

The Problems and Philosophy of State Forest Management by George Dey 1968

Document No 3

Section7 Planning: Surveying and Mapping

(((a) Surveying - It is difficult to be sure of the most appropriate stage at which to interject the matters of mapping and surveying. So far much has been taken for granted, and as the ensuing sections of this work may depend on further references to mapping, this seems as appropriate a stage as any.

The work assumes that the responsibility for preparing the blueprint for the Afforestation of an Acquisition rests with the District Officer. Having allocated a space in time for its treatment within his 5 year plan, a preliminary walk must be made to size up the scope of its standard of difficulty. If a map is carried, it is a good idea to carry a series of coloured pencils - say three - and, by using symbols, mark on the plan items such as vegetation, soil type and appropriate ploughing, marked change of slope (for reading), likely selection of species etc. as one proceeds over the ground. This may come in very useful for later reference, and helps cultivate that all-seeing Forestry eye.

It is probably not essential to proceed with the detailed task of compartmenting until a year or so before the planting is due. Certainly the datum is to have it completed before ploughing starts, and before the species selection for Plant Requirements is undertaken.

The modern practice is to create a compartment layout using a combination of natural features and future road alignments as the boundaries.

The decision as to whether this basic road layout is the responsibility of District Office, or ancillary Engineers, must rest at higher levels. But there can be few satisfactory results compared with laying the responsibility on the shoulders of the District Officer, who can then refer to the Engineer for advice.

For leveling, he will require an Abney level, for surveying, prismatic compass and chain. No doubt, every manager will have his own preferred techniques, but to match British weather and Highland conditions there is little to match compass and chain traverses. Working on his own, a surveyor can manage fairly accurately by pacing, using a hand tally counter to count his paces, but even this should be checked against known chainages. One very useful instrument which could find a place at this stage would be a simple pocket rangefinder operative between say, 25 and 400 yards, but alas, no suitable small cheap instrument of this nature seems to have yet been devised.

As has already been indicated, the timing means this work will probably be fitted in during the months November to June but those with fire protection commitments may have less time - November to February perhaps. The fact that these are winter months is not all that much a drawback. Vegetation such as bracken will be flat for one thing.

Much will be said on whether the District Officer should undertake this personally. That he should be first and foremost a quantity surveyor is often overlooked nowadays. In his early years, he should undertake this work not merely to gain experience, but to prove his capabilities in this direction. Later much depends on pressure of work, level of assistance, etc. Suffice to say, if he can continue to undertake this task, not only will it enable him to enjoy a physical tonic to office work, but to keep abreast with reading and extraction techniques - and to get to know the ground much more intimately.

On large acquisitions, it will be necessary to cover more ground than just one imminent year's planting in order to sketch out a comprehensive, basic road system. But it is often possible to split the ground into different entities by))

((Recognising "cruxes" to roading i.e. finding the spots where, no matter what happens, a road is sure to be sited. This eases the task into separate parcels. Once such a crux is found, it frequently offers a more convenient starting point than the access to the nearest public road. If pegs are to be used they should be put in at intervals so that one can be seen from the other - essential when using a compass later. If working on his own, the surveyor will opt for pegs of 3 to 4- feet in length. Working with an assistant, they can be about 18 inches or so. One alternative to pegs, is to use a spade, cutting a turf, or a series of turves with which to build a cairn.

In making compass traverses, the more checks with known features shown on Ordnance Survey maps, the better. It is always best to take forward and back bearings, ensuring, before moving to the next point that the back bearing corresponds with a 180° difference from the complementary forward bearing from the previous point. One or two degrees probably makes little difference (and an average can be struck anyway), but 3 or 4 or more of a discrepancy may point to a misreading and a recheck.

Surveyors should beware of the influence of the sun on the Magnetic Field round about midday, and of local attraction from ore bearing rocks.

Subsequent plotting can be done in the office on tracing paper, which can then be fitted on to an Ordnance Survey sheet covering the acquisition. If the traverse does not close on the fixed points, and a check reveals no errors in the plotting (generally in calculating the deflections between sightings), there is a standard routine which can be resorted to whereby the error can be apportioned out over the whole line.

Generally speaking, compartmenting of this nature can be done at a rate of somewhere between 70 to 100 acres per day, plus half that again for plotting and planimetering. Larger acquisitions, naturally, call for more time per acre than small.

It has already been stated that it is eminently desirable to make complete compartments coincide within an acquisition, and that a compartment shared by acquisitions should be avoided. Also, the total area of the component compartments should tally with the acquisition area. Also, that - should it be difficult to obtain a logical numbering series because of acquisitions being very scattered territorially (and in time), it may be expedient to start a temporary numbering series specific to the acquisition, in which the compartment number is prefixed by the acquisition number.))

Mapping

Two things can be said on mapping at the outset.

(1) It is unlikely that a truly definitive mapping system will be possible until full colour reproduction becomes feasible, and reasonably cheap.

(2) Relying on Ordnance Survey sheets for the basic map, the obvious starting point to get at the very root of the problem, is to set up, if possible, a very close liaison with that body, so that the essential requirements of the Forester can be embodied at revision stage, without the unnecessary trimmings. Admitted, only F.C. owned land could thus be mutually surveyed but even here the attendant saving all round speaks for itself.

This apart and starting with what is available - i.e. a 6 inch O.S. sheet - various solutions are feasible. One such method is based on "whole" sheets. While there is no doubt that the District Management must have a set of O.S. sheets covering his District, a system based on whole sheets is rejected on account of its inflexibility and wastefulness of material. So, too, is the ultimate embodiment of this method - cutting whole sheets into smaller squares, pasting them on linen to provide folding field naps. These are not only expensive, but difficult to maintain and keep up to date. All too often the wretched gap between sections comes just where one wants to measure.

The solution being offered here accepts certain principles:

(1) Colour should be embodied on the mapping legend to great advantage increasing clarification. Therefore what seems called for is a basic black and white print which allows for subsequent addition of colour.

(2) To minimise work, and to make effort as productive as possible, the system should be dynamic. This means that the symbols should be capable of progressive amendment.

Both these principles are embodied in the following system. What is visualised is that there should be two types of map: (1) for use in the field; (2) for use as wall map or demonstration map in the office.

Before proceeding further it should be said that reproduction of O.S. sheets can be done in a number of ways. For example, a photo negative of a sheet or part thereof can be prepared from which prints can be taken. The disadvantage of this is that there will be carried over the extraneous detail which O.S. sheets carry. The pity of it is that the extraneous matter ever got there in the first place, and touches back on the point made at the beginning of this paragraph, on the mutual advantage of closer liaison.

The other solution is to obtain Astra positives - prints prepared on Astrafoil transparent material from the basic stencils from which the Ordnance Survey sheets themselves are printed. The advantage of this material is that the dye can be removed very easily by chemical means, so that before further prints are taken from it, extraneous detail can be removed, and if necessary additional detail added.

The drawback to this method is its initial expense, despite remaining the most satisfactory method of duplication.

The other solution is to prepare ad hoc tracings from 6 inch O.S. sheets. This may seem a laborious method but nevertheless the one which is being put forward here. Returning to the two types of map, both may be prepared in this way, but with this difference. The field map should be on a small format. This should be of the order of 10" by 8", or slightly larger, the essential restricting factor being the convenient size of a field map case to be carried slung round the neck, or carried in an anorak breast pouch. (The writer used an ex army map case - admirably suitable but which restricted the format to a working face of about 7½ inches by 9¾ ins. It even had provision for stowing a series of coloured pencils and 6 inch scale!).

Tracing paper is cheap and acts as a suitable positive from which to obtain photo prints. But if its susceptibilities in the long term to change because of moisture, give rise to worry, there are other materials which offer greater stability, although more expensive..

Whichever is used, the Forest should be carefully divided up on the selected size of format, allowing an overlap in solid blocks. Often, isolated acquisitions fall naturally on to sheets of their own. A 1 inch to 1 mile key should be prepared on which the Forest areas are marked, and a grid superimposed representing the accepted split up for these small 10 inch by 8 inch field sheets, each carrying an index number.

The tracing of these maps should be done carefully and accurately and should carry all useful detail inside and surrounding the Forest area which forms the centre piece of the sheet. Naturally extraneous detail such as tree symbols is omitted and contours can be restricted to 100 feet intervals. The National grid is a must and the appropriate lettering and numbering should be stencilled beside the lines, at the edges of the sheets.

The O.S. symbols for rides, compartment boundaries etc. within a Forest area should be accepted, even though they be double lines.

To demonstrate the dynamic character the system possesses, it is best to assume in the first instance, that the acquisition in question is uncompartmented.

The symbols required at this stage are essentially three:

(1) A symbol to indicate the boundary of the acquisition or acquisitions. It is suggested that what is required is an arrow pointing to the feature forcing the boundary. This does not obliterate features as a thick black line would do, and paves the way for subsequent addition of colour at the print stage. The colour suggested to bring out acquisition boundaries is yellow. The arrows must be drawn within the acquisition, really the only definitive thing to do. They must be fairly frequent - perhaps 5 inch apart - so that when planimetry is carried out using a magnifier instead of a metal point, continuity is preserved.

(2) A symbol indicating the number of the acquisition. Here a small box close to the boundary in two or three places, depending on acquisition size, is suggested.

The box can enclose the acquisition number and can later be coloured yellow.

(3) The access accompanying the acquisition should be shown where it has to link the area to a public road over private ground.

Other features can be added to the tracing at this stage, though these can be delayed till later - for example, electricity lines, where not on the O.S. sheet, details of the acquisition itself, to save the memory, and an inset of geology, from a 1 inch to 1 mile drift geology map.

Once this is completed and the sheet numbered as per 1 inch key, prints can be run off which can be used during the compartmenting operation.

Once compartmenting is complete, the mapped boundaries can be traced on to the same original tracing, and numbers added.

The symbol indicating compartment boundary on the tracing is a series of simple large black dots, spaced at the same $\frac{1}{4}$ inch for the same reasons as before. Later, when prints have been run off, the dots will be supplemented by a thin, red line, intended as the main compartment boundary indicator. These dots will accompany the natural feature representing the boundary, but where surveyed rides, or possibly roadlines of the future have been added, it is recommended that they should be represented as a double broken line (as they would be on O.S. sheets), with one dot between every alternate pair of dashes.

The resulting prints, should then be of use in the forthcoming plant requirement assessment exercise, and later the planting itself, for they can be coloured up using a colour code per species to assist the Forester in putting the proper species in its appointed place. (A simple schedule can be stencilled and completed in support of this co-ordinating area per species per compartment with thousands of plants).

After planting is completed the Forester can roughly survey the actual species boundary on to one of these blank prints for submission to District Officer and thence Conservator,

The District Officer, at this stage, can resume his carefully preserved tracing and mark thereupon the sub-compartments by a series of close, small dots, entering the species symbol and "P" year in small figures. From this, can be obtained prints which should now last for some time, unless further amendment becomes necessary, for example, replanting after fires, etc.

The symbol for public roads is a thick unbroken black line - or a pair of parallel unbroken lines, inked in. A completed Forest road is visualised thus - two parallel unbroken lines containing thick black bars about $\frac{1}{4}$ inch long. This symbol is chosen because it can be readily added to the two broken lines and dots of the earlier surveyed projected road line/compartment boundary, if the thick bars are made to obliterate one black dot and alternate with the other. Such a scheme allows the same basic tracing to be used again, making the original effort more productive.

Such is the outline of a very simple, yet very effective scheme which co-ordinates the production of a basic black print, with the subsequent use of colour, and yet extends the productivity of initial investment of time and effort.

BASIC MAPPING CODE.

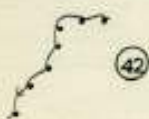
Black Outline Symbols.

Legend.

Colour Added.



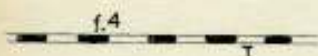
P.C. Acquisition Boundary plus acquisition number.



Compartment Boundary, supporting natural feature, plus comp. no.



Compartment Boundary supporting an artificial feature, e.g. a ride or proposed roadline.



Made up P.C. Road, with road No. and Category.



Compartment Boundary which has been made up into a roadline



Public Road.



Formed Plantations - common basic colour



Sub-compartment Boundary, showing Species Symbol and P.Year.



Other Spruces

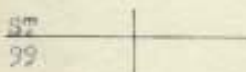
Other Species Colour Symbols -----



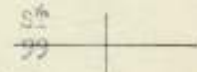
Public Footpath, as Ord. Survey.



Public Bridlepath, as Ord. Survey.



National Grid Reference Line.



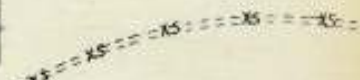
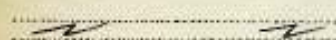
Contour Line - at 100 ft. intervals only.



Fire Rendezvous Point.



Right of Access over Private Ground.



Electricity line or Wayleave



The photocopy paper on which these prints are produced is not very enduring. It absorbs water readily, and darkens with exposure to light. But the prints so obtained are cheap and the solution is to have plenty of them, discarding the old and dilapidated, for a new sheet.

Once a series is built up, embracing the Forest, these, plus the 1 inch key, plus a series of compartment schedules for each sheet, can be held at the ready in a map case.

So much for the field maps.

The more comprehensive wall planning maps will be much bigger encompassing in all probability details from more than one O.S. sheet. But here no extraneous details need be added - only Compartments, sub-compartments (with species and P. Year), Forest Roads and the more immediate and integrated public roads. This should save time in their preparation. Such maps can be used for a variety of uses, the most obvious as a Thinning Plan map. If pinned to the wall, it must be remembered that a photo copy print from the tracing will gradually darken by exposure to light. The use of colour presents an intriguing problem. So far, it has been suggested that yellow be reserved for acquisition boundaries, and red for Compartment boundaries. One other use of red is for Fire symbols e.g. Fire Meeting Points, beater stances etc.

For a colour indicating plantations in general, grey is herewith put forward. The sole reasons are that grey is a neutral colour which can nevertheless carry other colour on top.

The uses to which a District Manager can put colour are many and varied. In some cases it is used to distinguish Planting, or Thinning, or Forest Years. In others merely to differentiate Blocks. Yet again it can be used to represent species, and it is in this last role that this system of Mapping finally supports,

The sample legend shows the suggested coding - blue for Sitka Spruce, felt to be as important as merit a colour to itself, green for other Spruces, brown for Larches, mauve for pines, pink for Hardwoods and orange for other conifers (i.e. something out of the ordinary.) The colour should be applied preferably by crayon (it can be subsequently rubbed out) and lightly. Its use should supplement, rather than replace the printed species symbols.

As a further guide, it should be practice merely to outline the sub-compartment with the appropriate colour i.e. within the dots. Complete colouring should be delayed until the stand reaches the first thinning stage and becomes productive. The exception to this, might be the coloured maps prepared as a guide to planting.

