STUDIA FORESTALIA SUECICA

Nr 30 1965

Distribution of the Costs of Joint Forest Roads According to Crosswise and Lengthwise Road Functions

Kostnadsfördelning för enskilda skogsbilvägar, grundad på vägens längs- och tvärsfunktioner

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This paper is an abbreviated version of a report by the author "Ett förslag till kostnadsfördelning för samfällda skogsbilvägar" (Cost distribution for private forest roads), published in Swedish only as No. 26 in the series "Research Notes", Department of Operational Efficiency, Royal College of Forestry, Stockholm, Sweden.

INTRODUCTION

In all countries with private land ownership there exist rules or laws governing the right to pass over private property, including the building of roads, and the obligation of the people and land owners to partake in the work or the cost for the construction and maintenance of such roads which are used by more than one estate or one individual. Some information on this matter has been published by *Argal* (1965). With the increasing importance of the roads for long distance transportation, the ancient road-holding systems, in which each township, community or village usually was in charge of the jointly used road net within its boundary, became obsolete. Gradually, state authorities have taken over the responsibilities for building and maintaining the main roads but a great deal of the road net is still in the care of local communities or private land owners and will probably always be so.

In Sweden about 68 % of the entire rural public road net is located on forest land, serving a dual purpose: to shorten the off-the-road transport and to carry the transport of forest produce, labour and material. The private forest road net is nearly two and a half times the length of the public one. (See table 1.)

Table 1. Road net located on forest land in Sweden (v. Segebaden, 1964 p. 48)

	Total length km	Road density, meters/hectare		
		N. Sweden	Mid and S. Sweden	Sweden
Public roads.........	64.600	1.5	3.7	2.2
Private forest roads...	150.750	2.5	10.7	5.1
Total	215.350	4.0	14.4	7.3

During the last decade approximately 3000 kilometers of private forest roads have been built annually. The majority of this road construction is in the form of joint enterprises in which a large number of forest owners often partake and share the cost. Of the total private forest road net only about 10 % has been built with subsidies from the government.

I. The Swedish Act on Private Roads

The existing Swedish act on private roads dates back to 1939. It provides an instrument to legally obtain *the right to pass over a property with a private road* and also *rules for the distribution of road costs* on properties benefitting from a joint road. Provided it can be proved that the proposed road is of considerable importance and benefit for the properties concerned, land owners can be forced to allow the passage of the road and also to partake in the road costs. There is in the law no fixed majority, either in numbers of property owners or in property area, required for a legal approval of the road enterprise.

Only the rules for the distribution of road costs in a joint road enterprise will be discussed here. The basic statements in this respect read as follows in the Swedish Act:

"In a joint road enterprise which is of considerable importance ('synnerlig vikt') for the rational use ('ändamålsenliga brukande') of two or several real estates, those (estates) shall jointly partake" (par. 10).

"Obligation to partake in road holding shall be distributed among those real estates, on which the obligation rests, with regard to the extent of use, to which they are expected to use the road, but greater share may not be placed on any real estate than what corresponds to its benefit from the road" (par. 11).

Many joint roads are built in Sweden on the basis of a voluntary agreement between the users and they are then free to share the costs as they themselves find most appropriate, regardless of the rules of the Private Road Act. When many estates are involved or someone objects to the road plan, it often becomes necessary to carry out the enterprise through an official procedure, based on rules laid down in the Private Road Act. A man — usually a forester or land surveyor — is appointed by the local governmental authority to constitute at a public hearing a road association for the project, with the owners of the real estates as members, to make up a complete plan and cost estimate and suggest how the road costs shall be shared. This plan must be approved by the association. There are certain rules and procedures if an unanimous decision is not taken with the view

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that a small reluctant minority in number or area cannot obstruct a road enterprise, beneficial for the majority.

The official executor of the planning shall consider the overall usefulness of the road. He shall also suggest how the road costs shall be shared and in doing so he shall interpret in technical or monetary terms the sense of paragraph 11 in the Private Road Act just cited above. No uniform interpretation of this paragraph is commonly used in Sweden — executers or a group of them use methods of cost distribution which vary considerably in principle and consequently also give different results. The purpose of this study is to discuss briefly different principles of cost distribution. An analysis is made with regard to the expected usage of the road over time with due regard to the state and productivity of the forests. Finally, a cost distributing method is suggested, which agrees with the Act on Private Roads. This method — for convenience abbreviated as the CLF Method — is further claimed to agree with the present transport theory on road spacing and road standards.

