1956: Forest Management in Plan and Practice

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AND PRACTICE

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The Scope of Forest Management Plans

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As an initial presentation on the program, it would seem that my job is to open up the subject in broad terms; to emphasize major framework, principles and functions of forest management plans. The assignment is so conceived.

The scope of forest management plans can be what you want to make it. Broadly taken, it encompasses the ordering of the whole forest production process from seedling to the severed product. A plan is a working guide to aid the forest manager in carrying out his job in a particular situation. Fundamentally, the aim is to integrate the purposes of management and the productive capacity of the forest into an orderly and effective plan of operation. It is the central operating control, the hub that brings all things together. The scope of forest management planning and plans cannot and, I think should not, be defined categorically. It means different things to different people at different times and places. It is one of those subjects that you have to deal with by talking about things with which it is concerned.

A basic requirement in management planning that should be emphasized at the outset is the fact that it is necessary for most commercial owners to make a living now as well as in the future from the forest. Forest management deals with a physically immobile and relatively slowly-changing productive mechanism - a living forest. It is necessary to provide for its continuity and look and plan ahead in long-range terms. At the same time, it is necessary to make the forest currently responsive to a constantly-changing, dynamic economic society and to cope with both physical and economic exigencies as they come along, as they most certainly will. The reconciliation and balancing of short and long-range objectives is a major problem and need in management planning.

Principles of Planning

The subject of forest management plans can be helpfully approached by factoring out some principles of successful planning. It goes without saying that they also can be reversed to emphasize reasons why the job may be unsuccessful. Here are seven of them.

1. Major emphasis should be on planning as a continuing function
rather than on plans as such. One should not let concepts, and possibly prejudices, about particular forms or kinds of plans divert attention from the substance that lies behind them, and which is of much more fundamental importance. Too frequently, planning and thinking stops when a plan is prepared. If there is effective planning, there is a plan of some sort, whether written or not. The center of attention should be on planning as a continuing function, with plans serving as reference posts along the way.

2. Planning must be commensurate with need. There is no virtue and much disadvantage in planning and preparing plans out of step with the realities of the situation. First things must come first. If the basic job is one of setting the forest house in order, of achieving a reasonable level of protection, of blocking out and consolidating ownership, of doing the obvious in silviculture, a detailed regulatory plan will lie unused no matter how skilfully it is prepared.

3. Planning is an evolutionary process. I doubt very much whether any effective management plan has ever been drawn up all at once, out of a clear sky, so to speak. One must recognize this and be patient. Almost invariably, successful operating plans are the result and fruition of much background, experience and thought.

4. There is no set pattern to plans. They come in all sizes and at all levels. For a small owner who knows his own situation and who can carry most of the essential forest information in his head, planning is a rather simple affair. For a giant corporation deeply concerned with forest production, management planning can take on various forms, ranging from top level forest policy considerations to the specific operating plan of an administrative district. There probably wouldn't be written plans at all these levels, but it does seem important to recognize that there is planning. Management planning, and resultant plans expressing it, encompasses all stages in the development of a forest production enterprise, extending from preliminary examinations and initial guides to operating plans for well-stabilized situations.

5. Timber management planning and preparation of plans are extremely responsible jobs. To me, at least, the existence of a plan implies its acceptance and use. It is serious business. Applying the test of acceptance and use, a great many plans that have been prepared, and with the best of intentions, are essentially proposals and not actual plans. There may be a lot of difference between a proposed plan and a used plan.

6. There should be close coordination between the preparer and user of a plan. In our American scheme of things, at any rate, full-dress plans handed down from above are not likely to be successful. The man on the ground must understand and believe in the plan. Genuine participation in its preparation is often the best insurance for its intelligent and vigorous
7. There must be provision for both flexibility and continuity. I am well aware that flexibility and continuity can work somewhat at cross purposes. That's exactly what makes the problem both difficult and important. It is essential to have a planning framework that extends considerably into the future and yet one that can be changed to meet current needs and exigencies. Perhaps the best way to put it is to say that the best argument for having a plan - for most anything - is that it can be changed intelligently. With a plan you can go from something to something with confidence and purpose. Without a plan there is a tendency to improvise from nothing to nothing.

Reasons for Having a Plan

Despite the fact that mere existence of a plan that can be handed out for inspection is not the acid test of whether the planning function is being effectively served, there are solid reasons for having some sort of a specific plan. The fundamental reason is that they are an administrative necessity. The kind and detail of a plan should stem directly from the administrative purposes it is needed to serve. I hold no brief for preparation of plans merely because they are more or less traditional, forestry pros and textbooks say you ought to have them, etc.

Some more specific reasons for having plans are:

1. To force and focus analysis. The process of preparing a plan makes one think the problem through and face up to what is entailed and required. Very possibly the process is more important than the plan. As a student, I used to take copious notes - and then seldom looked at them. The process of writing them down fixed them in mind - at least long enough for the next examination. A sentence from Bacon's essay on Studies puts the point very succinctly: "Reading maketh a full man, conference a ready man, and writing an exact man." You often really don't know what you have or what you need until you attempt to set it down systematically on paper.

2. To cushion personnel changes. Like other people, foresters come and go. If much of what they know is accumulated under their hats rather than on paper, much valuable information can leave with them. It is given to few foresters to reap what they sow and see the full fruition of their work. Personnel changes can be very expensive and disruptive to forest operations and are a problem with public and private agencies alike.

3. To give evidence of stewardship. This is a point of particular force with public agencies; there are sound policy reasons for having something tangible to show that public purposes of management are being served.
4. To evaluate and make provision for correlation of forest land uses when timber production is not the only one, as is often the case.

**Items to Consider in Framing a Plan**

Accepting the fact that there are good reasons for having tangible plans, the next logical step is to consider some problems in framing them. It seems to me that the most helpful way to approach this is through a check list of things that must be considered rather than by a set outline or model.

The items included in the following listing should all be considered and some decision made regarding them. Some may not be important in a particular situation and sometimes the problem is to decide that they are not important. Here is the list:

- Purposes of management
- Markets, labor, and general economic situation
- Forest organization and subdivision
- Accessibility
- Correlation with other uses.
- Protection against fire, insects and disease
- Silviculture
- Inventory data
- Growth data
- Regulatory framework - the specific mechanism providing for forest continuity
- Provision for continuity of the plan itself
- Cutting budget - the specific current operating guide

Each of the above items can be elaborated at considerable length; they assume varying importance and complexity in different situations.

**Form of Plans**

Because of these variations, the form a management plan may take can be extremely variable. In fact, I prefer not to think of a plan in terms of any particular form, feeling that form should be developed logically to meet the particular need. Models are often extremely helpful, but they can also be inhibiting and get in the way of creative thinking.

At this point I should make a confession. I have never seen a simon-pure industrial timber management plan, prepared strictly by industrial personnel for industrial use, and because industry on its own initiative wanted to have one. Frankly, I don't expect to see such a plan unless I was an employee or consultant for a particular firm.
I have, however, seen and studied a considerable number of timber management plans prepared by public agencies, both in the United States and abroad. Some of these plans are prepared for the agency's own operations, as for National Forest working circles. Some are prepared by state and federal agencies for private owners and as such are essentially proposals that may become plans if adopted.

The management plans I have seen come in all shapes and sizes. About the longest for its size that I have seen is a plan included in Knuchel's book, Planning and Control in the Managed Forest. This is a Swiss plan for 350 acres and its presentation occupies 72 printed pages. It is labeled as a "practical example." One might note, parenthetically, that four forestry students prepared it, at least one aspiring to a master's degree through its preparation. In distinction, I have seen some very simple but direct plans prepared by the TVA for a specific cooperator.

It is impossible, and I think unhelpful to generalize about the heft and scope of management plans as written documents. The only test is: do they meet the situation and need?

Subject Material Grouping in Plans

Another way to approach the framing of a management plan is to consider broad groupings of subject materials with which one works. They can be broken down into three general categories.

1. General background and foundation material. Included here are the purposes of management whatever they may be, accessibility, markets and the general market situation, labor conditions, social, economic, and political considerations, and the like. All of these things take on particular meaning when viewed from the standpoint of a forest owner with particular purposes, limitations, and capabilities. There may or may not be need to present this sort of material in specific written form. Public agencies often do, especially the U. S. Forest Service, and it serves a useful function of keeping these things clearly in mind. Private owners and organizations may feel little need for setting down such material in systematic form; general forest plans and policies may be sufficiently known or merely a part of a larger corporate framework of interest.

It needs also to be kept in mind that timber production is often only one of several important forest land uses in an area. A timber management plan is a complete land use plan only if timber is the dominant and near-exclusive use. Correlation of land uses is often a dominant problem on public lands and frequently assumes large proportions on private lands as well. Many private forest owners are deeply concerned with forage, recreation, wildlife, water, and other land uses and products whether
they want to be or not. While consideration of such matters and more specifically fire, insect and disease control problems must be faced up to as pertinent in timber management plans, such plans are often not an adequate medium for dealing with them adequately. The general trend is to handle these things, where they are of major importance, in separate plans. Consequently, specific timber management planning and plans may encompass only a part of total forest land resource management.

2. Forest inventory information. This includes specific information on the forest itself; its area, stocking, stand classification condition, growth, cutting history, etc. It also includes information on roads and other physical improvements and needs. This kind of information exists in various forms in files, maps, charts, and so forth, and obviously it can't all be bundled up and put into a plan, although I have seen it attempted to a considerable degree in some instances. The establishment and maintenance of adequate forest inventory control is a major problem and job in itself and beyond the scope of this discussion. It does seem important, however, to recognize that forest inventory information is an indispensable basis for timber management planning and consequently very much a part of the subject in general. In fact, I can rather easily conceive of a management plan consisting essentially of a well-organized and efficient body of forest records and other information periodically brought to focus through a cutting budget. The rest of the job is able silvicultural application. The Yurnaud-Biolley "Methode du Controle" essentially envisages this sort of situation.

3. General forest information. What I mean here is mensurational, silvicultural, economic and other forest information available that is pertinent in a given management situation. Research and other professional agencies release a large amount of such material. The effective carrying out of any forest production enterprise in large part depends upon how well best currently available information is understood and applied. I don't at all mean to imply that a review of literature and bibliography should be a part of a management plans. We have long since outgrown this, at least in the United States. It should be emphasized, however, that a large body of forest information exists and should be utilized in management planning and plans.

Summary

As stated to begin with, I don't think one can or should be categorical about the scope of forest management plans. They should reflect the administrative purposes they serve, which are extremely varied. Major emphasis should be on planning as a continuing function. Guiding principles, purposes served, items to consider, and groupings of subject materials have been suggested as aids in preparation of plans. My hope is that this
presentation will serve to open up the subject and facilitate its further consideration.
The rapid advances in industrial forestry in the United States today are familiar to all of us. Industrial executives are interesting themselves as never before in forest management. They want the answers supplied in a business-like way. They wish to know how much wood can be produced from a given acreage and when. The success of a company depends upon a sustained supply of raw materials as well as in good manufacturing procedures and efficient salesmanship. The term "management" to the business executive means control and direction. Foresters have to learn to control and direct that biological complex called a forest according to business principles. The point I wish to make is that forest management planning is part of good business management. The industrial forest manager has to be a business man as well as a forester.

The Society of American Foresters defines forest management as "the application of business methods and technical forestry to the operation of the forest property." Forestry conducted as a business must yield a net profit. This is not necessarily the case in public forestry since public forests also yield intangible benefits which cannot be measured by direct financial returns. A forest property owned or leased by an industrial concern may not make a profit by itself, particularly in the early years of management, but the manager has to constantly work towards the goal of a profitable enterprise as affecting the overall profit position of his company. Each step in forest development is taken after an analysis of the costs involved and the anticipated profit to the company. Business methods of efficiency rating and cost accounting are applied to the work to be done under the management plan. The possibility of sustained yield is conditioned by mill requirements. It may be necessary to postpone the realization of this longer than would be necessary from purely silvicultural considerations alone. Further, cutting budgets may have to be drastically changed due to special and unforeseen demands. Although farsighted top management may be in agreement with long range forestry plans, the industrial forest is still an adjunct of the industry to be used for its best interests. But it follows from the present trend towards more intensive forest practices in the industries that top management is more prepared than has ever been to entrust foresters with the task of formulating and executing sound forest policies. This means that the forest manager is not at the mercy of wood procurement and can stand up and be counted when it comes to decisions regarding cutting allocations.
In discussing the preparation of industrial forest management plans, it is well to remember this close relationship which the industrial forest must necessarily have with the industry controlling it. Accounting procedures and other record keeping must be tied into general company procedures, although the Forestry Department will develop separate records. In some companies, operating standards are set up along certain prescribed lines and may be carried over into forestry operations. The shape and form of an industrial forest management plan will for this reason not necessarily agree with that of the forestry textbooks. It may consist of a cutting plan based on growth and yield estimates and operating standards covering marking, planting, road construction and the like. These standards will be reviewed and modified from time to time. In general, they govern the day-to-day procedures involved in carrying out a cutting plan, a planting program, and protection. Objectives are included to spell out the purposes of the standards.

To give an example, a preamble to timber marking standards might read something like this: "timber marking will be based on the objective of building up growing stock by increasing growth through thinnings and improvement cuttings. Since the timberlands are understocked, average volume per acre needs to be increased from less than six cords per acre to an estimated potential of 22 cords per acre. To do this, the annual cut will be limited to less than the annual growth, and harvest cuts will be kept to a minimum for the first ten-year period." The marking standards will then give the rules governing clearcutting, specifications of seed trees, thinnings, and so on. This statement of objectives serves the purpose of reminding field foresters of the policy of conservative cutting until growing stock is built up.

Marking standards will naturally vary according to the condition of the particular forest. Where a company has well-stocked stands to start with, the job is mainly one of thinnings and harvest cuts. Where there are many understocked stands, it is necessary to take account of minimum densities below which it may be advisable to clear cut or cut to seed trees and start over again. In this case, the marking standards will set a certain requirement of minimum stocking. It may be on the basis of basal area, number of trees per acre, or another measure of stocking. In slash pine and longleaf pine types the marking requirements will again vary. Scattered, residual longleaf pine stands with low growth rates will be handled differently from poorly stocked slash pine stands where natural regeneration is coming in. Each company will have quite a different set of marking standards or rules depending on the forest type, the utilization, and the stage of management.

The marking standards are as important an element of management planning in the early stages as regulatory measures. The two go hand in hand, however, since the amount of cut decided upon will influence the degree of cutting. On the other hand, the actual condition of the forest
determines what you can do. No one supposes that a West Coast company with most of its timber in old growth can practice sustained yield. The cut is going to exceed the growth until a large percentage of the virgin timber is liquidated. For somewhat different reasons, an overcut may be required in a southern forest, not to remove large volumes of old growth, but to convert poorly-stocked to fully-stocked stands.

A company will not be wise to carry this policy too far. You cannot have your cake and eat it too. If you are going to cut every stand that is not fully stocked, you wind up with no cut at all. Here is where regulation comes in. "Regulation" is a good word to use, for it implies a form of control. When applied to a forest it is simply the control of the cut based on the present condition of the forest and its future possibilities in terms of growth and yield. A cutting plan shows company management what to expect from its timberlands. It presents the case for good forest practices and allows for long-range planning of mill requirements. When a cutting plan is approved, it has a status similar to the plans outlined for mill production. It is a business-like way of relating silvicultural considerations to the actual condition of the forest now and for so many years in the future. It takes the cutting operations out of that situation which might be called "ranger's choice," leaving plenty of opportunity for the individual skill of the operating foresters but setting up the limitations involved in working towards an objective.

A cutting plan is a cutting plan. Certain preliminary data must be collected. An inventory and growth estimates are required. Most companies use aerial photographs in typing and may use them for density classes and some form of volume estimates. The continuous inventory system of growth determination is being applied on industrial forest land to a greater and greater degree. If the forest property has recently been acquired, however, growth estimates from increment cores must be used.

One of the questions asked of the industrial forester by the officials of the company is what can be expected in yields from the forest property. What is the ultimate potential? We have very little information on the yields from managed stands of southern pine and hardwoods. We have reason to believe that planting and tree improvement programs will increase average yields considerably. Until we have more information on managed pine stands, we have to depend on yield tables for estimates of desired volume. Assuming a rotation, the usual method is used of summing the volume for the age intervals in the yield table or:

\[
\text{Desired Volume} = \frac{n}{r} \left( V_n + V_{2n} + \ldots + \frac{V_r}{2} \right)
\]

where \( n \) is the age interval in the yield table, \( r \) the rotation age, and \( V \) the volume at the given ages.
In our case we took a rotation of 40 years. For Site Index 75, considered average for our area, we came up with a desired volume of 27 cords per acre*. Since complete stocking will never be fully reached for the forest as a whole, we took 80 per cent of this or 22 cords per acre as a measure of the forest potential. For most relatively understocked, newly acquired, southern pine timberland the discrepancy between present volume and the potential needs to be spelled out at the outset. Justification can then be made for a conservative cutting policy in order to build up growing stock. We might have simply divided volume at rotation age by two and obtained the same volume as from the summation formula. This method assumes, however, that the net annual increment of an even-aged stand remains the same, which is not the case. On short rotations only can you adopt the simpler method. Such general planning as I have mentioned might well be incorporated into the objectives of a formal forest management plan, if that is desired.

The company may now wish to know how many years it will take to reach the desired volume per acre on the basis of a certain delivered quota of timber to the mill. Or the forest manager is empowered to set the cut for a given period in the light of the forestry data available. If the industry has to have a certain volume of timber from its lands, a quick method can be employed to see how this will affect growing stock. The operable acreage of the forest must be divided out from the total acreage. We can then apply the adjustment period formula, using the period of years which gives us the cut required. Suppose we have a forested area comprising one township, 23,040 acres. Most of it, 20,000 acres, is found to be operable for pulpwood and some sawtimber. The present volume in cords is 180,000 or nine cords per acre. Our desired volume is 22 cords per acre or 440,000 cords. Growth, including ingrowth, is nine per cent. The company, on a proportional basis, would like to get 7,000 cords per year from this township. With such a cut, how long will it take to reach the desired volume per acre?

Given: \( C = G \cdot (\text{Growth}) - V \cdot (\text{Present Volume}) - V_1 \cdot (\text{Desired Volume}) \)
\( \frac{A \cdot (\text{Adjustment Period})}{A} \)

Then on a per acre Basis:
\[
C = \frac{0.810 \cdot 9 - 22 \cdot 30}{0.377 \text{ cds/Acre}}
\]

or 7500 cords for the township, approximately what is asked for. The required adjustment period will be 30 years.

