks planning should consider long term maintenance and operation. Therefore, an ideal park plan includes consideration of equipment acquisition and maintenance staffing. By eliminating high cost maintenance tasks in the planning stage, the maintenance of original designs can be more esaily assured and/or carried out in the future. If continued maintenance is not economically feasible, a new development will replace the original design plan.

Total maintenance expenses depend heavily on such significant factors as human labor and machine usage. By considering these factors, design criteria based on low cost maintenance can be developed for site planning. For example, a paved surface extending 3 foot beyond all edges of a picnic table make mowing operation easier and saves time in cleaning. In the case of planting design, narrow distances operations. Thus, based on equipment specifications developed by the Park Deparment or the designer, minimum distance between objects can be suggested. Steep slopes present another factor hindering easy machine operation. Layout plans impact maintenance cost. For instance, when compared to scattered picnic tables, the grouping of picnic tables will save in cleaning cost.

By considering such factors, the following sample design creteria have been developed.

1) Minimum X1 distance concrete slab around picnic table.
2) Minimum X2 distance between trees.
3) Minimum X3 distance between curbs and trees.
4) Minimum X4 distance between fence and trees.
5) Maximum Y degree of ground slope.
6) Layout consideration for picnic area.

The distance of X1, X2, X3 and X4 will vary based on the different types of equipment. The mower width is probably the most significant factor in determining these distance. The Y value will also vary by different types of equipment (i.e.tractor mower versus push mower). The appropriate values can be determined by the local Park Maintenance Department based on the equipments they own. By considering such development criteria during the design process, economically effective criteria during the design process, economically effective maintenance can be assured.

2. Development of A Simulation Model

Planning is a continuous and incremental process that evolves development management or guidelines. Recreation Planning should be a systematic way of anticipating, causing, or monitoring change related to providing public and private leisure opportunities (Gold 1983). The traditional view sees planning as a static and linear process that follows a series of logical and consecutive steps. A more contemporary view of planning sees the process as dynamic and incremental as illustrated in Figure 5.

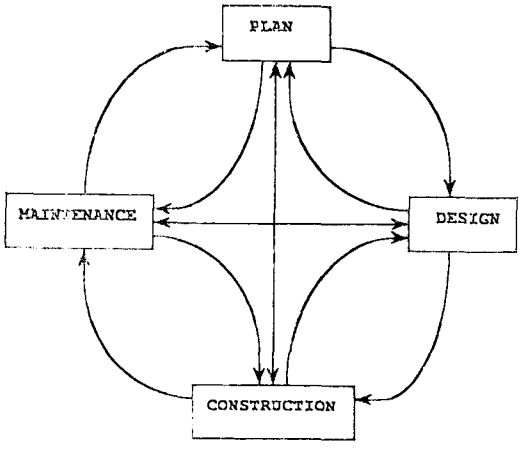


FIGURE 5. Schematic Dirgram of Park Planning

One way to develop an "ideal plan" in the planning stage is by simulation modeling to predict future phenomena. One purpose of simulation modeling is to determine the plans most effective spatial pattern for maintaining the functional and aesthetic quality of parks.

Simulation models were developed for both Hauntz Park and Big Walnut Park. Plans of both parks were entered into a Geohraphic Information System (using ERDAS software) and the surface areas devoted to various cover types were calculated (Figure 6 & 7). Then a spread sheet program (EXCEL) was used to analyze cost of maintnance in both parks. Later a new plan was developed to simulate alternative development options. The Geographic Information System and spread sheet programs were used again to compare with the previous plans.

For this simulation, the spatial distribution of surface cover becomes the fundamental determinant of maintenance cost. The surface cover patterns of the two parks were interpreted from aerial photos and site visits. Each surface cover area requires different maintenance techniques. Therefore, each surface cover area becomes a maintenance zone. Three maintenance zones are found in Hauntz park and 5 sub-zones in Big Walnut park. The determaination of these zones are based on the significant effects of site condition (i.e. slope, grass cover types and site characteristics) on equipment selection and operation in mowing. For example, the nature of equipment used in mowing of the site will be significantly impacted by physical conditions. Steep sloped (more than 15 degree) turf areas will require the most expensive mowing techniques of the various turf areas. Unmowed of meadow-like grass areas require the least expensive maintenance. (In Big Walnut park, natural turf areas are retained with no maintenance.) These natural grasses may create more visually interesting views through the modulation of color, texture, and height of plant materials (Hurdzan 1986). Wildflowers have a much stronger impact on the visual landscape and have a considerably lower maintenance cost than any other turf areas.

