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Field Notes

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Analysis Principles for Use in Planning

How "Rops" can Serve as "Fops"

Washington Office Division of Engineering News

FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

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FIELD NOTES

ANALYSIS PRINCIPLES FOR USE IN PLANNING[1]

By Victor M. DeKalb
Project Leader, Forest Service Transportation System Planning Project

INTRODUCTION

During the last half century, the Forest Service has passed through various operational phases in meeting the responsibilities assigned to it by Congress. Today, Forest officers join with the people of the United States in recognizing a new challenge to provide an adequate environment with limited resources.

The problems arising from "limited" resources, special interest groups, and a land ethic have caused many of us to rethink the relationship of mobility to the use (or management) of resources in the National Forests. The notion that resource development and transportation system plans must be developed as one unit has been extensively discussed in meetings and in Forest Service publications (for Forest Engineers, *Engineering Field Notes* has had several articles) during the last four years. This notion has not received overt opposition. In fact, most Forest officers agree that the concept is right. However, habits are stronger than logic and in the realm of action and decisions for planning there is a long way to go before the two processes are fully implemented. This is a part of the bigger problem of obtaining a change in Forest Service officers from the traditional "functional" thinking to "total resource" thinking.

The above objectives and problems have been repeatedly discussed in recent Forest Service meetings and they serve as a foundation for the following discussion on analysis principles for use in planning.

As a result of the need for better integrated planning in the Forest Service, a considerable amount of time is being spent by Forest officers in developing methods to apply planning theory to wildland use design problems. This presentation will discuss some aspects of planning which should provide help in the practical analysis of a resource development problem.

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[1] *Presented at the Region 4 Forest Engineers Meeting, Salt Lake City, Utah, January 26, 1972*

THE LEVEL OF INTENSITY OF PLANNING

Forest Service management planning is a continuing, adaptive process. Planning and "planning" tools are used at every level of operation from developing a land management plan to developing a procedure for yearly maintenance and operation of the transportation system. In each situation, data collection and analysis efforts must be in tune with the risks and values involved – that is, they must be as *intense* as is necessary to *minimize irrevocable decisions.*

Peter Drucker has expressed the relation between present planning and future events as follows: "Long-range planning does not deal with future decisions. It deals with the futurity of present decisions."[2]

Today, land use decisions set the stage for tomorrow's decisions. They must balance economy and flexibility and must meet the social objectives of today with the capacity to react to further circumstances and needs.

Land use planning in the Forest Service usually begins seriously (because of lack of money and manpower) when there is a need to do something about one or more resources in the area. At present, the resource usually triggering land use planning is timber. Since only one resource will be manipulated intensively as result of the plan, it follows that several levels of intensity in data collection and analysis will occur within the same planning area. Such variation depends on the intensity of planned use and the effects on other resources and lands within the planning area. This concept requires that the intensity of the planning process be varied over a selected area and be based on the principle that "irrevocable activities should be minimized." The first planning step is long-range analysis and planning which gives a broad but shallow coverage so that an analyst can then select, when the need arises, the area or areas requiring more penetrating studies.

Based on the above brief discussion, the following two principles can be stated:

(1) Intensity of planning should be enough to minimize irrevocable decisions.

(2) At any one time, intensity of planning will vary within a planning area, depending upon the particular problem being considered and the portion or aspect (function) of the area being studied.

Many regional supplements on transportation planning suggest that the *primary* system should be considered under long-range planning and the secondary collector system should not be considered until a shorter time horizon is in effect. This procedure does not fit the above principles.

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[2] *"Long Range Planning," Management Science, April 1959, p 239*

PHASES OF DIFFICULT PLANNING

During the last few years, many *planning* processes have been developed by Forest Service units and other experts. They all work and, under the present state of the art, require considerable hand analysis. In applying any planning process, the same sensitive areas of importance are often overlooked by the analyst. The phases where difficulties occur are discussed below.

One area we fail to recognize is the importance of reviewing an existing system. In many cases in the Forest Service, a system of operation already exists and is recognized, but the individual parts, their interrelationship, and their individual and overall objectives have been established in a prior time period and their *characteristics are no longer valid.* This situation makes objective planning or analysis of the system much more difficult than in many non-land use situations where no system exists. This leads to one of the areas of planning weakness – that of insufficient time spent on analyzing the existing situation in establishing objectives for the planning project.

A typical planning process is shown in Figure 1. This process can take several man-months to complete. A 20,000 acre area using overlays takes four men at least 3 months to *plan.* The establishment of objectives should have taken 3 to 5 days with the full participation of the decision maker and should have had periodic review during the operation.

A more intensive breakdown of the *Definition of Goals and Objectives* box is shown in Figure 2. The last box could be rewritten as *Decision Making for Definition of Goals and Objectives.*

This leads to principle 3 –

(3) Decisions about goals and objectives are no different than other management decisions. They must be established through a planning process and this process must allow sufficient time to assure reasonable goals. Such goals and objectives must then be periodically reviewed and subjected to change in view of information obtained in the full planning operation.

Most planning processes indicate a flowchart like that shown in Figure 1. Feedback lines are usually limited to points where the feedback is considered essential. These flowcharts create an impression that feedback to the decision maker and between boxes (phases) is not continuous and universal. Perhaps a better picture of the planning process can be developed by redrawing Figure 1 to look like Figure 3.