No doubt every manager will seek to use colour to suit his own purpose, so legislation on its use may not be necessarily very rigid. The above system, however, serves well in a build up towards Thinning, especially as a young Forest passes from the maintenance stage into production, and further if each species is treated separately on a thinning plan. Later, when the Forest is wholly productive, and if difference in species is not of great account during Thinning yield forecasts, the need for colour differentiation by species is not so great. The tendency then would be towards using colour to indicate Forest Years.

In fact, using the basic species colour code described above does not preclude use of colour in differentiating Forest 'Years. What is visualised is that pins with small spherical coloured heads can be used, if the map is itself pinned to a cork board. The sequence of Forest Years in chronological order is best paralleled by the sequence of colours in the spectrum. One pin per sub-compartment is all that is required. However more reference to this will be made later under the Thinning Plan section of Timber Production.

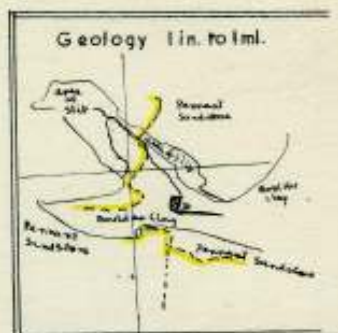
So far, all this has applied to 6 inch sheets. If 1 inch, or 2½ inch sheets are to be used, the very simple colour coding recommended is as follows. Acquisition boundaries should be marked in green ink. All F.C. owned land coloured in Yellow crayon. As and when the land is planted, it should be coloured green by overshading the yellow with blue. If further differentiation is required, the green could be made brown to indicate productive woodlands and the yellow into orange for permanent agriculture.

ST. GWYNNO FOREST

P 68 Areas

Acquisition Details.

11. Blaenau Foch. Purch. of 31/12/51
fr. M. I. Jones. (179 aacs.)
18. Blaenau Foch Pt. Purch. of 11/9/57
fr. G. P. de Winton. (432 aacs.)
20. Redalwen & Pwllfa. Lease of 14/7/58
fr. Lord Aberdare.



Afforestation		Forest. Map No.	
Replanting		Species Analysis	
F.Y. 68		(Black-acres. Red-Thous.)	
Aqsn Comp. No.	Area aacs. Tot. Aq. Th. Fins. Rble	SS	NS HL NF Lay RO
11	204 25		22 3 45
20	229 21	8 14	5 7 1 15 25

CWMAMAN

This plan, as well as embodying the suggested legend (in symbol and colour), illustrates its use during the afforestation stage to serve as a choice of species plan to Forester



To Face P. 51

Section 8

Timber production

Foresters plant trees to produce timber, and inevitably the Forest Manager will reach the stage when the plantations in his charge commence to offer marketable products. 'When this takes place, he will enter a new dimension, as exacting as it is exciting, and begin to raise his eyes, hitherto fixed firmly on the ground, upwards and ever upwards. What exactly his role is likely to be vis-a-vis timber production, (taken to include marketing), will not necessarily be of his own choosing. It is quite feasible that the task of timber production in the broad sense, or timber marketing in the restricted literal sense, will be eased out from the tangled complex that is Forestry to become functions or "jobs" of their own, delegated to a "specialist" in these spheres.,

This is scarcely compatible with the spirit of this Philosophy, which reaches towards comprehensive management.

It can be shown that in a Forest of full production - especially if Normal - the replanting element of the year's work is a very small item compared with the production of timber. The latter will occupy the Manager more and more of his time, and the task of replanting will be an interesting and easily embraced complement to the timber routine. To try and separate these two tasks and place them in the care of two different functionaries will begin to appear, in the long term, some thing incongruous and almost petty.

Splitting the harvesting side of Timber Production, from the marketing of its proceeds, is a matter for more delicate conjecture, and cannot be exhaustively argued about here. But there can be no more inspiring impetus, no more satisfying conclusion to the whole span of growing and harvesting timber, than to sell it too. However, the main concern here is not so much with conclusion, but commencements, and it is no easy matter to select an obvious starting point in a subject embracing so many facets.

Timber Production Management can be broadly divided into several fairly distinct tasks involving qualification or measurement of timber as follows: -

- (1) Long Term Estimation of Timber Production from Thinnings and Fellings, i.e. predicting up to, perhaps 20 years ahead.
- (2) Short Term Estimation of Timber.- Production from Thinnings and Fellings i.e. anticipating the immediate future 3 to 5 years ahead.
- (3) Estimates in detail, for the forthcoming Forest Year i.e. Thinning Plans.
- (4) Thinning Control - i.e., knowing how much to take out in an immediate Thinning, plus checking and regulating.
- (5) Actual measurement of the timber thus felled, collectively by sub-compartment or individually as logs.

Finally the subject includes - - -

- 6) The paper control of timber stocks.

Long Term Thinning/Felling Timber Estimation

This item has been put at the head of the list because, in logical sequence, it may well be the first involvement with Timber Production the Planning Manager will have. It also provides an interesting exercise in the need for a co-ordinated approach to this whole business of Forest Management, and some clues as to why certain basic records are required.

As soon as trees have been planted they have a potential as Timber Producers quite conceivably within the range and compass of a 20 year estimate, depending on their subsequent relative success and productivity.

But, first of all, let us introduce Inverliever.

((Introducing Inverliever

Situated on the west side of Loch Awe in Argyll, Inverliever was purchased by H.M. Office of Woods in 1907. Planting began in 1909, continuing through until 1933. The two Spruces, Sitka and Norway were well featured but a wide range of species were also represented. Management passed to the Forestry Commission when formed in the early 20's. More recent acquisitions heralded a recommencement of afforestation in F.Y.52., thus providing an example of Afforestation proceeding concurrently with the Thinning/Maintenance/Felling/Replanting stage.

It was the writer's privilege to serve at Inverliever for 10 years prior to 1964, and hereby acknowledges that this experience, literally a fascinating glimpse into the future, provided the inspiration which led to this Philosophy.

When it is remembered that Inverliever with its wide range of species and diverse range of site, was all planted before the days of ploughing, etc., it need come as no surprise to find a resulting patchwork of irregularity, with trees of often the same age and species growing adjacent to one another with differences in top height of 80 feet to 18 inches quite common.

A Volume Assessment of the Standing crop was made early in 1956. The Assessment revealed the following split up:-

Unproductive Area (acres)			Productive Area by Species (acres)							Total Area
In Check	Failed or Unplanted	Windblown	S.S.	N.S.	D.F.	E.L.	J.L.	S.P.	Other	
505	363	37	644	603	64	152	51	16	16	2,551

Following only one of these items through, the age class structure in 10 year intervals was as follows:-

	1 to 10 yrs.	11 to 20	21 to 30	31 to 40	41 to 50	Total
S.S.	17	12	178	316	121	644

Again concentrating on only one of these groups, embracing P.09 to P.15 inclusive, further break down is illustrated:-

S.S.	Qual. Class I	Q.C.II	Q.C.III	Q.C.IV	Q.C.V	Q.C.VI	Total
Age Class 41 to 50	12 acres	10 acs.	29 acs.	26 acs.	17 acs.	27 acs.	121 acs.

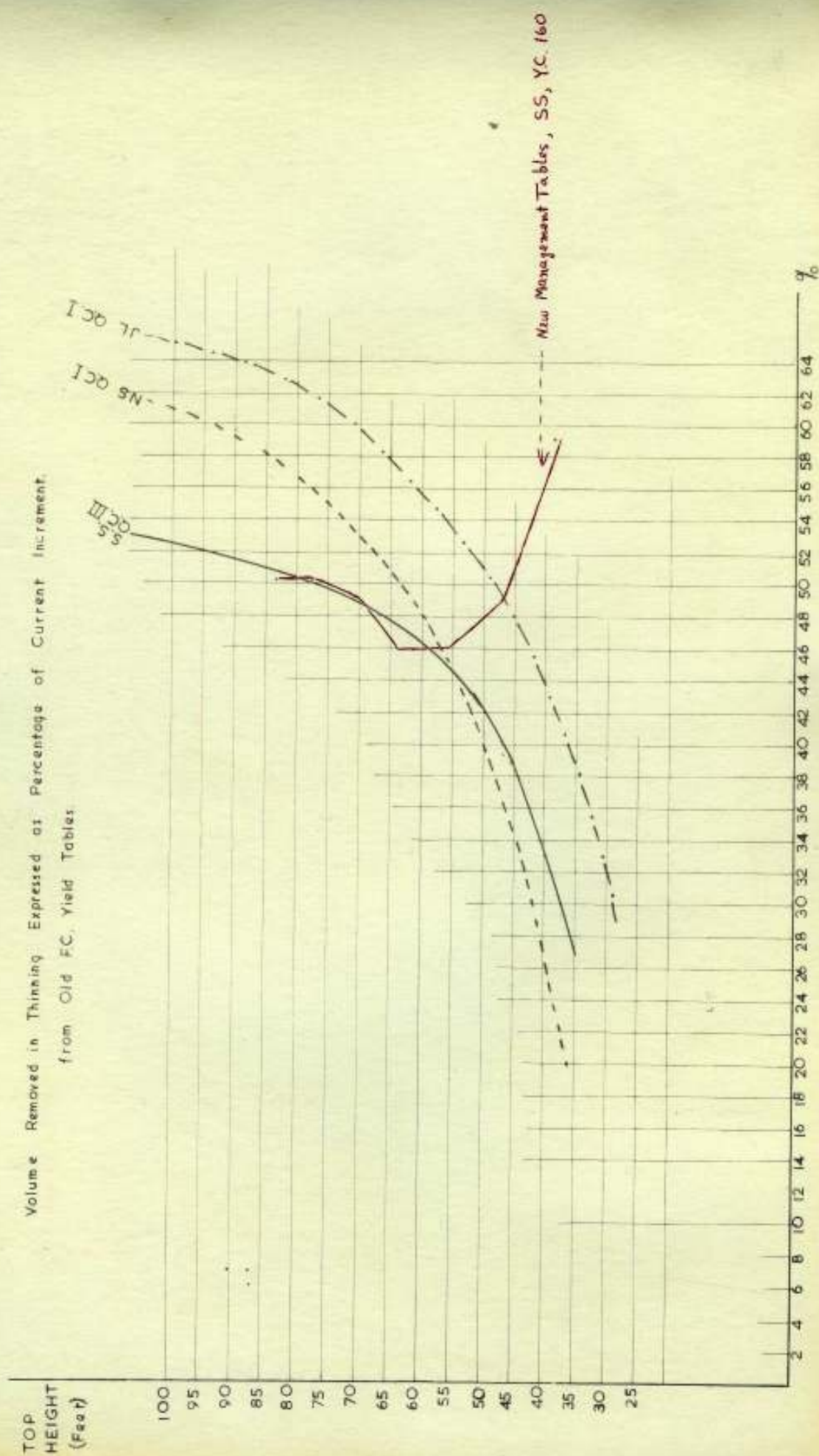
Similar diversification was found with other species.

Note that all these factors (species, age and quality class) served as criteria for deciding sub-compartments, and the vast array thus assembled, seemed very formidable.

Inverliever's 2,551 acres were contained by 95 compartments with average area 27 acres. Many of these contained over a dozen sub-compartments and the average area of these was about 3 acres.

Such was the background behind the first attempt to produce a Working Plan, which was completed about a year before the Forestry Commission Working Plan code was issued.

The Thinning Estimation problem loomed large, but a fairly workable solution was sketched out.))



((This may be not only of interest, but of some assistance in the understanding of the problem.

((Researches into Timber Production Estimation

With so many factors to be reckoned with, the maxim seemed to be, keep it simple. Furthermore as clear felling was in the offing, and as higher echelons of Policy makers may have wished to use the data with which to confront the Timber Trade, a fair degree of accuracy seemed essential.

Quality class alone could not be used as a factor, unless it was further qualified by age or Top Height. Furthermore under the Quality Class system, the different species were by no means compatible - a drawback readily overcome however, if each species was treated individually.

The only guide available in those days, was the Forestry Commission set of Yield Tables, whose usefulness to Forester and District Officer alike should never be underestimated and overlooked despite anything which has superseded it since.

A careful analysis of these (they graphed admirably!) revealed certain characteristics relating to Top Height which seemed to offer possibilities.

For example, for a given Top Height, per species, the thinning yield did not seem to vary a great deal, e.g. S.S. - 50 feet - Q.C.I, III and V - 540, 550 aac! 520 Hoppus Feet per acre respectively.

Then, there seemed to be a clear relationship between Increment, Top Height and Thinning Yield, for if Thinning Volume removed expressed as a percentage of Accrued Current Increment is plotted against Top Height, a smooth rising curve is obtained. This indicated that during earliest thinnings only about 20 to 30% of the Increment is removed as thinnings, rising to 50 even 60% as the Height approaches Clear Felling stage. This relationship seemed to hold irrespective of Productivity, but would, of course, reflect a certain pattern of Silvicultural regime.

So, whilst there also seemed to be a 40% in Thinning/60% as Felling relationship, in the total volume yield of a Stand of Trees, it would be invalid to arbitrarily reapply the 40% to any thinning as the apt percentage of Increment.

The answer seemed to be to create a series of Top Height Classes which could form the basis of Increment % groups too. Tentatively, the choice settled on 30 to 39 feet, 40 to 59 feet, 60 to 79 feet and 80 feet upwards.

These could form the basis of tabulations in which either area or volume - or both - per species would be channelled under the appropriate Top Height columns. To the totals finally obtained, would be applied multipliers obtained, from averages per height class to provide the "allowable cut" figures in terms of volume.

An extended schedule was designed on the above lines to cover both short and long term production plus a tabulation form in foolscap size,

The scheme would serve short term estimations by offering a quick method of calculating the annual Allowable Cut on a volume Control Basis.

Another increment relationship was made use of here - namely the Current Annual Increment expressed as a percentage of Growing Stock Volume and plotted against Top Height, per species and per Quality Class,

For the average Quality Class found at Inverliever (i.e. equivalent to just under Q.C.I N.S. or Q.C. IV S.S.), this would give percentages varying from 15% at 35 feet, to about 3% to 80 feet. The average Top Height of the Forest at that time proved to be 59 feet. This indicated that the Increment of the Forest then was in the order of 6½%.

Simple calculations would reveal whether or not the average Height was increasing (which it was), and at what sort of rate, so that one could predict fairly))

((accurately what the average Increment would be the following year. In fact the Top Height was increasing at the rate of 10 feet per 5 years, and from this one deduced an Increment destined to drop during the same period from 6.4 circa 4.770%.