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* Volume, yield, and stand tables for second-growth southern pines.
U. S. Dept. Agriculture, Miscellaneous Publ. 50, page 162.
The forest manager may not, however, be in the position of having to conform to a quota at the outset. He can prepare a cutting plan based on the inventory and growth data along with silvicultural considerations and development plans. He might decide to reduce the annual cut to less than the 40 per cent of the growth in the example first given. The long range planning sets the goal, while the actual calculation of the cut can be for a ten-year period or less. Frequent re-inventories or growth data from sample plots will give the information for needed changes in the cutting plan at the end of the first management period. Mill requirements, of course, may change radically and require important revisions in the plan.

Before drawing up a cutting plan, some kind of subdivision of the woodlands has probably been made for administrative purposes. If smaller subdivisions are impractical for the first management period, at least the larger administrative units should be inventoried separately. Even if smaller subdivisions are made in the form of compartments, I would still think unnecessary any particular effort to institute a rigid area allotment system. In our company operations, it will be a long time before individual stands are mapped out and inventoried separately.

In calculating the allowable cut for a forest property inventoried by large subdivisions and comprising a wide variety of stand conditions, several methods may be necessary. We might decide upon cutting a certain percentage of the growth of the types above a certain stocking. Types with low level stocking are not paying their way and will be cut to seed trees or clearcut if adequate seed source is lacking. The trend, as you know, is towards a standard procedure of clearcutting and planting southern pine in the Coastal Plain. The combination of a growth per cent figure and the clearcutting of submarginal stands will together give the total volume to be cut.

My company employed a combination of methods in drawing up a cutting plan. The adjustment period method was used to calculate the cut in the high density stands for the entire operable pine acreage of the forest. This cutting volume was allotted to the subdivisions in proportion to present volume. In addition, cuts from submarginal stands were added to the calculated cut. For example, a subdivision with 12,000 pine acres had 9,990 acres operable. The total volume was 79,520 cords or 8.0 cords per acre. An annual cut was determined for the high-density classes by the adjustment period formula. To this was added the volume of the low-density classes to be cut. The annual cut was set at 3,900 cords or 39,000 cords for the ten-year period. The planned cut of the submarginal stands represented 23 per cent of the total. In order to evaluate this cut against growing stock at the end of the period, an amortization procedure, developed by Dr. Walter Meyer of Yale from the financial amortization formula, can be used. A formula such as this involving the use of compound interest should not be applied to tree growth for a longer period than 10 or 15 years. Otherwise, over-estimates are made.
The formula is:

\[ V_n = V_0 \left(1 + \frac{g_t}{g_m}\right)^n - \frac{C}{g_m} \left[\left(1 + \frac{g_m}{g_m}\right)^n - 1\right] \]

where \( V_n \) is volume at the end of the period, \( V_0 \) the present volume, \( g_t \) total growth including ingrowth, \( g_m \) the growth of the merchantable trees, and \( C \) the cut. The total periodic annual growth for the area in our example was 8.8 per cent and the ingrowth 1.7 per cent.

Applying the formula:

\[ V_{10} = 79,520 \left(1 + .088\right)^{10} - \frac{3900}{.071} \left[\left(1 + .071\right)^{10} - 1\right] \]

\[ = 79,520 \times 2.325 - 54,930 \times 0.986 \]

\[ = 184,884 - 54,161 \]

\[ = 130,723 \text{ cords or 13 cords per acre} \]

We see from this that the proposed cut is a conservative one and the volume will increase from 8.0 to 13.0 cords per acre by the end of the period.

I certainly cannot exhaust the field of forest regulation in the time allotted me. I am sure there are many with us today who can throw additional light on the subject at hand. There are some foresters here, no doubt, who were in the enviable position of starting with fully stocked stands with the only problem one of maintaining a balanced condition. The large acreages of young, poorly stocked pine stands in the South require flexible and diverse applications of regulation, not losing sight of a build-up of growing stock as rapidly as possible.

If a cutting plan is prepared for the whole property, allocations are made to the subdivisions roughly in proportion to the existing volumes. If the cuts are determined by subdivisions, the total make up the cutting budget. A number of considerations influence the sequence of cutting operations by subdivisions in an initial period of management. If there is a large road-building program, the cutting will have to be geared in to a road-building schedule with budgetary and tax aspects borne in mind. Silvicultural considerations, of course, influence the sequence of cuts. Where a subdivision has a large number of stands requiring thinnings or submarginal stands to

be removed, priority is given this unit over others with less pressing cutting requirements. The cutting plan and the planting plan have to be synchronized. The cutting budget with its sequence of cutting operations for a ten-year period is finally a product of inventory and growth data, some calculations, silvicultural knowledge, further field examinations, coordination of all planned forest operations, and some sound common sense. It probably cannot be followed to the letter. Equal annual cuts are budgeted, but mill requirements may necessitate some changes, as will weather or perhaps fires. The objective will be, however, to treat the entire operable area during the ten-year period. The cutting cycle is then the same as the management period.

While technical forestry considerations play a major part in the preparation of a cutting plan for the forest land owning industry, business methods are employed in the proper keeping of records. The system of regulation as outlined does not require a record of the cut from each stand. There must be a cutting record form for each compartment, or whatever the smallest permanent unit of the forest is called. In some companies the general accounting office takes care of the entries. It is advisable for the Forestry Department to have its own set of cutting records if reference to these requires much "digging out" in the accounting office. Some companies have a greater or lesser problem than others in this respect. The cutting records of compartments are grouped under blocks, districts or other major subdivisions of the property.

Progress maps supplement the cutting records. These are important in all forest planning and emphasis should be placed on keeping them up to date.

The forest manager now has the basic ingredients of a management plan. He has a cutting plan which guides him as to what to cut, where to cut, and when to cut. Operating standards in the form of marking and planting rules, road specifications and so on give the standards under which his staff carry out the work. A goal is projected ahead and a conservative cut allowed for. The separation of all the even-aged stands on the large forest property has not been considered practicable in the first management period. A tentative rotation has been used for long-range considerations, but does not play a part in present regulation. Size classes are more important than age classes. A case can be made for maintaining this form of management indefinitely, but I am not prepared to say that my company will not go to a more rigid type of regulation after the first management period. The flexibility of the present system is particularly important where the cutting operations are largely thinnings, improvement cuts, and salvage operations. This type of management lends itself very readily to the use of the continuous inventory system where the periodic cut is based mainly on current growth determined for past periods of management. The harvest cutting records need not be kept separately from those for thinnings in young stands. The
control is over the total volume of all the trees cut above a fixed lower diameter.

This volume is entered on a ten-year growth and yield record sheet for the particular compartment. The record sheet is kept in book form along with the timber inventory by stand and stock tables. The record sheet lists the year, volume for that year, annual growth, cut, mortality due to insects or disease, balance for that year, and acreage cut over. A summary at the bottom balances the drain and estimated growth against the original inventory and provides for an adjustment to a new physical inventory based on a recruise or the remeasurement of permanent plots.

The formal forest management plan has some very real advantages. As a matter of record, it pulls together all the data collected in calculating the cutting plan and places this in an ample-sized appendix. There is no hunting around in files for the proper table or recapitulation. The pertinent information is all there. Not only do forestry staffs change, but offices are moved around and file clerks are transferred. The formal management plan for a ten-year period is a much more handy reference book than a scattering of disconnected write-ups on development, protection, and regulation. When a new man comes into the Forestry Department he does not have to dig through the files to find out information which should be all together under one cover.

Many industrial forestry departments are so busy with a program of forest management, wood procurement, and continuing land acquisition that there is little time for other than the immediate job at hand. Some form of forest management plan, however, is just good business practice and should be sold to the company by the foresters in charge on that basis.

The long-term nature of forestry requires careful and orderly planning for all the operations on the forest. This fits in to sound business management. The form of the industrial forest management plan will vary from company to company. The essential elements remain the same.
DISCUSSION

Q. "About this amortization formula, doesn't this assume that you're going to get the same rate of growth regardless of the level of growing stock that you've got, and regardless of how you cut? This leaves you quite an element of uncertainty."

A. (Stevenson): "You are assuming a calculation of growth which, of course, can't be assumed except, it seems to me, over a short period. Now, I wouldn't want to use that formula for longer than ten years, and maybe a shorter time is better. But I think it does give you something to shoot at that is about as reasonable as we can expect for our particular situation, particularly since we have understocked stands to a large extent; we recognize that our growth figures are probably considerably off. And you might ask why I use them at all. That's a good question. But as long as we think that our figures are conservative, I think that we are staying fairly well within the limits, and we're not trying to use a lot of formulas necessarily just to make it appear to our management that we're pretty learned. Actually, they don't see these formulas, but we do come out with some figures that we think are about the best that we know how to get at the present time."

Comment (Moderator): "There is a mathematical philosophy that actually backs up the use of a formula which applies to a specific time and place and to a specific stand when you're trying to manage a large forest property. It was pointed out here that many of us are trying to operate, and some are trying to manage, relatively large tracts of land that have been rather heavily cut over, either yesterday or twenty years ago. We're all of us dealing with very fluid and fluctuating individual stands, but our averages do have a tendency to remain rather constant. For that reason, the use of the formula applied to a large property may be more valid than if applied to one stand or a small group of stands." 

Q. "I was under the impression that the forest must have been in evenaged condition, and you spoke of residual stuff that went on into the sawlog class. I would like to ask if this would apply to an all-age class?"

A. (Stevenson): "Yes, it can and, in effect, we have an allaged condition. And that is typical, to my mind, of many southern forests today. We do not have any evenaged condition in that we have an even distribution of age classes. We have large areas with classes of all kinds of conditions. For our purposes, for our first ten-year period, we can just as well handle it as uneven-aged management, but we can't as evenaged management, particularly because we don't want to start cutting our
forest in order to put it into any type of area allotment method immediately. I think we'll come to area management later on, but for the present time, we want to build our growing stock. For that reason, we can handle it as unevenaged management or even-aged silviculture within unevenaged management - if you want to bite that one off!"
The theme of this symposium, "Forest Management in Plan and Practice," probably implies, for most of you, the practice of pine forestry in the coastal plains of the deep South. This paper may be somewhat out of character in such discussions, for it is based on experience gained on a mountain forest where we are concerned with the management of upland hardwoods and one single species of pine - the shortleaf.

To install and carry out a program of management on a Southern National Forest involves some problems and difficulties that are not normally encountered in large private holdings. One of these problems is the matter of scattered and broken ownership of land. There are about 19 million acres within the unit boundaries of the national forests in this region. Of this the government owns 9-1/4 million acres, or about half. The Ozark National Forest has a net area of 1 million acres. If this were a solid ownership, square in form, it would have 160 miles of boundary. Actually, the Forest has almost 4,000 miles of common boundary with private property, each mile inviting ownership dispute and the possibility of trespass, either innocent or intentional. Providing transportation and communication facilities and installing adequate protection and ownership control are, of course, more difficult and costly where ownership is so poorly consolidated.

Private ownership means forest residents. The Ozark National Forest has 10,000 people living within its boundaries, and five times that number live closely adjacent. We are grateful for these forest residents for many reasons, but their presence does create some difficulties. In order to bring the forest under planned management it is necessary that we take these people into our full confidence and partnership, first in obtaining an effective fire organization and later in the care and harvest of the timber.

The National Forest system aims to protect, develop, and make available all of the resources of forest land. This brings water, wildlife, recreation, and range into our considerations, and poses the problem of adjusting the treatment of each to accommodate the needs of the other resources to the fullest extent that is practical. The degree to which timber management must give way to the needs of these other resources requires careful consideration in planning. Often these considerations are a matter of judgment, for research has not had time to study our problems in the light of existing conditions.
Multiple resource management brings to bear the desires and interests of many groups of people. Each group is naturally anxious that their interest receive primary consideration. I do not say this critically because each special interest group has been of real service to the Forest Service in placing its over-all program into effect. They undoubtably have a very healthy effect on each of us, for, in a word, we live right with our board of directors. Every taxpayer is a shareholder in the National Forest system and entitled to express his views on how his property should be managed. You can be assured that they exercise this right very freely and that we listen very carefully, because we don't get very far without their vote of confidence. A forester's success has a measure in his ability to get along with people. I believe that this ability is more critical in the South than elsewhere in our nation and more important to public than to private practitioners.

Starting from scratch, as we have had to do in the South, it takes many years to get a forest property ready for the type of regulated timber management that the text books talk about. Actually, what is involved is a gradual process of change from a program which can be outlined in a simple statement of policy and objectives to a closely regulated operation controlled by very precise current information and data. Getting management underway is a particularly slow process on those national forests where land has been acquired from many sources and in varying stages of depletion. Progress has been further retarded because of the limited opportunity we have had to make needed capital investments for timber resource development.

During the Emergency Conservation Program it was possible to do some planting and timber stand improvement work, but it was the Knutson-Vandenberg Act of 1930 which gave the Forest Service its first real opportunity for stand treatment measures other than harvest operations. The KV Act empowered the Secretary of Agriculture to require purchasers of National Forest timber to make deposits of money, in addition to stumpage payments, to cover the cost of planting, of seeding, and of disposing of undesirable trees to improve the future stand of timber. Note, however, that these expenditures are limited to the actual sale area, which means that such work can only be done in stands that are merchantable, and until fairly recently, markets have been poor or entirely lacking for many types of material. In the Ozark section of Arkansas good markets for low-grade hardwoods have developed only in the past five years.

So much for some of the factors that have limited the rate of application of planned management to Southern national forests. To illustrate how this has worked in practice, let us take as an example the Magazine working circle, one of four into which the Ozark National Forest has been divided for management purposes. In this working circle the process of working toward more detailed plans has been telescoped into a relatively short period of time.
The Magazine working circle is located in Yell and Logan Counties in Northwestern Arkansas. This area is characterized by several east-west ridges, including the highest point (about 2900 feet) between the Great Plains and the Appalachian Mountains. These butte-like ridges lie between, and are distinct from, the Ozark uplift to the north and the Ouachita Highlands to the south. Actually they are a part of the synclinal trough of the Arkansas Valley, and the Strata lies in a more or less horizontal plane which gives rise to a series of lesser bench-like ridges between the high points and the river bottom land.

In 1934, under provisions of the National Recovery Act, the Resettlement Administration commenced buying up submarginal farms and moving the occupants (Project LU-AK-1). In quick succession this project was transferred to the Farm Security Administration, the Bureau of Agriculture Economics, the Soil Conservation Service, and finally in July, 1939, to the U. S. Forest Service, as a part of the Ouachita National Forest. In September of 1941 it was formally transferred to the Ozark National Forest for administration.

In 1944 funds were made available for a management reconnaissance which had the following purposes:

1. Classification of the forest land by conditions and types
2. Development of an estimate of the net volume by commercial tree species groups.
3. Preparation of an estimate of net volumes to be removed under the approved marking rules.

A quarter of one per cent cruise was made and the findings incorporated into a policy statement which covered the period July 1, 1946 to June 30, 1951. The policy statement included the following information and guidelines for management of the working circle:

<table>
<thead>
<tr>
<th>Gross area</th>
<th>130,600 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owned by Government</td>
<td>80,800 &quot;</td>
</tr>
<tr>
<td>Commercial Forest land</td>
<td>78,525 &quot;</td>
</tr>
<tr>
<td>Pine sawtimber volume</td>
<td>46,895 M (BM)</td>
</tr>
<tr>
<td>Hardwood</td>
<td>34,481 M &quot;</td>
</tr>
</tbody>
</table>

(An indication of the trend in stand composition was available in the fact that volume in trees below sawtimber size was four times greater for hardwood than pine.)

Allowable Cut

Pine - 1000 M annually   Hardwood - unlimited.
(Percentage of cut in pine areas to be thinned was set at 39 per cent. Salvage of residual large pine trees was prescribed on all areas covered by sales. Hardwood was to be sold as rapidly as markets could be developed. All undesirable hardwoods were to be removed where pine release was possible.)

Cutting Cycle was ten years which set an objective of getting over half the area of the working circle in the five-year period.

Actual accomplishments under this policy statement were:

- Pine Cut, 5,260 M as against an allowable 5,000 M.
- Pine Cut included 2,437 M sawtimber 8" DBH and larger and 2,823 M pine products.
- Area cut over was 28,180 acres which was a little more than half the area classed as pine type. Hardwood cut was only 953 M with 1700 acres covered in addition to the area cut over primarily for pine.
- Total area covered was about 2/3 of the objective that had been set.

Silvicultural objectives of this first statement of policy were to:

1. Dispose of overmature residual pine.
2. Treat young pine stands in need of thinning.
3. Find markets for low-grade hardwoods and remove as much as possible.

A formal timber management plan was prepared and placed into effect for the five-year period July 1, 1951 to June 30, 1956. Estimates of timber volume and growth used in this plan were based on the 1944 reconnaissance cruise adjusted for growth and cut and timber volumes on land that had been acquired through June 30, 1951.

Basic data and management controls in this plan are as follows:

- Land owned by Government 92,269 M
- Commercial forest land 87,147 "
- Pine sawtimber volume 107,531 "
- Hardwood sawtimber volume 101,612 "
- Regulation of cut - based on area control - 8,000 acres of sawtimber and 16,000 acres of convertible products each year.
The following volume check was established:

<table>
<thead>
<tr>
<th>Product</th>
<th>Allowable amount cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine sawlogs</td>
<td>1,000 M</td>
</tr>
<tr>
<td>Hardwood sawlogs</td>
<td>1,000 M</td>
</tr>
<tr>
<td>Pine products</td>
<td>3,400 M</td>
</tr>
<tr>
<td>Hardwood products</td>
<td>100 M</td>
</tr>
</tbody>
</table>

Accomplishments through four years of operation of this plan are as follows:

<table>
<thead>
<tr>
<th>Product</th>
<th>Objective</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine sawlogs</td>
<td>4,000 M</td>
<td>4,848 M</td>
</tr>
<tr>
<td>Hardwood sawlogs</td>
<td>4,000 M</td>
<td>1,158 M</td>
</tr>
<tr>
<td>Pine products</td>
<td>13,600 M</td>
<td>5,554 M</td>
</tr>
<tr>
<td>Hardwood products</td>
<td>400 M</td>
<td>189 M</td>
</tr>
</tbody>
</table>

Area coverage has been only 40 per cent of plan.

Silvicultural objectives of this plan are:

1. To grow commercial tree species to the size and quality required for high-grade sawtimber.
2. To increase the average pine growing stock from 1,348 board feet to 5,000 board feet per acre.
3. To perpetuate the naturally prevailing forest types, shortleaf pine and oak-hickory.
4. Secure maximum quantity and quality by intermediate stand improvement measures.
5. To extend the pine type to all potential pine sites.
6. To coordinate timber use with recreation, wildlife, water and grazing uses.