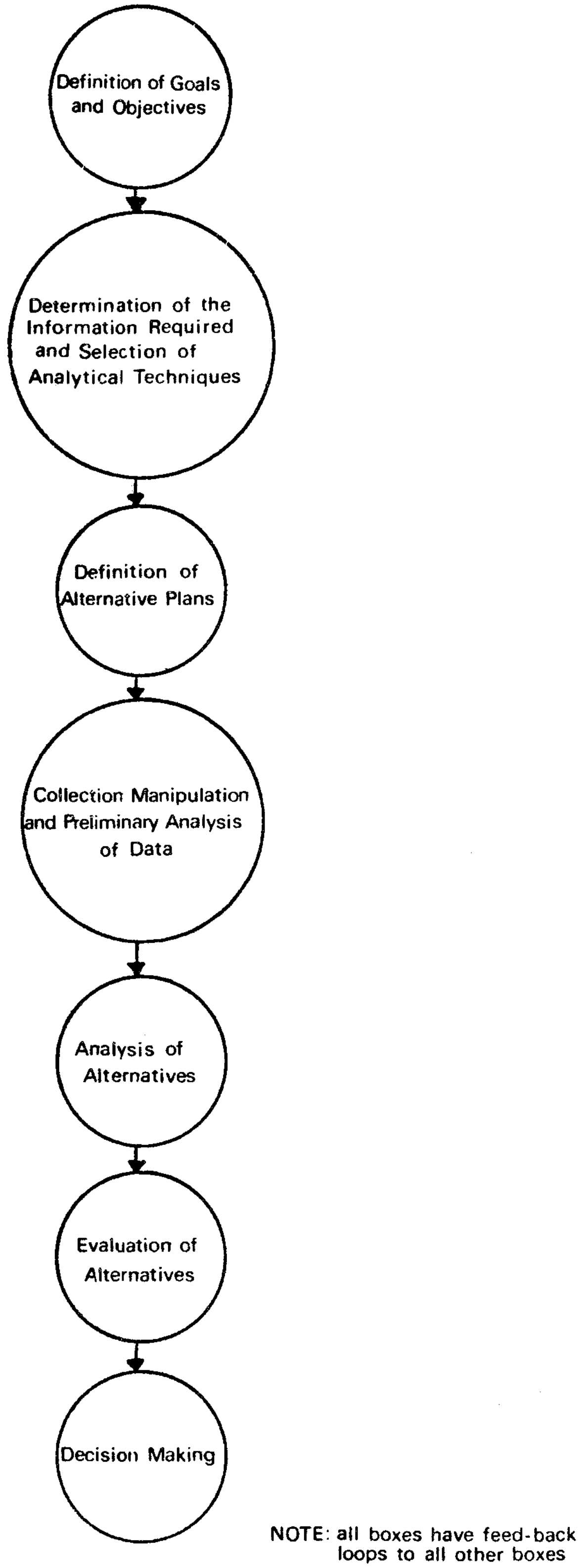

Figure 1. – A Planning Process

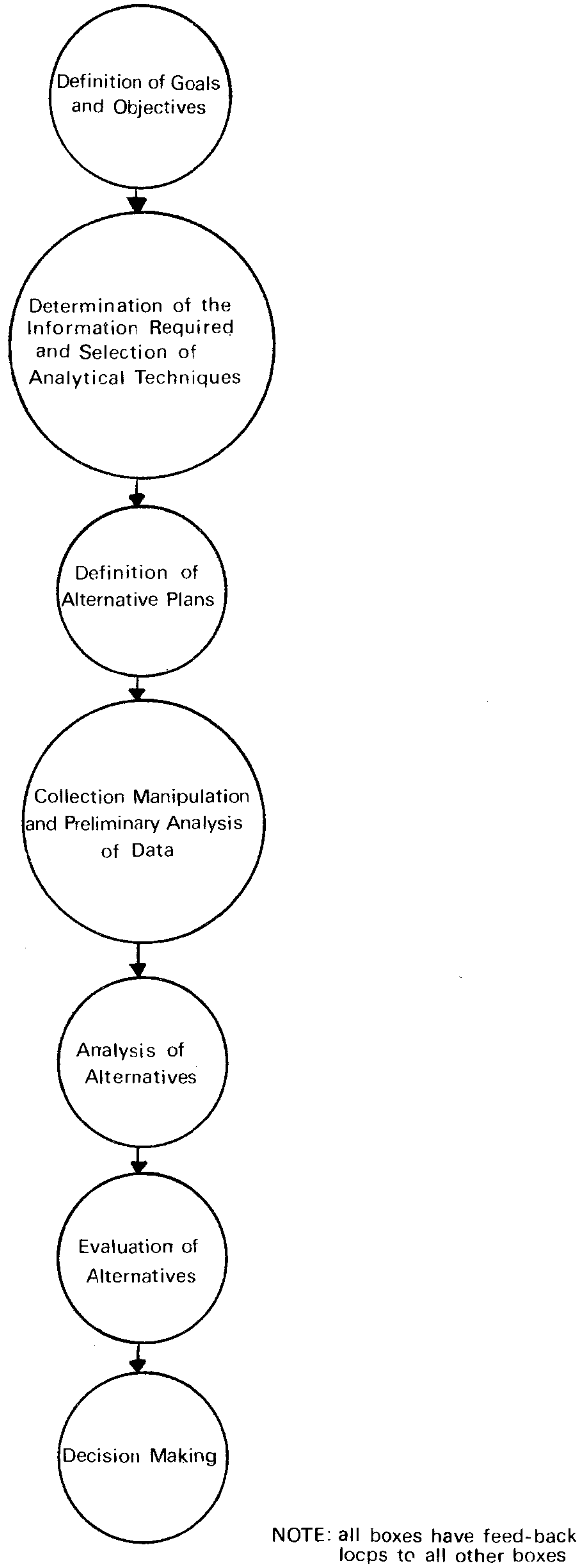

Figure 2. – A Process For Defining Goals and Objectives

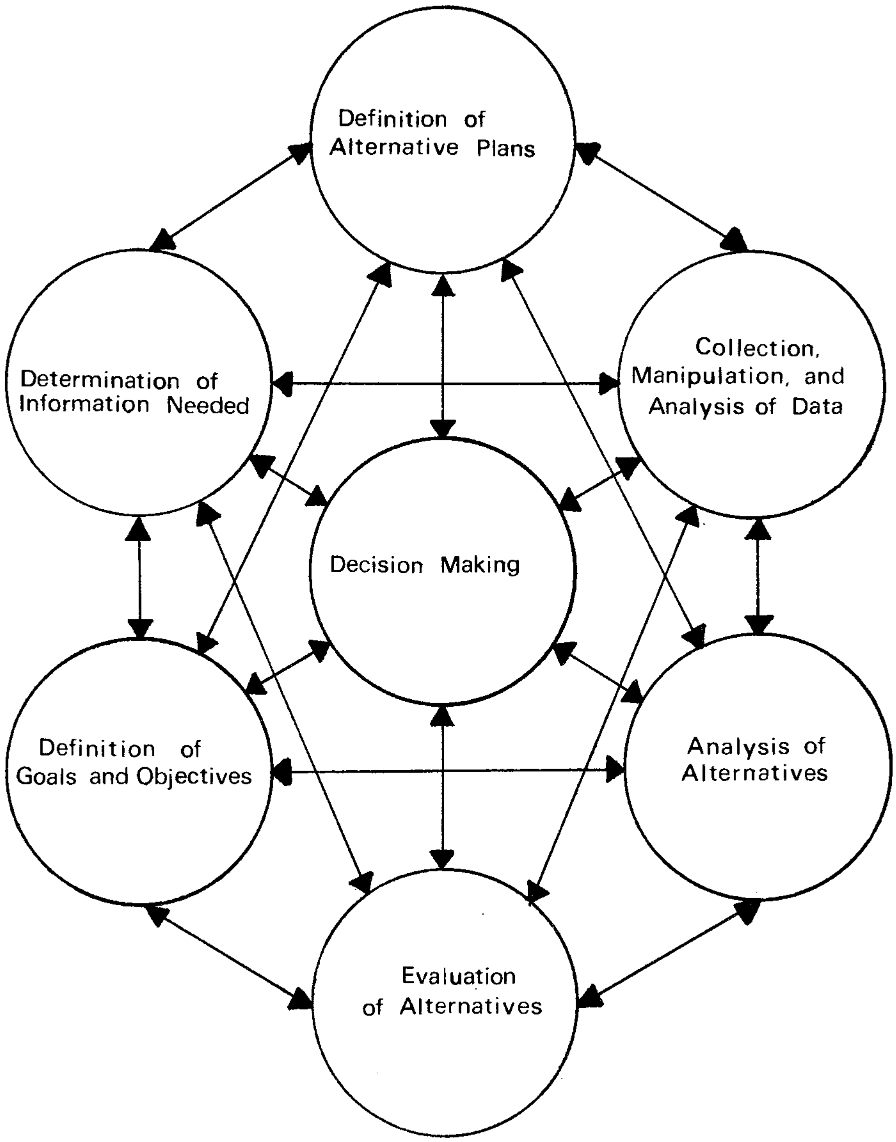

Figure 3. – Interaction Needed Between Steps

Principle 4 –

(4) The decision maker should be involved in continuous interaction with a planning analyst. Interchange and iteration between all phases of the planning process are necessary. Although he may be working in one phase primarily, a planning analyst must be working in portions of all phases continuously.

One of the early stages of the planning process is to define and/or recognize a planning strategy for the planning project being considered. This would probably occur during the definition of objectives. "Planning . . . . strategy is a procedure, established in advance, that determines how, when, and to what depth various parties will participate in planning, evaluation and decisions."[3]

Figures 4 through 8 indicate several different abstract approaches to interaction between a planner and other interested parties. We have adapted them to indicate parties dealt with when planning is at a Forest level.

A brief description of each strategy follows:

Strategy of Information – Figure 4

The planner/forest supervisor controls and conducts the study and only contacts others to present findings and gather information.

Information with Feedback – Figure 5

The planner/forest supervisor controls the studies. He develops alternatives and makes *planning* decisions. Alternatives are presented to others and feedback obtained. Proposed plans may or may not be adjusted based on these inputs.

Arbitrative Planning – Figure 6

Strategy places the forest supervisor or his assistant (or another officer) between the interested parties and the planning unit. He goes to interested parties, secures information and feedback, and then directs and guides the planner in analysis.

The Coordinator – Figure 7

The planning unit places itself in contact with interested parties, assesses their objectives, tests alternatives, and receives feedback. Interaction among parties is not encouraged.

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[3] *Bruce Bishop, Clarkson H. Oglesby, and Gene E. Willeke, Community Attitudes Towards Freeway Planning: A Study of California Planning Procedures, Highway Research Record No. 305, p 46*