Taking the Inverliever F.Y.56 total Standing Volume as an example the following was revealed:-

Total Growing Stock in May 1956	5,238,600 Hoppus Feet
Deduction for Thinnings during rest of year -	<u>125,644</u>
	5,112,956

Addition for Increment on Growing Stock
less only ½ Volume removed in Thinnings - + 332,000
i.e. 6.4% of 5,238,600 - 62,822 = 5,175,778

Revised Growing Stock at commencement of F.Y.57 5,444,956 Hoppus Feet

(During F.Y.56 total removals had been 245,419 Hoppus feet,
representing 74% of the Increment)

Now, the cut for F.Y.57 can be calculated readily.
Anticipated Increment 6% of 5,444,956 = 325,000 Hoppus Feet.

The Percentage of this Increment to be taken in thinning
commensurate with Top Height of 59 + 2 = 61 feet = 48%

.'. Allowable cut for F.Y.57 = 160,000 Hoppus feet

(As a point of interest, some 100,000 Hoppus feet were removed that year as Thinnings plus 110,000 Hoppus feet of Windblow which interceded).

Naturally, by using Species Working circles, and knowing the volumes represented in the four Height Class bands, more accuracy would be offered. Furthermore, this stratification of Top Height classes offered another service in that each served as a good guide to the likely Pitwood/Sawlog ratio of the stands totalled therein. From actual measurements made in the field, curves were produced correlating this ratio against Breast Height Girth and implied equivalent Top Heights) for a range of Mininum or Top Diameters.

The calculation of Allowable Cut could, of course, have been further simplified by expressing it directly as a percentage of Growing Stock.

It was also envisaged that retrospective checks on trees felled during the normal course of operations would provide an accurate assessment of the Year's Increment, which could then have been adjusted accordingly in the above calculation.

Here then seemed an admirable system offering area control for the Long Term Thinning Estimates and Volume Control in the immediate Short Term.

There seemed little more to be done for the time being, but await confirmation from the impending revision of the Yield Tables.

It proved a long wait.))

Long Term Production Estimations using the Yield Class System

The new Management Tables when they finally appeared, did not, in fact, prove to be a fund of support for the Height Class and Increment scheme outlined above.

The Yield Class system represented thinking on a grand scale, and was matched by a neat objectivity in its presentation,. It is assumed that the reader is familiar with the System.

Why, then, the incompatibility? This came primarily when an attempt was made to produce a similar graph of Thinning removed as a Percentage of Accrued Current Increment to that prepared from the old Yield Tables. The result was scarcely a curve at all, and what seemed to be 'on' with the Quality Class Yield Tables, was quite clearly not "on" new. (Ref. Graph P.54)

Returning to the Inverliever Assessment Example, illustrating how wide was the range of factors embracing Species, Age and Quality Class, a section of this example is reproduced here again, together with a reassessment based on the Yield Class System.

	Q.C.1	Q.C.11	Q.C.111	Q.C.IV	Q.C.V	Q.C.VI	
<u>Total</u>							
Acres	12	10	29	26	17	27	121

YC300	YC280	YC260	YC240	YC220	YC200	YC180	YC160	YC140	YC120	YC100	YC80	YC60	Total
Ac.1	2	5	6	24	6	6	21	5	25	5	14	1	121

Yes, the range of factors had, in fact, now been considerably extended. The lorry hitherto fairly well loaded, now felt decidedly overloaded!

However, on the maxim 'if you cannot beat them, join them', the writer recognised the element of enhanced accuracy which was offered, and renewed attempts to use the System as a basis for Timber Production,

The key lay in the fact that the index to the General Yield Glass, was an old friend, Top Height. So that method of using Top Height as the main index, gradually moving it up over the passage of years, might still be feasible,

The writer decided to be quite definitive, and chose individual P. Years instead of the traditional 10 year age bend. There is no doubt that anomalies do arise using 10 year bands, for example the 41-50 year band of the Inverliever assessment only included P.09 to P.15. The principle is really quite simple and is best explained by an example. The assumption is that an assessment has just been made and it is desired to plan timber production for three stands of the same species - two of the same P. Year but of different productivity - for the current year and for one 5 years ahead.

S.S.	- P.38 - Y.C. 240 - Top Height (say in P.Y.66)	61 feet - Area 17 acres
S.S.	P.38 - Y.C. 160 - Top Height	44 " - " 23 acres
S.S.	P.44 - Y.C. 180 - Top Height	35 " - " 9 acres

Thus the ages in F.Y.66 will be P.38 - 28 and P.44 - 22 years.

To find the average Yield Class of these, the simple arithmetical formula is to multiply first the age by the area, then the Top Height by the area in each case; find the total of the three 'age x area' and 'Top Height x Area' columns and find the average age and Top Height by dividing each of the totals by total area. From these averages, can be found the average Yield Class.

Thus:-

<u>Stand</u>	<u>P.Year</u>	<u>Y.C.</u>	<u>Top Ht.</u>	<u>Area</u>	<u>Age x Area</u>	<u>Top Ht. x Area</u>
1	38	240	61	17	28 x 17= 476	61 x 17= 1037
2	38	160	44	23	28 x 23= 644	44 x 23= 1012
3	44	180	35	9	22 x 9= 198	35 x 9= 315
				49	1318	2364

(Divide by Total area 49) Gives average age: 27 and average Top Ht: 48 feet
Average Yield Glass:- 180/200

Now exactly the same procedure is adopted for the fifth year, except that the revised, increased ages and Top Heights appropriate to the;Yield Classes are used, thus, for F.Y.71:-

Stand	Area	Age	Top Ht.	Age x Area	Top Ht. x Area
1	17	33	72)		1224
2	23	33	52)	33 x 40=1320	1196
3	9	27	46	243	414
Totals	49			1563	2834

(Divide by 49:-) 32 Yrs - Averages:- 58 feet
Average Yield Class:- 180/200

Note that a short cut has been taken in the multiplying of the two P»38 stands age x area expression. Being of common age (33 years) the total area «an be used and the sum done in one.

Strictly speaking, as long as the 49 acres of the three stands remains an inviolate entity throughout the 20 years of the Forecast Period, obviously no further multiplication is called for - 49 acres of Average Yield Class 180/200 remains constant.

Two factors can intervene to change this; (1) clear felling of one or other of the stands; (2) recruitment to the productive state of another stand of the same species, hitherto not ready for thinning.

For example a 4th stand, say P.46, Y.C. 120 (13 acres) will find no place in the F.Y.56 calculation being only 22 feet in that year. However by F.Y.71, it will now have reached 30 feet and qualified for first Thinning. The effect on the F.Y. calculation would be thus:-

Stand	Area	Age	Top Ht.	Age x Area	Top Ht. x Area
1,2,3 & 3 B/F	49			1563	2834
Stand 4 (P.46/Y.C.120)	13	25	30	325	390
Totals	62			1888	3224

Divide by 62:- 30½ Yrs - Averages:- 52 feet
Average Yield Class - 180

Long Term Production Estimation Form (Form 21)

In the final design of a suitable form or schedule, provision has been made to allow the areas of first thinnings to be tabulated separately. This gives guidance as to the measure of recruitment from year to year, valuable for other matters, like judging racking or brashing, or reading requirements - and also allows bulk multiplication to continue for further years. Provision is made for clear felling, and to save space, the columns giving statement to Top Height and Age, are shared with Thinning. Finally, columns are provided to cover the intervening years, between forecasts, to allow a more rational and timely tracking of these two factors which keep upsetting the status quo - recruitment of first Thinning and Clear Felling.

Thus the simple working "unit" which forms the basis of each Forest Year under Forecast assumes the following design:-

Thinning				<div></div>		Felling		
1st Acres	Sub. Acres	Age x Acres	Top Ht. x Acres	Age Years	Top Ht. Feet	Area Acres	Age x Acres	Top Ht. x Acres

There is in addition a column for Non Productive plantations. This is not merely for the purist who wishes to overlook nothing and have everything 'sown up tight', but is intended to allow inclusion of future afforestation and replanting taking place subsequent to the year of forecast, and yet which might - by virtue of high productivity - find expression in the productive element before the end of the Forecast Period*

The treatment of these unproductive plantations - indeed any plantations which have not yet been assessed and allocated a Yield Class, is likely to be the subject of some conjecture. A set of Index to Productivity columns is built into the design into which the individual stand areas can be entered and tabulated. This will not only enable average Productivity to be determined, but spread of productivity as well. Thus one will be able to appreciate the percentages of the species falling into a range of Yield Classes. Use of this ratio, i.e. by applying it to the bulk area of unproductive plantations per "P" Year, will give a more accurate forecast of production compared with only applying a flat average Yield Class. It is a function of this System that, having given due regard to species, age and productivity class, everything is allocated as accurately as possible its proper place in time.

The basic information which is used to feed this Long Term Estimation form, comes from records presented earlier in this work - namely Form 8 - the "Timber Forecasting, Sub. Compt./Area Summary". Tabulation on this form already stratifies the plantations into "P" Year, Species, and Productivity Class. Hence the bulk figure (i.e. the total area per species - per P. Year and per productivity class) can be used, not individual sub. compartments, which should ease congestion on the long schedule.

The recommended procedure is to take each species at a time, going through each P. Year in sequence to extract the areas per Yield Class in which that species is represented.

It is hoped that Form 8's have been kept up to date.

Recent and unassessed plantations which have not been brought on to a Form 8, can be located on the "Record of Afforestation/Replanting: Compt. /Species Summary" (Form 6).

The timing of a Long Term Forecast is, of course, at the discretion of higher levels of Management than District level, but a complete revision once every 5 years will probably suit everyone concerned.

The Allowable Cut

The figures so far obtained represent the total area of the plantation likely to be in a productive state at these particular years - 5, 10, 15, perhaps 20 years ahead.

The area figure must now be transmitted into volume.

In the case of clear felling, the gross area calculated can be accepted, or if fluctuations are suspected, can be evened out by reference to the "intervening 4 year" figures for felling due, on either side. Volumes per acre can be determined from Yield Tables - the Production Forecast Table - if local data is unavailable.

With thinnings, two choices are open - again some regard being paid to recruitment on either side of the year under review.

If a local figure per acre for thinning is available, the gross area can be first divided by cycle before multiplying by this local factor. Otherwise, a volume figure can be obtained by reference to the Production Forecast Table appropriate to species and Yield Class. This figure, representing the allowable or removable ratio of the Annual Increment (which is in fact 60% of the Yield Class figure), when multiplied by the gross potential area in thinning stage, provides a volume figure of allowable cut.

The calculation can be done on the body of the form below the line carrying the area totals etc,

Production Forecasting: Yield Class Slide Rule

It is quite likely that the procedure outlined above may come in for a good deal of criticism on the grounds that it is going to be laborious and time consuming. It is the Manager's employers who must decide on the level of accuracy desired and in how much they are prepared to pay for it. But what they should not do, is elect to pay for something less than completely accurate, then expect the employee Manager to fight for time to provide facts and figures of an accuracy the System does not supply. Actually by following the sequence outlined, with its implied short cuts, and adroit use of a normal slide rule, it is quite surprising how much headway can be made in an uninterrupted day; and it is time definitively spent. The task can be hastened if a team of two get to work with it, but it is unlikely that the extra cost is really justified, unless some urgency has arisen over the matter,

Incidentally, what a delightful tit-bit for a computer!

The multiplications and additions apart, what would have made the task a drudgery would have been the determinations of age and Top Height. Happily, by designing a special Yield Class Slide Rule, the writer was able to greatly ease and accelerate this aspect of the routine.

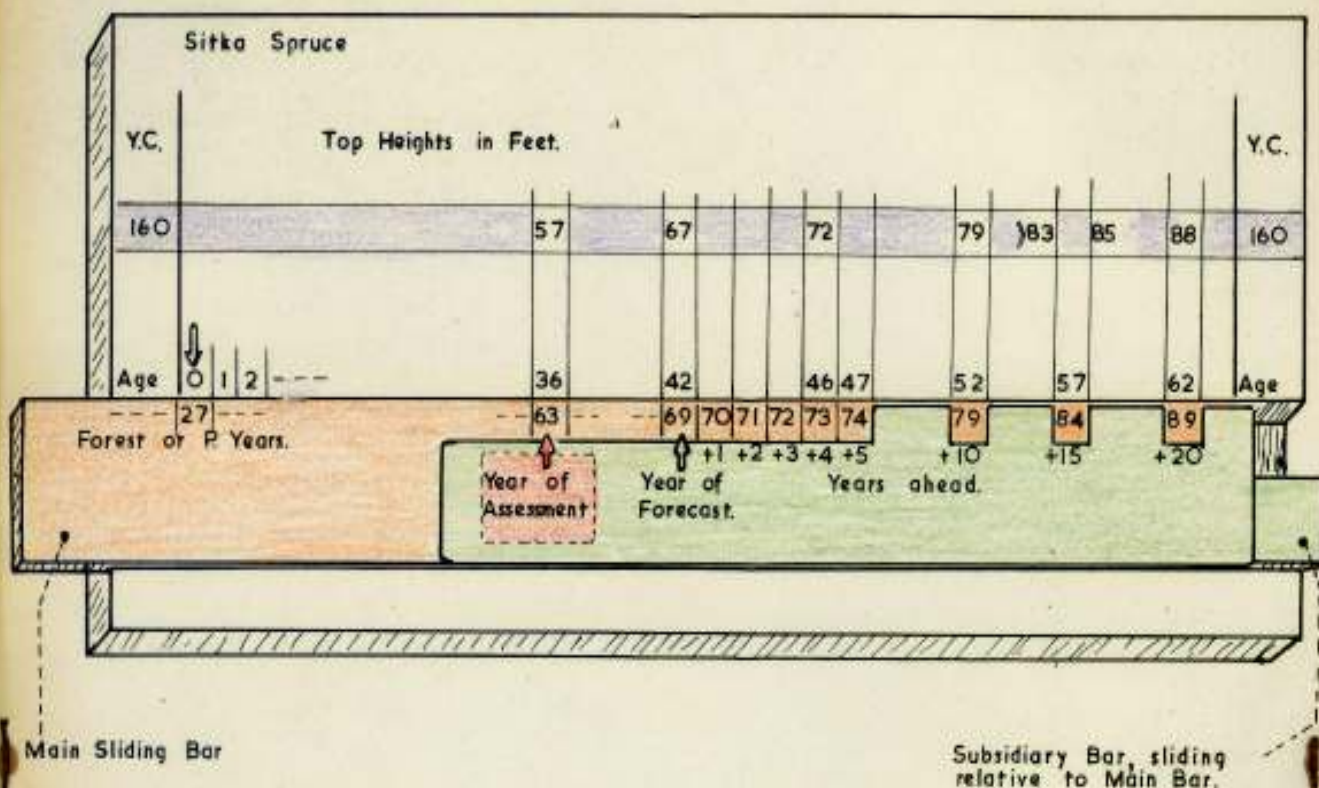
The conception is quite simple, it merely presents in tabular form - one table per species - the Yield Class Age/Top Height curves. A scale of "P" Years on the sliding bar can be set so that the age "0" comes opposite any "P" Year under consideration. The age and top height can then be read off the table for any year for which a forecast is required, granted the Yield Class is known. A moving bar within the moving bar can highlight these years of forecast depending on whether the exercise is for one year, or five successive years (Short Term Estimation) or selected years at 5 year intervals spanning 20.