II. Principles of Cost Distribution

It seems that there are two principles of cost distribution which could be considered more justified than others: (1) *according to the benefit of the road* and (2) *according to the extent of the use of the road.* Benefit and extent of use are of course always correlated but only in exceptional cases they are identical. For the following discussion some terms need defining.

Road Cost:		costs of the construction and the maintenance of the road.
Value Increase:	(1)	present worth of future changes of revenues and costs, caused by the road.
	(2)	difference of market value after and before the road construction.
Road Benefit:		value increase plus present worth of the future maintenance costs.
(Net) Road Gain:	(1)	value increase minus road construction cost
	(2)	road benefit minus road cost.

"Road Benefit" as defined above should equal the present worth of all cost reductions through the road without inclusion of the road cost.

Distribution according to benefit means that each estate gets the share of the road costs which corresponds to its share of the total benefit of the road. The road enterprise can be looked upon as a stock company, through which the share holders enjoy equal dividends on their stocks (investments). The benefit of the road is estimated by comparing the costs of utilizing the estate before and after the road construction, disregarding the costs of the proposed road. Such estimates are often difficult to make and subject to criticism. The benefits may vary with the structure of each individual estate for reasons which are irrelevant to transportation inside the drainage area of the road. The benefits may also be changed by future technological developments. Furthermore, the full benefits of the road enterprise may not be achieved until complementary branch roads are added in some areas. Such branch roads may often not be built at the same time as the main road but successively added as harvesting operations take place.

Distribution according to the extent of the use of the road is based on an estimate in technical terms of the transport volume of each estate and the road costs are distributed according to each estate's share of the total transport volume. An estimate of transport volume should be less difficult than an estimate of benefit. It should also be less influenced by technological changes or by structural factors of the estates which have minor relationships with the transports within the drainage area of the road.

It seems that distribution according neither to benefit nor to extent of use can be considered preferable for reasons of justice or precedence. Both principles are commonly used in joint industrial enterprises. In communication and transport cost sharing between users according to extent of use seems by far the most common principle. A method for cost distribution according to the use of the road shall therefore be presented.

There are several reasons why I consider cost sharing according to extent of use more advantageous. It seems that cost sharing according to benefit is better fitted for improvements, which aim at an increase of revenues, whereas cost sharing according to extent of use should be preferred for improvements, which — as in the case of forest roads — have the main purpose to reduce the costs. Cost sharing according to extent of use is less complicated and should be easier for the members in the enterprise to understand. It is also less sensitive to technological and economical changes during the long life of a road. It also agrees with The Swedish Act on Private Roads, an argument, which has no scientific validity but should nevertheless at present make its use feasible.

III. Cost Distribution according to Extent of Use

A forest road serves the purpose of the carrying on the road of transport of forest produce, labour and equipment. This purpose can be called the *lengthwise function of the road.* In addition, when the road runs through forested areas, it shortens the distance from these areas to the road and consequently influences the cost of the extraction of forest produce and the cost of supplying these areas with labour and equipment. This second purpose of the road is the *crosswise function of the road.* The dual function or use of the forest road is clearly shown when question of road spacings and road standards are discussed.

In the cost distributing methods according to use developed in Sweden, the crosswise function of the road has been almost entirely neglected. The method presented here, for convenience abbreviated to the CLF method (cross- and lengthwise function), fully recognizes the dual use of the road and aims at the allocation of the road costs in agreement with this dual use.

(1) Traffic volume, generated by a unit of forest area over a period of time

Forest roads are investments bringing services over generally long periods of time. In forestry of the "cut and get out" type, the time horizon with which road investments are viewed may be short. In sustained yield forestry with only minor variations of the harvest in time and space, forest roads are of lasting use but should nevertheless be considered as being bound to become obsolete. Each area unit within the drainage area of the road will generate use of the road, the extent of which will vary in time. It must therefore be justified to take into account not only the extent of use but also the time when the use can be expected to take place. One way, which will be used here, is to capitalize the future expected use to the "present worth traffic volume". By applying a rate of interest, the time preference is taken into account.

Thus, in the grading of each unit area of forest within the drainage area of a road the following should be considered.

(1) choice of planning period—planning horizon,

(2) present worth of traffic volume during the planning period,

(3) location of the unit area along and across the road.

As (2) will depend very much on (1), these two items may be simultaneously discussed.