The current management plan expires June 30, 1956. We are now working on a complete revision of the Magazine working circle management plan, employing completely new and different methods for collection of data and incorporating more precise procedures for controlling the management of the stands. Collection of data for the preparation and maintenance of this revised plan involves two main processes:

1. Classification and mapping of forest type and stand classes with the aid of aerial photos with primary emphasis on the location and description of operable areas.
2. Establishment and initial measurement of a system of continuous inventory plots for the purpose of determining volume, current periodic growth, and allowable cut by type and stand class for the entire working circle.
Stands are being classified as follows:

1. **Forest cover type**
   - Shortleaf pine stands
   - Shortleaf pine - hardwood stands
   - Hardwood stands.

2. **Stand Size Class**
   - Large sawtimber stands
   - Small sawtimber stands
   - Pole timber stands
   - Seedling and sapling stands
   - Nonstocked and other

3. **Stand structure**
   - Prevailing species
   - Stocking
   - Prevailing age of overstory
   - Condition of trees in overstory

4. **Method of Cutting**
   - Regeneration
   - Removal
   - Improvement
   - Thinning
   - None

5. **Operability**
   - Operable for sawtimber
   - Inoperable for sawtimber
   - Operable for pine pulpwood
   - Operable for hardwood pulpwood
   - Inoperable for pulpwood

6. **Priority of Cutting**
   - 0-5 years
   - 5-10 years
   - 10-15 years

Classification of the stand then consists of determining for each stand: forest cover type, stand size class, stand structure, method of cutting, and operability and priority of cutting. These data are then entered in code on a stand description sheet.

Aerial photos being used for stand classification and mapping are the regular U.S. Department of Agriculture contract pictures using panchromatic film and taken at a scale of 1 to 20,000, which means a scale of slightly over
3" per mile. Individual prints are 9" x 9". We have found that pictures taken when hardwood leaves are off are definitely preferable for stand mapping in this working circle. Cost of the required pictures was about $140.

Pictures are indexed and prepared for use by computing average scale; laying out effective area, principle and conjugate points; and adding compartment boundaries and government ownership. Stereo-pairs are then selected and stands ten acres and larger in size are delineated within the effective area on the pictures. After stands in a compartment are so delineated, the photographs covering the area are taken to the field and the stand classification completed. As the stand classification is made the classification sheets are completed and the stands numbered. A map symbol is entered on the picture consisting of code numbers for stand number, forest cover type and stand size class arranged as a fraction, with stand numbers as the numerator.

The delineated and classified stands are next transferred to atlas sheets having a scale of two inches to the mile with a SKETCH MASTER. Areas for each stand are calculated and recorded on the stand description sheets. Aerial photos, atlas sheets, and stand classification sheets are all made permanent records and integral parts of the plan. They provide a complete story for every stand of ten acres or more in the entire working circle.

Volume, growth, and cut will be determined by sampling the area of each stand class through the establishment, maintenance and periodic remeasurement of not less than thirty 1/2-acre continuous inventory plots at randomly-selected locations. Principle features of this procedure are:

1. The same area and the same trees are measured in the same way each time.
2. Local volume tables are prepared and used to compute volume each time, making remeasurements truly comparable.
3. Plots are treated in the same manner as surrounding areas and all cutting and cultural operations are entered in a plot felling record.
4. Average acre volumes are computed from the plots established in each stand class, and from this total volumes can be calculated. Likewise, growth can be calculated for each stand class by comparing original volumes with those determined by remeasurement.

It is estimated that 300 to 400 plots will be required to establish this system on the Magazine working circle.

When stand classification and mapping is completed and plots established and measured, the data will be summarized and the plan prepared. Objectives for the plan are still to be decided; however, it is likely that they will include:
1. Continuation of the aim to grow high-quality sawtimber.
2. Provision to assure that the working circle is forced toward a
   more uniform distribution of age classes. This will require
   regulation of regeneration cuts.
3. Provision to further increase the per-acre volume of pine growing
   stock.
4. Further effort toward extending the pine type.
5. Establishment of new guide lines for timber stand improvement
   measures in hardwood and pine-hardwood stands.
6. A ten-year cutting cycle will be continued.

The estimated total cost of this plan is nine to ten cents per acre.

The plan that is being prepared is a far cry from the policy statement
placed into effect only ten years ago. In plan revisions made ten and twenty
years hence, the differences will undoubtedly be just as spectacular.

Management planning involves still another step, that of entering each
compartment on the basis of the tentative order of priority that will be
listed in the plan and making the final decisions for annual and periodic
sales programs and subsequent cultural measures. In many respects this
is the most important step in the program of forest management. Plans
are only guides, and success in their execution depends on the soundness of
the prescriptions made by the forester in charge.
Q. "In coming to your conclusion on the conversion to the pine type from the hardwood type, what criteria did you use as to whether or not it can be converted?"

A. (Swarthout): "One of the common sense criteria, of course, is the presence of residual pine in the area. I think we would be satisfied if we could return pine to the area that we know it once occupied. The evidence is there upon the stumps."

Q. "Have you found it necessary to make plans for other resources beyond the management of timber? Grazing, for instance, will come up."

A. (Swarthout): "I imagine I should have said something about that. Yes, it is necessary for us to make plans. Now, likewise, they are frequently merely policy statements, where we say we will do certain things. Take wildlife. The title to game in the South reposes in the states. A state owns the game; they set the laws for the harvest of the game; they enforce those laws; they set the harvest season, bag limits, etc. All that we can throw in the pot, really, is the habitat - the range. All that we can do about the game, if the state game department is not equipped to go further, is to keep the habitat in as favorable a condition as is possible for us to do. We have, in this particular case, a wildlife policy statement which says what we will do with respect to timber stand improvement; it says what we will do with respect to logging roads where they might be used for habitat and food spots; and that's about as far as we can go in that resource at this time."

"In its range, the Ozark is one of the few in the southeast which is under grazing regulation - very similar to the type of grazing regulation that obtains in the West. It has grazing allotments for people who establish a preference and retain a certain acreage for the pasturage of a certain number of animal unit months each year. Now, our objective and our plan there is very simple. We're trying to get those people out of the forest. We're doing it for their own good, and most of them believe it after three years of trial. It is a losing proposition for them and most of them are realizing it."

"In the field of recreation or recreation plans, timber management is affected to this extent: there are certain areas on which we refrain from any cutting operations in an attempt to keep them in
their natural state, and certain areas are definitely dedicated to recreation and no cutting or timber harvesting operations are allowed therein."

"Water management is largely controlled by two means. First, in a timber sale contract, certain rules and regulations and requirements are placed upon the operator, including how he will build his skid roads, and how he will leave them after he completes his operation. The second thing is that in all of our roads - the permanent road system - as rapidly as we can, we try to treat the roadside to reduce sediment loss and to keep the cuts and fills from washing. We know that the single biggest source of sediment in that area is the roads."
"THE PLACE OF THE CONSULTING FORESTER IN MANAGEMENT PLANNING"

Frank W. Bennett,
Frank W. Bennett and Associates,
Baton Rouge, Louisiana
(Presented by Lewis C. Peters)

Only eleven years ago, in 1945, there were just ten consulting foresters in the South. At that time a paper on "the place of the consulting Forester in management planning" would not have had much significance. In 1950, however, there were 82 consulting foresters in the South, and in 1955 there were 181. This rapid increase, and the present large number of forestry consultants, indicate that this class of foresters must certainly be considered in any discussion of forest management, in plan and practice. In the South, 1,600,000 forest landowners hold 163 million acres. This makes 91.5 per cent of all commercial forest land in the South in private ownership. Certainly the field is wide open for the private forest manager or consultant.

Most forestry consultants include the preparation and supervision of management plans among the services they offer. This paper will discuss the class or type of forest landowners who use these services, and how the services are supplied.

The owners of large forest areas, and especially industrial or corporate owners, generally employ foresters on a permanent basis to manage their lands. Such owners may employ consultants now and then for special jobs or advice, but most, if not all, of the preparation and operation of forest management plans is done by the company or other owner's forester - often with the help of a staff of assistants. Large forest landowners now generally realize that they can hardly have their lands managed intensively without their own permanent or full-time foresters.

At the other extreme are the owners of very small forest areas. Such owners generally cannot afford to employ consulting foresters to make and operate management plans. Moreover, most, if not all, of the forestry advice and assistance that is needed by these owners is obtainable without charge from public agencies - state forestry organizations, state and federal extension services, the U. S. Forest Service, and the Soil Conservation Service. Conservation foresters available through many pulp and lumber companies may also provide management services to the small landowners without charge.
Between these two extremes is a very large number of landowners who have medium-sized holdings. In Louisiana, for example, about one-third of the forest landowners own from 500 to 25,000 acres each. It is with owners in, or not far outside this group, that most consulting foresters will deal. The exact limits of acreage that define this group are certainly not fixed, nor is there any reason that there should be precise limits. The group begins with the landowners who need more forest assistance than can be provided by public agencies, which have a time allowance limit per client so that their services can be extended to as many landowners as possible. The group extends to the point at which landowners have such large holdings that they need and can afford full-time foresters as permanent employees. The group includes bankers, doctors, lawyers, merchants, farmers, estates, small lumber companies and so on - a wide variety of interests indeed.

The place of the consulting forester in making forest management plans has been discussed with respect to the type or class of landowners who will be served. Let us consider next the place of the consultant in carrying out management plans - or just what services in this field the consultant does, can, or should supply. Consultants are a diverse group of individuals, and the profession is still very young and in process of development. For these reasons, I will not attempt to generalize but will outline our own services.

Based on an inventory, we prepare a management plan in the form of a long-term contract. It remains in effect as long as agreeable to both parties. It provides for an annual fee for supervision, based normally on acreage. In addition, the fee is supplemented by a percentage of the forest receipts.

Management plans are rather simple guides at first. As the program develops, these management plans are intensified.

In general, they set forth what is to be managed; i.e. the forest areas by types and conditions. Protection and improvement jobs are set up. Tree planting and girdling, if necessary, are scheduled. The cutting of timber is budgeted. Cutting units may be necessary on the larger tracts. Periodic revisions are necessary to keep the plan up to date.

Our management plans are not hard and fast courses of action which cannot be changed. They are definite enough to chart a course of action, yet flexible enough to permit a change. They serve as a guide to the manager, and the forester is not a servant to the plan.

We furnish all technical personnel and technical equipment, pay our own salaries and travel expense. The landowner normally furnishes unskilled labor and work tools such as axes, etc. Sometimes landowners prefer to contract the work to be done rather than become an employer with all the risks and headaches occasioned by taxes, insurance, and labor laws.
In recent years, we have even contracted the jobs set up in the management plan. We prefer not to do this; however, sometimes it is the only way to get the job done.

A consultant is often an absentee forester with respect to carrying out a management plan. Either the landowner or the consultant has to employ local men to do much of the management work.

The question might be asked: if a landowner can afford a consultant over a period of years to manage his timberlands, why not hire his own forester? Some do; others find it less expensive and more satisfactory to engage a "part-time" forester - a consultant.

In Louisiana and throughout most of the South, one of the first and most important jobs of the forest manager is to gain the respect and good will of local residents. This should develop into active cooperation on their part. In preparing management plans, this must be recognized and included in the plan.

Some lands that we have placed under management have been used for years by open-range cattlemen, hunters, squatters and the like. In many cases the only act of ownership exercised by the legal owner is the act of paying taxes. When this situation exists, extreme care should be taken to get control of the land for the owner without invoking the wrath of the local residents. This is not an easy task.

We are managing 81,000 acres of forest lands in Louisiana. Most of these tracts have formal management plans. This work consumes approximately one-third of our time. One cannot afford to "put all of his eggs in one basket" when he is working for Mr. John Q. Public. We make damage appraisals, sell timber, plant trees, and make plant location surveys in addition to managing timberlands.

In conclusion, let me say that consulting foresters need help from Schools of Forestry and public agencies in developing management plans which are sound, yet practical. The consultant is looked to as an "expert" in every phase of forestry. He is so busy practicing forestry that he has little time for research or for developing techniques. This is true of management planning as well as all other work.

SUMMARY

The field for consultants in forest management is broad and expanding. In ten years the number of consulting foresters in the South grew from 10 to 181. Private owners hold 163 million acres of forest land, or 91.5 percent of all commercial forest lands in the South.
Consultants usually manage lands for the middle-size group of landowners, those owning 500 to 25,000 acres.

Management Plans for the consultant must be definite enough to chart a course of action, yet flexible enough to permit change.

Improved techniques which may be developed by schools, researchers and others are indeed helpful to the consultant. He is expected to be an expert in every phase of forestry, yet he has little time to develop improved techniques. This is true for management plans.
DISCUSSION

Q. "You didn't say anything about charges - I wonder if that's taboo?"

A. (Peters): "Normally, it's about the same for most of the consulting foresters in the state."

Q. "My question concerns the contract cost on the T.S.I. work that you do. I know that it's variable, but what's the average figure?"

A. (Peters): "It varies so much from job to job that I just couldn't give a figure on T.S.I. work."
When looking at the opportunities for industry to improve management on small woodlands there are many things to consider.

First let's look at the magnitude of this field and as we develop the situation, come a little nearer home. On the chart I have listed just a few facts taken from "Dick" McArdle's summary of the "Timber Resource Review."

1. A total of 484 million acres not including Alaska
2. Excess forest land can be considered negligible
3. One-fourth poorly stocked or non-stocked
4. Fifty million acres plantable
5. 4,250,000 small woodlot owners, their ownership comprising 60 percent of the entire acreage
6. Conditions poorest on small farms and private ownership

Especially in the South

That phrase, "especially in the South," is the challenge for us. Were I to enumerate the possibilities or opportunities, I'm afraid it would be like reading the classified section of your local telephone directory. This reminds me of a situation which occurred in the Richmond, Virginia, Public Library. Each day early in the morning there was a gentleman who came in, picked out six books and left. At noon he came back, returned the six books and got six more. One of the girls at the desk, being very quizzical and having a little spunk, asked him if he read all of them. To which he replied, "I surely do." She then asked him if she might pick out six for him. He readily agreed. She picked out six, one of which was the Richmond Telephone Directory. He tucked them under his arm and took off. At noon he returned in his usual manner and she asked him if he read all of them. He said, "Yes, I did, young lady." She picked up the telephone book and asked "How did you like this one?" "Oh," he said, "it was great for characters but a very poor plot."
In order for our forest industries to take advantage of the opportunities present, we have to have tools and properly develop and use these tools. Our best tools are the youngest men in our organization, more specifically our young forester. They are our first line of attack; they are the ones who take the message first hand, person to person, to the public and to the small woodlot owner. The majority of the responsibility for hitting pay dirt is directly in their hands.

I have been observing with keen interest and a great deal of enjoyment and satisfaction, the newly graduated foresters my company has been employing for the last several years. His enthusiasm and confidence is boundless. And no wonder, he went to the best school in the country, was taught by the best professors and on top of that, he didn't look us up we looked him up. He is rearing and ready to go. He reminds us very much of the young brave out West on the Navajo Indian Reservation. This Young Brave walked out into the middle of the reservation, planted himself in a prominent spot and began yelling in a loud voice, "Chance - Chance." It wasn't long before all the Indians were quite concerned and took the matter up with the wise old chief. The chief walked up to this young brave and said, "Young brave use wrong word; right word is How." The Young Brave replied, "Chief, me know How, me want Chance."

The ambition, drive, and enthusiasm of youth is not only difficult to control, it's contagious. He not only wants to show all the world he can get the job done, but he wants to "handle that job all by himself." With a mild feeling of trepidation, the boss gives him his chance. The resulting situation is not the same but somewhat similar to the young buck Australian aborigine who has just been presented with a brand new boomerang. He has driven himself crazy trying to throw the old one away.

The time is now ripe to smooth out, sharpen, and develop this valuable tool so essential to the forest industry. His boss or bosses, whoever they may be, with their years of experience in the woods, dealing with people, and knowing company policy, begin to get their ideas across and into practice. Now, I am not one to say that the boss is always right. I will agree, however, that the boss is always boss. Experience is a good teacher but not always the best teacher. Those things learned through experience are sometimes learned so well that we resist change. Here again, the young forester does his part. His new and different thoughts, ideas, and suggestions, although at times revolutionary and surprising, help keep an organization awake and growing, even if it takes using explosive tactics to make himself heard. I heard a statement the other day that was made by William Wrigley: "When two people always agree, one of them ought to go."

These young fellows need tools, also. Two types: the physical kind like increment borers, compasses etc. and another kind like the proper mental attitude, the understanding of people. It is most in keeping with
sound business economics to spend a little time and money properly prepar­ing and equipping your men to do the job. It is certainly a source of joy and satisfaction to see one in your employ after having driven fifty, sixty, or more miles, show up with the proper mental attitude and the tools to do the job.

There are many, many things that can be done to insure a man being a benefit to your organization by seizing and carrying through opportunities that are presented on small woodlands. I would like to mention four that I think are essential.

First, be sure he is properly equipped with the necessary physical tools, whether it be a compass, pickup truck or a snake-bite kit.

Second, give him an opportunity to keep up to date by attending and studying short courses. It may be serial photograph interpretation, genetics, insect control or a host of others. I know of nothing that more completely sells a small woodlot owner than for a forester to arrive knowing more about the land and timber than the owner himself. A lot of this can be learned in the office, with less time and expense by the use of serial photographs and ownership maps than any other method.

Third, he should have periodic training in good human relations. I don't mean trying to sell a product or an idea to the entire state of Louisiana. Just selling himself and his idea to one person. Only a very few people come by this naturally and I think they learn unaware, by association. Others have to learn it by being taught.

Fourth, and one which is most important, is to learn to improvise and use expedients. It is practically impossible to be present every time with all the proper tools. It is likewise practically impossible to run into a situation where, with a little thought and use of expedients, you can't get the job done.

In the October 31, 1955 issue of Life there is quite an article entitled "Comeback In The Woodlands." At the bottom of the first page there are two sentences which caught my eye. With reference to ownership and manage­ment: "... the rest is split up among 4.5 million private owners who for the most part manage their lands poorly. They will have to learn from their bigger brethen, if the United States is to satisfy its future wood needs."

A statement such as this is not only a compliment, it's a challenge and a responsibility. The small woodland owner can learn both by active instruc­tion and by example. We are setting to the best of our knowledge and capa­bilities a good example. We have got to continue to carry the message in our down-to-earth, on-the-ground methods.
To those of you who have been beating your brains out trying to get the job done, I would like to quote something which I think will be of interest and satisfaction to you. At the Annual Southern Pulpwood Conservation Association meeting in Atlanta, Clint Davis, Chief, Division of I & E, Forest Service, made a speech he called "Getting more Through the Door." He mentioned that Drs. Bohlen and Beal of Iowa State College had made a study and found that farmers and rural people adopt new ideas in five stages:

1. Awareness  
2. Interest or Informative Stage  
3. Evaluation  
4. Actual Trial  
5. Adoption.

The average time from awareness to adoption is seven years.

So, if you have noticed some improvement, somewhere, on a piece of land that you spent time on five or ten years ago, it could be that the seed you planted is just beginning to sprout.