If the Yield Class is not known, any measurement of the stand's Top Height can be used, provide the year of the measurement is known. A small sliding pointer can be moved to indicate this on the P. Year or Forest Year scale. By adopting this approach one in reality pin points the Yield Class. Thus, this device takes the thinking and risk of mistake out of the tedious job of subtracting P. Year from Forest Year, and tracing across curves to determine Top Heights etc.

Other features which can be added to the Table are:

- (1) an indication, against appropriate Top Height, of the correct stocking in stems per acre after Thinning, (the use of this has more application in Short Term Estimation and will be dealt with there); and
- (2) a symbol indicating the Top Heights per Yield Class at which clear felling is recommended for Financial Rotation reasons.

Yield Class Slide Rule.



In the above example all detailed figurework is omitted except what is relative to the following example:-

Sitka Spruce, P.27, Yield Class 160 - from an assessment made in F.Y. 63 - for which Forecasts are being prepared in F.Y. 69 covering Short Term (i.e. immediate 5 years '70 to '74 inclusive) and Long Term (i.e. at 5, 10, 15 and 20 years ahead).

Main Sliding Bar should be set with P.27 immediately under arrowed "age 0"; a subsidiary bar with "Year of Forecast" arrow pointing to F.Y. or P.69.

If a Yield Class was allocated in F.Y. 63, the "Year of Assessment" slider can be disregarded. If only a Top Height is available, this should be sought in the table immediately above the F.Y. 63 setting. The line in which it is located should indicate Yield Class.

Top Heights and ages appropriate to the Forest Years under consideration can now be read off.

In above - in F.Y. 84 (i.e. 15 years ahead of Forecast Year), the Top Height is judged by interpolation between 83 and 85. It will be seen that Y.C. 160 should have been clear felled circa F.Y. 82.

The colouring of the Yield Class lines is of no significance - merely being added to facilitate horizontal reading.

((Yield Class Assessments

One other factor which legislated against the Top Height Class/Volume Control method described earlier, and which was introduced with the Yield Class System, was the rather negative one of dropping the provision of Main Crop Standing Volume during assessments. Yield Classes are still, in general, assessed on age and Top Height.

It is true of any system that it is only as accurate as the figures fed into it. Having evolved this Yield Class System to offer a high level of accuracy, it behoves the Management to ensure that the field work which forms the basis of all subsequent figure work is done with great care and accuracy. Anything less, must surely be incompatible, and a waste of time and money.

Yield Classes must be surveyed and booked nett, and not averaged, except within reason. It is really not enough to say "the 20 acres of this sub. Compartment averages Yield Class 180", if the spread is considerable. It is far more use to the Manager to say "the 20 acres of this sub. compartment contains approximately 6 at Yield Class 240, 8 at 180 and 6 at 120".

While Yield Class 180 brings the timing of a first Thinning at 20 years, 240 will have passed the same stage 5 years earlier, and 120 5 years later.

This really highlights one of the big problems in the whole of Forest Management - the prediction of this first Thinning. While this may not appear of very significant in the Long Term, it is all important in the Short Term. In fact its importance cannot be over exaggerated.

Irrespective of Productivity, the datum put forward here as a suitable index of a stand's preparedness to take a first Thinning is 30 feet Top Height. This is, of course, a matter for local experience, but it must give a blend in which sufficient material can be taken out, of a size allowing economic handling, while still leaving a stocking which allows the same again next time round of the chosen cycle.

But even here, 30 feet cannot be accepted as definitive unless one other factor is taken into account, namely stocking.

No stand can really offer timber surplus to requirement unless a certain level of stocking is present.

Any depreciation in this acceptable level - ideal level it could be called - will have the effect of delaying the time when a thinning can be practiced.

For example if 1,200 stems per acre represents a fair figure of an acceptable stocking of a stand 30 feet in height - after the first thinning - clearly a stand with only 800 stems per acre could not come up for consideration, until approximately 10 years later.

Therefore, any Yield Class Assessment intended to serve the needs of the Manager in his Short Term Estimates, should carry with it an index of stocking - preferably in stems per acre.

To sum up then, the Manager will require, to equip him adequately for any Timber Estimation task likely to be demanded of him, an assessment for any sub. compartment made homogeneous by species and age, of Top Height and Stocking in stems per acre - at least.

Furthermore, the sooner each sub. compartment can be thus assessed, the better. It is a sobering thought to realise that fast growing stands which have reached 10 feet in height, will probably be ready for thinning only 7 or 8 years hence. ' This consideration seems to point to assessments which are not the special tasks of a flying team, calling in at every Forest once every ten years, but which are carried out as a matter of routine by the local staff in possession. This does not mean to say that the whole Forest is assessed anew every year. But a check, or first assessment or reassessment can be made any time a Forester visits a sub. compartment for routine reasons of thinning, or drain maintenance, or racking for example - i.e once a cycle; Not only would this provide a smoother, and ever up to date build up of information, but would probably be much cheaper, being built in to normal routine. And what an added interest to the local staff.))

Timber Production - Short Term Estimation

Estimating Thinning and Felling Production over the next 5 years is a more exacting, and to the local Manager, more necessary task than in the Long Term. Here he must come down to brass tacks and deal in sub. compartments - - at least those likely to be, or become productive within the period under review. An extended Form (No. 22) on the same lines as that for Long Term Estimates can be used - only without the "Intervening Years" columns. No further description of it will be pursued here, but, as a matter of interest, the same form can be used to deal with one year in detail, using the 'Forest Year' units for species instead. A somewhat abbreviated system has also been devised and will be described now in greater length. Here the big Form's main functions are separately presented on foolscap (size).

It consists basically of two forms, the first (Form 23) being a Short Term Estimation schedule of area. The procedure is as follows assuming the Manager is settled at his desk with the following items arrayed conveniently around him, in addition to Forms 23 and 24.

- (1) A Thinning record map of past thinnings.
- (2) The Yield Class Slide Rule.
- (3) A set of Forms 8 or, failing that;
- (4) Compartment Records.

He will take a page to each species in turn. If he uses Form 8, he will then go through the P. Years in sequence. If he uses compartment records he will go through the compartments in sequence. But the former should be quicker in the end, involving less slide rule work.

As each sub. compartment is dealt with in turn, a glance at the Thinning Record map will show if the stand is already productive. If so, the year of last thin is entered in the appropriate column, the 5th on the sheet 23. If it has not been thinned before, a glance at the slide rule, set for the appropriate P. Year will indicate whether or not it will attain 30 feet within the Forecast period, and if so, when. The Forest Year thus indicated will be marked in the column in this case. Similarly, the Year of Clear Fell will be entered in the appropriate (6th) column, if applicable. He can also note down other relevant details about each sub. compartment e.g. P. Year, Yield Class find area.

Having covered the whole Forest and its range of species in this way, the Manager can now concentrate on the Form, and the Thinning record map. The idea is to try and allocate each sub. compartment to a Forest Year of treatment. If the sub. compartment has been thinned, and the cycle fixed, the Forest Year will automatically follow, and a series of brackets on the form just above the 'Forest Year' columns, can be filled in as an easy reference. First Thinning subjects will go under the Forest Year in which they reach 30 feet or other agreed datum.

What follows is better left to the section allocated to "Thinning Plans" but once a final plan has been decided, the subjects forming the forthcoming Forest Year, can be extracted and entered onto the second Form (No. 24), the Annual Programme Estimation Schedule. This is actually the unit already described in the extended forms, given more space on a foolscap sheet. As before, the average Age, Top Height and hence Yield Class, of the forthcoming Forest Year's thinnings can be calculated.

((Thinning Plans

These are, of course, fairly controversial items not merely in their final presentation on paper as an affirmed programme, but in the scope and method of their application in the field. The element of difficulty involved in designing or redesigning a Thinning Plan will depend a great deal on the age of the Forest, the number of P. Years embraced, and the degree of irregularity due to differences of site, species and productivity.

What is visualised here is an irregular Forest in its first few years of productivity, facing an imminent and extensive build up of first Thinnings, probably the most taxing contingency of all.

Of the many possible approaches, the most conventional is the fixed block, but even here a range of choice exists.

For example the blocking may be short or long term. Short term blocking seeks to create blocks which produce fairly even outputs of timber. In Forests which are largely productive this is not too difficult to achieve. In the 'adolescent' state which here merits our special attention this is not so easy and more or less resigns the manager to a re-blocking fairly quickly in the future.,

To avoid this, the Manager may resort to Long Term blocking. Here he carefully shapes his blocks so that ultimately, as the Forest gradually enters fuller production, the blocks themselves will become equiproductive. The chief difficulty here is to achieve a blocking which, though acceptable in the long term, does not bring rather violent fluctuations in annual output in the short term. Of course, if this fluctuation is deemed tolerable, then it seems the obvious course to adopt.

The number of blocks generally depends on Thinning cycle. If the cycle is four years, then the number of blocks will be four. Often managers prefer to have two series of blocks, so in this case there would be eight blocks - two to be thinned each year.

One favourite approach is to have two series of three blocks, so that in the early years a three year cycle can be followed (i.e. thinning two of the blocks every year), while later a six year cycle can be resorted to *when* only one of the blocks per annum will be treated.

There is no doubt; that blockings of this type look well on paper, and evoke impressions of high standards of professional competence and organisation. To now set about demolishing the fixed block theory is thus a matter of considerable delicacy. The writer can only look back on his own experiences (embracing 17 years now) and seek to extract some of the factors which gradually weaned him away from the fixed block approach.

Let it be said beforehand, however, that to abandon fixed blocks, does not necessarily imply that one also disregards the principle of trying to concentrate territorially, annual thinning programmes.

Next, let it be understood that in a fixed block system, a complete census must be made of all the productive, or likely to be productive, sub. Compartments over the whole span of the forecast period. This must be done to provide the anticipated outturn of produce by species - an item demanded of any manager nowadays.

In 1952, the writer as a very keen, green District Officer, completed the task of furnishing his District in Kincardineshire and Angus with a new set of Thinning Plans. These were the culmination of a big "push" on volume assessments started by the East Scotland Conservancy in 1951. Most of these Plans were on the 3/6 principle of two series of three blocks. They were short lived - - the great gales of December 1952 and February 1953 saw to that - - they were effectively rendered obsolete. Not having learned a lesson, the writer, 18 months later, completed, Phoenix like, from the ashes, a revised Plan of similar design and scope.))

((In 1956, the writer had completed a similar task for Inverliever in the West Scottish Conservancy, and was the proud admirer of a beautifully coloured map on which the Forest was carefully bisected into two series, each of three blocks, and a supporting schedule carefully listing all the sub. compartments and their expected outturn on a three year cycle - of timber, as pitwood and sawlogs. It is even painful now, to recall the gale which in 1957 hurled to the ground nearly 200,000 Hoppus feet of timber - - about a year's cut.

Meanwhile, an adjacent and younger Forest just entering production and which had just been furnished with a Thinning Plan on the two series of three, Long Term Block principle, was ill served by a Timber Merchant who allowed his Standing Sale to drift nearly a year out of schedule.

These are all contingencies which can happen to any Manager at any time and, of course, are not the only ones by any means. The important inference is that in the design of any Planning scheme, due allowance must, repeat must be made for such eventualities. Time must not be wasted in trying to make firm and inflexible plans too far ahead.

The solution lay in adopting a principle of free blocking.

This accepts the principle that one should try and concentrate one's annual programme territorially into one, or two places, but does not look on the principle as justifiably sacrosanct (these days of easy access and great mobility), and manifests itself in prescribing such blocks only one year ahead. This does not mean that the whole course of thinning beyond the one 'forthcoming' year is being left to drift haphazardly. The answer is really embarrassingly simple. Past thinning -and this is something definitive - is carefully recorded, not only on documents but on a wall map. So, all being well and no contingencies arising, and the cycle agreed, it is tentatively preordained where at least the nucleus of the thinning will be for the subsequent few years ahead too.

But the blocks need not be the same, allowing for carry forwards etc. and no time has been wasted making forecasts in detail for them.))

((Thinning Cycle

The number of blocks into which the Manager will divide his Forest will be based on his Thinning Cycle. This in turn will depend on the Average level of Productivity of his Forest. It will also depend on any specified mandate vis a vis the minimum volume per acre he can take from a sub. compartment for economic handling.

Mention has already been made to the 3 year/6 year system. This takes the view that a visit can be made every three years during the early years of fast growth, later falling back to a visit every 6 years,,

Actually, this does not make very much economic sense. A more rational approach would have been to use the 6 year visit first, and then the three later, on the grounds that early thinnings are otherwise likely to be relatively expensive to handle, with many trees per acre causing the Forester's task of marking and measuring twice round in 6 years very dispersed, and time consuming; while in the sawlog stage, a three year visit will not only be justifiable as an economic entity, but will offer less chance of making drastic openings to the wind.

What led to discarding either of these somewhat slick approaches was the simple realisation of the Philosophy's conception of a Mature Forest, "- - - in any one year, in any one compartment, can be found any of the whole range of operations, felling, thinning (first and subsequent), etc, - - -" (Page 1).

No doubt the whole thing could be carefully controlled on paper, but far better to accept one average cycle for everything and differentiate between young and old, high and low Yield Class, by controlling the volume per acre removed from each.))

((It was tempting to be smug and say the average of 3 and 6 is 4½. However, this is a matter for productivity, although in the general run of Irregular Forests, particularly up the West Coast, it will be somewhere around 4 or 5. But why fix it too rigidly? By all means set it on 4, and be thankful if the cycle is achieved in 4, but satisfied if in fact it takes 5. Bear in mind, too, that the longer the cycle, the less harm will be done should contingencies intervene to prevent a timely coverage. One very important rule emerging from this is that if a Thinning regime, because of say windblow, has drifted in arrears of cycle, one should, having overcome the unexpected obstacle, never attempt to 'catch up'. This will inevitably lead to a mark time period of no thinning, or if lighter thinnings have been used to cover the ground more quickly, further trouble if new contingencies arise.

Thus the Thinning Cycle can be regarded as 'the fuse in the circuit' should something go wrong - - the factor which can "give", to absorb a temporary shock.))

((Thinning planning on the Free Block Principle

A good deal of ground has been covered since the Forest Manager was seated at his desk with a Thinning Map and a set of Forms 23 and 24 before him.

What steps should he follow to apply the Free Block System?