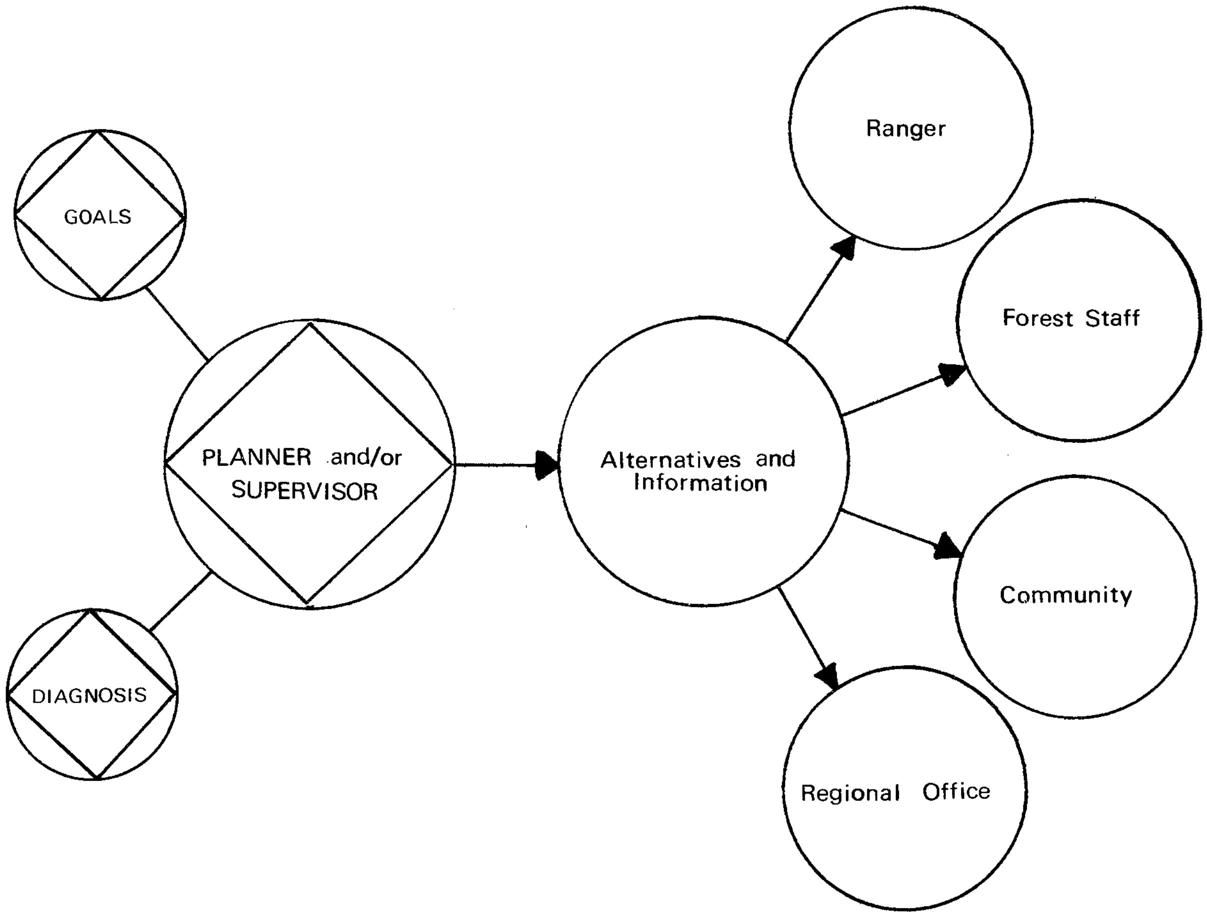

Figure 4. – Strategy of Information

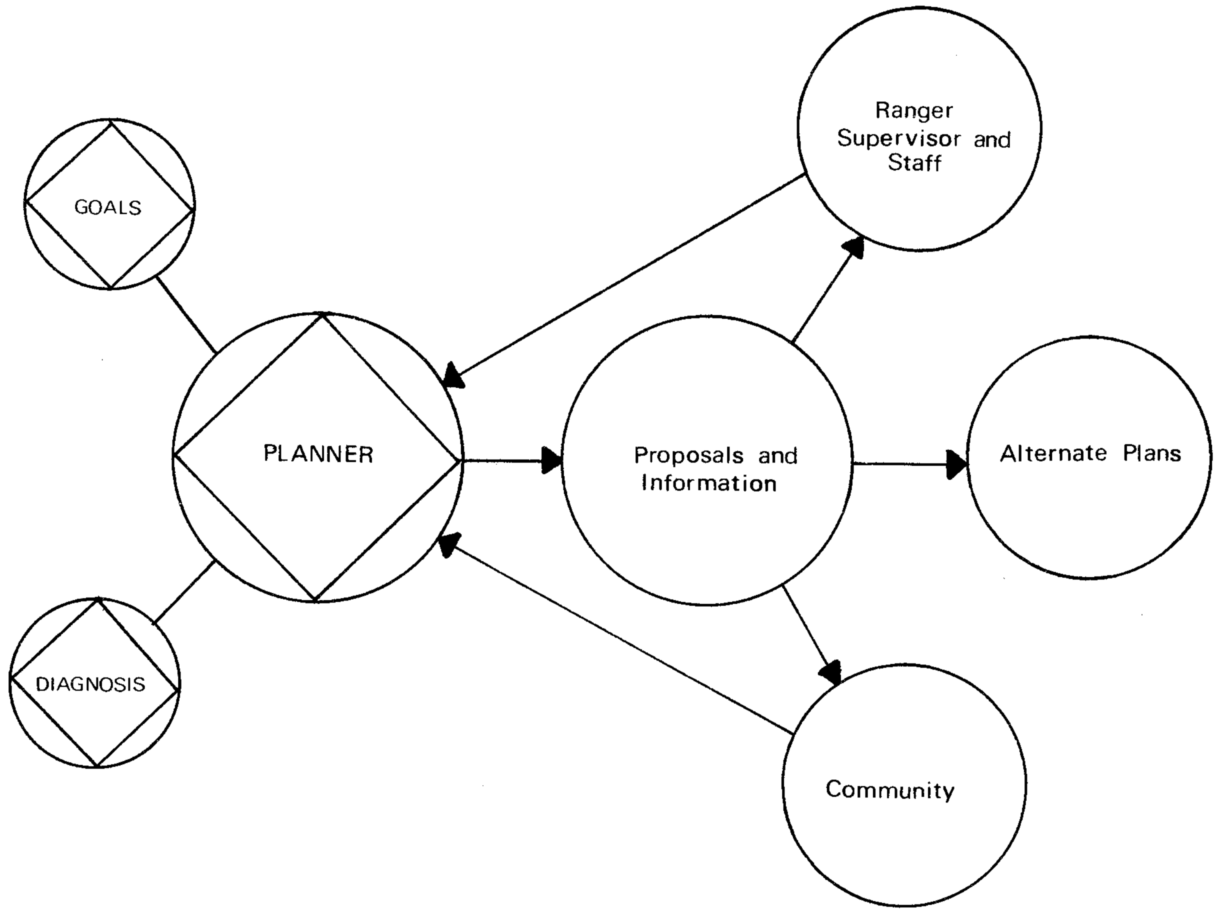

Figure 5. – Information with Feedback

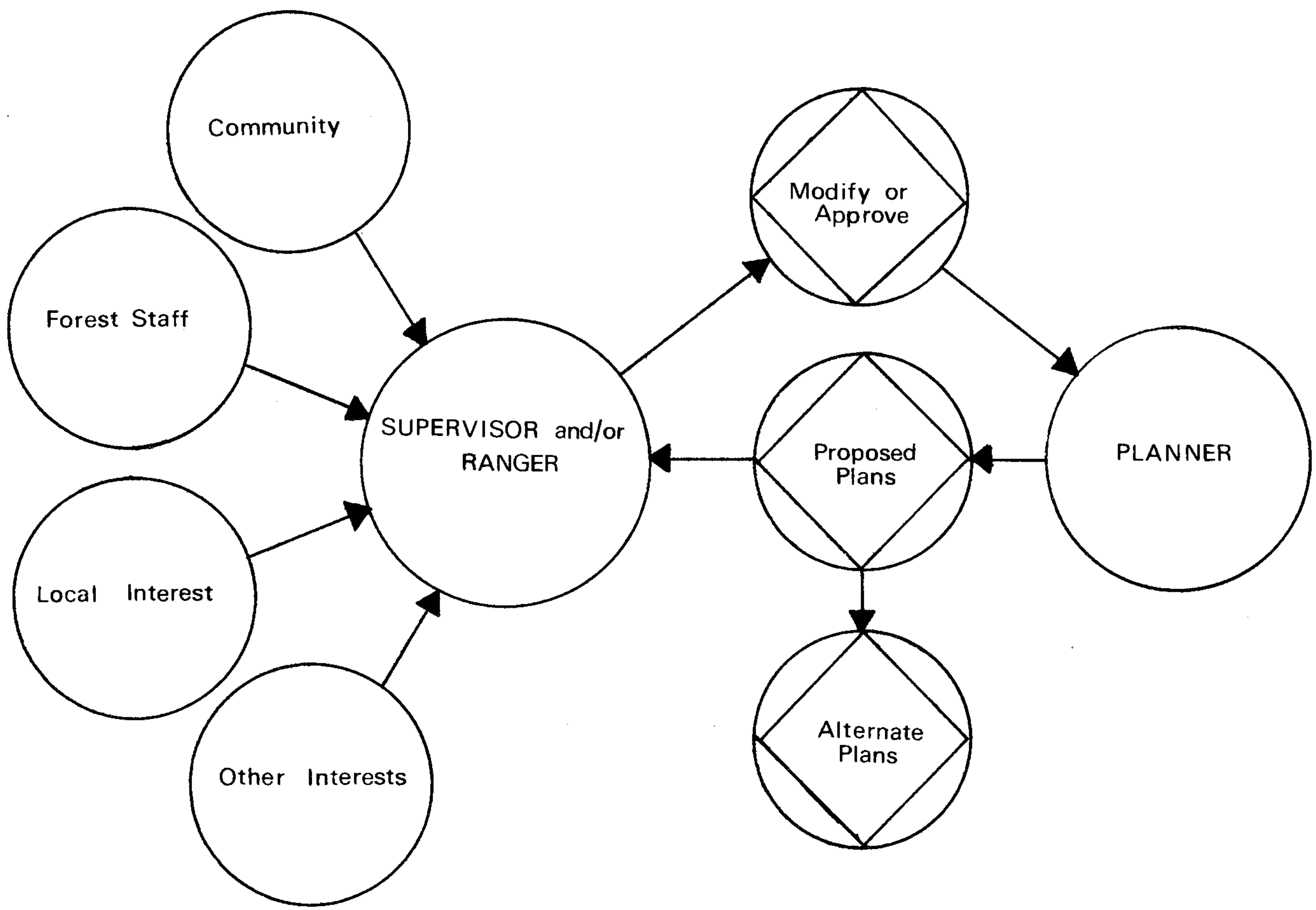

Figure 6. – Arbitrative Planning

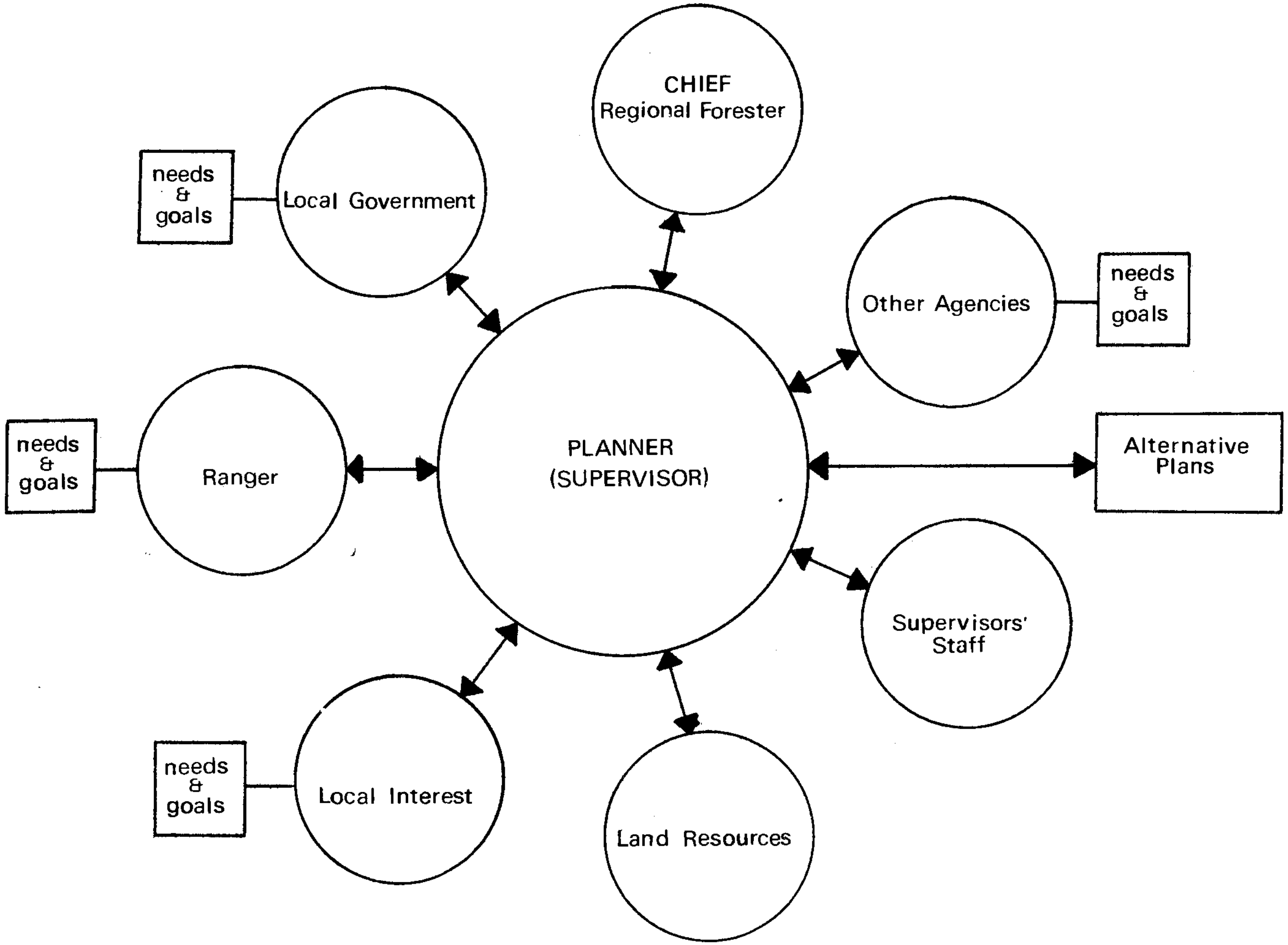

Figure 7. – The Coordinator

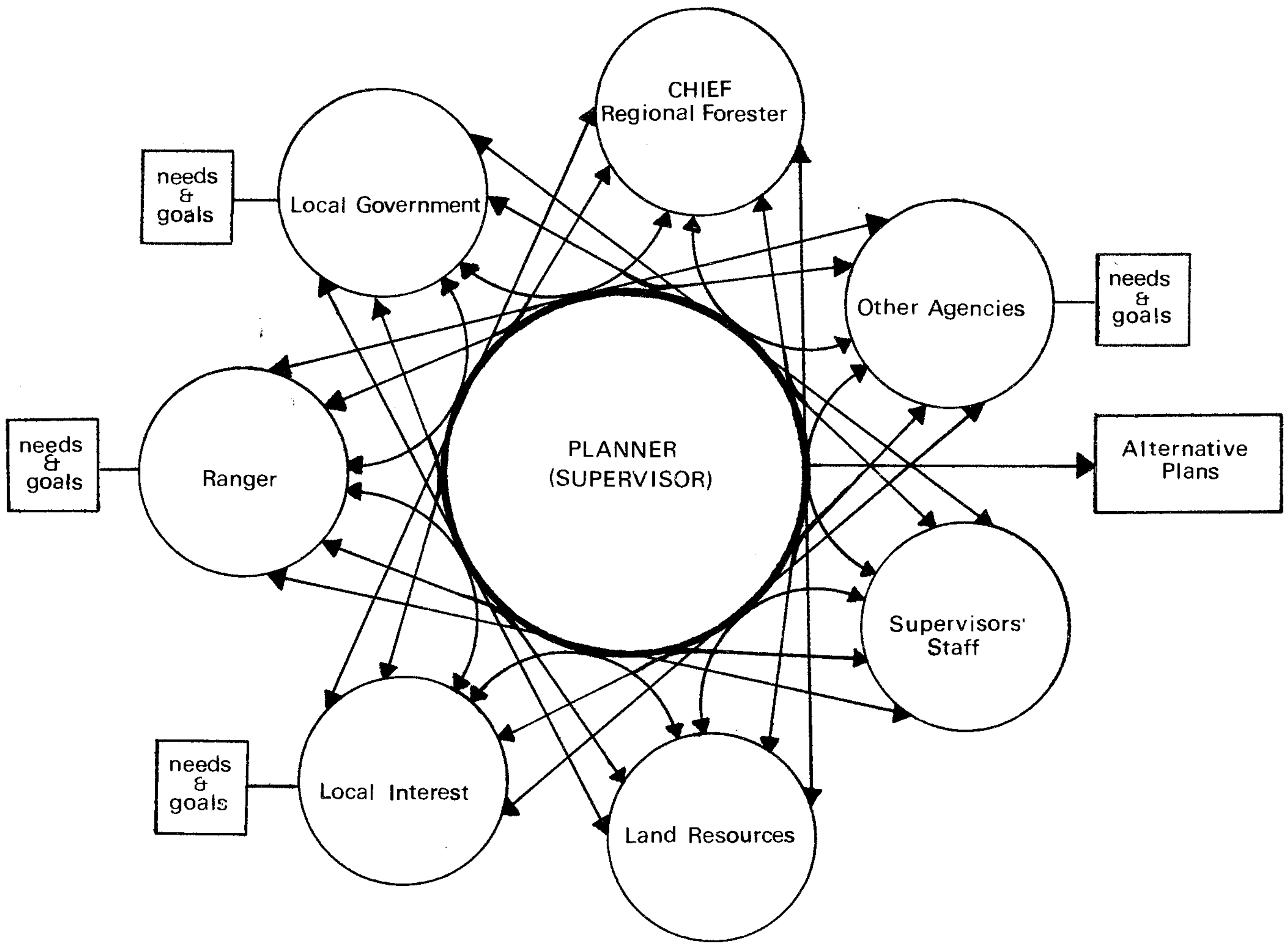

Figure 8. – The Coordinator Analyst

The Coordinator Analyst – Figure 8

The planning unit promotes participation in planning studies. Parties confront and interact directly with each other. The planning unit supplies methodological and technical skills and synthesizes objectives. It works out compromises in areas of conflict.

We suggest that the coordinator-analyst approach is usually best whether the planning unit is one person or a planning group. In any event, principle 5 would state that:

> (5) The management unit should decide before planning begins what planning strategy it wishes to use, recognize its operation and operate accordingly.

