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Right-of-Way Forestry

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Since World War II, the landscape-architecture approach to the maintenance of the right-of-way (ROW) of our major highway systems has been most commendable. The grade of the nonpaved portion of the ROW has been aesthetically maintained by planting grass and a combination of woody shrubs and trees. This was accomplished at relatively low cost compared with the annual new-highway construction budget. Since 1973, widespread inflation has caused a marked reduction in annual transportation department budgets, which has made a review of maintenance costs necessary. An alternative approach to ROW maintenance is forestry. This should reduce costs considerably and under normal economic conditions should actually yield a net profit. In addition, ROW forestry will produce many thousands of tons of biomass annually for energy, food and fodder, and feedstock for the chemical industries.

When the U.S. highway system was primarily gravel roads, the width of the right-of-way (ROW)--owned, easement, or both--was usually one chain or four rods, which is 66 ft. The advent of the Interstate highway system in the 1950s encouraged an expanded ROW at least 300 ft wide with a median strip of variable width. This permitted better use of existing grades to meet the standards of the new highway system. The most practical way to keep the nonpaved portion of the total ROW in place at the desired grade was by planting grass. Then interest and concern with the overall aesthetic appearance of the highway system led to the planting of perennial woody shrubs and trees to supplement natural vegetation.

It was logical to turn to the landscape architects for support in ROW maintenance, because their training and philosophy fitted into the perceived needs of ROW management as delineated above. During the 1950s and 1960s, when all of the states were participating in the construction of the Interstate highway system, the ROW maintenance budget was small compared with the new-road construction budget. With the funds available to them, a comparatively small corps of landscape architects and supporting technicians did a magnificent job of maintaining and beautifying the Interstate highway system, for which they deserve much credit. As construction of the Interstate hignway system slowed in the 1970s, the annual maintenance budget, which had not increased substantially, appeared to be a larger portion of the total annual budget. Now in the 1980s each state transportation department is being forced to reduce every component of its annual budget, including maintenance. Under these circumstances it is appropriate to raise such questions as: Why mow grass? Why plant perennial woody shrubs and trees? Are there alternative uses of the nonpaved portion of the ROW that might produce essential usable material and income? The purpose of this paper is to explore answers to these questions from the point of view of forestry.

FORESTRY

From a strategic point of view, forestry has been defined by the Society of American Foresters as the science, the art, and the practice of managing and using for human benefit the natural resources that occur on and in association with forest land. The tactics of forestry have followed the wave theory (1) proposed for the development of human society. The first wave, the use of solid wood, began thousands of years ago similar to the evolution and development of agriculture and encompasses building, boats, furniture, and so forth. The second wave, reconstituted products from wood, began about 1870, 200 yr after the beginning of the industrial revolution, with the manufacture of paper and continued more recently with the manufacture of particleboard and waferboard. The third wave, the molecular use of wood, is just now getting under way and parallels the computer age and the return of cottage industries. It is the use of wood by the chemical industries as an alternative for oil, coal, and gas. The molecular use of wood will alter the molecular structure of the wood and virtually eliminate the significance of species or tree size, which have been important factors. The first two waves have been able to coexist because there has been an abundance of forests and a relatively small world population. The third wave undoubtedly will compete with the first two waves because there is already keen competition for the available raw material from the world's forests due to annual shrinkage in the area of forests and a world population, now about 4 billion, that is doubling every 30 yr.

In 1959 Young and Chase of the University of Maine began a series of biomass, nutrient, and pulping studies of merchantable-size trees, later extended it to smaller trees, and finally included woody shrubs. This effort led initially to the complete-tree concept and eventually to the complete-forest concept, which is now defined as follows: biological and technological investigation of all of the woody-shrub and tree species in the forest from the root tips to the leaf or needle tips inclusive with a view to intensive management of a portion of the forest for (a) solid products, (b) reconstituted products, (c) solid or liquid fuel, (d) food and fodder, and (e) feedstock for the chemical industries. Studies within the complete-forest concept have required the collaboration of many scientists and the assistance of many students. This effort has been documented (2) in more than 120 papers and bulletins. The perspective of this research during the past 23 yr has been biomass in the sense of all of the woody vegetation in the forests; it must always be borne in mind that clean air, clean water, and recreation are priority considerations in sound forest management.

The complete-forest concept is imbedded in the basic strategy of sound forest management and is compatible with all three waves. It is flexible in the tactics of forest management and represents not only the present but also the future, when the full potential of the forest is reached as chemists and engineers extend their research and industrial talents into the biologically complex environment known as the forest.

FOREST ENGINEERING

Axes, crosscut saws, and oxen and horses for transportation characterized forest harvesting until World War II. Since then, forest engineering encompassing all aspects of mechanization in forest management, harvesting, and transportation has truly come into its own because the new equipment has been and is being designed for forestry purposes and with regional and climatic factors in mind. There is now a tremendous range in size and variety of forest-engineering equipment and more is becoming available each year because of the market potential. The limiting factors now may be the ingenuity and imagination of the design engineers because the price of some self-propelled machines exceeds $250,000. The tactics of forest management should be modified to utilize mechanized procedures within economically sound planning in conjunction with markets and demand trends. There is little evidence that foresters have fully taken machines in stride. At the same time, existing and potential forest industries are not fully aware of the millions of tons of forest material that can be harvested and transported to industrial sites at relatively low cost.