By continuing our efforts toward effecting a more thorough and widespread private land management program, I believe we are realizing that there has to be a feeling of landowner responsibility in order that our gains will continue to pay off.

There are three essential elements in building up this feeling of landowner responsibility: the desire for proper management practices; the knowledge of effecting proper management practices; and the rewards he can expect.

The desire for proper management practices is the hardest one to sell and this is where the proper mental attitude and knowledge of human relations comes into play.

I believe I can illustrate my point with a story. A few years back there was a farmer who was quite a devotee of mules. He went to a local auction and was the lucky bidder on two outstandingly good-looking mules. He bought them at such a reasonable price that he could not help but be concerned. Upon questioning the previous owner, he found that everything was fine but that you had to drive them in very gentle tones. When he got ready to plow the following day, after hitching them up, they wouldn't move a peg. Very excitedly he looked up the previous owner and explained the situation to him. He said, "I'll be over in a few minutes and help you out." As soon as he arrived he grabbed a big stick and whammed both of them across the head. The farmer said, "Why, I thought you said be gentle and talk only in soft tones." "That's right," the previous owner replied, "but first you got to get their attention." Now just how can we get their attention?

Pause for a minute and think of the efforts that industries such as Ford
Motor Company, Coca-Cola, Toni, and Gillette Razor Blades put into creating a desire for their products. We can do the same through the medium of radio, TV, newspapers, and outstanding magazines. To those of you who may not have received a copy of this brochure, Forest Tree Improvement For The South, and to remind those of you who have, a reproduction of this in a magazine like the Saturday Evening Post would be well received by a very appreciative audience. We have messages such as this in our professional periodicals which merit being repeated in our most popular magazines. Radio, TV, and other mediums of communication are just itching to help us if we will furnish the material and assistance.

All of these methods, plus the irreplaceable person to person contact, bring about the desire to get in the swing of good land management.

The knowledge or know-how for the small woodland owner is just waiting for the asking. Foresters and forest technicians are only too happy to extend the help and explain the proper practices. Literature and instructive bulletins are available on most any problem. The more desire that is created, the more good work that can be put into effect.

The final selling point to the small woodland owner is the reward expected or received for his efforts. During the last several years there has been an increasing number of concentration points or yards for forest products. These yards have been developed by all types of forest products industry, whether they are interested in logs, pulpwood, veneer bolts or other products. They have taken a lot of the guess-work out of marketing forest products and have brought home a realization of the true value of growing timber. Methods such as this, or any method that tends to make the owner an active participant in harvesting and marketing, does much to encourage good management practices.

Now to mention briefly some of the many opportunities we have, both tangible and intangible.

In Plain Dealing, Louisiana, there has been developed in the past few years the Dogwood Trail, a six-eight mile drive through some of the best-managed forest in northwest Louisiana, a large portion of which is owned by Bolinger Lumber Company. I made this little trip on the 25th of March and I estimate that there was a carload of people traveling this route, that day, every two minutes. By association, they saw an inspiring example of good land management.

I was very much interested in the "Cinderella Story" as mentioned by G. B. Banfield, with American Box Board Company, in which aspen or "Popple," as it's called, as a result of its management as a worthy raw material, has given birth to an increasingly large deer herd. Another multiple use. Also here is another pamphlet which merits wide circulation.
We in the South have similar situations. I notice in reading the latest information as a result of recent surveys, facts such as these:

1. Somewhat over half of our growing stock in the South is hardwood.
2. It would seem wise to intensify research in hardwood pulping technique.

I am certainly in favor of more research and additional uses for our hardwoods. What a lift it would give to management practices on our small woodlots! The control of fire (and it should be added its use), insect and disease control, tree improvement through the application of forest genetics, and other opportunities, for research could be listed ad infinitum.

And what are industry's rewards? The wealth of a country or portion of a country is measured by its goods and services. Through the understanding of and application of technological progress by us, and through our extending it to others, we receive the following benefits:

More production
More money
More leisure
A more enjoyable way of life.

I would like to refer once more to this December, 1955, issue of Life Magazine. Shortly after it arrived, I sat down and read the article, "Comeback In The Woodlands," from beginning to end. After I had finished, I turned to my wife and mentioned that, "Here is an article on the good management of one of our greatest resources and the word 'forester,' or the phrase, 'forestry profession,' is not used once." She looked up and said, "Well, I certainly think that's a compliment to the profession of forestry." "You know," she continued, "it's surprising how much good can be done by one person, or one profession, if they are not sitting around worrying about who is going to get the credit."

I consider this article a glorious tribute to the forestry profession. For all of us there are challenges, there are opportunities, there are possibilities and there are a great many rewards. Let's share them together.
To attempt to intelligently discuss the management of pine-hardwood stands in south Arkansas I'd like to use the results from some of the Southern Station's older research studies at Crossett. And to do this I'd like to ask you to go back with me to the year 1937 when timber management, as we know it today, was just beginning.

Although we had about as much forest land in those days as we do today, the trees then present in our stands more or less just happened to be there. We had done little or nothing to get them. It had been only a relatively short time before that we had, we thought, removed all the merchantable trees present in the stands and we had spent little or nothing to keep fires from burning up what was left. We had, in general, taken out the good trees and left the poor, and we had removed the pine and left the hardwood.

Would it be possible to start with badly understocked stands of this type that contained a large amount of low-grade hardwood and pine, and make something out of them? Could we start with stands containing some mature trees, some that were rough and low quality, and considerable, but scattered, good second-growth pine, and develop the stands into a high-value, income-producing property, and do it in a reasonable period of time? Could this be done at the same time that a relatively large volume of logs, pulpwood, and other products of good quality was being removed in order to make the business a profitable one?

To attempt to answer such questions, a study was undertaken on a "pilot plant" basis on a 958-acre tract of quite typical unmanaged, shortleaf-loblolly-hardwood stands on the Crossett Experimental Forest in 1937. About five per cent of the tract had been farmed in the earlier years and these areas supported even-aged old-field pine stands ranging from ten to sixty years of age. The remainder of the tract had contained virgin timber at the time the area was logged over to an approximate 12-inch d.b.h. in 1915.

Only the very best of the hardwoods were cut in 1915. Removal of most of the large pines and the leaving of the hardwoods, meant that considerable seeding of hardwoods had taken place between 1915 and 1937. The result was that hardwoods had completely taken over many spots throughout
the pine stands. In 1937, hardwoods four inches and larger in diameter averaged 88 per acre and were more numerous than the pine in diameters below 7 inches d.b.h.

Pine distribution was patchy. The most lightly stocked 40-acre compartment contained 1,900 board feet. International scale in trees 12 inches d.b.h. and above. Others had from 2 to 8 thousand board feet per acre. The average stocking was 4,699 board feet, or 48 square feet of basal area.

Management was started on the area in 1937. The system of silviculture used was a modification of the single-tree selection system. Within limits of the allowable cut, trees were left depending upon the potential growth possibilities of each tree, and there has been no hesitancy about removal of two or three trees in a group if all were mature or of low quality. Ten thousand board feet per acre was considered full stocking. If this amount was present at the end of the cutting cycle, the periodic cut has been approximately equal to the growth over the given cycle. If, on the other hand, the stocking was only 2,000 board feet per acre, the cut has been limited to about half the growth. The amount cut in the stands with volumes between 2 to 10 M board feet per acre has been, in proportion to the stocking, from one-half to all the growth.

Quality has always been a major concern because of the much greater value of clear lumber as compared to knotty lumber. As a result an attempt has always been made to remove the poor and low quality stems first and save the best. You might call this "improvement selection," but any worthwhile management involving thinning or partial cutting is of this kind.

Many of the hardwood species found in our upland pine stands are good species. However, the growth rate, the clear length of the stems, and the prospective returns per unit area occupied just can't begin to compare with the pine. Too, once the lower limbs of a pine have been killed and shed through competition, there is little danger of new limbs sprouting out from the bole after the tree has been released. Not so with hardwoods. Unless the tree has a very large crown, the bole will "feather out" like a turkey once the tree has been given even a small amount of release.

It is for these reasons that we have constantly removed the hardwoods in favor of almost pure pine stands. Of course, we probably will never get rid of all of the hardwoods in our pine stands, and, as yet, we do not know whether we want to. Hardwood litter may help maintain the site.

Over the first fifteen years of the study the cut has averaged 3,518 board feet (Int. scale) of pine logs per acre. In addition, we have produced 746 board feet of hardwood logs, 4.7 cords of pine pulpwood, 0.8 cord of gum pulpwood, and 3.9 units of hardwood acidwood per acre. Approximately 42 per cent of the total pine log volume that has been cut has been Grade #1,
and logs averaged 109 board feet International scale.

The average annual growth of pine over the first 15 years has been 407 board feet per acre per year including ingrowth. Average annual growth for trees of all sizes has been 75 cubic feet. Growth has been at the rate of 10.1 per cent simple interest for sawlog sizes and 7.1 per cent for all sizes. Pine growing stock has increased from an original stocking of 4,700 board feet to 7,300 board feet per acre International scale during the period that we removed the 3,500 board feet per acre.

Stumpage returns over the fifteen years have been estimated at $81.33 per acre. At the same time, there was a net accretion of growing stock amounting to $23.17 per acre. Gross total returns were therefore $104.50 per acre.

Costs to an individual company growing the timber crop have been estimated as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost per acre per year (Dollars)</th>
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</thead>
<tbody>
<tr>
<td>Road depreciation</td>
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<tr>
<td>Road maintenance</td>
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<tr>
<td>Cruise and management plan</td>
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<tr>
<td>Timber stand improvement</td>
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<td>Car depreciation</td>
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<td>Taxes</td>
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<td>Fire protection</td>
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<tr>
<td>Timber marking (220 acres per year)</td>
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<tr>
<td>General supervision</td>
<td>0.180</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.823</strong></td>
</tr>
</tbody>
</table>

Total cost per acre for the 15-year period has been about $12.35. Net return, including addition to growing stock, has therefore been $92.15 per acre, or $6.14 per acre per year.

I know that some of you will wish to know about our experience with the hardwood problem and the pine production successes or failures under the type of management I have described. A small portion of the original hardwood component on the managed area was large enough and of good enough quality and was removed as logs in the early years. A larger portion, mostly oak, was removed and sold as acidwood. After these operations there remained many crooked, very rough, rotten stems of the better species, and some stems of all sizes of very low value species. All of such
hardwoods 3.5 inches d.b.h. and larger were girdled at one time or another during the 15-year period of the study. Chemicals for controlling sprouting were unknown in those days and none were used. Cost of the treatment to date has been $2.51 per acre.

The above treatment has, of course, not eliminated the hardwoods from the area. In fact, on parts of three compartments where we failed to get a good pine seed crop for a number of years after the deciduous species were cut, we now have quite a dense hardwood understory that is needing some attention. We also have some hardwoods on almost every acre. However, except for the areas noted above, they do not seem to be seriously interfering with the pine reproduction.

Studies have shown that in areas where the hardwood seed source has been eliminated, 99 per cent or more of our problem has been caused by the sprouting of stumps and root-stocks. Almost none is from new seeding. Consequently, where hardwoods are not wanted for game food or to grow another crop of hardwoods, they can be controlled if we use methods that kill root systems rather than temporarily retard the new growth.

What pine stocking do we have? To find out, we ran a pine stocking survey at the end of the 15-year period. We ran ten lines across each forty and took a milacre sample plot each two chains. A plot was considered stocked if it contained a pine of any size. It was also considered stocked if it was covered by the vertical projection of a pine that was off the plot.

Overstory stocking of pine larger than 3.5 inches varied from 27 to 61 per cent and averaged 47 per cent. Fifty-three per cent of the plots had established pine reproduction. Some of the plots had both pine reproduction and pine overstory. Eighty-one per cent of the plots had either one or both overstory and reproduction. Seven per cent of the pines were overtopped by hardwoods that will have to be removed before the pine will be free to grow. Consequently, our net effective pine stocking was 74 per cent. This must be considered excellent considering our high standards for full stocking.

Now what are some of the general conclusions to be had from this and from some of our other sixty-odd studies underway in the Crossett Branch territory in northern Louisiana and southern Arkansas?

Perhaps one of the most important things that we have learned is to "make the most of what you have." Too often we may be too easily discouraged with the stands with which we have to work. If we don't have a dense overstory and/or a sea of reproduction, we too often think we should tear down what we have and start over. We have learned, however, that pine reproduction does not always jump into an area that we have cut heavily. Neither does it always survive the dry summers, the fire, and the tip moth. It often seems better to save what you have and add to it rather
than to start again from the ground.

I know that there are forest areas where we must start from scratch. But also in the large majority of cases we can start with a pretty much run-down understocked stand and by a reasonable amount of timber stand improvement, fire protection, and management make a very good thing out of it in a very few years.

Our so-called "poor" farm forestry forty on the Crossett Experimental Forest is a case in point. Our pine stocking in 1937 was about 2,750 board feet per acre (Int. 1/4-inch rule) and we estimated that total pine stocking was about 20 per cent of desirable. Pine trees 12 inches d.b.h. and larger averaged 17 per acre and growth was well under 200 board feet per acre per year.

In 18 years we have removed stumpage with a standing tree value of $96 per acre and have cut 20 per cent more sawlog volume than we had when we started. Yet, today, we have twice as much sawlog volume than was present in 1937. Our growth is now 460 board feet per acre per year, and we have almost 100 per cent pine stocking.

Of course, not all understocked stands can be developed into as good income producers or for as small a price as our "poor" forty. Some will require heavier timber stand improvement at greater cost, some will require reinforcement planting, weeding, etc. Droughts may reduce seedling catch for a number of years and postpone the day when good stocking will be had. Be that as it may, the point I wish to get across is that one will be amazed at the kind of a stand one can develop out of a poorly stocked area, and at what a short time it will take to do it. Furthermore, one can't help but be pleased at the return one can get while the development work is being accomplished.

This brings up another important point to remember in the management of our shortleaf-loblolly pine stands. If you own a pulp mill, and must grow your own wood in order to supply the mill, maximum production of cellulose is of utmost importance. Dollar returns per acre per year from stumpage may be considered secondary. In such a case, the landowner may wish to manage his stands on short rotations with clear-cutting and planting. For him, that may be the ideal type of management.

For landowners without pulp mills, there are other important points to consider. The most important of these is the maintenance of the productive or earning power of established forest stands. It may take thirty to forty years to develop trees that are large enough to be growing sawlogs or poles and piling. It may take another thirty or more years to get the trees to the size and quality that will produce logs of large size and high quality, or to get long, high-value poles and piling. If we assume that the annual dollar
earning power of a tree over the first thirty-year stage of development is equal to \(X\) per unit of area occupied, than the annual earning power of the same tree over the second thirty-year period can easily be \(2X\), and over the third it could easily be \(4X\).

Now we once thought that shortleaf and loblolly trees would surely be mature by the time they were 18 to 20 inches in diameter. Some of us also thought that the rotation age for loblolly pine was about 60 years and that in general, 60-year-old trees as well as 60-year-old stands would be mature and therefore should be cut. Over the last ten years or so it has become quite apparent that we should take another look at these ideas.

In the first place we know that trees are very like people in that they live and breathe and grow. We also know that some of them grow better than others, and have better form and grow well to a much older age. Many trees are financially or biologically mature before they have reached 15 inches in size and 30 years of age, but many others are not mature until they have reached 25 or more inches in diameter and perhaps 125 years of age. We have many such trees that are now 80-90 years old and are perfectly clear of limbs or other defects for two to three logs and are growing from 2.5 to 4 inches in diameter per ten years. Many of such trees are increasing in volume and value at from $1.00 to $2.00 per tree per year. These are the kind of trees we should strive to grow more of and then keep them, individually and collectively, as long as they are earning us such good dollar returns.

There is one other item that we should always keep in mind. Any immature, good-quality tree that is, say ten inches or larger in diameter, that has a chance to grow into a large, high-quality pole or piling or sawlog tree, and that is growing 2-1/2 or more inches in diameter per ten years, is producing more dollar income per unit of area occupied than any combination of smaller trees one could put on the area the tree is using. Obviously, one could not afford to leave one, or two, or even a few of these trees per acre on a 40-acre tract and cut everything else. But when we begin to think in terms of ten or more of such trees per acre, the dollar return possibilities from growth become interesting.

But now that we have discussed and described some of the items in the puzzle, let us put it all together. The typical second-growth shortleaf loblolly pine stand has trees of three or more age classes, there are a great many different diameter classes represented, and a few trees are increasing in value at the rate of \(4X\) per year. Several more are increasing in value at the rate of \(2X\) and some of these have an excellent chance to grow into \(4X\) producing group. There are others in the X group and many of these have a chance to grow into the \(2X\) and \(4X\) groups. Even lightly-stocked stands of such a character often are found to be growing at the rate of 300 or more board feet per acre per year. If given a reasonable amount
of protection, improvement cutting, and management, and if trees are removed as soon as they become biologically or financially mature, such stands have a growth or earning power potential that is very great. One should hesitate a long time before destroying this potential by clear-cutting or cutting to a small diameter limit wherein all trees are again increasing in value at a rate. It may take 40 to 50 years to reestablish the annual return potential to the same level it was before the heavy cutting.

Forest soils studies have been underway for only a short period at the Crossett Research Center. However, we already have very strong indications that conservation of soil moisture through methods of stand management may be more important than the silvicultural system of management employed. Our soils in northern Louisiana and southern Arkansas will store from 8 to 14 inches of available moisture. At the same time any reasonably heavy stand of timber, either overstory or overstory plus understory pine or hardwood, will use up this water at the rate of about two inches per week. It also seems to be true that the rate of tree diameter growth is affected once the soil moisture supply is reduced by 50 per cent or more. Our soils, therefore, can hold enough moisture (without additional rainfall) to supply a well-stocked stand for two to four weeks at maximum growth rate, and will contain enough water to permit any amount of growth for 4 to 7 weeks, depending upon the soil type.

I'm sure that many of you know that forest stands in general practically ran out of water by the first of July or thereabouts in the dry years 1952, 1953, and 1954. The result was that we had very little growth produced during the summer months of these three years. Even during the "wet" summer of 1955, there was very little growth produced during August and September because of the dry weather.

Now evaporation will affect the soil moisture supply in about the upper six inches of soil. The supply in the profile is, however, reduced only by trees or vegetation whose roots extend into all portions of the lower horizons. The upper four feet of soil can therefore be likened to a water tank and the length of time that water will remain in the tank is dependent upon the number of horses drinking out of the tank and the amount of rainfall that will recharge the tank.