Usually, planning is done with no definition of the role of the planner in the process and he or the planning unit wastes considerable time learning how to operate.

A dilemma encountered by many of the planning teams in their first project or two was the problem of balancing data collection and analysis. This should be studied and a direction established during or just after definition of objectives. If not seriously considered, it has often been the case that the planner (or planning team) *collects data* during 75 to 95 percent of the effort and *analyzes* during the remainder of the effort. This results in poor analysis for the data collected and causes principle 6.

> (6) A planning unit should always analyze the planning problem in advance and define the amount of effort needed for each of two major jobs – data collection and analysis. Care should be taken not to spend too much time on data collection.

And so management and the planning unit set objectives, collected data, and analyzed expertly and well. The last and biggest problem of all is to present the alternatives and their consequences (the assessment) to the decision maker in a form he can observe easily and structured to fit his frame of reference. Very little guidance is given in the literature on how to present alternatives to a decision maker (including the public); therefore, this step is open to creative imagination and innovation, particularly for nonquantifiable consequences. How does one present the amount of scarring a road will have on the landscape? Or the value of scenic views? Or the increased fire protection or hazard incurred? Analysts have said, "We presented alternatives and consequences to the supervisor and staff and they then turned around and discussed the matter based on their experience (limited) in the area without any reference to the planning team's presentation." Their charts were much too difficult to read.

Principle 7 –

> (7) Present alternatives and consequences in a form which is simple and in the same frame of reference as that of the decision maker.

CONCLUSION