The actual maintenance cost of the two sample parks was acquired by interviewing a manager of the Columbus Park Maintenance Division. A matrix table was developed by assigning the cost of maintenance tasks to maintenance zones composed of different surface areas. When comparing the existing and simulated plan of Hauntz park, one can see that mowing maintenance cost is much lower in the simulated plan (Refer to Table 6 and Figure 6 of Maintenance Cost Analysis). This simulation was done to observe or to determine the advantages of grouping facility areas instead of having separate facility zones with intermediate turf areas. A plan like this will create turf areas more easily accesible by machinery.

TABLE 6. Maintenance Cost Analysis For Hauntz Park

Types	Acres(%)	Mowing	Trimming	Cleaning	Pruning
Flat turf	3.2(56)	460	759	2020	0
Block turf	1.3(23)	270	316	843	0
Others	1.2(21)	0	0	257	1608
Subtotal	5.7(100)	730+	1075+	3120+	1608+
			Present	total $	6533
Flat turf	3.7(66)	454	884	2354	0
Block turf	0.7(13)	123	165	439	0
Others	1.2(21)	0	0	257	1608
Subtotal	5.7(100)	577	1049	3040	1608
			Simulated	total $	6264

Note : Figures of symbol + came from yearly total maintenance cost of each task shown in the right end column of Table 3. The allocation of specific maintenance cost by surface type was determined by multiplying the total maintenance cost by percentage of surface area. The flat turf area is less difficulty to mowing than block turf area. Thus, it will be multiplied by a fraction value of 0.7. This value was determined by a manager of the Columbus Recreation and Park Maintenance Division.
(i.e. 460=730 * (56/79) * 0.7)

In Big Walnut park, another approach was used in modifying the design. The simulation involved changing the planting of steeply sloped area to natural grass (Refer to Table 7 and Figure 7 of Maintenance Cost Analysis). By simulating only this one change, approximately 9% of total maintenance cost was saved (Notice that this area covers only 2.5% of the parkland). Even though such an idea is very simple it can considerably impact the magnitude of future maintenance expenditures.