Since we have quite long dry periods nearly every summer in the area of the South away from the coast, it becomes very important to learn ways and means of conserving the water supply in our tank. Through very heavy thinning we had water left in the soil even at the end of our very dry summer of 1954. Of perhaps more interest and importance has been our studies on the effect of removal of a quite dense hardwood understory in some of our pine old-field stands. Removal of this hardwood brush conserved enough moisture to permit the overstory pine stand to grow for from four to six weeks longer than the stands did on plots that did not have the understory
I'm sure you can appreciate the fact that we obtained a considerable additional board-foot growth on the treated plots. We are a right smart way from completing this study so have no final figures to offer. At the present time the indications are that additional growth that will result from the understory removal in these old-field stands will, in a very few years, pay for hardwood treatment costs. At the present time there are also indications that hardwood removal from our so-called all-aged pine stands is also very important from a water conservation standpoint. And finally, there are indications that the sea of pine reproduction and the very heavily stocked merchantable stands that so many of us associate with successful forestry may be the type of thing that we definitely do not want. The amount of summerwood growth in our pine has great influence upon lumber density and strength. It likewise makes a difference in pulp yields and paper strength. If so, then we need to channel more of the available and limited amount of soil moisture to our good trees and cut down on the runts drinking out of the trough.

As you realize, I have been able to touch on only a very few of our studies in the limited time. I do hope I have given you the impression that there are tremendous possibilities for dollar-and-cents forestry in the South and that in a majority of cases we can make something very good out of what we have to start with. I also hope that you feel, as I do, that so far we have only barely touched on the outer edges of the possibilities of increased timber production to be had through research and good management.
Q. "I'm interested in the remark that you made about shrinkage taking place among those pine trees, especially about the bark. To what do you attribute this?"

A. (Reynolds): "Water in the cells."

Q. "Isn't it a generally accepted fact that at fiber saturation point the cells are in flux? In other words, those cells would be below fiber saturation point to exhibit shrinkage."

A. (Reynolds): "I'm not an authority on that particular subject; all I know is that the trees were definitely smaller in October than they were in July."

Q. "In other words, you don't think that moisture content is an element in the loss?"

A. (Reynolds): "No. We do know, however, that in some of the fires we had during those periods the trees were so dried out that they would practically explode. The fire would run up the bark. In fact, in one fire, according to one of the boys, the fire travelled from tree to tree and halfway up the stems.

Q. "Do you discriminate against shortleaf?"

A. (Reynolds): "I don't have the answers, truthful figures, that shortleaf will grow so much and loblolly will grow so much. In the early years we made a study and the shortleaf with similar size in diameter and crown grew about 40 to 50 per cent slower than the loblolly. Now, you can call it 30 per cent or you can call it 60 per cent. There is some difference there. The shortleaf does have an advantage in that it either has more limbs and the limbs will shed easier, so that in particular spots if you have a choice between a good shortleaf and a good loblolly, the shortleaf perhaps. On the other side, why we'd say loblolly. We favor loblolly and not the shortleaf if it's equally as good or perhaps better."

Q. "Suppose you had pure stands of both species, which would outgrow the other?"

A. (Reynolds): "I don't think there's any question. If they are on the same soil type, I think the loblolly will outgrow the shortleaf. That's no
reason to say that you shouldn't grow shortleaf up in the mountains, if that's all you have."

Q. "I'd like to ask a question about your costs. I recall some years ago seeing your costs slightly over 70 cents per acre per year, and now it's up to 82. Does this still exclude taxes?"

A. (Reynolds): "It does include taxes. We tried to include everything that a prudent landowner would include, which includes road depreciation, road maintenance crew, management plans, timber stand improvement, car depreciation, car expense, taxes, fire protection, timber marking, and general supervision. I will say, however, that some of that was capitalized rather than expensed. If you expense it, it would be greater than that."

Q. "Well, that was my next question, whether or not the capital expense was included in the 82 cents, but I see it is not."

Q. "What about road construction?"

A. (Reynolds): "The road depreciation would be for areas that were assumed to be constructed when we assumed that the person would very likely want or need a road at a two-mile spacing. Now, some of those are already there, so that the amount that you have to construct is not four miles for every two."

Q. "So really won't it be a cost of road maintenance rather than basic construction?"

A. (Reynolds): "That's right."

Q. "Mr. Reynolds, do you have any figures to show the increase in the quality of the trees grown there?"

A. (Reynolds): "We're keeping such figures, but at the present time we can't show any definite increase, mainly because we have got an increase in volume and most of that increase in volume has been from ingrowth, and when you're dealing with trees that run up to 14 inches in size, the quality is going to be relatively low; so that you can have an increase in quality for trees over, say 14 inches, but that will be balanced if you get an increase in growing stock. It would be overbalanced by the decrease in quality of your whole stand because you've got so much low-quality material moving into that size class."

Q. "I'd like to know just about where you draw the line on pine reproduction as to whether to go ahead and burn or do something to get rid of the
hardwoods, or to go ahead and do the T.S.L work."

A. (Reynolds): "Well, that's going to vary so from one area to another that I couldn't make any general statement, but I think any time you have the equivalent of 25 per cent stocking of pine reproduction, because of the experience that we've had in the last two years, say, or since 1950 - and since the experience that you fellows have had over in Texas for the last ten or more years, you're certainly taking your risks if you're interested in just natural reproduction - in getting your pine naturally. You're taking a great risk in doing away with what you've got with the hope that you're going to get some more. Now, even up in our country, our good seed years may be three to four years apart and then we lose about every other one to drought or for some other reason. And that brings up another point that I think if you're interested in full stocking, and you should be, we just can't afford to sit down and wait for reproduction. We should jump in there and plant it or direct seed it just the minute we see that we aren't going to get seed right after cutting, or if we're going to keep the area, it's no use just fooling around with a portion of the stand - get in there and do whatever it takes to put it in shape."

Q. "I want to know about this quality. What are you doing about pruning that stand?"

A. (Reynolds): "Nothing, except in the areas where we've thinned very heavily on this "sudden sawlog" study, we're trying to get enough reproduction in our groups and in our openings and where necessary so that we can grow them thick enough to get natural pruning. I think very definitely, if you are a sawlog outfit and you plant, I would prune, and I don't think you can afford to go along for a long number of years with the hope that a planted stand is going to prune up in good shape for two or three logs."

Q. "Aren't we well advised to try to keep a mixture of hardwoods in the stand?"

A. (Reynolds): "Maybe we're doing away with a certain percentage of them, but even if we wanted to, I don't think we could do away with all of them. You might be interested in knowing that because of the controversy that's been going on for years, we already have a study underway where we are trying to find out whether or not hardwood leaves are going to help us; that is, help the soil, probably from the water infiltration standpoint, maybe from the nitrogen standpoint, or something else."
Most of us will have to admit that the application of good forest management to hardwoods has not progressed as rapidly as it should have in the South. We have been so engrossed in managing pine that few of us have had the time, or the inclination, to look at the hardwoods. Those we did see were, in most cases, on pine sites, were difficult, if not impossible, to sell and were considered a problem. Thus, where the subject of hardwood management was mentioned, there was a tendency to wonder why bother about it. A brief look at the relative importance of hardwoods may help to answer this question.

**Importance of Hardwoods**

Twenty per cent of the sawtimber volume and thirty-one per cent of the growing stock volume in the United States is hardwood. In 1952, one-fourth of the timber cut from live sawtimber was hardwood.

The eleven states in the southern region have thirty-seven per cent of all the hardwood sawtimber in the country. We have nearly all the gum, about half of the oak and half of the yellow poplar. In 1952, fifty-eight per cent of the total hardwood timber cut from live sawtimber was cut in this region. The southern region occupies an important place in the hardwood industry, and that industry, in turn, exerts a tremendous influence on the economy of the region.

The latest figures show that 47 per cent of the sawtimber volume and 54 per cent of the growing stock volume in this region is hardwood. Seven of the eleven states have a higher percentage of growing stock volume in hardwood than in softwood; Florida, Georgia, South Carolina and Texas have more softwood. Incidentally, Louisiana has more hardwood sawtimber and growing stock than any other state in the region.

It is quite evident that southern hardwoods are an important resource which should be managed wisely.
Obstacles to Hardwood Management

There appear to be numerous obstacles, which, coupled with some false notions, have tended to make hardwood management seem complicated and mysterious. Before considering how to manage hardwoods, it is necessary to orient our thinking with respect to the hardwood viewpoint.

Stand Quality

One of the common statements heard is that hardwoods are culls and are not worth much. This apparently comes from failure to recognize that there are sites where pine should be favored, sites where hardwoods should be grown and some where it is possible to grow both pine and hardwood to advantage. True hardwood sites are not always easily differentiated but they are usually on the better, deeper, moist but well-drained soils. On these sites hardwoods attain their best growth and rapidly produce high-quality veneer and sawlogs. This discussion will be confined to hardwoods on hardwood sites. Another point to be considered in this connection is the fact that many of the hardwood stands we see have been high-graded, leaving the poorer trees and the less readily-marketed species. It takes time to build back the stands. Pine management is about twenty years ahead of hardwood management in this respect.

Markets

It is also frequently stated that there is no market for hardwoods. It is true that the market for low-grade and small hardwoods is limited and cheap. Local-use markets for the lower grades are developing in many areas and the use of hardwoods for pulpwood is increasing at a rapid rate. The production of hardwood pulpwood in this region nearly doubled from 1950 (the former high year) to 1954 when two million cords were produced. This increased use of hardwood for pulpwood provides an opportunity to accomplish some needed cultural work in hardwood stands.

In considering markets for hardwood sawlogs, it must be remembered that there are several utility classes and corresponding values. Sawlogs classed as local-use or tie and timber logs are not of much value to a factory lumber mill. Highest values will, of course, be realized by selling the timber for its highest use. This involves the need for the ability to recognize the various classes as well as grades within the classes where they are applicable. There is good demand in most areas for high-grade logs in the factory lumber class. Many hardwood factory lumber mills will reach out as far as one hundred miles for such material. High-quality hardwoods suitable for face veneer are being imported in increasing quantities, which indicates the growing scarcity of this class of log. There is a
tendency to think of the sawmill as a market for all sawlog-size material, overlooking considerations of class and grade and with disappointment when the mill man does not want to buy material which is better suited to some other class of use.

Growth

Figures show that hardwoods, on hardwood sites, grow rapidly and compare favorably with pine in this respect. It is interesting to note that, in general, the better species are the faster growers. The red oaks, as a group, are fairly rapid growers; diameter increase of six inches in ten years is not uncommon in such species as cherrybark oak and northern red oak. Because of differences in utilization, the board-foot growth of sawtimber per acre of hardwoods is apt to be a little less than for pine. For example, the Forest Survey shows an average annual growth of 198 board feet per acre in softwood types and 153 board feet in hardwood types in Louisiana. Figures for Georgia show the lowland hardwood type to be intermediate between the slash pine and loblolly pine types in board feet per acre per year. In terms of growth in cords and cubic feet, however, there is no difference. It must be remembered that these are average figures and that few of the hardwood stands are being managed. Under good forest management, growth rates of 400 to 500 board feet per acre per year may be expected on hardwood sites.

Regeneration

Considering the amount of time, effort and money expended on the so-called "hardwood problem" in pine stands, the number of people who think that hardwoods do not reproduce readily is surprising. Many of them just fail to recognize some of the "brush" as hardwood reproduction.

Given a seed source, proper conditions of light, soil and moisture, and protection from fire and grazing, most hardwoods will reproduce naturally. Hardwoods are more severely damaged by fire and grazing than is commonly thought. Most of the better species are relatively intolerant of shade, require direct sunlight on the ground for germination and need release for further development. All these things must be considered when thinking about hardwood reproduction. There has not been much hardwood planted in this region to date and there is need for increasing our knowledge of this subject. Much of the planting has been done on old fields which were not hardwood sites. This has resulted, in many cases, in unsuccessful plantations which have created the impression that hardwoods are hard to plant. There are enough good plantings on hardwood sites to prove that this is another false notion.
The Hardwood Industry

One of the biggest stumbling blocks to most foresters initiating a program of management in hardwoods is the failure to recognize that they are not only dealing with different families of trees, but that the hardwood industry is entirely separate and distinct from the pine industry. Utilization practices and markets are different and they have a definite effect upon the intensity of management which can be practiced.

The forester finds that he has to deal with a variety of species, each with its own peculiarities of silvics and utility. Certain species may be preferred for some uses but worthless for others. The merchantability of all trees is influenced by species, size, form, soundness and quality. Species, size, form and soundness tend to indicate the utility class which provides the best market. Within these use classes, price is largely determined by quality. There are more species and utility classes to consider in marketing hardwoods than there are in pine.

Since the majority seem to think primarily of sawlog utilization and since most of the hardwood sawlog material is made into standard factory lumber, some of the differences in the manufacture and use of pine and hardwood lumber are worth noting. Pine sawtimber is cut into lumber and about 75 per cent of it is used, as such, in construction. It is cut in even lengths, even widths from 4 inches to 12 inches, and in thicknesses from 1 inch to 1-1/2 inches for lumber and 2 to 4 inches for dimension.

Hardwood, on the other hand, is cut into lumber for use as a raw material in manufacture. About 80 per cent of it is so used, and for many of these uses it cannot be replaced. It is cut in odd lengths, in any width, and in thicknesses varying from 3/8 inch to 6 inches and is usually sold rough, dry. Pine lumber, therefore, is graded on the basis of the utility of the piece. Grade is largely determined by the size and number of knots which affect the strength. Hardwood lumber, however, is graded on the amount and size of usable clear lumber which can be cut from the piece. High-grade boards are those which will yield high percentages of clear material in relatively large, individual pieces. Grade is largely dependent upon the number and location of defects. Pine lumber is graded on the better face, while hardwood is graded on the poorer face. Since quality and value depend upon the defects present in the lumber, the recognition of and ability to evaluate these defects is important in management.

Preliminary Examination

Utilization and marketing have been emphasized because a knowledge of these things is essential to a determination of possible markets for the material to be cut. Management is practically impossible without markets.
With a knowledge of the possible markets for the various classes of material which may be encountered, the forester is ready to begin thinking about management. Before getting out in the woods with a paint gun, however, there are several other considerations involved.

The first step, of course, is to get an idea of the policy and objectives of the owner. This may influence the type and intensity of management which may be applied. With that in mind, the forester makes a reconnaissance, or examination, of the woodland to determine what he has to work with and makes a general prescription for the area. This prescription must obtain the best possible balance between the owner's objectives, the silvicultural needs of the area, and the economic factors involved in furnishing an operable cut for the purchaser.

A preliminary examination is always needed. In some cases it may amount to no more than walking over the area making mental notes. On large areas and where high values are involved, however, facts and figures should be obtained on which to base the prescription. Information needed includes the volume, by species or species groups, classified as that which should be left for further growth, that which should be cut and that which is financially mature but which may be stored on the stump or cut depending upon the policy of the owner or other economic factors. Basal area per acre, classified as cut, leave, storage, desirable growing stock, unmerchantable, or other meaningful breakdown, is also useful in making the prescription, as it gives a good idea of present and prospective forest conditions. If trees which are unmerchantable but definitely should be removed for the benefit of those remaining are tallied separately, an estimate of the size and cost of the timber stand improvement job may be obtained.

In sawtimber-size stands, especially hardwoods, some indication of the quality is essential. This may be obtained by classifying trees on the basis of the grade of the butt log until standard tree grades are available. If a high proportion (60 per cent or more) of the trees to be cut have butt logs of grade 2 or better, the chances are that a factory lumber mill will be the logical buyer. If most of trees have butt logs of grade 3 or poorer, a tie mill is a more likely possibility. Species, local markets, and other local conditions will, of course, have a bearing.

All of this information can be obtained easily and quickly by the use of point sampling. A suggested tally sheet which illustrates how the required data can be obtained by the point sampling method is attached as Appendix A. A more complete discussion of point sampling and tree classification may be found in Occasional Paper 145 of the Southern Forest Experiment Station by L. R. Grosenbaugh, entitled "Better Diagnosis and Prescription in Southern Forest Management."

In hardwoods, the species have so much influence on possible markets
that it is deemed desirable to segregate this preliminary information by species or species groups. If species are grouped, the groupings should conform to those used in the trade. The hardwood mill man wants to know what species are included in "miscellaneous."

Notes on logging conditions should be made while making the examination.

Diagnosis and Prescription

With the information at hand which was obtained in the preliminary examination, the forester is ready to plan his management operations. Small tracts, up to 200 or 300 acres in size, might be handled as one operating unit. Larger areas should be divided into convenient operating units, or compartments, with permanent, easily identifiable boundaries. Aerial photos are of great value in selecting compartment boundaries, laying out fire lines and other administrative detail.

Provision must be made for fire protection, and grazing should be eliminated in areas where reproduction is needed. Boundaries should be surveyed and plainly marked. Indicated management operations may proceed concurrently with the installation of protection measures.

Analysis of the reconnaissance data will indicate the type of treatment needed in the operating unit. The objective should be to grow large, high-class, high-grade trees of the best species for the site so as to produce the highest value product. It must be remembered that where pine matures at 20 to 24 inches, hardwoods do not ordinarily reach maturity until they are 26 to 30 inches d.b.h. This means that operations should be directed to favor the development of good growing stock of the better species and the removal, through sale or deadening, of the less desirable individuals and species. Since most of the unmanaged stands will contain a relatively high proportion of low-grade or cull trees and less desirable species, the first operations will be improvement and salvage cuts with occasional thinning plus timber stand improvement.

It is not always necessary to make a cut on each area. If the tally shows most of the volume to be in trees classed as "leave" or "storage" with a basal area of less than 75 square feet per acre, it may be desirable to defer cutting until the basal area builds up to about 90 or 100 square feet. On the other hand, if most of the trees are classed as "cut" and are salable, it may be good management to cut them now, making provision for adequate seed trees of desirable species, regardless of the basal area in "leave" trees. To make this cutting most effective, the timber stand improvement job should be done at the same time. The aim should be to build up the growing stock so that 60 to 75 square feet of basal area per acre in
the better trees are left after cutting. The first cuts should be allocated to the compartments, or operating units, with the greatest volume in trees in the "cut" classification.

The volume per acre in saleable trees whose removal is silviculturally desirable shows whether there is an operable cut. The species and quality of these trees, together with a knowledge of the markets available, will indicate which type of operation best fits the needs of the stand. All possible markets should be explored before any trees are cut or deadened.

The increased use of hardwoods for pulpwood will supply a market in some areas for the product of thinnings. Most hardwoods will respond favorably to release and the pulpwood market will open up opportunities for treatment of young, crowded stands as well as disposal of some material formerly unsaleable.

The success of the forester will be demonstrated by the financial and silvicultural results of applying his prescription to the stands. His skill is needed in defining the tree classifications which indicate the trees to be cut and those to be left. It is important to keep in mind that marking should be on an individual tree basis and that growth capacity, form and quality are usually more important than species in deciding which tree to cut.