The application of the principles listed herein to any planning process will enhance informed decision making and will cost no more in terms of effort expended.

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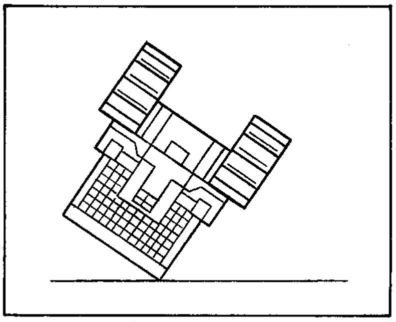
HOW ROPS CAN SERVE AS FOPS

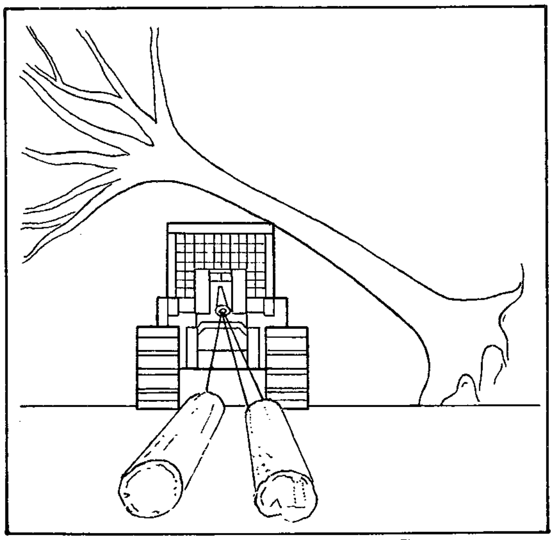
By Leonard Della-Moretta
San Dimas Equipment Development Center

This article contains an estimate of the size of trees which a tractor's roll-over protective structure (ROPS) can serve as a falling object protective structure (FOPS). Track-type tractors used in timbered areas are commonly equipped with the same structure to protect the operator from tractor roll-over and from falling objects.

Paragraph 2.9 of the *Society of Automotive Engineers (SAE) J395 Performance Criteria for ROPS* recognizes the limit design concepts underlying the roll-over safety problem by reminding the reader that the true *safety factor* of a ROPS is related more to energy absorption characteristics and weldment design details (to insure structural ductility) than to static force resistance.