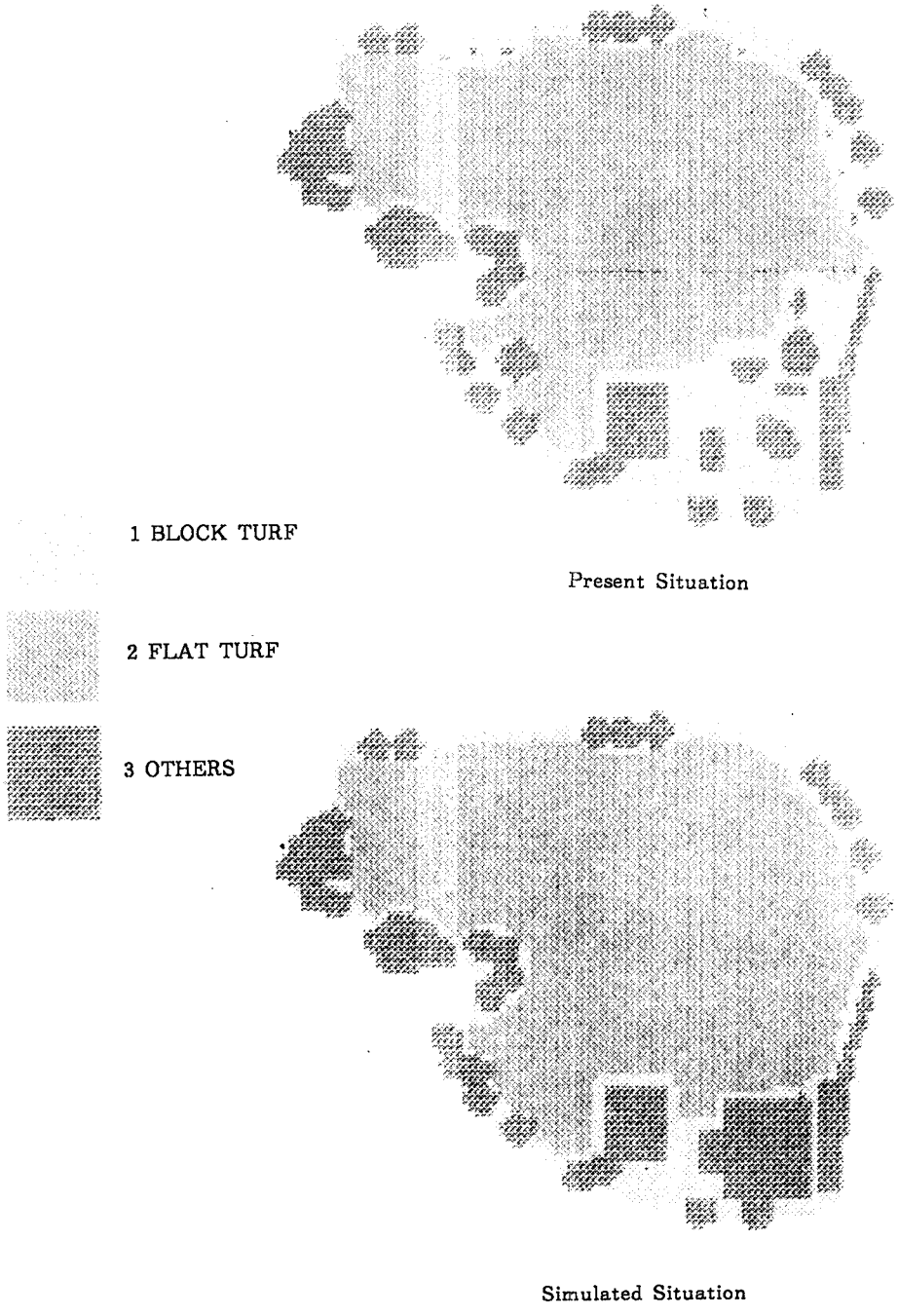
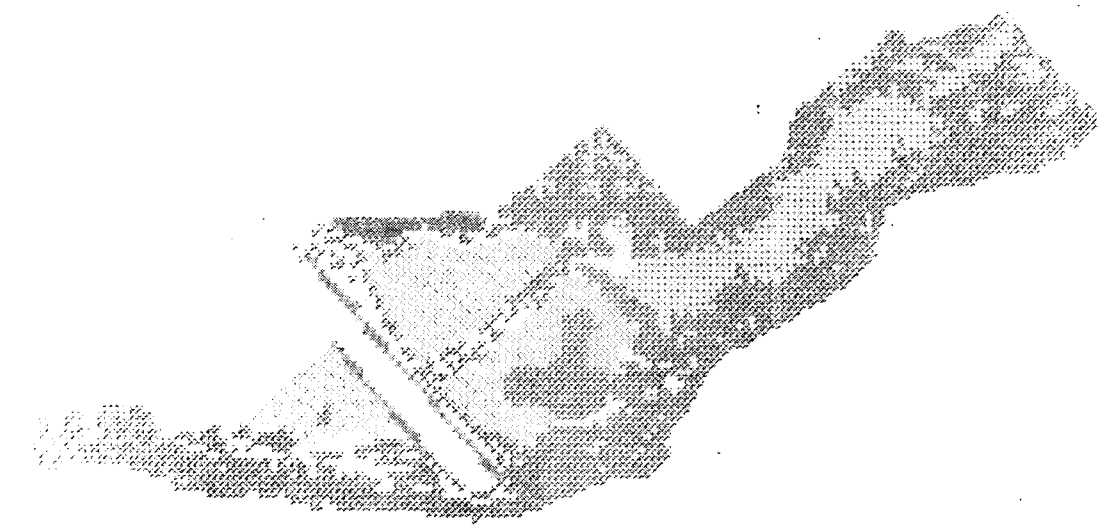