The use of colour has been discussed in the section on maps, but to use it with Thinning Plan Maps in particular, merits further consideration. Colour can be used to depict the Blocks, or - really the same thing - the cycle,

In Free blocking, colour used in this way, would be used to indicate the Block or Areas which had been thinned in any particular Forest Year, This sets, in retrospect, the chronological sequence for the future immediately ahead - - - only by that time overlaps may creep in. Thus such a map is only likely to last a cycle. At this stage a new map must be used in conjunction with the old until a second cycle is covered, when the first map can be discarded.

However, a more lasting map can be prepared if colour is used to depict species, in outline in the first instance for impending first Thinnings, and complete colouring only added after the stand has become productive. A small insert per sub. compartment can be made to indicate year of actual thinning. Naturally this is done in retrospect, after the work is definitely completed. To use the map for emphasising the cycle, it is suggested that it be fixed first to a cork board.

Sets of pins with small coloured spherical heads should be obtained and a chronological sequence decided, Forest Year with colour. It is suggested that the most logical sequence should basically follow the spectrum. The starting point can be a cycle back if need be, but preferably the immediate Forest Year, of review.

Using the 5th and 6th columns of his Form 23, the manager will start to mark his map, pinning each sub. compartment with the appropriate colour per Forest Year of Treatment. With stands which have been thinned, this will be a cycle ahead. It is better to have a duplicate colour for first thinnings at this stage.

Having completed the Forest, the Manager must step back, take a long look at his map and think. He will look for some semblance of affinity between the coloured pins, and territorial blocking. He must decide on whether he is prepared to tolerate "out of sequence" thinning in favour of concentrated blocking; or determined to stick to the already established cycle of productive stands and let blocking go to the winds.

If he opts for the blocking, some pin moving is now called for and generally speaking, established stands, although preferably fixed, can be moved a year either way (or may even be given a subsequent light thinning in quick succession after the previous to bring it into line with the desired blocking); first thinnings, however, - can seldom be moved back (i.e. thinned sooner than the 30 feet datum prescribes), but may be moved, one, two, even three years forward (i.e. delaying first thinning) depending on Species, Yield Class and stocking.))

((In his blocking, the Manager will consider diverse matters having a bearing on thinning - e.g. dispersing the load on existing roads, likely availability of future roads, etc. etc.

He will also be deciding on whether each species is to be considered separately or merely to fit into the jigsaw and conform to a territorial blocking embracing all species.

In fact, there is not a great deal more help to be given at this stage - -
- from now he is pretty well on his own!

On the matter of allowable cut- however, this can only be calculated for Productive Stands. The build up of first thinnings should be added as a supplementary, with attempts made to portion these out to supplement the 'productive stand' cut to fairly even proportions.

Once having made adjustments on the map to his satisfaction, the Manager will commit his strategies to paper on Form 23, entering these up under the appropriate Forest Year, he will pay special attention to the forthcoming year, and analyse it statistically speaking on Form 24. This in itself can act as a Production Plan, but there are more suitable, specialised forms with which he can communicate the finally decided programme to the Forester.))

The Production Plan - Form 25

The final shape which the Prescribed Thinning/Felling Plan will take depends, first of all, on whether higher levels of management expect a copy, and, if so, whether they have already decreed what design the form will take. In this event, it is only to be hoped that their chosen design will be of intrinsic use to the Managers - District Officer and Forester alike.

Form 25 shows a satisfactory design used at Inverliever, where much of the production involved sawlogs. It must be borne in mind that during its lifetime, a stand of trees will produce over 60% of its timber as sawlogs.

The form presupposes that guidance must be given to the Forester in respect of the small wood/sawlog ratio he can expect from any of the prescribed sub.compartments.

It also presupposes that certain other routine information has to be collected and passed back along the line - information which may offer useful clues as to the performance in growth of sub.compartments, and seasonal differences.

The layout is similar to the Plans of Operations Form (No. 11) seen earlier in that sufficient vertical space is left in which to summarise actuals at the end of a Forest Year, and indicate any carry forward.

There will be tie up with the Plans of Operations in general in that the total area per compartment will be covered under the Production columns there.

In these Thinning Plans, three alternative courses can be followed:-

(1) all species can be grouped irrespective, on the one Plan. Thus all the Compartments and sub. compartments due for treatment can be listed in numerical order, but separate totalling per species is difficult.

(2) Species can be covered separately - i.e. a Plan per Species. This is probably the best solution in foolscap size. A key or principle species can be used as a basic sheet in which, in brackets, any other sub. compartment containing a different species due for treatment can merely be mentioned. No entries for area, volume etc. will be followed through on the key form except for the chosen key species; such details will be kept for the separate, specific Form.

(3) An extension sheet can be added to the basic (2), or what is preferable, the plan designed on a larger e.g. double foolscap format, to allow all the species to be covered and seen at once for one entry of compartment number. Although epitomising the comprehensive approach, it is doubtful if this really saves all that much space and in the end, solution (2) is probably the most satisfactory choice, i.e. separate plans per species, accepting the repetition of the compartment number this involves, and the less tight coordination.

Inevitably, the time comes round for the Forester as executor of a planned programme to disappear in the direction of his plantations clutching a billhook or marking axe. He will be intent in starting to mark a thinning in which he will seek to compromise two things. In the first place, by removing surplus stock, and trying to make the operation at least pay for itself, he will aim to encourage the favoured remainder of the crop to maintain a deep green crown thus guiding them towards the sawlog stage all the quicker. Secondly, he will be seeking to accumulate volumes commensurate with his plans and sale commitments timberwise.

There has been much controversy about how best to achieve this. Bearing in mind that time is money in this business, he will not have to be too long in making up his mind about where his axe should fall. In the end, experience will take control, and he will gradually get the "feel" of a thinning by its appearance. Tables may come and tables may go, but the sheer 'look' of the thing will remain the most expedient and the most satisfactory method of thinning plantations.

One or two rules of thumb can be suggested. If a minimum volume per acre has been set, delay thinning until fairly sure of conforming with this.

If economic thinning is stressed, consider setting a minimum datum in tree size e.g. 1 Hoppus foot, which means not bothering to mark trees in the early thinnings under about 3½ inches B.H.Q.G.

Always have a reason for taking a tree.

Have a cycle in mind and when marking, remember one hopes to take out as heavy a thinning next time round.

If there are problems, face up to them now rather than pass them on to the future, but if in really serious doubt - better to leave it in, there is always a next time!

Before commencing to mark a thinning, be sure of the mandates regarding:

- (a) mixtures i.e. which species is to be favoured with retention vis a vis the other;
- (b) whether quality is to be given priority over quantity - i.e. do the big rough ones get the axe in favour of nicely formed, but smaller trees; and
- (c) Rotation,

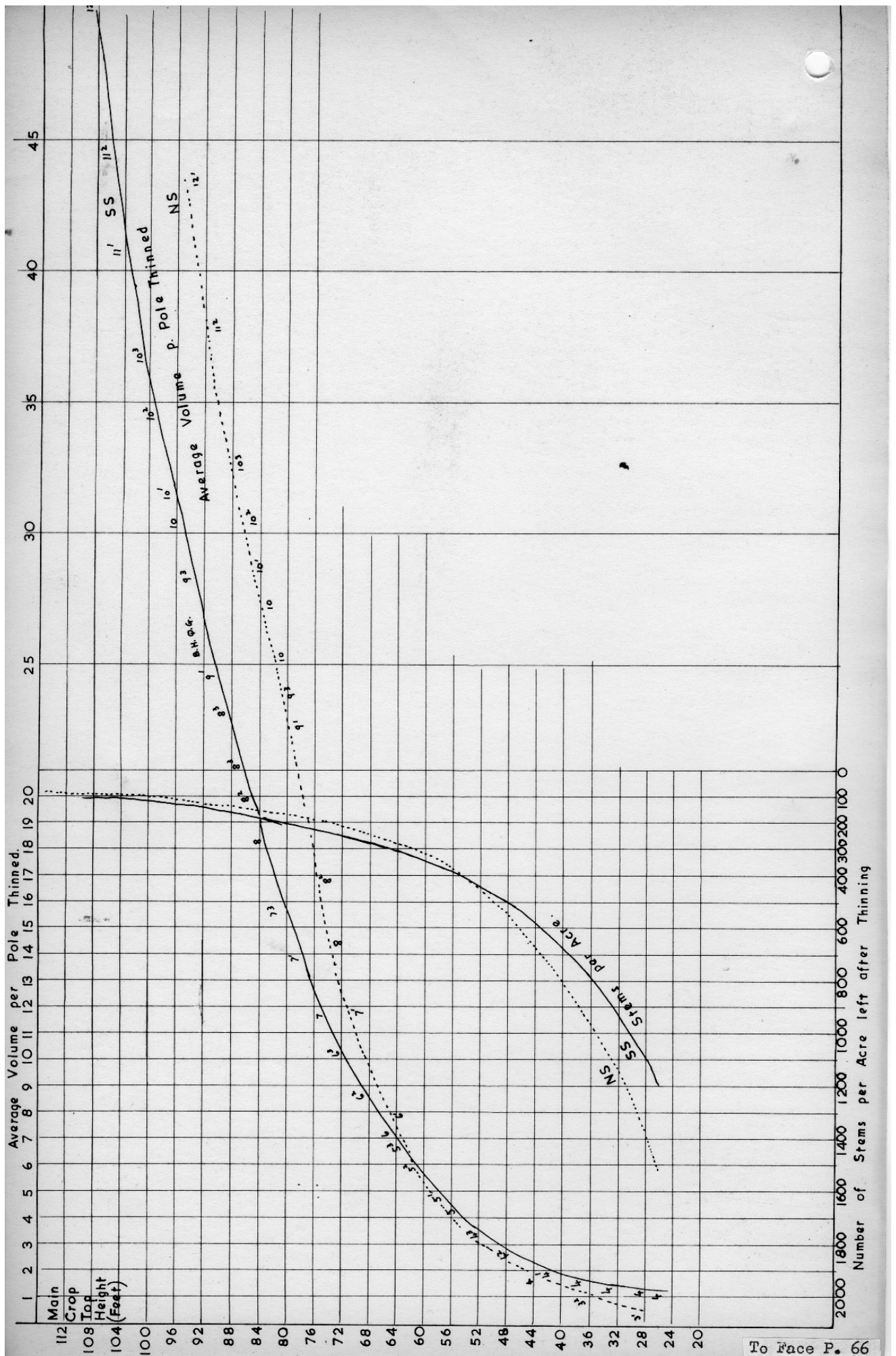
Set the back against a nice tree expected to be there as a final croper. See that its crown can be freed from competition. Look for the next likely final crop trees - if the Rotation and Yield Class is known think in terms of the distance apart these Final Crop Trees will be. Then decide on not just one tree to mark for thinning, but three or four which will all benefit these final crop trees, before finally getting busy with the axe.

All this is cold comfort to those who seek the guidance of firm, printed figures.

For those who must check up to ensure they are on right lines, two courses are open - control by Basal Area, or by number of trees.

Only the latter will be pursued further here.

The Manager dreams of a unique, definitive mathematically based formula in terms of progressive destockings, by which he can keep pace with the site's and the species' mutual productivity to the absolute limit. Such a formula does not seem to have been built into the New Yield Class Tables, but nevertheless they remain the best alternative now available. Form 26 has been compiled from graphs prepared from the Yield Tables (from which no doubt the Yield Tables themselves had been prepared), in which Top Height has been plotted against stocking per acre - after thinning.



Thus it presupposes that there is an ideal stocking in terms of number of trees per acre for a certain Top Height. This seems to be true irrespective of Productivity.

The reason for the choice of Number of Trees per acre is that it is definitive. Once, a Forester knows his stocking in terms of numbers of trees per acre, and also knows how many has come out in a thinning - or a number of thinnings, he should always be able, by simple subtraction, to quote from his records the current

stocking. Furthermore the extra information of the number of trees per acre can prove a really useful supplement to Hoppus Feet. The Forester can deduce from this, for example, the likely production of pitprops of a certain size - even Christmas trees!

The reason for the 'after Thinning'¹ approach, is that it helps to ensure that the Forester's attentions are focussed on the surplus, and thus avoids the risk of passing on problems to the next thinning. In short, it should prevent over-thinning.

It has been said of this approach that it may leave the Forester short of the planned cut. This is so, if the planned cut had been estimated on the high side. But such plans are mere guides and must not be treated as rigid instructions. Furthermore, should the whole year's programme seem likely to fall short - and strong reasons exist for still achieving it - by using a Free Blocking Approach, the solution is to move into the next compartment on the list, albeit next year's list. Although this does seemingly hand on a problem to the future, it is done gradually with time in the Manager's favour to adjust future estimates. Next cycle round things will be on a much sounder basis.

The Yield Table figures commence generally on a 'measurable tree only' basis, i.e. 1,200 to 1,300 stems per acre - with no adjustment made for subsequent recruitment from the "unmeasurables". The table on Form 26 uses absolute stocking figures, but by dovetailing into the Yield Table figures, presupposes that all the surplus is swept away to a large extent in those early thinnings. This is admittedly not altogether valid, and Foresters would do well to keep a little in hand at first, second even third thinnings to avoid either uneconomic handling or depreciating the capital stock. There is, in fact, every likelihood that some 200 to 250 Hoppus feet of extra timber may be tied up in these "unmeasurables" which a system of Crown, or "Scottish Eclectic" thinning can expose and exploit.

No doubt as data becomes available from recent Mensuration Research plots which correlate stocking with Thinning Intensity, a table such as has been evolved on Form 26, could be adjusted accordingly.

Meanwhile, any cases of serious overstocking, because of say, close planting must be treated cautiously, and no doubt, the Forester's old friend, the eye, will help greatly here.

The success of a 'Trees per Acre Control' would depend on a fairly simple system of assessing this factor. Form 26 is built around such a quite simple method.

This relies on the fact that one chain multiplied by one chain, aggregates one tenth of an acre. Therefore if one makes a count of the number of trees per chain, one can readily arrive at an expression of stocking in Trees per acre.

However the system is so designed as to reduce the counting to only one dimension.

What in fact should happen is this, assuming that rows of trees are readily identifiable. First of all, count the rows per chain measuring at right angles across then. It is suggested that this can be done by pacing, the measurer being already aware of his paces per chain from previous experience. If this turns out to be e.g. 12 rows per chain, it will be akin to 5½ feet spacing. The basic Table has been prepared for this 5½ foot espacement. Therefore any count of trees per 66 foot chain run of any row will henceforth give an index to the number of trees per one tenth of an acre. This is written across the top of the table - e.g. 10 trees per chain will indicate approximately 1,200 stems per acre $12 \times 10 \times 10$

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To find the stocking per acre for other spacings, the same holds true. If there are 9 rows per chain (equivalent of 7 feet spacing) and 6 trees left in one chain of row, then the stocking will be $9 \times 6 = 54$ trees per one tenth of an acre, or 540 per acre.