(2) Planning period — present worth of future road use

Short planning periods for forest roads may only be considered in cases of immediate exploitation of large areas of virgin or mature stands. Such conditions very rarely exist in areas where joint forest roads are needed. Also, very simple roads may be expected to have a short life. Usually we are concerned with a staggered ownership pattern and with second-growth stands of varying age in different stages of development. The "present worth traffic volume" (PWTV) of a stand will depend on such factors as (1) site class, (2) age of stand, (3) density of stand, (4) planning period, (5) rate of interest (time preference). An analysis of the influence on the PWTV of each of these factors has been carried out, and is reviewed in Swedish in the main report. The PWTV is in principle the future traffic of timber, personnel and goods, capitalized to the day of the completion of the road enterprise. The analysis shows the influence on the PWTV's of the factors (1)—(5), listed above. The factors (1)—(3) — stand and site factors — can be measured or estimated in the field and are therefore used as the basis for the stand classification. As regards the factors (4) planning period and (5) rate of interest a choice must be made, which — of course — is arbitrary and could be different for each road enterprise. However, a planning period of 40 years and a rate of interest of 5 % have been considered as most realistic for Sweden. On this basis, the PWTV's have been transformed to TI's (Traffic Indices = TI), a procedure through which the stands are classified as ratios to the stand "middle aged forests", "average site class", "density 0.7—1.0", the PWTV of which has been set as

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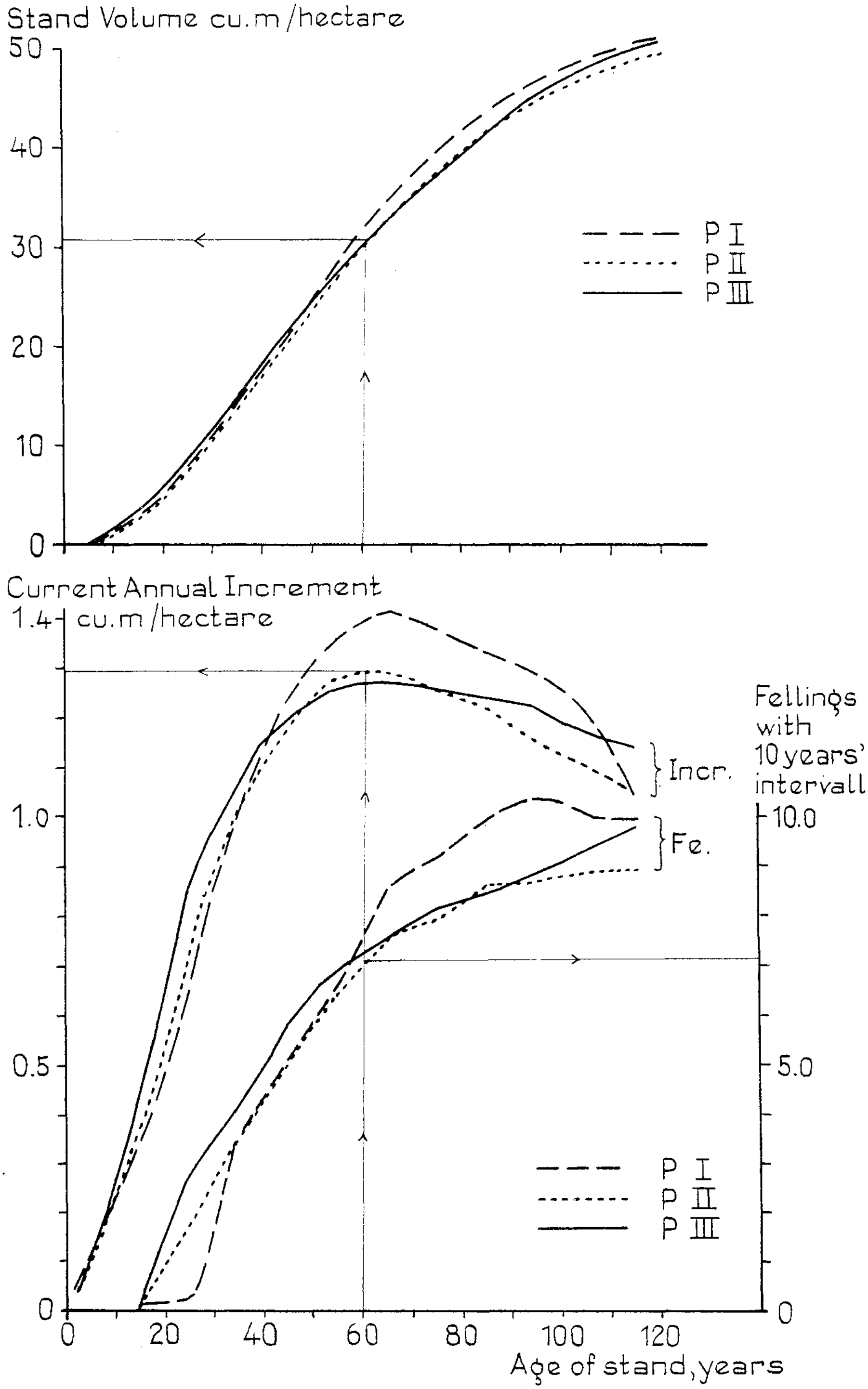
Figure 1. "Type scheme" for the regions I—III, Northern Sweden, all tree species. This graph is based on an approximation of stand developments in all site classes, reduced to the imaginary site class 1 (with an average annual growth of one cubic meter per year and hectare during the rotation period). To obtain real figures on stand volume, annual increment and harvest, multiply with the actual site class (expressed as above for site class 1). Example (see graph). A normal stand on site class 3 will at the age of 60 years have a standing volume of $3 \times 31 = 93$ cubic meters per hectare, its current annual increment, which just is culminating, will be $3 \times 1.3 = 3.9$ cubic meters per hectare and year and the volume removed at a thinning with a 10-year interval will be $3 \times 7.2 = 21.6$ cubic meters per hectare. Incr. = Increment. Fe. = Fellings with 10 years' interval.