**Conclusion**

Many people seem to be afraid of trying to manage hardwoods. Hardwood management may be a little more complicated than pine because it is necessary to know something of the silvics and utility of a large number of species and because the hardwood industry is so different. Once this is recognized and the basic knowledge gained, hardwood management offers an interesting challenge and does not appear quite so mysterious or complex.

Hardwoods are an important part of the southern forest resource. Research has shown that they grow and can be managed. We are only doing half of the management job if we are not putting our hardwood lands under management.
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Q. "Many of us probably would have difficulty recognizing hardwood sites, particularly if the hardwood stand itself is run down and in poor condition. How would you recognize a hardwood class?"

A. (Tomlinson): "You're going to have to call on the research people for that. Actually, when you come down to it, I said that hardwood management was about twenty years behind pine management. Now, I don't know how far behind hardwood research is. It's a long way behind. Right now they have some studies in both the Southeastern and Southern stations on the identification of hardwood sites based on soil-site relationships. We don't have the results, of course, yet, but that will give us some help. Now, I'm not sure that we do have site information on all the pines, either, in spite of the fact that we've been working on that for a long time. I don't think that I've answered the question except that they are working on that to get the information, and we do know, of course, that there are general things. In mountain areas or hills, for instance, the site depends, of course, on the slope, on the position on the slope, and the aspect, and on the depth of the soil. In the bottomlands, the position with respect to the water table; that is, whether it is high, low, or intermediate, has a lot to do with it."

Q. "Of course I realize that we are not far enough along to tell the quality of the hardwood site. How would you recognize it?"

A. (Tomlinson): "The only way that I can tell you how to do that is just go by what you have there. Pick the best species that is growing there - the best hardwood species - and see what it's doing. If it's growing as well or almost as well as the pine, why you may want to try to grow hardwoods. If the pine is outstripping it and you don't have much chance of getting some hardwood in there that is going to bring you more money than the pine, grow the pine."

Q. "Should we practice even-aged or all-aged silviculture with hardwoods?"

A. (Tomlinson): "I'd like to try to stay away from that argument. Actually, I think you'll find that there are some areas where, of course, you're thinking in terms of large acreages when you talk of even-aged against uneven-aged management. Actually, if you define your size of the area down to a small size, most management is going to be even-aged management, no matter what system you use to get it, if you get the size of the area that you're thinking about
down small enough. Now, when you get it up to the size that you perhaps are thinking of, you are going to find that there are some species of hardwoods that are going to respond better to even-aged management than to all-aged management - cypress, tupelo, maybe even gum in some areas - such things as that. But for the most part, it would probably be called all-aged management."

Q. "What would be your idea on a minimum merchantable top for hardwoods?"

A. (Tomlinson): "Some companies actually will go down to a 10-inch minimum top."

Q. "What do you consider?"

A. (Tomlinson): "I consider 11 inches."
USE OF BUSINESS MACHINES IN FOREST MANAGEMENT

Douglass A. Craig
In Charge, Cooperative Forest Management
Division of State and Private Forestry
U.S. Forest Service, Southern Region, Atlanta, Georgia

It is amazing to me how old-fashioned we foresters are about many of the methods and procedures we use in our every-day work in our profession. We are not old-fashioned when it comes to transportation. You don't see many foresters still riding horses in our southern woods. No, we use the modern automobile. The same goes for many of the other modern developments we use in every-day living. But let's take a look at some of the procedures and tools that foresters use and let's see how slowly we have accepted improved techniques and procedures.

Hand Paint Gun

For years and years, those who marked their timber prior to cutting used a marking axe. Blazes were made at breast height and on the stump and a distinctive brand placed on each blaze. Using a marking axe was work—but a lot of timber over the past years was marked in this manner.

When the hand paint gun first came out, many foresters were very skeptical about its usefulness. How could you put paint marks on a tree and still identify the mark? Others said paint wouldn't last a sufficient length of time on trees. These and many other complaints about paint guns were heard at first.

Now the hand paint gun is used almost entirely in marking timber. Everyone's happy with it now—it's easy to use and does a good job. But many have forgotten their stubbornness and reluctance to use the hand paint gun.

Sample tree measurement to determine volume.

Here again we find reluctance and hesitation on the part of foresters to use an improved method that saves both time and money.

For years and years, all sawtimber cut for sale on the stump was scaled prior to sawing in the woods, on trucks or at the sawmill. Each log was measured, examined for defect and a net volume recorded. Someone then
figured that if adequate information were available on the cull material in the trees, net volume could be determined as each tree was marked. To save time, and particularly when large volumes were being marked, a system of accurately measuring sample trees marked and just recording D.B.H. for the others was developed. Surprisingly enough, this sample tree method gave a volume sufficiently accurate for sale purposes. Using this method there was no need for a scaler, and it was much easier for the buyer to cut and haul the marked trees.

Was this system quickly accepted by foresters? No! Many thought that sampling marked trees was not accurate. Others felt that the cull material would be overlooked. However, gradually the use of the method grew until now it is widely used.

Others.

I could go on at some length and recite similar cases where foresters have been hesitant to adopt improved forestry methods and techniques which in every case had been developed, tested and proved to be acceptable. We as foresters, I believe, are mentally lazy. When new systems, procedures and techniques come out, we don't want to spend the time to study them and put them to use.

Right now I can think of a fairly recent development that, surprisingly, foresters have in general been very slow to adopt. No doubt Lew Grosenbaugh will mention it in his presentation - and that's "plotless timber cruising," using an angle gauge device and more recently the wedge prism. This system, originally developed by Bitterlich, was introduced in our units of measurement by Grosenbaugh. Later Bruce employed the wedge prism. Here is a system that offers foresters a quick and time-saving procedure to compute basal area and volume. Some say the system just can't work because no plot radius or D.B.H. is taken. But how many of us have taken time to study the system?

Business Machines

Now let us take a look at a lumber company that owns, say, 100,000 acres of forest land, has a forester, and is managing the property using good forest practices. I am not using any particular lumber company for this example.

If you were to ask the president of the company the following questions:
  1. What is the sawing cost per M at the mill?
  2. What are the office and overhead costs per M?
  3. What are the average daily sales in M board feet?
What would the president say? In no time at all, he would call his office manager and tell him to bring his latest reports on the items mentioned. In a matter of an hour or perhaps a little more, you could get your answer to the nearest cent or nearest board foot.

But then ask the president about him timber land - what is his present volume of timber? Volume by species? How fast is the timber growing? and many other questions. If the president calls his forester, what kind of answers does he get? It may be something like this:

1. We had a cruise a few years ago and we have been cutting some timber so the figures I give may be just approximate.
2. The timber is growing around 275-350 board feet per acre per year.
3. Other answers may be just estimates and are quoted from obsolete data.

Why isn't it just as important for the president to have reliable answers about his forest land as it is for his milling, sales, etc.? The office manager uses modern business machines to summarize his data. When new, modern office machines are developed, the company buys them; they keep up to date with the latest developments in business machines. As a result, the office and mill records are accurate, up to date and are done with a minimum of cost. But what about the forester? He no doubt works far into the night, working up management data by hand - an adding machine on one side and a calculator on the other. He checks his work, finds a mistake and then makes a correction. No modern business machines for him - he doesn't trust them. Why, only a forester can work up forest management data!

If business machines are good for most businesses, why can't they be used in forest management? Business machines can be used and are being used in forest management, as our next speaker will tell you.

Types of Machines for Discussion

In my discussion, I want to talk about the Remington Rand or IBM type of business machine that utilizes a series or group of cards on which management data has been placed. I will refer to the IBM type of machine since that is the one I am most familiar with. The Remington Rand, I understand, does almost everything that the IBM does. So I want to recognize both companies here to avoid any partiality.

Development and Use of Business Machines in Forest Management

The use of IBM machines in summarizing forest management data is not new in the South. The U. S. Forest Service Experiment Stations,
in summarizing their re-survey data gathered plot by plot, have been using IBM machines for some time. Soon after World War II, I believe Joe Wiley, West Virginia Pulp and Paper Company in Summerville, South Carolina, was summarizing forest management data on Remington Rand machines. In the Lake States, private forest industry, and state forestry organizations primarily, have been using IBM machine summary of forest management data since 1945. Here in the south the Union Bag and Paper Company and the Brunswick Pulp and Paper Company were some early ones who employed this technique in forest management in private industry. This began in 1952. Since 1952, here in the South, the use of business machines in forest management has increased very rapidly. Most large pulp companies, some lumber companies, some state forestry organizations and the U.S. Forest Service all summarize their management data by business machines.

Owners of properties of 30,000 acres and up who plan on periodically and methodically collecting forest management data, should consider business machine processing of data.

What Business Machines Can Do For Forest Management

In this part of my discussion I want to talk about the use of the business machine (IBM in this case) in summarizing the data normally gathered for preparation of a timber management plan.

First, let us examine some of the advantages of the use of business machines to summarize management plan data:

Advantages

1. More accurate. Once the figures are entered on machine record, cross checks are made to insure accuracy.
2. Cheaper. Machines can add, subtract, multiply and divide much faster than human beings.
3. Can gather more data. Because of the favorable cost of using business machines, more data can be taken in the records for summary and analysis.
4. Results obtained quicker. Business machines work rapidly.
5. Releases foresters from summary work for other jobs.

Now, how is the forest management data handled so that an IBM machine can process it? There are two ways to record the data:

1. A Mark Sense Card. Information is placed on the tally card with an electrographic pencil.
2. Field Tally Sheet - Key punch data on IBM card. In this approach
the field data is collected on a tally sheet, properly coded and transferred to an IBM card by a trained key punch operator.

Some people like the mark sense card approach and some don't. Actually using a mark sense card saves time and money, but the work must be done properly. The important fact is that, by one method or another, the field data is placed on cards which the business machine can process.

Once the tree data is placed on the card, the machines go to work, compute tree volumes, net volume, and prepare the plot or tree summaries desired. The final summaries are in printed form. The easiest way to describe what a business machine can do is to outline the handling of a sample case on a flow chart.

Exhibit No. 1 is a sample. In following the flow chart, one can see the many operations that take place, speedily and accurately, to save time and money for the forester in summarizing forest management data.

Summary

Business machines have a place in forest management. Their use is rapidly gaining favor in the South. They are most economically employed when a mass of sample plot data must be summarized in many forms for use in planning.

If you have a mass of field data from sample plots to analyze for management plan purposes, you should investigate the use of business machines for summary work.
EXHIBIT NO. 1, SAMPLE FLOW CHART
FOREST MANAGEMENT DATA FROM 400 PLOTS - 12,000 TREES - 12,000 CARDS

DATA TAKEN IN WOODS

MARK SENSE CARD
MARK SENSE PUNCH

FIELD TALLY SHEET
KEY PUNCH AND VERIFY

LIST FOR CHECK

SORT BY SPECIES DBH

TREE CARDS BY SPECIES-DBH

MERGE

GANG PUNCH-COMPUTE NET VOLUME
SORT-TREE AND PLOT SEQUENCE

PLOT TOTAL LISTING

VOLUME TABLE DATA

VOLUME MASTER DECK BD. FT. - CORDS

1/ Type of sort depends on method of volume computation. May sort also by product.

2/ Volume may be in any measure desired.
EXHIBIT NO. 1, (CONTINUED)

500 CARDS

PLOT TOTALS SUMMARIES

SUMMARY PUNCH

PLOT TOTAL LISTING

SORT PLOTS AND CARDS BY PLOT CONDITION

SORT ANY CONDITION BY D.B.H. SEQUENCE, SPECIES, ETC.

REPORTS

VOLUME BY STAND CONDITIONS, ETC.

REPORTS

VOLUME BY SURFACE CONDITIONS

REPORTS

NO. TREES BY D.B.H. CLASS, SPECIES, AND VOLUME, ETC.
Q. "To how small an area would you regard L.B.M. methods applicable?"

A. (Craig): "I think I'll qualify it a little bit. At present cost, I don't know whether I would jump down below 30,000 acres or not. One point I didn't make, I want to make at this time. In talking about business machines you might get the impression that it's expensive and costly. A lot of companies have it for their regular bookkeeping work, and it isn't necessary to purchase or rent a series of L.B.M. machines. In most of our larger cities the L.B.M. and Remington-Rand also have service centers to which you can take a batch of cards, as I described. Tell them what you want and they'll do it on a job basis. I think you'll find that you can get it done a lot cheaper and quicker by putting it on the cards."
I think our original idea of this continuous forest inventory talk was to describe in detail our forest inventory job, but when Bill Bridges was asked to come here, we got together and thought it would be better to discuss briefly how we apply the results and the information we obtain from our continuous forest inventory, and we have titled this particular paper, "The Management Application of Continuous Forest Inventory Data."

We get a lot of inquiries from foresters, and from some of our management people - our accountants and our tax experts - as to just how in the world can you apply a forest management program from a series of isolated plots that just tell you how much timber you have and don't tell you exactly where it is. The answer that we give them is that our C.F.I. program is just the latest step in the collection of management data. These steps I mention consist of: (1) the acquisition of cruise data which we picked up at time of purchase; (2) the knowledge of the peculiar conditions of the property by our field foresters, the men engaged in applying our forest management, our men resident on the forest areas, and (3) the data that we have prepared by a control mapping section on our stand description maps. We have those three facts of data, and to that we add the continuous forest inventory data, and we have actually four broad classes of data. All four segments of this data complement each other. However, one thing that continuous forest inventory does for us more than anything else is that it provides our company management with a birdseye view of the prevailing forest conditions; it tells them what is out there, how it is growing, how the forester is doing in stepping up the growth rate, are they doing a good job. We believe that this particular program - the C.F.I. program - is the most efficient way of providing factual, up-to-date information of this character.

With this in mind, I'd like to briefly summarize our field and office procedures and then describe some of the management decisions and uses that we have made of the information that we gather. Our system is a lot like many of the systems you've probably read about and heard about. All of our basic records are collected on a series of systematically-located permanent sample plots 1/5-acre in size. These records consist, first of all, of a general description of each plot and then a separate detailed measurement and description of each tree on the plots. This information is recorded initially in the field on mark sense IBM cards, and then all of
these computations and summaries of volumes and growth and listings are made by the automatic machines. We're fortunate at Union Bag; we have an IBM setup of our own, so we don't have to worry about getting the work done. Now, we think that the advantage of this entire C.F.I. procedure and the machine usage there is twofold: (1) we have higher accuracy, and (2) we have greater flexibility. That flexibility, as I will explain in a few minutes, we get at a low clerical cost. By higher accuracy, I mean that our foresters in the field don't have to worry about whether a tree is in or out; they don't guess at the d.b.h. of the tree. We think we get higher accuracy that way. The plot itself is measured in the field; its boundaries are located; each tree is measured to the nearest tenth of an inch; that's the kind of a cruise that you don't get any missed trees on. We don't miss any on that; at least we hope we don't.

By flexibility, I mean that we have the individual tree records and we have our automatic machines, so we can get information pretty cheaply that we didn't think that we originally would want to report on. For example, we could be asked for a factual estimate of the volume of slash pine trees of poor vigor class on our upland sites on company lands and within 50 miles of our mill. If we didn't have these machines and we had to go out and make a guess at it, that would be rough. In the past, we used to do a lot of guessing, and we'd make a guess one year as to growth or the poor vigor that I mentioned, and some of our vice presidents have pretty good memories. They'd ask us the same question two or three years later, and then we'd change it a little bit. Then they would say, "Two years ago you said so and so." Well, with the machine you get a definite answer based on factual data, so we like it for that reason - for that flexibility that we get. And that, plus the accuracy, we think of as two chief advantages of our C.F.I. program.

This system of permanent plots will be completely remeasured, every plot, every five years. At that time, we will obtain accurate figures as to the volume inventory, the net change in volume, ingrowth, the growth on the original trees, mortality, and timber drain from our company lands - timber drain or timber removed. Since these plots, as I mentioned, are systematically located and they're treated - cut, controlled-burned, or roads built over them just like the rest of the land - we think that the figures we get will be representative of our entire company ownership. Since we measure the identical land area both times - that's the first measurement and the measurement of five years - the results of the data of the second measurement will be directly comparable to that of the first measurement. It's not like comparing two 10 per cent timber cruises.

However, as forest management becomes increasingly intensive, we believe that it is desirable to get more frequent birdseye views of our timber holdings, and for this purpose we have developed the method of an annual estimate of our timber and its behavior. We do this by measuring just a portion of our plots every year. That is, we have an original measurement,
and we have a five-year measurement. In between, in years 1, 2, 3, and 4, we measure a portion of the plots. We use those to change a forest growth estimate and overall mortality figures, and to that we add our stumpage removal data, which we obtain from our land management people, and together with our accounting records we have what we call an interim or a partial measurement. We recognize that this particular procedure is not exact. It's difficult to make a mortality or timber drain estimate over a short period of time such as a year. It's a relatively small segment when you think about 900,000 acres and the growth on it. It's hard to measure, so for this reason consider these annual reports to be a trial balance. Our 5-year measurement will probably be a grand trial balance, so to speak, and we may have to make some adjustment. We made our original inventory in 1953, and since then we have compiled and submitted the results of two partial measurements.

Probably the two most important effects that inventory data have had is first, highlighting the problems of hardwood management and hardwood control, together with the large volume and unusable hardwood stems we have on our land; the second is highlighting the low level of pine stocking we have on company lands. Although most of our lands are in the so-called longleaf-slash pine belt up and down the coast, we find that the company itself owns more hardwood volume than pine. That was a shock to us because we are a pine mill primarily, yet we've had a lot of this land since 1936 and we're getting more hardwood on it than we are pine. Our cutting policies in the past in hardwood were pretty light. We didn't cut too much hardwoods, and the rate of volume increase on our hardwood stands on a per-acre basis was a lot higher than it was on our pine lands. We knew this in the back of our minds, but we didn't talk about it much. We didn't have any data to back it up, but a couple of things happened as a result of coming out with these facts and figures. One is that we were able to increase the proportion of hardwood coming from company lands to our semi-chemical pulping installation. We have a small usage of hardwood pulpage at our mill - around 300 cords a day. In addition, we were able to convince some of our top-level men to use all species of hardwoods. In the past, when we originally started using hardwoods, they said all they wanted was the soft-textured hardwoods - the gums, the maples, poplars, bays and magnolia. They said, "Oh, we can't use water oak we can't use laurel oak; we can't use those things and we don't want them." But we took some of our management people out in the woods and showed them on the ground some of the large hardwoods we have on pine land that we have to control, and they told the boys at the mill to go ahead and use all species of hardwoods. So they did. And they're pretty well satisfied with it. There is only two they won't let us use and one I wish they would is live oak. They won't let us use that. I'd like to get rid of a lot of that. And, of course, we don't use cypress. In fact, the data we had on our hardwoods changed our land acquisition program a little bit. We have a rather current acquisition program, and we are now placing greater emphasis on acquiring lands with a minimum of hardwood types, and, of course,
we are willing to pay a little more for such land. Then we also used these same findings regarding the amount of hardwood on pine land and bottomland within hauling distance of our mill, together with the total volume we had on our pine sites and our hardwood control sites. That data, I think, had an important effect in building up our hardwood control program. Last year we treated about 8,000 acres and this year we hope to treat quite a bit more than that, so it got us the money for us to go into a hardwood control program. Then the other thing I mentioned - the long recognized need of building up our pine stocking. Now, the indications are at present from our study of this data that we could at least double our pine stocking on some of our lands. It contributed materially to building up our planting program to its present level of a little over 12-1/2 million trees our last planting season. So it helped out there also.