The table prepared for 5½ feet has been designed as far as possible on the stocking represented by an even number of trees per chain, with the appropriate Top Heights read off the curves and entered on the attachment form 26a. Half trees must be judged, or assessed by counting a second chain be it continuous with or parallel to the first.

What in fact has been made is the assumption that if an ideal stocking at a certain top height is accepted for one spacing, it should hold good for other spacings as well.

Thus to fit the same number of trees per acre irrespective of spacing, means accepting more trees per chain at wide spacings and correspondingly fewer per chain at close spacings.

Clearly if one were now to keep to a 66 foot chain basis, one would have to work out a new table for each and every other spacing.

However to obviate the need to prepare such separate tables for other spacings, what is conceived here is an "adjustable" chain. For example if the rows were found to be spaced at 5 feet, the chain run in the row - to bring the figures into line with the per acre basis of a $5\frac{1}{2}$ foot spacing - would have to be increased to 71 feet, or its corresponding number of paces.

Similarly, if the row espacement was 6 feet, the "chain" run would be reduced to 60 feet. If on a subsequent count, 8 trees per 60 foot chain were tallied, the stocking would be 960 trees per acre.

If paces are used, there may have to be adjustment made for slope. The fingers of two hands can be used to tally trees, against a spoken count of the paces. Even better, a hand tally counter can be used for the tree tally.

For greater accuracy, two "chain" lengths can be counted, instead of one, either in the same row, or two adjoining rows against one "chain" of pacing. This has particular application in later thinnings when trees are fewer and the "chain" shorter.

The procedure to be followed in using Form 26 for thinning control is "as follows.

Make the count of row espacement, thus establishing the adjustment of the chain measure to be used in the rows as described above. (It is conceivable that well kept planting records may indicate such row spacing). The small table on the body of the form on its left hand side, provides information to serve this stage. The user can make his own transfer of feet to paces.

Make some measurements of Top Height e.g. with a Haga .Altimeter.

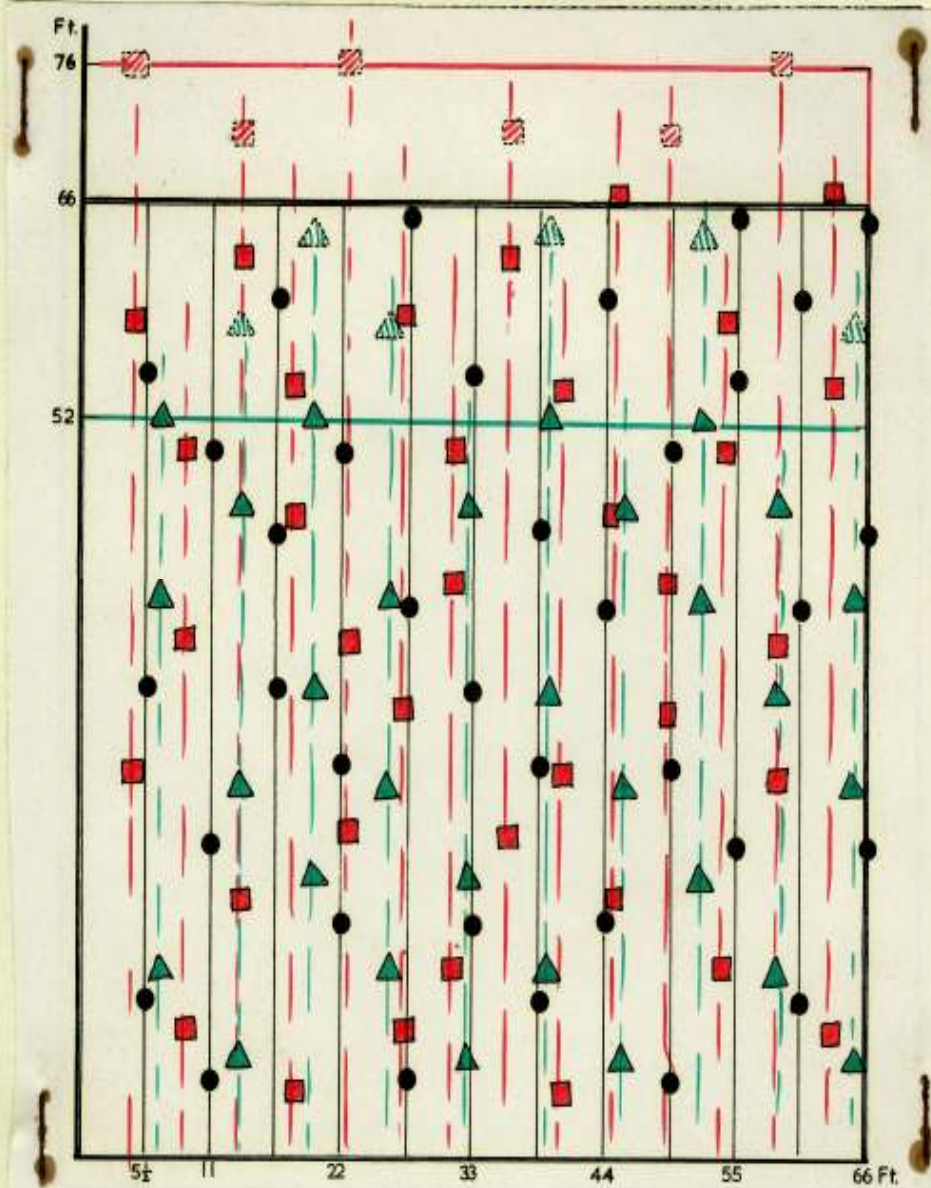
Make some sample counts of trees per "chain" in the rows and establish an average .

Run down on the 'Top Height' column of the Attachment to the Form appropriate to Species, to the Top Height figure just established.

Move along this line horizontally on to the body of the form until vertically below the appropriate stocking per acre (or equivalent trees per chain), also just established from counts, and indicated on the rows under the titling along the top of the form.

For example, S.S. - 41 feet Top Height, 8 trees per chain - - would be equivalent to 960 trees per acre. The normal stocking for that Top Height after thinning would be 660 trees per acre (or $5\frac{1}{2}$ per chain) - i.e. the top row figures to which the arrow points above the first blank space at the extreme right of the entries in the 41 foot line.

Thinning Control by Number of Trees per acre
Pictorial Example of underlying Theory



Area within black square (1 chain x 1 chain) = 1/10th acre

Stocking used in above example = 360 per acre (36 per 1/10th)

- Black Dots represent basic spacing of $5\frac{1}{2}$ ft. x $5\frac{1}{2}$ ft.
 There will thus be 12 rows per chain and, on average
 3 trees per chain of row in each.

The Exercise now is to use this figure of "3 per chain of row" as an index
 to a 360 tree per acre stocking for other spacings as well.

- ▲ Green Triangles Spacing $6\frac{1}{2}$ ft. x $6\frac{1}{2}$ ft. i.e. 10 rows per chain.
 There are now 3.6 trees on average per 66 ft. chain of row.
 Before "3" can be used as Index, the length of row has to be
 reduced from 66 ft. to 52/54 ft.

- Red Squares Spacing $4\frac{1}{2}$ ft. x $4\frac{1}{2}$ ft. i.e. 14 rows per chain
 There are now 2.6 trees on average per 66 ft. chain of row.
 Before "3" can be used as Index, the length of row has to be
 increased from 66 ft. to 74/76 ft.

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herefore the surplus which can in theory be removed is 960 minus 660, i.e. 300 trees per acre or approximately $2\frac{1}{2}$ per chain.

Thus as he marks, the Forester obtains a fair working guide in blazing

between two and three trees per adjusted "chain" row.

It is admitted that this system loses accuracy in older stands or later thinnings, especially when rows are difficult to pick out, and in some cases missing entirely. Here it may be more expedient to determine stocking as trees per acre and work with this expression. However it is visualised that later thinnings do not present the marker with quite the same problems as 'young stuff.

Returning to Form 26, in particular the 26(a) attachment, the Top Height columns are supported by appropriate averages for Breast Height Quarter Girth and tree (i.e. thinning) volume. In the example quoted above the average thinning removed from crops of S.S. 41 feet high would have B.H.Q.G. of $4\frac{1}{4}$ " and volume about 2 Hoppus feet. Thus if he wishes to estimate volume, the marker can multiply his 300 trees per acre by 2 i.e. 600 Hoppus feet per acre. Better still, especially if he has Local Volume Tables, he can girth his 2 to 3 trees and arrive at a fair average figure in that way. If his B.H. girth is less or more than the average, he can interpolate by comparing his new found girth with its tally up or down on 26(b) and using the average volume appropriate to that. For example, if he reckoned his average B.H.Q.G. to be more in the $4\frac{1}{2}$ " region, he could increase the volume to 2.4 or 2.5.

Also on the Form 26(a) are tables indicating the ages at which the various Yield Classes reach 20, 30, 40 and 50 feet, and the recommended Top Heights at which they should come due for felling.

An assortment table for Sawlogs is also incorporated.

Overstocked stands may tend to have average girths and volumes somewhat depressed.

Lastly, Productivity need not otherwise trouble the marker - - - it is self adjusting next time round by movement down the Top Height scale.

((Line Thinning

This article did not set out to be technical in nature. But even in Thinning control can be felt the impact of unexpected contingencies.

The application of Line Thinning techniques in unbrushed plantations presents obvious difficulties to smooth Volume Control.

What is suggested here is not so much a method of adopting Volume Control to cope with Line Thinning, but a means of 'sugaring the pill' by manipulating Line Thinning so that it becomes more akin to conventional thinning.

On flat ground where the tractor rules supreme this may not prove applicable. But under irregular Highland conditions with steep slopes and rough ground, the most likely standard form of extraction for a long time to come will be a winch of the 'High Lead', Double Drum principle.

No doubt ranges will increase, but a Double Drum winch drawing from an area 165 yards or so long by two chains wide on one setting up, covers about $1\frac{1}{2}$ acres. Two factors which contribute to successful, economic winching are:-

- (1) that the area covered per setting up should be as large as possible;
and

- (2) that the thinning intensity should be as heavy as possible.

These factors seem to be more important than mere tree average size. Furthermore they do seem to point to fairly long thinning cycles to ensure a heavy thinning, but naturally, productivity etc. must play a part in this too.))

((What is visualised are basic rackways set two chains apart. These should be at right angles to the roadway (discounting bends etc..), but if the road is on a gradient considerations must be given to setting the rackways straight up and down the slope to avoid hauling on the crossfall. The Line thinning can then be practised between the rackways - radiating in $4-5^\circ$ herringbone fashion away from the winch, and extending for about a chain or 25 yards in either direction.))

These will in all likelihood meet the extreme ends of Lines from neighbouring rackways at the one chain mark. It is suggested that this one chain limit - halfway between the two chain rackways, can, and should be brashed prior to the Line thinning*

The intensity will depend on the regime, but as a fairly normal early Thinning tends to remove about quarter growing stock, one row in four seems to suggest itself. But no doubt the choice will also depend on whether Line Thinning is being resorted to once only, or possibly twice. There is a case of sorts for delaying the first Thinning - if this is to be a Line Thinning - until the Top Height of the crop is 40 feet.

However, the point made is that by Line Thinning in this herringbone fashion, the technique not only assumes a more conventional appearance, and probably lets more light in, but allows fuller exploitation of the High Lead, Double Drum principle.

One advantage to be gained, is that the choker man can work in freedom arranging loads ahead in these side lanes, something he cannot do in main rackways while the winch is operating.

Furthermore, the marker does have a little flexibility in dodging very small trees, and very nice trees.

Three main contingencies will be met:

- (1) The Main rackway will follow the rows, while the side lines will be at $4-5^\circ$ across them.
- (2) The Main rackway will run at right angles to the rows and the side lanes will again lie at $4-5^\circ$ across them.
- (3) The Main rackway will run at 45° across the rows. In this instance, the side lines will vary on either side, one following the rows, the other at right angles.

It is acknowledged that, in the last case, the line can be followed right through for the two chains, i.e. from rackway to rackway, and that the winch can pull half upwards. This however is not likely to be so quick and smooth as the herringbone method.

It is also acknowledged that although three cases only have been quoted, the rows can lie relative to road and rackway at any angle from 0 to 90.

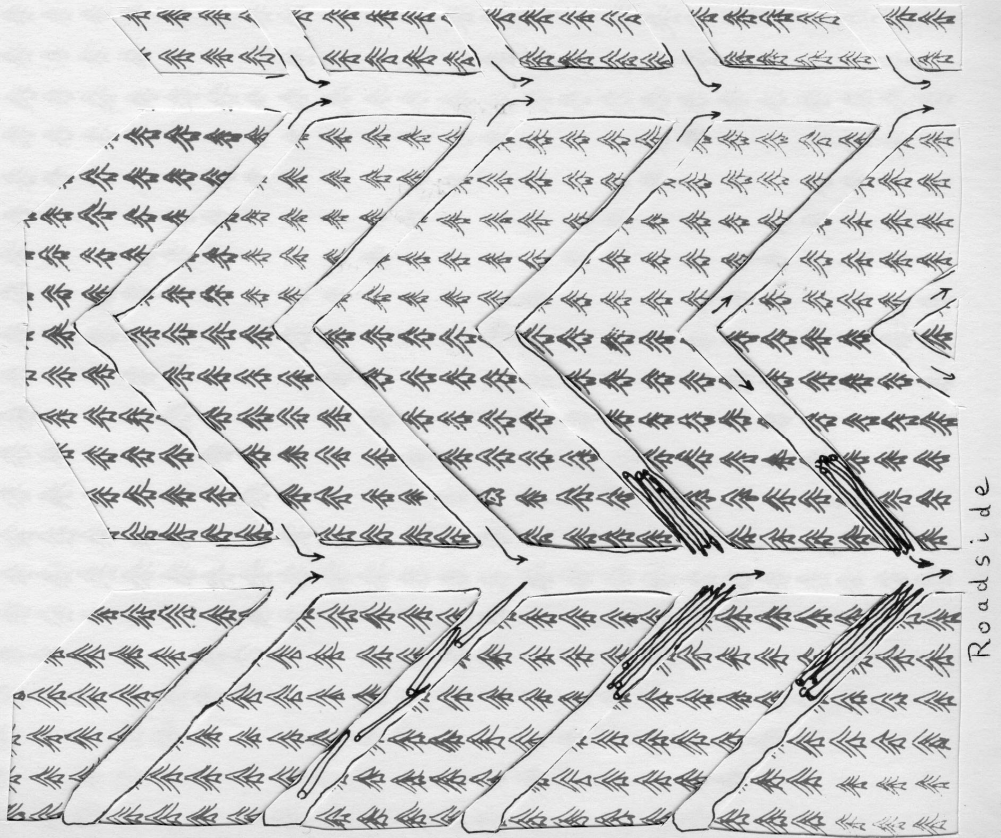
The Trees per Acre approach with its Form 26 can be used here, if the Manager wishes to use a little trigonometrical expertise to convert his "chain" to cope with the angle across the rows the lines will lie. 45° indicates a multiplying factor of sine 45. But coping with this, different spacings and possible slope as well may stretch ingenuity, and accuracy, quite a bit!))