Fig.1. "Type Scheme" for Growth Regions PI-III.
Nothern Sweden. All tree species.



TI = 1.0. (See table 2.) As an illustration to these estimates, the "normal" development of a stand in the regions I—III, Northern Sweden, is expressed in figure 1. For the interpretation of this graph, read the accompanying text.

On the basis of "type schemes", as the one in figure 1, the potential traffic volume (PWTV) of a stand can be estimated for various values of age, planning period, rotation and rate of interest. Such estimates together with other considerations have led to the choice of a planning period of 40 years and a rate of interest of 5 %. A shortening of the planning period will give a greater range in the TI-values in table 2 as will the choice of a higher rate of interest than 5 %. The derivation of TI-values in table 2 has been made not only with regard to the transport of wood. As forest roads also serve the purpose of labour and personnel transports, estimates have been made

Table 2. Traffic Indices (TI) for the grading of the present worth traffic volume per unit area of a forest stand.

Stand Description	Bare land, juvenile forests			Young forests			Middle-aged forests			Mature forests		
Density	< 0.7	0.7—1.0	> 1.0	< 0.7	0.7—1.0	> 1.0	< 0.7	0.7—1.0	> 1.0	< 0.7	0.7—1.0	> 1.0
Site Class			For each higher site class multiply by 1.33									
Better	0.5	0.5	0.7	0.8	0.9	1.1	1.1	1.3	1.6	1.3	1.7	2.1
Average	0.4	0.4	0.5	0.6	0.7	0.8	0.8	1.0	1.2	1.0	1.3	1.6
Poorer	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.8	0.9	0.8	1.0	1.2
			For each poorer site class multiply by 0.75									

Explanations to table 2.

Stand: Described in four classes, distinguished as follows.

Bare land, juvenile forest: no stand or stand with average height below breast height.

Young forests: stand with average height above breast height, but for which the current annual growth has not yet culminated (upper age in Sweden, north 60—70 years, middle 50 years, south 30—40 years).

Middle aged forests: stands from the age of the culmination of current annual growth to the age of economical maturity.

Mature forests: stands above the age of economical maturity.

Density: 1.0 = optimum economical stocking, 0.7 = 70 % of opt. ec. stocking.

Site Class: "Average" = the dominant site class within the drainage area of the road. "Better" and "Poorer" are based on the *Jonsson* site grading system, for which the difference between two classes is 25 % in average annual growth during a rotation. (Per cent difference is based on the site class with the higher production.)

on the magnitude and economical weight of these transports as compared to the timber transport. The need of labour per unit of cut wood is higher in the lower age classes and it is also rather high during the regeneration period. Through an analysis of the labour demand at various periods and by assigning the same relative weight to personnel transports as to timber transports, the TI-values in table 2 should represent all transports necessary for the management and harvest of the forests.