A few examples will be helpful. Since World War II hundreds of mechanized tree planters have been used to plant more than 20,000,000 acres in the southeastern United States. Since 1970 more than 800 mobile chip harvesters, a type of forest biomass harvester, have been used to produce chips from the entire above-ground portion of trees. This has doubled production in hardwood stands due to the utilization of tops and small trees that otherwise would be left as waste. There are about 150 stump-root harvesters in use in the Scandinavian countries and the United States. These are more efficient than bulldozers in removing the stump-root system from the earth, and the process makes more material, about 20 percent of mature stands or as much as 40 fresh tons/acre, available for use. Currently several prototypes of multistem harvesters, designed especially for dense stands of small trees and woody shrubs, are being tested. One of the machines being tested can pick up material lying on the forest floor and can harvest the above-ground portion of stumps.

RIGHT-OF-WAY FORESTRY

In 1972, as a pioneering venture, Young (3) proposed woody-fiber farming on ROWs as a means of producing usable material for reconstituted products (paper, particleboard, and so forth). The following year (4) this was extended into forest management of ROWs for the entire gamut of forest products as a means of reducing ROW maintenance costs. In 1973 dramatic increases in oil prices, an awareness of the finite amount of oil in the world and of the need for alternative sources of energy, and the beginning of a long period of inflation occurred. As a result of these developments, the potential for forest management on ROWs was brought up to date in presentations before the Landscape and Environmental Design Committee of the Transportation Research Board at a meeting in Orono, Maine, in 1981 and during the Symposium on Environmental Concerns in Right-of-Way Management held in San Diego, California, in 1982.

To explore the forestry possibilities along ROWS in some detail, Hatton (5) completed a study of a 23-mile section of Interstate 95 just south of Bangor, Maine. A field inventory conducted on a sampling basis indicated that about 22 acres/mile is currently mowed and another 22 acres/mile is covered with vegetation that ranges from a combination of grass and wood shrubs to deciduous and coniferous stands in the 40- to 50-ft height class. Inasmuch as the Interstate system in Maine is approximately 300 miles, the total available for forestry purposes is about 14,000 acres.

Analysis of the inventory data led Hatton to recommend that most of the nonpaved ROW should be encouraged to produce puckerbrush (currently noncommercial species), commercial tree species, or both with a limited acreage allocated to hybrid aspen and conifer plantations. Within 20 yr it should be possible to harvest Christmas trees, fuel wood, bolt wood, and saw timber annually. Plantation ventures have a higher initial cost but should bring a greater return in less time than if existing natural vegetation was merely allowed to grow until market conditions permitted harvesting.

It is not possible or desirable to switch abruptly from the landscape-architecture to the forestry approach. It is anticipated that current mowing and spraying practices will be diminished and plantations and other forest management practices will increase. It is anticipated that foresters and landscape architects will blend their professional backgrounds to develop ROW maintenance practices that will be aesthetically appealing, safe, and productive of many thousands of tons of woody material that can be used. Just as landscaping Interstate highways is not identical with landscaping estates, forestry on ROWs will not be identical with forest management of farm woodlots or large tracts.

We are convinced that there is little to be gained from more studies similar to those cited earlier. The next logical step is for one or more state transportation departments to try a combination of forestry and landscape architecture. For those so engaged this will be a new venture in which everyone will learn by trial and error. Results cannot be assessed after only 1 or 2 yr, for markets must be developed, contractors encouraged to participate in this new venture, and both field and safety methods determined. The potential decrease in maintenance costs as well as the potential contribution of an enormous amount of biomass to the nation's economy encourage a positive dynamic approach to developing ROW maintenance from a widely expanded point of view.

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New Program of Chemical Mowing Along Indiana Roadsides

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The objective of this research project—full-season vegetation control along Indiana roadsides through a single spray application with no need for additional herbicide application and the complete elimination of mechanical mowing—has been realized. A combination of materials is used that consists of a grass growth retardant, a primary agent to control broadleaf weeds, and various additives that potentiate the mixture. The application is made during a 1-month period in early spring by using standard commercial spray equipment. Formation of grass seedheads is prevented and by frost, in the fall, total grass height is still less than 12 in., well within the normal mowing limits specified by the state. Thus, the feasibility of chemical mowing has been demonstrated. In addition, by means of low-cost potentiating additives, the economics are such that the cost of the treatment is substantially less than current costs of three-cycle mechanical mowing with a herbicide treatment. Additional cost-reduction approaches are under investigation. The program has immediate application for difficult-to-mow areas or narrow medians, guard rails, bridge approaches, and so forth, where both cost and safety considerations favor complete elimination of conventional mechanical mowing.

Chemical mowing is the outcome of a program of research in roadside vegetation management initiated for the state of Indiana in 1966 under the auspices of the Joint Highway Research Project of the Department of Civil Engineering of Purdue University. The research was structured to include four phases (Table 1).

The first research phase, from 1966 to 1970, was largely one of problem identification in which surveys were conducted to evaluate existing vegetation management practices and to identify specific needs that, if met, would result in significant cost savings to the state.

The second phase, development of a herbicide program, was the first to be implemented. The program began in 1971 and was fully implemented in 1972-1973. A fall application of an environmentally safe amine formulation of 2,4-D was followed by a second application in early spring on a 3-yr rotation. This program was presented in 1975 (1) and has been very successful.

Research on phase 3, reduced mechanical mowing, was initiated in 1971 and first implemented in 1974. A report on this phase was made in 1978 (2) and remains the basis for current mechanical mowing practices in Indiana.

The project has now entered the implementation of phase 4, or chemical mowing. The objective was to develop and test materials that would eliminate or reduce the need for mechanical mowing and provide

Table 1. Indiana program of roadside vegetation management.

Phase	Designation	Begin	End	Total Study Cost ($)	First-Year Cost Savings ($)
1	Problem identification	1966	1970	25,000	None
2	Herbicide program	1971	1973	30,000	300,000
3	Reduced mechanical mowing	1974	1976	45,000	1,100,000
4	Chemical mowing	1977	1983	125,000	2,000,000[a]

[a]Projected.