Roll-Over Protective Structure



Falling Objects Protective Structure

Similar energy-absorption considerations are introduced for FOPS by the drop test apparatus and procedures outlined in *sections 3 and 5 of SAE J231* requirements for safety from falling objects.

Both sets of requirements include that falling objects and deflected structural elements are to be kept out of a *critical zone* surrounding the operator. This zone is outlined in SAE 397a.

The load on an overturned tractor's ROPS and the load from falling objects on its FOPS, are both *overhead* loads applied in the same place and from the same direction to the frame fixed in the tractor. By equating the energy absorbed from both loads, we can relate a tractor's weight to its combined ROPS and FOPS ability to withstand blows from falling objects. This relation can then be scaled from older Forest Service tests of tractor canopy structures for timbered areas to compare tree sizes that can be considered equally safe for different size tractors.

For a large inelastic deflection S, which we can assume to be constant, the distortion energy of a ROPS that must support the weight W of the overturned tractor can be written

$$E = C_s SW \qquad (1)$$

where C_s is some constant related to the overstrength of the design.

The energy of a falling object is the product of its weight and the distance it falls.

For similar trees the weight is proportional to the cube of the diameter. The distance the tree or tree top falls is proportional to the height of the tree and therefore, also, to its diameter.

If we provide constants C_d for density, C_f for the proportion of the tree's height that it fell, and C_e for impact-efficiency, the energy delivered to the FOPS by a falling tree of d inches diameter is

$$E = C_d \, C_f \, C_e \, d^4 \qquad (2)$$

Equating the energies from (1) and (2), solving for d and lumping all constants including the inelastic deflection S, we find

$$d = (CW)^{1/4} \tag{3}$$

This formula can be scaled to find a proper C value by using American Society of Agricultural Engineers Paper No. FE 1368 *Results of Tractor Canopy Tests* – Charles W. Howard. In substance, the paper by Mr. Howard found that a well-designed conventional tractor canopy of that period gave adequate protection to a 26,000-pound tractor from 26-inch diameter trees. This data, after rounding off inappropriate decimals, fixes the value at $C^{1/4} = 2$.

Therefore,

$$d = 2W^{1/4} \tag{4}$$

where,

W = weight of tractor, pounds
d = tree diameter, inches

yields the maximum tree diameter for which we can infer safe FOPS protection from the ROPS provisions on a conventional tractor.

We can study the implications of (4) by tabulating it over the range of familiar modern crawler tractors as in the following table:

Tractor	Weight (pounds)	Safe Tree Diameter (inches)
John Deere	6,000	18
Cat. D2	11,600	21
D4	16,600	23
D5	22,300	24
D6	27,400	26
D7	40,000	28
D8	63,000	32
D9	87,300	34

Two inferences can be drawn from this tabulation:

(1) Very small tractors furnish overhead protection from rather large-diameter trees.

(2) Even very large tractors are not structurally safe for falls of very large trees and tree tops. Reconnaissance or other safety measures appear advisable to supplement the machine's structural provisions for safety.

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WASHINGTON OFFICE DIVISION OF ENGINEERING NEWS

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director of Engineering

Initial Range Pole Surveying Tests. We have completed the initial laser range pole tests for locating property lines between National Forest lands and adjoining property. The range pole and accessory sensing equipment provide a "line of sight" between two adjacent nonintervisible property corners. In property line surveys on National Forests near Denver, Colorado, and on National Forests in Tennessee and in Florida, the instruments worked as designed, and the surveyors report that they are locating property lines more accurately with much less effort and at reduced costs. The equipment consists of two main instruments, (1) a laser signal that beams vertically in the air at one property corner and (2) a receiver at an adjacent property corner that detects the laser signal and thus projects a true direct line between the corners.

These initial tests indicate that we can improve survey quality and reduce costs. We believe this equipment will double cadastral survey output; it is a significant breakthrough in survey instrumentation. Surveys scheduled for winter and spring operations will give us more accurate production procedures. Operation, maintenance, and training manuals are being prepared and will be available for the three new units scheduled for delivery next fiscal year.

The instruments were developed for the Forest Service by NASA scientists of Goddard Space Flight Center at Greenbelt, Maryland, and were designed and built under contract by Radio Corporation of America. The development is successful culmination of a 5-year joint venture between Forest Service surveyors and NASA scientists.

OPERATIONS

Harold L. Strickland
Assistant Director

Geometronics. The new multilayer map system was discussed in the July 1973 issue of *Field Notes.* Concurrent with the development of this mapping system, another study was made of the organizational alternatives for producing the maps. The massive cost of equipment pointed out that a greater degree of centralization would be needed for the Forest Service to maintain a cost-effective in-house capability in the future.

The organization study was culminated on November 1 when T. C. Nelson, Deputy Chief, National Forest System, signed a letter (1200 Organization) to the Regional Foresters announcing the plans for implementing a Geometronics Service Center. Plans are to begin operation of the Center by phasing work there in Fiscal Year 1975; the rate of phasing depends on available financing. The location for the Center is not definite; selection of the area will depend on the Department's approval.

The establishment of the Center will not eliminate the Regional Offices' units; however, the following items of work will be transferred to the Center:

- laboratory support for aerial photography
- base series mapping (ref FSM 7140)
- orthophotography
- major "project" type work as requested by users

As the Center becomes fully operational, other items of work may be shifted from the Regional Offices' units. Regardless of the ultimate work load for the Center, present plans call for continued support in each Region to coordinate Regional programs, provide consultation to users, and to handle "rush" jobs.

For the time being, no major change is anticipated in procedures for ordering work. All work orders will be processed through the Regional geometronics units. It is hoped that direct user/center communication channels can be developed in the future as appropriate.

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