(3) Location along and across the road

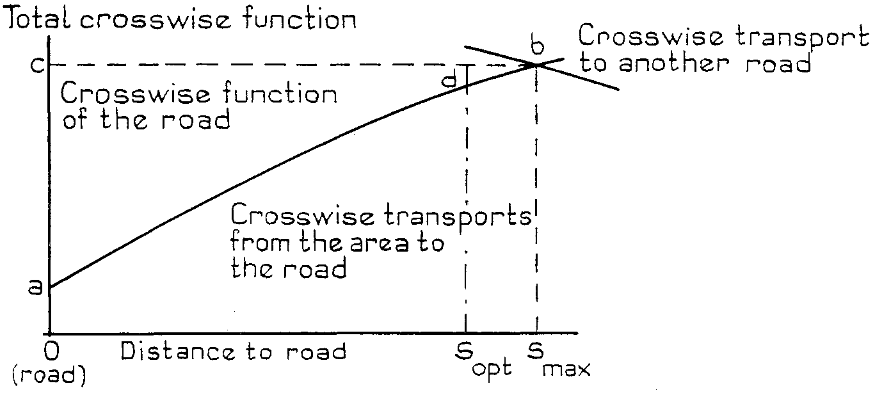
The distance from the stand or the unit area to the road indicates its location across the road. The distance from the point of the road, at which this cross-wise transport terminates, to the beginning of the road describes the location along the road. For a non-dead-end road linking two existing roads together, a stand or unit area may require transports in both directions along the road. An estimate should then be made on the division of transports in either direction and the TI-figure in table 2 should be consequently divided.

The extent of use along the road for a stand or unit area may be derived by multiplying its TI-value (table 2) by the location along the road as defined above.

The extent of use across the road is derived on the basis of figure 2, in which the cross-transport is described by the curve a—d—b. The area a—d—b—S_{max}—0 represents the total cross-transports. An optimum range of a road can be calculated assuming a specified set of conditions. In figure 2 this range is indicated by S_{opt}. In practice, the real range of the road (S_{max}) often deviates from S_{opt}. It may be shorter or longer as in figure 2. The real range of the road is represented by the boundary beyond which — for technical or economical reasons — cross-transports go to other roads. It is evident that the cross-wise function of a unit length of the road is described by the area a—c—b—a in figure 2. The extent of cross-wise use for a stand or unit area will then be in proportion to the vertical distance between the curve a—d—b and the line c—b in figure 2.

For practical purposes, isodromes are drawn in the area, which the road serves whereby the area is subdivided in "distance-zones". (Isodrome = line connecting points on equidistance from the road.) On the basis of an analysis of the cross-wise transports the following table 3 has been derived with ratios (correction factors) signifying the extent of cross-wise use of each unit area. By multiplying the TI-value of a stand (see table 2) with its correction factor in table

Fig. 2.
Total crosswise function



3, an expression is obtained on the extent of use for each stand or unit area. Thus, the derivation is based on the rule that the sum of cross-wise transport and road obligation shall be equal for unit areas with identical stands. This sum can be measured in monetary terms, including only variable costs related to transport functions. Or it can be estimated in technical terms, e.g. ton miles. The latter alternative is less subject to personal judgements and is also not influenced by technical or economical changes during the life of the road. It can be noted, that the structure of transportation prior to the proposed road is completely irrelevant to the CLF method, whereas cost distributing according to benefit rests on present techniques and costs applied prior to road construction.

Table 3. Correction factors for the grading of the cross-wise function of a road with regard to the cross-wise location of the stand (unit area).

Distance-zone	Correction Factor
< S	1.0
S—2S	0.6
2S—3S	0.4
3S—5S	0.3
5S	0.2

Note: It is recommended, that S should be approximately one fifth of the maximal range of the road. S. should also not be shorter than the average distance between the landings — if any — at the road side.

(4) The minimum standard road

The dual service — cross-wise and length-wise — of a forest road is evident. It is also evident that the cross-wise function of a road is not influenced by the standard of the road, once it meets the minimum requirements of the transport system for which the road net shall be designed. The standard of the roads shall vary in different parts of a road net, the lowest standard to be found in the distal (upper) section of a dead-end road. As the traffic volume increases in lower sections of the road net, the road standard should increase so as to secure minimum combined road and transportation costs in any section of the road net. *The minimum standard road can thus be defined as the standard in the distal end of a dead-end road with optimum spacing, meeting the technical and seasonal requirements of the transport system.* It seems logical that the cost of that road should be used in calculations on optimum spacings of roads rather than the average road cost for the whole road net. It also seems logical that *the cost for the building of the entire road net, to minimum standard, should be distributed among road users according to the extent of their cross-wise use of the road. The cost of the improvement of road standards above the minimum should then be distributed according to the extent of length-wise use among road users.* A method for cost distributing according to these principles is presented in the following chapter.