Chevron Line Thinning

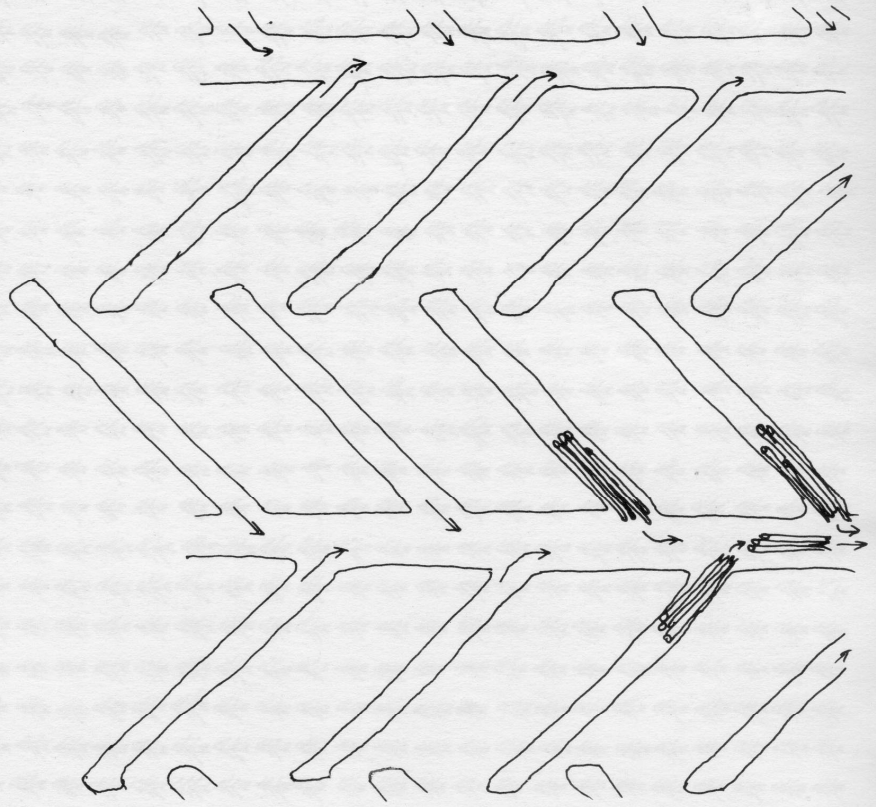
Extraction Racks every 12th. Row

Lines 1 in 5 at 45° to Racks, and opposite.

Percentage of growing stock removed (No trees) 26½%.



Chevron Line Thinning, as on left but Lines staggered, and 28% removed



((Measurement of Timber

The focus has now narrowed down to the measurement of timber, either collectively as thinnings or as individual pieces of tree.

The obvious question to pose at this stage is to ask, why in fact, is there a need to measure at all?

The reasons include the following:-

Measurement is required:

(1) For record purposes, i.e. not only for silvicultural interest but for profitability significance - to prove whether or not profit is being made, as evidenced in the Costing documents.

(2) For research purposes, i.e. to compare the relative profitability of different techniques.

(3) For control reasons - - - to gauge the intensity of a thinning with the economic ideal.

(4) For incentive payment - (a) first to ascertain the average tree size to be handled so that appropriate rate can be fixed; and (b) secondly, to serve as a measure of achievement before the incentive earned can be paid.

(5) For Sale purposes - (a) as a tally for payment; and (b) as a gauge of conformity with specification.

(6) For stocktaking purposes, i.e. for controlling the flow of stocks vis a vis sales commitments.

(7) For supervisory purposes, to check on the honesty and competence of staff.

It does not need a lot of measurement to begin to add up to a bill of £100 per acre in the lifetime of a plantation, even without paying heed to compound interest.

Thus the clever thing to do, as well as seeking for a cheap but accurate method, is to kill as many birds with one stone as possible by making one measurement serve as many of the above reasons as possible.

Measurement can be carried out at three stages of the harvesting range of operations:

- (1) before thinning, generally with marking;
- (2) during the thinning operation, generally while converting;
- (3) after extraction to roadside.

Measurement before Thinning

Measurements before thinning satisfy a number of counts. They are very applicable, of course, for Standing Sales.

They offer ready information on which piecework rates can be fixed and further provide figures for the records, once the thinning or felling has been duly completed.

The unit is the Hoppus Foot.

The three most usual systems are quoted hereafter and readers will no doubt be conversant with their theory and application,

(1) The Tariff System - This is a relatively cheap system based on the relationship of Breast Height Basal Area of a tree to its Volume. It is a trifle inflexible in that, in practice, the marking is generally completed as a separate task before measurement.))

((It accepts a sampling principle and lays down a rigorous code of field work, devised to minimise human bias.

While no manager is likely to question its accuracy, there are many who feel that it might be slightly fortified by 100% girthing, and the employment of a statistically devised "controlled" sample to ensure coverage of the girth classes.

Inasmuch as it is an 'ad hoc' measurement it contains its own errors and spreads none to other projects.

It is laborious to work out the data in the office.

It is vulnerable in that subsequent contingencies can arise to invalidate the measure e.g. Windblow occurring when part of the compartment has been treated, or increments being added because of a merchant's laxity.

(2) The Basal Area System - Much of what has been said above applies here, except that it is an easier proposition to work out the figurework officewise. It does, of course, present a figure of Basal Area per acre for the thinning as a matter of routine.

(3) Local Volume Tables - This system is very cheap and more flexible than the preceding two. The marker can girth as he proceeds and leaves the plantation, with information complete up to date.

It is vulnerable like the rest, to later unexpected contingencies. It must be looked upon as less accurate, and any errors contained will, of course, be spread much wider, even to Forest scale. This could be to some extent countered by an after felling retrospective check, which would serve as a check not only on the accuracy of the immediate parcel, but of the Tables in general. Its usefulness can be most fully exploited if used to give prior thinning figures of F.C, handlings for record purposes, and piece rate setting - assuming that for subsequent sale purposes, some other measurement regime is employed.

"Before Thinning" measurements tend to be less useful for subsequent sale purposes at later stages especially if trees are large and different elements of the trees e.g. sawlogs and pitwood, are sold to different merchants, or even to the same merchant at different prices,

Measurements during Thinning - Two methods are used here - both employing the Hoppus Foot.

(1) Length x mid Quarter Girth - This is the traditional method of tree, or log measure and by far and away the most accurate for Record keeping and piece rate setting, assuming men are on a pre-accepted scale per Hoppus Foot. It is virtually invulnerable in that all the windblow in the Forest can descend on top of what has been done without invalidating previous measure, unless passage of time allows shrinkage.

It is, of course, very expensive, involving tape and measuring rod.

As one single measure to serve records and subsequent sales it must be regarded as fallible, but it can be done by a rather complicated process which does tend to put strain on human accuracy and smoothness of working.

It is possible that the expense can be defrayed if the sale specification includes a price gradient based on Mid Quarter Girth. A little money spent on accurate measure can more than pay for itself, though this is very difficult to prove in retrospect.

(2) Length by Diameter - Ideally there are two methods here; (a) Hoppus feet reached by Length and Top Diameter, generally measured as under bark, which can be done before crosscutting with calipers.

(b) Hoppus Feet found by length x M.Q.G-. - which has been determined by calipers, not tape.

These must suffer in comparison with the above method by being less accurate and not a great deal cheaper.))

((Measurements after Extraction - at Roadside

There are a number of measurements which can be made either on timber stacked at roadside, or being loaded on to lorry. What these are depends on the purpose - be it for Record, Piecework payment of Sale, and, in particular, the commodity being sold.

The Length x M.Q.G., and Length x Diameter methods to obtain volume in Hoppus Feet already mentioned, of course can apply here, the latter as evidenced in Pitprop Tables. Again they are expensive, but accurate, and even essential if the sale specification incorporates a price gradient based on either M.Q.G. or Diameter.

Other methods include the following:-

Stacked measure, either on roadside or on lorry, to give volume in Hoppus Feet. The accuracy of this method must be regarded as very much in doubt.

Lineal Footage (or 100 Lineal Footage) - This is a fairly definitive method of measure, and from it Hoppus Feet for record purposes can be deduced. Where it has to be measured, however, it involves expense once more. It comes into its own with commodities of fixed length e.g. like pitprops.

Piece - This is also a very definitive unit of measure but from it, Hoppus Feet can only be deduced if the commodity in question is of consistent dimension e.g. again, pitprops, or stakes. Even here, such volumes must be regarded as being limited in accuracy.

Measurement after Dispatch

Tonnage - Here there are two possibilities:

(1) straight tonnage with the sale concluded on this basis, or
(2) a Hoppus sale in which the volume has been deduced from Tonnage by application of a conversion factor of Hoppus Feet per ton. This can be ascertained on a trial load basis, a regular sampling basis (e.g. one load every ten), or by using an accepted factor based on trials of say a year's duration. The advantages here are twofold -it is definitive, and cheap.

Measurement after Reconversion - True Cubic Feet - This is generally reserved for timber converted by sawmilling.

To summarise the most useful units and methods of measure include the following:

Before Thinning Hoppus Feet-	(a) Tariff Method
	(b) Basal Area Method
	(c) Local Volume Tables

During Thinning/At Roadside -

Hoppus Feet	Length x M.Q.G.	(0/B or U/B)
" "	Length x Top Diameter	(0/B or U/B)

At Roadside -	Stacked Hoppus Feet
	Lineal Footage
	Per Piece

S	After Dispatch - Tons converted to Hoppus Feet
	Straight Tonnage

After Reconversion - True Cubic Feet))

((Sales of Timber

It might prove useful at this stage to list some of the more common methods of sale which can be found nowadays.

1. Standing

2. Stump

3. Roadside (a) Unconverted (i) Lump sum
(ii) Continuing
(b) Converted

4. Free on Transport; (F.O.T.) (a) Unconverted (i) Lump sum.
(ii) Continuing
(b) Converted.

5. Delivered (a) Unconverted
(b) Converted

1 Standing sales

Reference has already been made to this type of sale under the Tariff System, which is the usual method of measure. This is a most satisfactory type of selling timber but to the Forester it can mean a fairly concentrated task in marking and measuring in the plantation, and working out in the office.

The Forester's dilemma can be eased if a continuing Standing Sale policy is adopted. Here a "resident" merchant is guaranteed an annual quota, with price tentatively agreed. The Forester then keeps ahead of the merchant and has 'lots' made ready as he needs them. The unlucky party in this regime becomes the District Officer, for whom it will generally multiply checking, drafting contracts, mapping, etc.

It should be made clear that Standing Sales do not wholly come as a relief on their times as supervisors.

2 Stump

This sort of sale is not very common and is usually the result of the unexpected impinging on management, e.g. bad weather and lack of work, or perhaps windblow has led the Forester to employ men on taking trees off root and trimming. He may lack means of extraction, so the timber is sold 'at stump'. Measurement may have been by the Tariff system, or by Tape and measuring rod i.e. Length x M.Q.G. on felling.

3 (a) (i) Roadside - Unconverted - Lump Sum

This is a common method of sale in which all the timber has been extracted and is then put up for inspection to a buyer who agrees a lump sum for the lot. The "unconverted" tag, generally means that the produce will be either thinnings from young plantations, or the tops of older trees - all of which the merchant will want to take away to a depot for conversion, or convert on the spot. The same sort of sale can apply to larger sawlogs.

3 (a) (ii) Roadside - Unconverted - Continuing

This is also very common in irregular Forests where steep slopes make stacking space limited. Consequently a sale is agreed before more than a sample of the produce may actually be at roadside. The Forester must then ensure a steady flow to make the agreed total available in the time limit and that it is up to the agreed specification. The most suitable method of measure is either Tariff if young trees, all of which go to the one merchant, or tonnage or tonnage converted to volume, if the tops of older trees. The specification is likely to include minimum top diameter, maximum, minimum and even average length, and average volume per pole.))

((3(b) Roadside - converted

In this case, the commodity becomes less nebulous and is in its final form for use. What this is, will dictate the method of measure. For example, it might be pitprops, or stakes, or scaffold poles - all of which may be sold by volume, lineal footage or preferably, by piece.

4(a) (i) F.O.T. - unconverted lump sum

4(a) (ii) F.O.T - unconverted - continuing

Both these follow the same lines as 3(a) (i) and (ii), but the onus and cost of loading falls upon the department. One of the advantages of this system is that it attracts merchants to buy who might otherwise be put off because of the need to draft in labour to load. It also gives the Forester a bigger part to play in the movement out of timber generally.

4(b) F.O.T. Converted

Much the same remarks apply here as were applied in 3(b) and the 4(a)'s.

5 (a) Delivered unconverted

5 (b) Delivered converted

In this instance, the onus on the Forest has been taken further and it now bears cost and responsibility of delivering the produce to the mill. This the Forester can do either by his own lorries or by contractor. Either way, he has more control than ever over timber movements out from the Forest. If he uses a contractor, or if he pays his loaders and drivers incentive, the Forester will seek to make one measure serve this and sale too. Thus measurement on to lorry by the Tape over Bark method (i.e. Length x M.Q.G.), or length/Diameter method, would prove most satisfactory. If something cheaper is required, then Tonnage or Tonnage Conversion may well be considered, especially for unconverted produce. Pieces - lineal footage etc. will suffice if converted.

Specification and Continuing Sales

A few words of amplification may not go amiss on the matter of continuing sales, be they Roadside, F.O.T. or Delivered, and the contracted specification.

Naturally when a sale is advertised, it must be qualified by an expected set of specifications upon which merchants will base their offers. Such specifications will in all likelihood be based on past experience with previous sales, plus a fairly shrewd prediction from the parent thinning (or felling) from which the sale is being shaped. Once an offer is made, it is still possible for merchant to have the specification amended to serve his personal needs. But once such mutual negotiations have been concluded and the contracts signed, it is up to the Forester to see that his production towards the sale conforms with the agreed specification. This may mean measuring, either all, or a sample, and it will mean analysing the results so they can be compared with the promise.

If, however, a Manager is uncertain about anticipated specification, he may adopt the procedure of requesting offers to cover a range of "pre-set" specifications. These might be based on bands of Mid Quarter girths, for example.