FIGURE 6. Maintenance Cost Analysis For Hauntz Park



1 BLOCK TURF

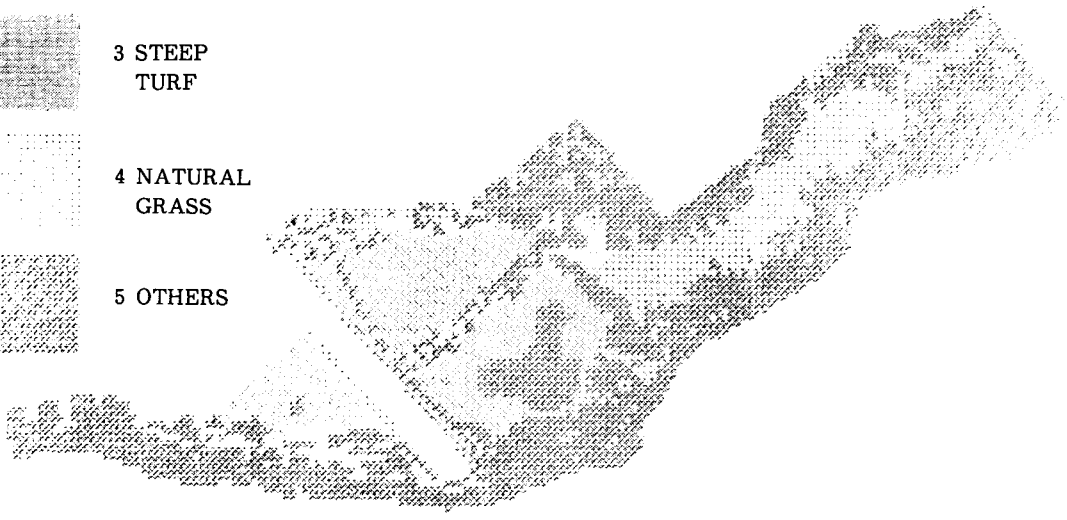
Present Situation

2 FLAT TURF

3 STEEP TURF

4 NATURAL GRASS

5 OTHERS



Simulated Situation

FIGURE 7. Maintenance Cost Analysis For Big Walnut Park

TABLE 7. Maintenance Cost Analysis For Big Walnut Park

Types	Acres(%)	Mowing	Trimming	Cleaning	Pruning
Flat turf	24.8(17)	3534	7269	1129	0
Block turf	14.3(10)	3020	4210	649	0
Steep turf	3.5(3)	784	1049	161	0
Natural Grass	22.3(16)	0	0	1017	0
Others	89.9(54)	0	0	1204	482
Subtotal	142.8(100)	7338	12528	4160	482
			Present	total $	24508
Flat turf	27.0(19)	3869	8111	1228	0
Block turf	9.0(8)	2370	3368	510	0
Steep turf	0(0)	0	0	0	0
Natural Grass	26.9(19)	0	0	1212	0
Others	89.9(54)	0	0	1204	482
Subtotal	142.8(100)	6239	11479	4154	482
			Simulated	total $	22354

Note : The calculations in this table are the same as Table 6.

This plan/cost simulation analysis demonstrates a useful and practical technique for determining the estimated expenses associated with a proposed (or existing) development plan. We believe this approach can provide a foundation for sound planning and decision making. However, conducting an accurate plan/cost analysis is not a simple process. It can be very time consuming and expensive to gather the estimated or actual cost data referred to in this paper. Also if the data is not used correctly, misleading conclusions can be reached.

The use of such data will be more effective when combined with various computer analysis capabilities. For example, using a Computer Aided Design (CAD) or GIS system which attaches to areas or facilities increases the speed with which quantifies and costs can be calculated. Even greater speed will result when the CAD or GIS based attributes can be easily transferred to Data Base Management system (DBMS) for rapid, dynamic simulation. By using this kind of interactive system, we can examine the visual representation of a park plan and its associated maintenance costs and there by compare and evaluate alternatives for reducing long term maintenance while in the planning stage. Thus, it can be concluded that the adoption of an interactive planning and design system may help to significantly improve park design and future maintenance.

CONCLUSION

There has been little study of park maintenance systems due to on over-emphasizing on planning, design and construction issues. However, effective management of public places such as parks requires careful analysis of maintenance programs and costs in the planning and design phase of development. One of the most effective ways to control future park maintenance budgets is to establish a method for predicting and dealing with maintenance issues/concerns in the planning stage. A simulation model was developed for selected sample parks in Columbus, Ohio. The characteristics of these sampled parks are commom to other urban parks in the United States. By considering ways to reduce or control maintenance expenses in the planning stage, a considerably large amount of money can be saved. Applying the plan/cost analysis concept generally to many parks in a system (Note that there are 101 Neighborhood parks and 24 Community parks in the city of Columbus) could have a very strong effects on total park operation budgets.

The model developed in this study proved to be an effective way to predict and evaluate alternative future maintenance expenses associated with plans. It is suggested that the system of relating park planning and future maintenance can be based on an interactive computer information system. The park system is the desirable management level for properly evaluating and determining local situations and future plans. Future research to improve such planning might include (1) determining how to calculate accurate maintenance budgets and expenses (2) development of design criteria reflecting cost effective maintenance (3) methods of connecting administration, planning and design by using interactive computer systems.

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