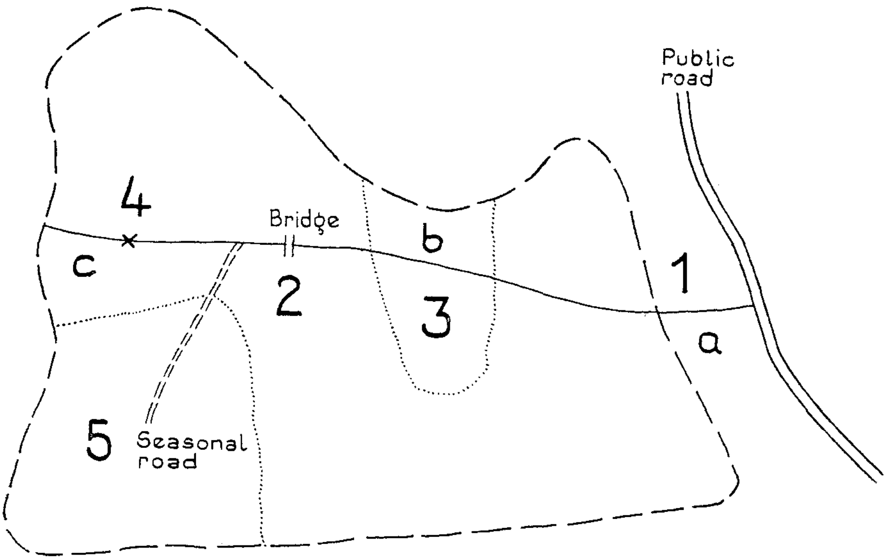
IV. The proposed CLF Method

(1) The road lay-out

The road net should be planned as to meet clearly defined and uniform requirements with regard to seasonal trafficability and transport systems (vehicles). If it proves useful to build at the same time branch roads with lower requirements (e.g. winter roads), such parts of the road net should in the cost distribution be regarded as separate undertakings of those road users, for which they are of importance. The same method of cost distribution is then employed for each such separate undertaking as for the main road net.

After the road net has been laid out, preferably to an economical, optimum density, the parts of the road net without cross-wise funcions are singled out. The costs of those parts shall be shared by those road users enjoying their length-wise function. In figure 3 some such examples are indicated. Assume that the road section *a* (from the public road to point (1)) goes over farmland. The cost of this section shall be shared by the road users according to their length-wise use (as derived with the aid of table 2). — At point (2) an expensive bridge has to be built. If the transport pattern in the area is uni-directional — all transports flow down to the public road — only road users above point (2) shall partake in the cost of the bridge according to their length-wise use of it. If, on the other hand, the transport flow is bi-directional, or multi-directional, the traffic volume of each road user, as estimated with the aid of table 2, has to be devided on the expected transports in the various directions. At point (3) the road passes through a depression, giving a very limited drainage area for the road section *b*, so that the road density exceeds the optimum. The part of the road section *b*, exceeding the optimum road length per unit area, should then be treated as a road part without cross-wise function and the cost of it shall be shared by users of it according to their length-wise use. The same procedure applies if the catchment area of road section *b* is nonproductive land, e.g. a swamp. — Point (4) denotes that point to which the road is extended if the road users are interested only in a uni-directional transport flow to the public road. However, it may be profitable to connect the road with the road net in an adjoining drainage area,

Fig. 3.



adding the road part *c*. The cost of that part shall then by shared by road users according to their expected length-wise use of it. — Forest owners in the area (5) consider it useful to build a seasonal road at the same time as the main road net is constructed. The seasonal road should then be regarded as a separate undertaking and the cost of it should be shared by those within the area expected to make use of it. They shall simultaneously partake in the cost of the main road net as if the seasonal road were not to be built. — These are only examples as a guide for distinguishing the cross- and length-wise concept underlying the CLF method.

(2) Minimum standard road and road standard fitting

The cost of building the entire main road net to minimum road standard as defined on page 17 shall then be estimated. If this cost varies much in different parts of the road net, it may be preferable to divide the road net in a few drainage sub-areas, within which the cost to minimum road standard is fairly constant. Road users within each such drainage area share the cost of the minimum standard road net within their area according to their cross-wise use.

The improvement cost incurred by the fitting of the road standard in the different parts of the road net to the traffic volume shall then be estimated. In an area with uni-directional transport flow, road standard should vary considerably whereas a multi-directional transport flow tends toward more uniformity. This improvement cost shall be shared according to the length-wise use.