While this will not free him from having to measure, it does offer some flexibility and freedom. Whereas, if our fixed specification sale was drifting out of line, he would have to intrude and alter the field practices of conversion (possibly thus altering the specifications of other elements of the produce, by so doing), with the latter approach, it would simply mean the ratio of one of the ranges altering vis-a-vis the others.

Lastly, a point is stressed here, whose significance and importance may easily be overlooked. Generally, a Forester has to track every sale. A sale can become a clearly separate entity even to the same merchant if (a) species differs; (b) price differs; (c) specification differs.

Estimates of sales (for offer or advert) which are prepared with annual estimates maybe somewhat premature for accuracy. But it is most expedient that sale estimates and contracts should coincide with or contained within Forest Years. If not the overlaps which ensue may treble the work of estimation.

Log Measurement Tallies

Measurement of individual logs by the Length by M.Q.G. method requires a tally book in which to note the measurements. Such a tally is shown as Form 27.

Many designs were tried at Inverliever, including 'roll on' camera-like types. But it was always to a stiff backed note book that the measurers returned.

The design is comprehensive and allows for the tallying of a complete tree and the timber derivations therefrom. Full recording of tree and sub.compartment identification is allowed for, and the design also looked ahead to the possibility of the routine gathering of additional statistical data from which deductions of Current Annual Increment can be made.

The split up of total volume into a range of Girth Classes was accepted at the time as a mandate. Its inclusion at the tally book stage was the prelude to a build up of information which fed the Timber Recording documents, including the official Felling/Thinning record.

This Girth Class split-up, reviewed in the light of this Philosophy, has little place in the definitive scheme of things. In fact the need to include it proved an embarrassment to design of the tally and other documents. If it continues to be required, it should be included preferably under number of trees - not volume. Fairly accurate predictions of average tree per girth class can be made from which a pro rata split up of the final end of Forest Year Volume is feasible.

It is most important with a tally of this kind to record sub.compartment top height, and the felled tree Breast Height Quarter Girth. These factors correlated to the timber actually produced can form valuable material for compiling Local Volume Tables.

Dozens of such tally books must have been completed at Inverliever as a prelude to constructing L.V.T's - a task the author did not remain long enough to complete.

((Researches into Timber Measurement at Inverliever

A considerable amount of investigation was undertaken by the author while at Inverliever, much of it of an ad hoc nature relative to the sawlog sales structure in force at the time. Cross cutting schedules were evolved, but they proved very vulnerable to change in price or specification. The sheer expense of measuring individual pieces of timber, other than the largest logs, seems forbidding. Much of the routine measurements at Inverliever did in fact go a long way towards paying for themselves, such was the structure of the sale price gradient, and of course a vast fund, of information was being accrued.

The definitive starting point - other than the specification and price structure of a sale - hinges round the mode of extraction. This will vary with topography, and changes in technology. But, to illustrate the point, if an Isaachsen winch is the standard method of extraction and the working load is 10 to 12 Hoppus feet, then the basic cross cutting must aim towards producing units of 10 to 12 Hoppus feet. On ground of amenable topography where tractors can be used in the wood, loadings can be allowed for which may be large enough to offer no real restriction to the cross cutting regime. Here the sale specification can become paramount.

A stage was reached at Inverliever where a clear choice seemed left. A special measuring cum cross cutting operator had to be trained; or the regime had to switch to one man doing the complete job embracing felling, measuring, snedding, cross cutting, etc.

Out of all the methods tried, and these included hammer stamping, there was no doubt that felt markers used to mark trees in the wood came out best in leaving figures which could generally be identified during loading,, The rough cut of the power saw proved one of the real drawbacks. Furthermore the measuring had to be done and the cross cutting completed before the measurement could be marked on the logs. Hence the pointer towards a specialist measurer/cross cutter, or a one man band. Neither case made full utilisation of a power saw, although the one man band would come near it, if snedding could also have been accomplished by saw.))

((Looking back now, some of the avenues pursued seem quite fantastic, but just as fantastic is the present situation in which the Manager finds himself immersed in a veritable plethora of units with which to quantify his timber. Some of these are applicable at different stages of conversion and the threads of compatibility become very strained indeed. It becomes scarcely valid to investigate losses when like is not compared with like.))

With so much utilisation now taking place of what was hitherto waste, and with a switch to a decimal/metric system fairly imminent, the time is ripening for really sweeping changes.

From all his researches, the author emerged finally attracted to a simple solution which seemed to invalidate all the conscientious and complex work which had preceded. Namely, measurement by weight.

For basic records, for rate fixing etc., the cheapest and most expedient method seemed to be Local Volume tables. And much can be said for paying men, and completing records on a number of trees basis instead of volume.

((Working backwards from manufactured produce, sales, etc. to serve records and piece work earnings somehow never offered a satisfactory solution. While this certainly avoided paying for waste, men had, through no fault of their own, spent time and effort producing the timber, waste and all.

Furthermore the possibilities of time lag before figures come back, the vulnerability to contingencies, the whole business of handling timber and rate fixing without prior knowledge of tree size - all tend to legislate against this approach.

For conversion and sale of manufactured commodities such as pitprops, stakes, etc., the method of measurement would remain the piece or the Lineal Foot.

But for the rest, unconverted pit or pulpwood, and sawlogs, the simplest and most definitive mode of measurement, seemed to be by weight.))

Measurement by Weight

The pattern of timber production at Inverliever over the years 1954 to 1964 was fairly simple - - - sawlogs were cross cut from a minimum diameter of 6 inches; the tops were sold at roadside as long length pitwood. Both were on a continuing sale basis -- - - stacking space was at a premium.

Most of the pitwood was sold on Tonnage conversion basis the factor being determined by weekly measured sample loads.

The sawlogs were measured length by M.Q.G. on loading.

But an extended trial took place during which many of these sawlog loads were weighed too, and with whose result the buyers seemed perfectly satisfied.

Two main criticisms are generally leveled at measurement by weight

The first is loss of weight by drying out. Assuming a volume has been established at the felling stage, if the timber is extracted and lorried away quickly -especially during May to August, when sap is "up" - the conversion factor will be favourable - - possibly in the region of 28 Hoppus feet per ton. If however, extraction and further conversion and dispatch proceed slowly, and if the weather is dry, evaporation will lead to a loss of weight, with conversion factors climbing to the 35 or 36 Hoppus feet per ton region. Depending on the average factor upon which a sale is concluded, - these diverging figures represent gains or losses. Of course if timber has dried 'out over a long period, there will also be a loss of volume by shrinkage.

The question which must be posed as a result is this - is it right and proper that the conduct of selling timber as a business should be influenced by moisture content? After all it is timber that is up for sale - not water.

Furthermore, it has been alleged that selling by weight prevents the inclusion of price gradients, i.e. an increasing price for increasing specification.

During the course of his investigations at Inverliever, the author analysed a series of 32 loads of sawlogs embracing 12,220 Hoppus feet.

It should be first explained that the basis of the sale included a price gradient based on Mid Quarter girth, of which there were three classes:

- (1) under 8 inches M.Q.G.
- (2) 8 inches to 11¾ inches M.Q.G.; and
- (3) 12 inches M.Q.G. and up, all O/B.

Minimum top diameter was 6 inches U/B and length 10 to 25 feet, average 15.

Each of the girth classes commanded a separate price.

In the analysis, the total value of the load was computed, i.e. by first totalling the volume of the logs in each girth class.

Then the following were worked out, (a) the average volume per log per load; and (b) the average price per Hoppus foot for the load.

When graphed against each other, the increase in average price per log with increasing log volume appeared linear.

Thus it seemed a feasible proposition to weigh all loads and determine volume by an annual factor, or one agreed for the term of the sale, or one discovered periodically from trial loads. Then, from a count of logs per load, the average volume per log would be found, although, of course, the average could remain expressed in weight.

A scale of prices could be fixed, the price rising with average log volume. Various approaches could be made, in fact, but two are outlined here, differing only in the size of the 'jumps' in average volume. (The prices quoted are for demonstration only).

e.g. (1) A rising price based on increase of 1 whole unit of Volume

Average Log Volume H.Cu.Ft.	Average Price Payable per H. C. Ft.
below 6	(say) 3.13/- (3/1½d.)
6 to 6.9	3.17/- (3/2d.)
7 to 7.9	3.22/- (3/2½d.)
8 to 8.9	3.24/- (3/3d)
9 to 9.9	3.26/- (3/3d)
10 and over	3.31/- (3/3½d.)

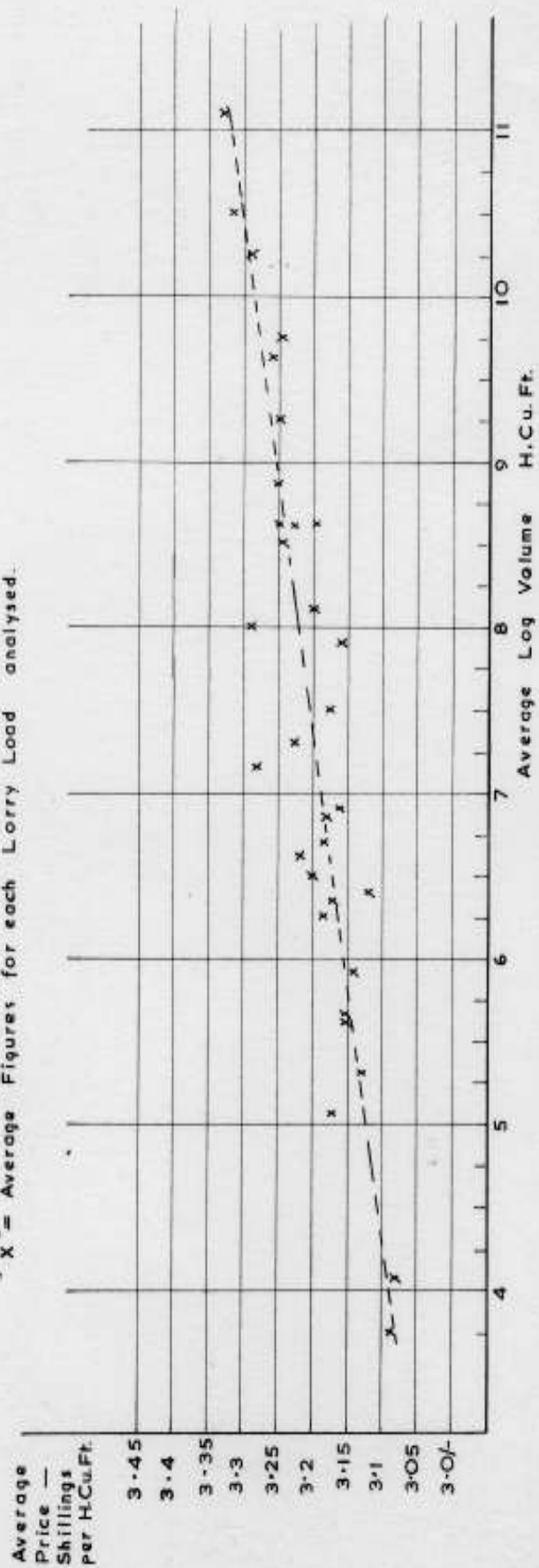
or (2) A rising price, but based on bigger banding of the average volume, and allowing for a large band which the analysis revealed as occupying 60% of the volume (i.e. 6 to 9 cu. ft.).

Average Log Volume (H. cu. Ft.)	Average Price Payable (per cu. Ft.)
below 6 cu. ft.	(say) 3.13/- (3/1½d.)
6 to 9 cu. ft.	3.21 /- (3/2½d.)
over 9 cu. ft.	3.28/- (3/3½d.)

Naturally, by employing such a price structure, encouragement if offered to the seller to aim for a high average volume per log, which is generally in keeping with what a mill wants, but, of course, commensurate with the usual mode of extraction. The detailed measurement on loading has thus been dispensed with, in favour of a simple count of logs, and subsequent weighing.

INVERLIEVER FOREST : Measurement of Sawlogs by Weight.
Price Gradient Investigation.

"X" = Average Figures for each Lorry Load analysed.



This is all very well, but still the problem remains of measurement in the wood, and if not for record/piecework purposes, it will be to assume conformity with specification. Can this be made cheaper too?

It can, provided three important considerations are agreed to by the Timber Merchant.

1. Acceptance of the measurement by weight and count of logs principle, with a range of prices fixed on the basis of average log volume per load. In effect the real implication to the merchant is that he is being asked to pay the same price for logs of a certain volume, irrespective of length or girth. For example a log of 12 feet x 11" M.Q.G. and a log of 24 feet x 7½ M.Q.G. are both 10 Hoppus feet, but are they worth the same price to him?
- 2» Acceptance of a practice of trying to even up log volumes in cases where extraction dictates a maximum in which the butt log might have to be cut shorter relative to subsequent cuts.
3. Acceptance of crosscutting in random lengths, random in the absolute sense of the word, i.e. not even to a round predetermined foot (plus two inches).

No doubt, many heads are shaking vigorously already! It is a tall order, indeed, to expect even a fair measure of agreement on what contains elements which have provided endless controversy in the past. What has this quite revolutionary approach to offer? It takes the saving of money in measuring to its extreme conclusion. In fact measurement could be made virtually by pacing, saving the need for measuring rod, etc. All that need be reconciled - if extraction places a limit on log size - is that the limit is exploited for as many logs as possible. No doubt a simple etching or painting on to power saw blades, for a target log volume, can indicate the length appropriate to the top diameter required to give this volume. And measuring prior to trimming would prove easier and less rigid.

What may be agreed to however.-... is that such technique may be accepted as a standard, with appropriate standard price level. If, however, a merchant wishes more precise measurements, built in to a sale, then the price would have to be adjusted to allow for the extra cost of measuring the 'deluxe' commodity.

It is certainly conceivable that some merchants may put more premium on girth, others on length in the contribution these make towards the average volume of the log. In this case, then at least one extra dimension must be measured to qualify volume. (Weight is the only simple method of measuring a log in one dimension, but does produce the ambiguous result already referred to - namely that logs of the same weight, and hence volume, may have radically different length/girth ratios).

Probably top diameter is the easiest to add, if the merchant has not insisted on length to an even foot.

In such cases, the weight/price gradient would have to be fixed in terms of the important dimension. One solution thereafter is to sort the logs, only loading and dispatching one of the price classes at one time, routing the lorry via a weighbridge. Naturally, this is more expensive but may well be worth it to the merchant. It may bring the risk of logs of a poorly represented class lying for a while before sufficient can be gathered for a load thus involving the risk of drying out etc. It may be that several compartments may have to be "raided" to provide the load, with attendant book-keeping difficulties, somewhat untidy working and costly handling.

However, there remains much to be said for the serious consideration of weight as the basis of selling sawlogs or other basic material. It is definitive and cheap, and may prove less vulnerable than the aging Hoppus Foot if the Industry goes Metric.