We feel that over the years we are going to be able to use our C.F.L program as a yardstick to measure the effectiveness of our forest management program, especially regarding hardwood control, and just how much we have added by stepping up our pine stocking and things of that sort, and also improving our species composition - that is, getting rid of some of our undesirable hardwoods. Now, another thing we used our C.F.L program for - we haven't used it yet, but we may use it - and that is in probably changing our present cutting policy a little bit. Perhaps we are cutting a little too much or maybe we're not cutting enough, but it certainly may change, and any change will be based on decisions made from looking at this C.F.I. data.

Someone mentioned a while ago about C.F.L plots on small tracts. We have a use for that on tracts - I know one particular property of 20,000 acres. Those are properties the company has leased under a long-term lease arrangement where the payment to the land owner is based on what is growing every year, say a half a cord an acre a year. The payment to him is based on that, and usually somewhere in the deal in the contract they sign, either the lessee or the lessor can request a timber cruise after a certain period of time - a cruise to actually determine the growth. Well, we have only used our C.F.L plots for that determining of the growth. Of course, our basic unit of reporting forest inventory is our forest area, which is a unit of our company management. We have nine forest areas in our entire holdings. The forest areas average 100,000 acres each.

Our forest inventory, generally speaking, is good for the 100,000 acres, but on this 20,000 acre property we didn't have enough plots for a figure for the tract itself, so we just had to go in and put in some more plots. Of course, the important benefit of this method of using it on leased tracts to determine growth is that we separately measure the various elements that go to make up growth. We had a hassle with our legal staff not too long ago on one of our leased tracts, and they said, "Can you give us a figure as to what the growth is?" I said, "What do you mean by growth?"
and they said, "Well, growth." I said, "Do you mean the increase in volume on the trees since we leased the tract, and how about the trees that grew into merchantable size - are they included? And how about the trees that were cut, and how about the trees that were killed by lightning and insects - do they all come in there? And especially how about the trees that had a little growth on them before we got around to measuring them any one particular year?"

There were many of elements of growth, and I had no backing on that thing. I saw an article in some professional journal - I think it was titled, "What is this thing called growth?" We threw that thing at them, and we told them, "Now, define exactly which of these segments of growth you want?" Of course, we felt pretty good because we have a hard time with our lawyers - they're pretty exact. We had it on them - we got a little too exact with them!

Speaking of mortality, our partial remeasurements and our original remeasurements did highlight to us the amount of unsalvaged mortality we have on company lands. Some people thought it was considerable - it was, in total volume - and it did look bad until you thought about the entire company ownership, but there was some of it that could be recovered. Using the data, we were able to institute a small salvage program. We did recover some of that volume. That's another use we made of it.

Another usage of our C.F.I. data has been in determining the location of some of our wood concentration yards - our so-called wood yards, where there is a lot of company land in the immediate area. We used the data to try to get a little idea about how much wood will be available from company lands and as to whether a yard will be a success or not. An indirect usage we make of this C.F.I. is in training some of our young foresters and some of our new men. We feel that this entire process where we stress accuracy under adverse conditions (and they do get adverse sometimes), and also by having the man under close supervision, both by our field supervisors in inventorying and also by our local foresters resident on the tract, we can form a good idea of his ability and more important, we can form a good idea of his work capacity. It's meant a lot to us. In our inventory work, it gets us mad sometimes, because we get a good man who does a good job and he impresses some of our land management people, and bingo, the next thing you know he's been transferred to land management, so we've got to find somebody else. But it is a very good way to classify the abilities of your new men.

I think all these things that I've mentioned have made it pretty clear to you that we're quite fond of this C.F.I. program, and we're convinced that it's been a worthwhile expenditure of company time and money. As we're working toward more intensive forest management in the South and we are (this particular series of symposiums is indicative of that) as we're working toward that, we're going to have to have detailed forest data in usable form that can be quickly sorted and obtained and printed. I know that a lot of you probably have been told by your company management to give a quick
answer to what the growth was or what the volume was on a certain piece of property. We used to be called on for the same things, and as I mentioned before, we used to guess. Well, we don't guess any more - we get the machines at the plant to do all the work for us. I don't think that foresters have been the best business men in the world, and when you think about it, we're all in business actually. As we grow in number and stature - and we are growing in both - and as our lands do become more intensively managed, we're going to need a C.F.L. program or some similar data-gathering arrangement. We're going to need that to do a good job as foresters and as business men.
DISCUSSION

Q. "Mr. Malecki, have you noticed any tendency of your men to treat these plots in any special manner and if so, how do you overcome it?"

A. (Malecki): "We thought about that. We set up plots and our plots themselves are square instead of circular, and we have small angle irons at each corner of a plot. Instead of painting numbers upon the tree, we use a very small metal tag. Our plots, unless you know exactly where to look, are very hard to find. We thought that if we used paint for our timber, the bolt cutters would say, 'That's a special area; don't fool with it.'"

Q. "Do you make an attempt to keep track of individual trees so that they can be compared later in re-inventories?"

A. (Malecki): "Yes, each tree on the plot is numbered and each tree has a separate mark sense card. Even on our re-measurements, we take our old cards with the previous tree measurement and punch that right on the mark sense card so that we know what the old measurement was when we go out there in the field."

Q. "About what percentage area of coverage do you have on these sample plots?"

A. (Malecki): "It's a little hard to say. I can tell you this, though. We have a little more than 1600 plots for an ownership of a little over 850,000 acres - 1600 one-fifth acre plots."

Q. "Do you have a machine especially for your work, or have you found that you can conveniently work it in with other phases of the business?"

A. (Malecki): "The only machine that we have that is specifically assigned to the Woodlands Section is the mark sense attachment to our machine in our I.B.M. installation. In other words, the installation at the plant was originally put in there for the use of the plant and we have a hard time getting permission to use it. One of our vice presidents from New York happened to be down one time, so we got after him about it. He finally said to tell those foresters that any time they want to use the machine Saturday or Sunday, to go ahead and use it - and that's the way we got our machine."

Q. "Do you locate your plots based on the number of acres that you have by condition classes from the photographs or by mechanical location?"
A. (Malecki): "We do it mechanically so that our plots are located on a grid. All we were interested in mainly was total volume, but we do locate them off our Georgia Coordinate system. We worked it out that way so we feel that on our total holdings we have a little over 3 per cent. In our individual forest areas it will vary a little bit; it may run as high as 8 or 9 per cent.

Q. "I wanted to ask about the question of re-measurements. You stated that you re-measure plots every five years. Is that all in one year or one-fifth every year?"

A. (Malecki): "We re-measure all the plots every five years and a portion of the plots every year."

Q. "In your gathering of data, do you get such information as quality of logs in trees?"

A. (Malecki): "Yes, we get a pretty detailed breakdown as to other things about trees besides just their size and merchantable length - cull, grade, usable length, bark, and any other information that we can think of, even though we don't have an immediate need for it. You can take most anything you want on a mark sense card; you are limited only by the 28 or 29 columns. If you can code it, the card will take it."

Q. "Do you have one team that takes all the data?"

A. "We have what we call an inventory section, consisting of five foresters in charge of a supervisor; they are the men directly responsible for our forest inventory work, and they have no other duties. They stay in the office quite a bit. We have been in touch with the Dictaphone people and they tell us that they now have a portable dictaphone that weighs only four pounds and has a record that will take three hours of talk. We're thinking about putting one of these things on each forester's back and having him take it out to the field and talk into this thing, so the only thing he'll have to worry about is the measuring of the tree. He won't have to measure the tree and then back up and mark the mark sense card. We'll bring the record into the office."

Q. "In your gathering of data, do you feel that by using several men, that your data would be out of line?"

A. "We train the men to use a diameter tape in the same way, etc., and to do very careful work."

Q. "I take it from your statement that you don't try to make any attempt to
A. (Malecki): "We don't try on our partial re-measurements. We do feel that we will get a good measure on our five-year re-measurement."

Q. "In your particular instance you're concerned with large blocks, concentrated holdings. Do you see any particular problems in your experience with C.F.I. in trying to apply it to broken holdings, where it may be scattered over several states and a wide variety of timber types?"

A. (Malecki): "I'm going to be frank about that. We're running into the same thing. Most of our acquisitions now are in the Piedmont country in Georgia - small tracts, scattered tracts - and we're worried about whether the 70-by-70 chain grid will do it. I don't know the answer, but I don't think it's going to be the same as for our large block inventory data."

Q. "What do you get on your permanent plots that you wouldn't get from temporary plots, assuming the same degree of accuracy? The permanent plots, I know, are very costly to put in and to maintain. Wouldn't you be better off to get more plots - temporary plots - rather than permanent plots?"

A. (Malecki): "That's a good question. We only have so many plots, and I guess the main thing we like about permanent plots is that we have a regular schedule of management, and we have some men specifically assigned to that particular task. I think that's about the best answer I can give you."

Q. "You could get the same thing, though, on temporary plots?"

A. (Malecki): "We could, yes."

Comment (Briegleb): "One theoretical advantage of permanent plots as I understand it is that if you can eliminate bias of treatment of the plots themselves, you can measure change in inventory with greater accuracy on permanent plots - with the same number of permanent plots - as you can with temporary plots."

Q. "The time interval between the first and the fifth measurement on your plots: the time of the growing season produces the same per cent in diameter in your fifth year as it did your first year. Couldn't you get messed up there if you took your measurement during the growing season at one time and at the beginning of the season in the fifth measurement?"
A. (Malecki): "Yes, you could get messed up, so for that reason we have scheduled our re-measurements in the same month as the original measurement was made."

Q. "What size do you start recording?"

A. (Malecki): "5 inches d.b.h. class and over, 4.6 inches in diameter."

Q. "You don't record the reproduction?"

A. (Malecki): "No, we don't count it, but we make a note on our plot description cards as to how much of it there is on a percentage basis."

Q. "On your annual re-measurements, do you measure different plots or the same plots each year?"

A. (Malecki): "Well, on the first partial re-measurement we made we took every eighth plot. On the last one we made, we took every fourth plot."

Q. "I want to make this observation. We've done a lot of work down through the years with aerial photographs and their interpretation. It appears to me that the deeper we go into this, the more the plot distribution is going to have to be placed in homogeneous units, rather than mechanically placed."

A. (Malecki): "That's right. I think that's perfect sense."
AN APPROACH TO KEEPING
MANAGEMENT RECORDS

J. E. Bryan, Jr.
L. N. Dantzler Lbr. Co.
Perkinston, Miss.

Of all the activities engaged in by forest managers, the keeping of records is certainly the least interesting. Of all the phases of forest management on which to speak, record keeping is unquestionably the dullest. Of all the foresters qualified to speak on the subject, I haven't yet figured out why they picked on me unless it was because they wanted someone whose qualifications as a speaker matched those of the subject.

If you are wondering why I accepted the invitation to speak on this dull subject, it was because of the subtle approach used by Dr. Burns in asking me to participate in the Symposium. In his invitation he suggested that I was considered somewhat of an expert on the subject. Confronted with such flattery, naturally I accepted; and it wasn't until several weeks afterwards that I learned the true definition of an expert. It seems that the word is defined by breaking it down into its two syllables - an "X" is an unknown quantity, and a "spurt" is a drip under pressure.

I accepted the invitation to speak on the subject of record-keeping with the understanding that I could describe to you the records kept by our company in the management of its lands. In doing this we are not advocating their use by other companies; we are not setting them up as model records; we do not contend that they are the final answer, even for us, for we frequently find it necessary to revise them. Basically, however, they seem to fit our own peculiar requirements and provide us with the information we need when we need it.

History of L. N. Dantzler Lumber Company Records

About ten years ago when I was employed by L. N. Dantzler Lumber Company as their first technically-trained forester, I was given what seemed to me to be a rather peculiar assignment by Mr. A. M. Dantzler, President of our company. In addition to my other duties, he instructed me to follow our land agent around, get out of him as much information as I could, and put it down on paper. "Never again do I want our company in a position where one man is so indispensable as our land agent is at this moment," he said.
If there was ever an indispensable employee, our land agent, Mr. P. N. Howell was one. With over forty years of experience, he was the only member of our company who was familiar with our lands, and he held a wealth of information in his head. He could show you the corners of any forty, tell you when it was acquired, when it was last cut, who cut it - anything you wanted to know about it. With so many memories over so long a period to clutter his mind, however, he often dated something a few years back which may have occurred thirty years ago - such as a logging operation in a certain section, or a big fire, or perhaps a seed-year. Also, like so many of the fine old-timers of his generation, he drove like a teen-aged hot-rodder - a fact which made neither Mr. Dantzler nor his insurance carriers rest easier.

At about the same time that I joined the company, an attorney was employed to make new abstracts and give initial title opinions on all our holdings. Based on these opinions, the necessary title curative work was begun. This work is not yet complete; however, most of the major requirements have been met.

After our last mill shut-down in 1949, Mr. W. W. Barber, Secretary of the company, took over the land records. He has brought them up to date, put them in order, and developed the present system we now use in that department.

Permanent Land Records

The key to our land records is a large Land Index Sheet which contains adequate room on each side to record complete information on two full sections. There are columns in which to record, for each forty, the (1) deed number, (2) the abstract number (both old and new), (3) the exact acreage by government survey, (4) fee acres owned, (5) fee acres sold (with spaces for entering the deed number and date of sale), (6) easements (with space for the type, number, and date), (7) date mineral tax was paid and number of tax receipt, (8) survey number, (9) patent numbers (both U. S. and State), (10) acres of minerals owned, (11) acres of royalty owned, and (12) remarks. A space is also provided for a map of the section. We use this to indicate ownership by coloring each forty owned by the company.

All deeds, abstracts, easements and surveys are filed either alphabetically or numerically, and tax receipts are filed numerically by years. All land records are kept in a vault at our office; however, for additional safety they have all been microfilmed with copies of the films stored in safety deposit boxes in several banks.

About eight years ago we started a modest project to resurvey, correctly establish, and paint our boundary lines. At the same time, we
devised a Survey Form on which to record data obtained in these resurveys. This form is on legal-sized paper with appropriate spaces in its heading for (1) the deed number, (2) county, (3) township, (4) range, (5) survey number, (6) date, and (7) scale. A plat of one section is provided, drawn to a scale of one inch to 10.00 chains (or 660 feet). This plat may easily be converted to a scale of one inch to 20.00 chains (1320 feet) and provide room for data on four (4) sections. Below the plat is a legend, a space for remarks, and a place for the surveyor's signature. On this form is entered the measurements of land lines established, witnesses to corners, location and status of fences, and other pertinent information obtained in the survey.

Since we have a ten-year adverse possession law in our state, our lawyers caution us to be careful not to allow any fence or other act of possession to go unchallenged for any length of time. They also advise us to record any acts of possession that we may perform, since all such acts help strengthen our titles. For this reason we try to repaint our land lines every three to five years, and in each case record the date they were repainted, who performed the job, and what they found. We use a Standard Township Plat for this purpose, and indicate lines repainted and trespasses found with pencil notations in the appropriate places. These are filed by townships in chronological order, and have already served as the basis for several "act of possession" affidavits which were required to establish title to certain property.

Permanent Forest Management Records

Some of our forest management records date back to 1944 when we began to record the dates and amounts of timber cut from various sections of our lands and fire losses suffered each year by our company. Our present system of records, however, is based on an inventory of our lands made by Pomeroy & McGowin in 1950.

The Pomeroy & McGowin Inventory of our holdings is no different from inventories of other holdings in the South, except possibly in one respect. Our inventory is not summarized by forties or sections, but by logging compartments, or units. These compartments - 248 in number - contain an average of 377 acres each and may be composed of parts of one or several sections which would logically be cut in one logging operation.

With the inventory, we were furnished the usual set of type maps which now gather dust in our vault; and a complete set of aerial photographs, the most useful tool we have found to date. These photos were taken by Fairchild with infra-red films and minus blue filter, printed to a scale of 4" to "1" mile; and, as part of the deal, Pomeroy and McGowin located our land corners and drew in our boundaries on each picture. These aerial photographs are consistently used by our surveyors, markers, fire crews
and foresters in all phases of their work.

Our present plans are to have our lands re-photographed and re-inventoried at ten-year intervals. We feel that a comparison of the new photography and estimate with the old will provide a real basis for evaluation of our management program.

For recording the removal of timber from each compartment, we use a Timber Depletion Record Form, with columns for (1) the description of the entry, (2) the date or period, (3) the number of pine trees 5" and up in d.b.h., (4) volume of pine in board feet, (5) the volume of pine in cords, (6) the number of hardwood trees 8" and up in d.b.h., (7) board-foot volume of hardwood and (8) pulpwood volume of hardwood in cords. In its heading, there are spaces for numbers of the applicable photographs, appropriate survey numbers, compartment number, acreage, and description. The first entry - in black - is the Pomeroy and McGowin estimate, with figures on subsequent cuttings entered in red. Theoretically, in order to determine what is left in the compartment, one simply deducts the sum of the red figures from the black, adds the growth and gets his answer. Actually, we use these records as a basis for making future cutting plans without having to wait for another estimate. When our next inventory is made, we plan to enter the new estimate figures in black below our last red entry and start over again.

The bulk of our timber cut is in formal sales regulated by cutting agreements. We keep separate folders for each sale, with complete information on tree sizes and volumes enclosed; and whenever more detailed information is needed on the timber cut from a particular compartment, it can usually be obtained from these sales records.

Records of Other Major Forest Management Activities

We keep these records in the same book in which depletion records are kept and on forms of a similar size and covering the same compartments as do the timber depletion forms. These forms have sections for (1) planting operations, (2) stand improvement measures, (3) turpentine operations, and (4) other miscellaneous activities. It has sufficient space for mapping the areas receiving various treatments and a space for appropriate remarks. The section on planting has columns for the date, description of area planted, acres, trees planted per acre, species and first-year survival per cent. Columns for the date of treatment, description of area treated, acres, and description of treatment are provided in the section for T. S. L measures; and for the dates, description of area worked, acres, number of trees worked, faces and remarks in the section on Turpentine Operations.

This form needs some revision. We originally intended the plat to be
a type map of the compartment and provided space for type descriptions. Now we use the plat to indicate areas planted and treated with T.S.I. measures and have no need for describing types. Also, we question the need for permanent records on turpentine operations since our policy is to limit an operation to three years or less, then cut all the trees that were worked. Since turpentine operations are considered "acts of possession," however, at the present we continue to record them.