(3) Through traffic, other road users than forest enterprises

Through traffic should partake in the road costs. It seems most rational to make separate agreements with such road users, and use the revenues of this traffic to reduce the road costs to be shared by the road users within the catchment area. Thus, the ratios of the road cost of the "primary" road users will not be influenced.

Road users, other than forest enterprises, should be treated in the same manner. If there are large numbers of them (e.g. farms, summer cabins, etc.) it may prove useful to work out rules concerning their participation. Such matters are outside the scope of this study.

(4) Subdivision of the road net in sections

In most cases it is practical to divide the road net into sections, each with a drainage area of the nearest lower order as compared to the whole road net. The topography will be decisive in this subdivision. It should start from the upper part. The upper-most section in a dead-end road net should be so large as to ensure approximately the same road length per unit area as for the whole road net. The length of each road section should preferably not be less than half of the road spacing. Road parts without cross-function, as exemplified in figure 3, should be treated as separate sections.

(5) Subdivision of the drainage area in distance classes

When the road net has been laid out, it is recommended to plot on a map isodromes subdividing the drainage area into classes with regard to the distance to the road. Single woodlots and parts of them can then be located in the relevant distance class (cf. table 3) for the estimate of the cross-wise function. — Sometimes some areas enjoy less cross-wise use than expressed by the distance class. For example, a road may in some part follow a waterway or swamp which cannot be crossed during the whole or part of the year. A special estimate should then be made of the magnitude of decreased cross-wise function. A reduction of the cross-wise share, as derived with the aid of tables 2 and 3, should consequently be made. Only if such topographical or other obstacles direct the off-the-road transports to other road nets should a reduction of the length-wise share be considered.

(6) Stand classification in the field

With the aid of an ownership map on which the road and the isodromes have been plotted, the area of each woodlot is broken down on the road sections and within each section on distance classes. The site classes and stands on each such sub-unit are then classified in the field according to table 2, rating the traffic index (TI) of each stand. As the TI-values, derived in table 2, represent an approximate and rather arbitrary prediction of future road use, it will be quite adequate to perform the site and stand classification as an ocular estimate. The cost of this field work is negligible as compared to the road building costs.

(7) Computation of the cost shares

(1) The cost of the minimum road for each section shall be shared by all road users within its catchment area according to *the corrected traffic index,* obtained by multiplying the traffic index (table 2) with the correction factor for cross-wise function (table 3). Then the corrected traffic indices are summed up for each section. The share of each woodlot owner in the cost for the minimum standard road within the section will be in proportion to his share of this sum.

(2) For each section the sum of all traffic indices is made from the areas and woodlots served in a length-wise manner by that section. The improvement cost of the road standard fitting is then to be shared by each woodlot owner in proportion to his share of that sum.

(3) The cost shares of each woodlot owner is then summed up. The sum shall equal the total estimated road construction costs. The share of each woodlot owner can then be estimated in percentages for the distribution of the *real* road building costs, which will be known only after the completion of the road construction. — Forms for the classification of the stand in the field and for the computations are included in the Swedish report (see p. 1).

V. Distribution of Road Maintenance Cost

Several methods are available for the distribution of road maintenance cost. One is to charge a fee for the use of the road as it appears in terms of e.g. dollar per ton mile. Often this method will involve an unreasonable amount of reporting and control, and is therefore to be recommended only for transit traffic or in cases of few and large partakers.

The costs of road maintenance consist of a fixed and a variable fraction. This fixed cost is incurred by time through maintenance work with the objective to keep the road in its original shape. The variable cost is incurred by usage — the wear and tear by traffic. Furthermore, road maintenance usually tends to increase the road standard and to a certain extent can be regarded as an investment similar to the cost of road construction. No information seems to be available with regard to a breakdown of road maintenance costs into fixed and variable components. If we assume that they are proportional to the ratio of "road building cost of a minimum standard road" to "road improvement cost for road standard fitting", the same cost distribution for road maintenance could be justified as for the cost distribution of road construction cost as outlined in the CLF method above. Such an assumption seems to be reasonably true. It should be emphasized that the financing of road maintenance through fees requires working capital, because income from fees and periodic expenditures for maintenance may not be well synchronized. Furthermore, woodlot owners who do not cut and consequently do not pay their contribution to road maintenance still enjoy the increase in value of their forest holdings. This increase can be cashed in at a sale. They should therefore always partake in the fixed maintenance cost. It should be remembered that the CLF method is based on a planning period of about 40 years. Therefore, a new estimate and stand classification should be made at the end of this period, evaluating the expected future use of the road of each woodlot owner from that date.

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Sammanfattning

Kostnadsfördelning för enskilda skogsbilvägar, grundad på vägens längs- och tvärsfunktioner

(Föreliggande uppsats utgör en sammanfattning på engelska av den fullständiga rapporten: Ett förslag till kostnadsfördelning för samfällda skogsbilvägar, Rapporter och Uppsatser Nr 26/1965, Institutionen för skogsteknik, Skogshögskolan, Stockholm.)

Lagen om enskilda vägar stadgar, att väghållningsskyldighet skall »fördelas med hänsyn till den omfattning, vari de (fastigheterna) beräknas komma att begagna vägen». En analys utföres över den trafikvolym, som ett skogsbestånd kan beräknas generera under olika förutsättningar beträffande markbonitet, beståndsålder och slutenhet. Vidare belyses, hur nuvärdet av denna trafik skiftar vid olika val av planeringsperiod och räntefot.

En skogsbilväg har två transportfunktioner: en funktion längs — att möjliggöra transporter *på* vägen — samt en funktion tvärs — att avkorta transporterna *till* vägen. Tvärsfunktionen uppfylles i princip av en väg av så låg standard, att den nätt och jämnt tillåter trafik med för hela vägsystemet avsedda fordon, en väg av s. k. minimistandard.

Ett förslag till kostnadsfördelning framlägges, baserat på att vägbyggnadskostnaden till minimistandard skall fördelas efter den tvärsfunktion, som resp. bestånd eller fastigheter får del av, medan byggnadskostnaden för standardanpassning av vägen i syfte att uppnå en optimal vägstandard skall fördelas med hänsyn till hur skogsbestånden eller fastigheterna utnyttjar vägens längsfunktion.

För gradering av skogsbeståndens andelar i trafiken har upprättats nedanstående tabell, i vilken andelen per arealenhet (hektar) uttryckes i relativa tal, s. k. trafiktal. Dessa trafiktal användes direkt för fördelning av vägbyggnadskostnad för standardanpassning.

Trafiktal för gradering av skogsbestånd vid skogsvägbyggnad med avseende å beståndens potentiella trafikvolym.

Bestånd	Kalmark, plantskog			Ungskog			Medelålders skog			Mogen skog		
Slutenhet	< 0.7	0.7—1	> 1	< 0.7	0.7—1	> 1	< 0.7	0.7—1	> 1	< 0.7	0.7—1	> 1
Bonitet (enl. Jonsson)	För varje högre bonitetsklass, multiplicera med 1.33											
Närm. högre	0.5	0.5	0.7	0.8	0.9	1.1	1.1	1.3	1.6	1.3	1.7	2.1
Medel	0.4	0.4	0.5	0.6	0.7	0.8	0.8	1.0	1.2	1.0	1.3	1.6
Närm. lägre	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.8	0.9	0.8	1.0	1.2
	För varje lägre bonitetsklass, multiplicera med 0.75											

Fördelningen av vägbyggnadskostnaden för minimistandard är grundad på att summan av denna vägkostnad och transportkostnaderna tvärs vägen skall vara konstant. En tabell har upprättats (se nedan), med vars hjälp beståndens trafiktal omberäknas till korrigerade trafiktal, vilka sedan utgör fördelningsgrund för vägbyggnadskostnaden till minimistandard.

Korrektionsfaktorer vid gradering av en vägs tvärsfunktion för olika avståndszoner från vägen.

Avståndszon	Korrektionsfaktor
< S	1,0
S—2S	0,6
2S—3S	0,4
3S—5S	0,3
5S—	0,2

Anm. Vid tillämpningen av denna tabell bör S inte understiga medelavståndet mellan avläggsplatserna belägna efter vägen (eller de större utfartsvägarna från omkringliggande areal). Följande värden för avståndszonerna (värde på S i ovanstående tabell) rekommenderas

Del av landet	*Rekommenderat värde å S i tab. 3*
Övre och mell. Norrland	500 m
Södra Norrland, Bergslagen	350 m
Södra Sverige	250 m

Den föreslagna metoden för kostnadsfördelning, på engelska förkortad till CLF och på svenska till TL, bör även under vissa förutsättningar kunna användas för fördelning av vägunderhållskostnader.

En del anvisningar föreslås för metodens praktiska användning.

ESSELTE AB. STHLM 65

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Edited by J.G.K.Flower-Ellis