You will note that no place is provided for recording fire occurrence on the above-mentioned forms. In our section of Mississippi fires occur so frequently that we felt there would be need for more space to keep our fire records than could be made available on our management forms, so we keep separate records on fires. For each fire that occurs, our crews make out an Individual Fire Report very similar to those made by state crews. Aerial photographs are used whenever possible to pinpoint the location of fires and to accurately measure their acreages. Each report is numbered and pertinent information is entered on an cumulative report. The location and approximate size of each fire is indicated on an Ownership Map which is made a part of the fire records for the year. A summary of the number of fires, acres of company lands burned, and percentage of land lost by counties and districts completes the wild fire records. Prescribed or controlled burns are recorded in the same manner.

Current Records

In addition to our permanent records, there are several periodic reports that we make to our directors and stockholders which might be classed as records. Each month we give them a detailed report of the Cost of Forest Management showing how much of their money we spent in our management activities and for what it was spent. There are fifteen such activities or accounts shown in this report under the major headings of (1) Timber Sales, (2) Surveys, (3) Forest Protection, (4) Forest Management, and (5) Administration. Accompanying this report of expenditures, we furnish a monthly Progress Report indicating the volumes of timber marked; miles of land lines established, painted and repainted; number and acreage of wild fires on or threatening company lands; number of acres prescribe-burned; miles of fire lanes plowed; number of acres planted; miles of road constructed; miles of fence constructed; number of acres treated with T.S.I. measures; etc. Unit costs are computed, where applicable (costs per thousand for marking, per acre for planting or T.S.I. work, etc.), and made a part of the progress report. Consolidated cost and progress reports are prepared for the year. Comparison of these reports from month to month and year to year keep us in line on our spending and give us an indication of what is being accomplished.

Another monthly report of considerable value to us is our Cost of
Transportation report. It gives the expense, depreciation and insurance charged to each vehicle for the month, and the mileage and cost per mile. An cumulative report for the year is also compiled. We find these reports valuable in determining which vehicles are being abused or neglected and when they are ready for trade.

If you are still with me at this point, and have concluded that this record keeping takes a lot of time, you are absolutely right. If you are wondering if they are worth the effort, you are experiencing a normal reaction. I certainly was not completely convinced of the value of our records until they were put to test in 1951-52 when both foresters then employed by our company were recalled to active duty by the Armed Forces. We were given only two months in which to locate, employ and train a replacement to carry on our operation. Of course, we were fortunate in finding a capable man to fill the vacancies, but the speed and smoothness with which he took over and handled the operation would not have been possible without our records to guide him.
Q. (Briegleb): "As I recall on that compartment form you showed, it indicated an area of 177 acres. Is that about average for a compartment?"

A. (Bryan): "The average compartment is 377 acres."

Q. "Do you indicate on your records that certain lines have been painted, or do you record the men who painted them, the date they painted them, and what not?"

A. (Bryan): "I record the date it was painted and the crew that painted them. We have used that as a basis for several acts of possession. We have never done so, but we are available to testify to that effect."
Fortunately, a tree tends to be elliptical or circular in cross section. This happy fact means that a random sample of a single dimension (tree d.b.h.) when squared and multiplied by $\frac{\pi}{4}$ will lead to an unbiased estimate of tree basal area. Basal area is the only quantitative variable in a standing tree that can be sampled cheaply and without bias. Also, basal area tends to be strongly correlated with the tree's height and volume. Hence, the wise forester samples basal area intensively and samples much less intensively the relation of volume (an expensive determination) to basal area or to some joint combination of basal area and other variables. Many foresters are so happy with an arbitrary volume table (entered with basal area and height) that they feel it unnecessary to sample the actual local relationship of volume to these variables at all.

The discussion which follows will explain two techniques that those who are satisfied with very infrequent sampling of tree volume may prefer to the use of arbitrary volume tables, and two techniques that are well adapted to breaking down individual tree volumes into component parts. For simplicity, this discussion will deal only with board feet according to the International log rule with 1/4-inch kerf (since it is the most consistent and hence the most nearly additive of the board-foot rules). Just as board feet (Doyle) for 16-foot logs can be easily calculated as $(d-4)^2$, board feet (Int. 1/4-inch) for 16-foot logs can be easily approximated as $0.8(d-1)^2$ where $(d)$ is average small-end diameter inside bark; this formula is the basis for the Roy log rule in Canada.

The first of the four tricks is useful when relatively rough estimates of volume per acre are adequate, as in silvicultural cruises, where trees may be classified into a large number of classes based on vigor, value, risk, growing space, etc. Here, the simplest sort of point-sampling with an angle-gauge affords the greatest shortcut of all. The only tally needed is the number of 16-foot logs $(N)$ for each point-sampled tree, which is recorded under the appropriate tree-class. No estimate of tree d.b.h. is needed. To estimate board-foot volume per acre, the sum of the number of logs is multiplied by

\[
(60) \text{BA factor of angle-gauge} \times \frac{\text{number of points sampled}}{
\text{Thus, if a prism with a BA factor of}}
\]
were used at 20 points, the average volume per acre would be 

\[ \frac{10}{20} \times 30 \times \text{number of logs in the tallied trees} \]

Even though the trees had been broken down into a large number of classes, that factor 30 could be used to convert the sum of logs in each class to board feet; 20 logs tallied in a class would mean a total of 600 board feet.

A more locally valid factor than 60 can be estimated by measuring (on sample plots) the ratio 

\[ \frac{183 \times \text{tree volume}}{\sum (d, b, h)^2 (N)} \]

If this ratio is estimated from point-samples instead of plot-samples, the ratio for each sample tree must be calculated, and then the ratios should be averaged.

Those interested in more detail are referred to Southern Forest Experiment Station Occasional Paper 145.

The second trick is only slightly more complicated. Even though point-sampling will be much more widely used in the future than it has been in the past, there are situations where plot-sampling will still be used or where approximate volumes of individual trees are desired. Here, in addition to N (or number of 16-foot logs in the sample tree), D (or sample-tree d.b.h.) must be estimated. Board feet in the tree can be estimated as 

\[ (D - N)^2 (N) \]

for trees with a Girard form-class of about 80. Such a 20-inch, 4-log tree would be estimated to contain 

\[ (20 - 4)^2 (4) (\frac{1}{2}) = 512 \text{ board feet} \]

This can be raised or lowered by roughly three per cent for each unit deviation from 80 in estimated form class. Hints on how to mentally square non-integers or numbers larger than 25 are given in Southern Forest Experiment Station Occasional Paper 126.

A more locally valid factor than one-half can be estimated by measuring (on sample plots) the ratio 

\[ \frac{\sum \text{tree volume}}{\sum (D - N)^2 (N)} \]

point-samples instead of plot-samples, the ratio for each sample tree must be calculated, and then the ratios should be averaged.

Although local ratio sampling instead of use of the arbitrary ratios 60 or \(\frac{1}{2}\) will render the above techniques as accurate as desired, the adoption of the arbitrary ratios where no tree measurements other than N (or N and D) are to be sampled will often be preferable to using equally arbitrary volume tables. Furthermore, the ratios allow estimates to be worked up on the ground with no tables and little arithmetic.

The third trick is especially helpful in sampling cull per cents or the proportion of individual tree volume falling into various grades or product classes variable in length. It is also convenient as a sort of universal volume table, entered with a single diameter inside bark at any specified height above the worst of the butt-swell; it then assumes 1/8-inch taper per
foot of length in either direction. The easiest way to visualize it is as a giant tree whose cumulatively increasing height and volume can be read at each d.i.b. in a diameter series diminishing upward in steps of 1/8-inch for each foot of length. The whole table from 0 to 400 feet of height, and 50 to 0 inches of d.i.b. can be seen on pages 20-23 of Southern Forest Experiment Station Occasional Paper 134, but only a portion of it is shown in Figure 1.

In Figure 1, a sample tree has been recorded as having d.b.h. 10.1, form class 74, with the butt 6 feet being grade A, the next 4 feet being cull, and the last 14 feet being grade B. Thus, the heights at which grade changes are 6, 10, and 24 feet above stump. First, the diameter inside bark 16 feet above the stump would be calculated (or read from a table) as \((10.1)(.74) = \frac{74}{8}\) inches. Then a graduated movable "pole" is placed on the tabular sheet portraying the giant tree, with the 16-foot mark of the "pole" coinciding with the \(\frac{74}{8}\) diameter of the giant tree. Cumulative volumes on the giant tree are then read opposite the 0-, 6-, 10-, and 24-foot marks on the pole and these volumes are differenced, as Figure 1 illustrates. If only gross total volume of the tree had been desired, it could have been obtained by a single subtraction, thus:

\[
\begin{align*}
14,742 \\
-14,699 \\
\text{43}
\end{align*}
\]

It can be seen that the single giant-tree table serves as a whole family of form-class volume tables if d.i.b. at 16 feet \((= \text{d.b.h.} \times \text{form class})\) is read from some table or graph and if the movable "pole" is then positioned properly against the giant-tree table, or if the giant-tree table (on a circular wheel or drum) is properly rotated and positioned against a curved stationary "pole" or scale. The irregular upper-log tapers of conventional volume tables do not correspond to actual tree form enough better than the constant 2-inch taper per 16 feet to justify the complicated stem-volume breakdown they necessitate. Hardwood taper in particular tends to follow no single pattern, since the location of branches is almost unpredictable. In the ordinary range of trees encountered, the constant taper-assumption will differ less than 5 per cent from variable-taper assumptions of Mesarvage's tables. The table is convenient for cull-per cent estimation in standing trees, as well as for grade breakdown. Other uses include scaling long logs (entering at either large or small end or at some intermediate point), scaling logs in fractional-inch diameters or in odd-foot lengths, etc.

Where mark-sensed cards are used and the new electronic punched-card calculators are available, the giant-tree concept is still helpful, but the table itself becomes unnecessary. The electronic machine rapidly calculates distance in feet from the stump to the tip of the giant cone (rather
Given: Tree d.b.h. = 10.1 : Form class 7 1/4 : d.i.b. at 16 ft. = 10.1 x 0.74 = 7 3/4 inches.

Set 16 feet on movable "pole" or height scale opposite 7 3/4 inches.

Read cumulative volume opposite desired heights 0, 6, 10, 24.

Subtract to get volumes in intervals = 15, 9, 19 board feet.

Figure 1.--Portion of giant-tree table
than to the base) thus: \((8)(d.b.h.)(FC) + 16 = 76\). From this the machine would deduct 6, then 4 more, then 14 more feet, so that it would punch 4 distances (in feet) from tip to quality changes, thus: 76, 70, 66, 52. It would feed these each in turn into the following function:

\[
0.002592(d\text{istance})^3 - 0.01159(d\text{istance})^2 + 0.04222(d\text{istance})
\]

and punch the results, which when differenced would give exactly the same volumes in each grade as by differencing the giant-tree table.

The fourth and last trick that will be discussed here is that of height-accumulation. This technique can be applied either by using a dendrometer or by relying on the woodsman's eye (as is done in most form-class estimates); if it is desired to handle upper-log tapers without either dendrometer or woodsman's eye, a constant upper-log taper can be assumed as in the giant-tree table. A volume breakdown by grade (and by log diameter) can be provided even more efficiently than when the giant-tree table is used. Until a good hypso-dendrometer with two slope-compensated counter-rotating prisms is commercially manufactured, the woodsman's eye aided by relatively crude instruments will have to suffice. In any case, some type of multiple-register accounting machine or punched-card equipment is needed to efficiently work up and sort the volume data supplied by the height-accumulation technique.

In height-accumulation, the basic quantities estimated and recorded are the successive lengths which are involved in each two inches of taper (outside bark). Of course, some other constant taper interval could be selected. In general, these lengths will be relatively short near the base, growing longer in the mid-section of the tree and shorter again as the merchantable top is approached (wherever large branches "drain" diameter away from the main stem, as it were). For a number of reasons, it is usually convenient to code the lengths as the number of four-foot sections involved, and to start the taper series with the first even-numbered inch of d.o.b. encountered along the bole (or to round d.b.h. to the nearest even-inch and assume there is one four-foot section below it).

The outside-bark shape of a tree can be described by letting an arithmetic progression of even-inch d.o.b.'s partition a tree's total merchantable length into segments. Thus, on an 8.1-inch tree with 6 four-foot sections in its merchantable bole, the stump d.o.b. of 10 inches cuts off 0 four-foot sections, 8 inches d.o.b. might cut off one section, 6 inches might cut off 3 more, and 4 inches might cut off 2 more, accounting for all 6 sections lying between the 10-inch stump and the 4-inch merchantable top. On a mark-sensed card this shape might be recorded as tree d.b.h., followed by 1, 3, 2, 0, which figures describe its shape in terms of the lengths where small-end d.o.b.'s of each are 8, 6, 4, 2 inches.

In using woodsman's eye, it is well to think of the total length to be
distributed (6 four-foot sections) and the number of taper steps into which it will be partitioned (3, since only 8, 6, and 4-inch d.o.b.'s lie between stump and merchantable top). Absolutely constant taper would be 2, 2, 2, 0, but butt swell is apparent, so 1 is taken away from the butt and given to the mid-section, making 1, 3, 2, 0.

If instruments be used, a gauge-type dendrometer is most convenient (with slope correction), since it can optically run up the tree till it locates the 8-inch d.o.b., and then by either contracting the angle or approaching the tree, it can be used to locate the 6-inch d.o.b., etc. The Biltmore pachymeter (described by R. G. Burton in 1906 Forestry Quarterly 4: 8-9 and endorsed by Austin Cary) is the simplest angle-gauge of this type--it is merely a slit in the upright of an L-shaped instrument, with the eye placed at the extreme of the horizontal leg of the L. Whatever width at the base of a vertical tree is exactly framed by a horizontal view through the slit will also be framed at some higher point on the tree by a line of sight inclined upwards and passing through a higher part of the slit.

In addition to recording the lengths required for each 2-inch decrease in d.o.b. progressing up the tree, the estimator can record grade (or product class) of each length. If mark-sensed cards be used, 2 columns will be needed for each graded 2-inch taper step. Since use of both front and back of card makes 54 columns available, even large trees can easily be recorded on a single mark-sensed card. Reproducing punches in the office will automatically punch a separate card for each graded segment of a tree to allow for sorting and recombination.

For simplicity of illustration, Figure 2 assumes that average d.i.b. is 93 per cent of average d.o.b. over entire tree, with wood volume being 87 per cent of wood plus bark volume; different values would merely modify the boxed constants somewhat. Two trees are tallied, broken down into grades, recombined by grades, and converted to volume. The process (done by punched-card techniques) is the same where thousands of trees are involved. Volumes are machine-computed for a few composite aggregate classes--individual tree volumes need never be computed.

Once the basic data on taper-lengths and grades are recorded on the mark-sensed cards, machines will sort by diameter and grade, array by diameter within grade, and accumulate L as desired. As figure 2 shows, Σ L, Σ H, and Σ H' are merely the sum of lengths and of the first and second progressive totals of those lengths. These three quantities can be automatically furnished by machines for as many different classes as desired (instead of just Class A and Class B as shown). Note that it is not at all necessary to calculate the total volume in each individual tree unless it is desired. Additional information on volume by diameter as well as by grade can also be calculated, but the calculations will not be described here.
Machine calculations

<table>
<thead>
<tr>
<th>d.b.h.</th>
<th>Inches d.o.b.</th>
<th>ΣL</th>
<th>ΣH</th>
<th>ΣH'</th>
<th>Bd.ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>8 6 4 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Field tallies

- Tree #1: 8.1
  - 1A 3B 2B
- Tree #2: 10.3
  - 1A 4B 1B

Machine sorts and sums

- Grade A: 1 1
- Grade B: 4 4 2

Machine totals: 1 5 4 2

ΣL = 1 + 1 + 0 + 0 + 0 = 2

ΣH = 1 + 2 + 2 + 2 + 2 = 9

ΣH' = 1 + 3 + 5 + 7 + 9 = 25

Figure 2. -- Height-accumulation procedure
Many variations can be made in the above technique: multiple register accounting machines (instead of punched-card equipment) can furnish $L$, $H$, and $H'$ if the L's are manually entered as on an adding machine; pole-calipers can furnish taper data on the more important basal portion of the tree; different taper-steps or different bark relationships can be used. All of this is discussed in more detail in Southern Forest Experiment Station Occasional Paper 134.

The most useful application of the technique is probably in providing estimates of the ratio of volume to some function of basal area in classes of trees where a much more intensive sample of basal area or some joint function of basal area is available. However, woodsmen who become adept at using it to describe the shape of the lower part of a tree may well prefer it to conventional volume tables, because of the ease with which cubic-foot and board-foot volumes to several different merchantable tops can be machine-calculated.

In conclusion, let me summarize the gist of the four tricks in sampling tree volume discussed above.

(1) In point-sampling, board-foot volume per acre tends to be proportional to aggregate number of 16-foot logs in sample trees. A multiplier of $60$ (BA factor) is adequate for roughly estimating volume per acre per point where 1-log trees average form class 75, 2- and 3-log trees average form class 77, 4-log trees average form class 79, and 5-log trees average form class 80. This can be generalized to include all situations where board-foot volume = $327(d. b. h.)^2 (N)$. Local sampling can check this and develop a more appropriate factor than 60 if desired.

(2) In plot-sampling, board-foot volume of sample trees tends to be proportional to $(D - N)^2 N$. A multiplier of $\frac{1}{2}$ is adequate for roughly estimating tree volume where form-class 80 prevails. Where deviation in form class is known or estimated, appropriate adjustment can be made.

(3) Tree taper above the first log tends to average about 1 inch per 8 feet. The giant tree which has been constructed on this assumption is useful as a universal volume table entered with d. b. at the top of the first log (or at some other point), and it is especially useful in breaking down tree volume into various grades or classes.

(4) Height accumulation can either be applied accurately by using a gauge-type hypso-dendrometer, or it can be applied less accurately by relying on the woodsman's eye. In either case, mark-sensed cards are desirable. No volumes need be calculated until trees or portions of trees have been sorted into classes, which are treated as huge individual trees. Then board-foot and cubic-foot volumes may be readily calculated from $L$, $H$, $H'$ for each class.
DISCUSSION

Q. (Briegleb): "I take it a main advantage to some of these tricks may be to help in accomplishing a job with speed and at the same time at whatever accuracy was appropriate to the objectives of the work. Is that right, Lew?"

A. (Grosenbaugh): "Yes."

Q. "In this height accumulation measurement, if you wanted to use that to build a volume table, would this be faster than using a formula method, and if so, is it comparable in accuracy?"

A. (Grosenbaugh): "Yes, I think that it is geometrically accurate."