PLANNING LARGE-SCALE LOGGING OPERATIONS

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SYNOPSIS

Logging planning aims at attaining the quantitative, qualitative and cost targets pre-set by forest management in order to effect the regular harvest of the forest resource. These targets determine the scope and size of the logging operation; but, in order that appropriate decisions may be made, all possible alternative courses of action must be recognized and realistically evaluated.

Competence in this field presupposes that the process of logging, its constituent elements, and their relationship to the field of forest practice as a whole are fully understood. Cognizance must also be granted to the socio-political overtones particular to the environment in which the logging operation is being carried out, inasmuch as they demand modification of otherwise theoretically correct decisions.

THE PROCESS OF LOGGING

Fundamentally, logging is an exercise in transportation. This suggests a separation of the points of origin and utilization of the material to be transported. Normally it is a two-stage process — *i.e.,* hauling (stump to bush transfer point) being the initial or *primary* transportation stage, and trucking (bush transfer to point of utilization) the *secondary* transportation stage. These stages may vary — *e.g.,* when logging is by direct skidding to a millsite, or when other stages such as railing, rafting and/or barging are added. However, as the two-stage operation is most common within New Zealand forest practice, discussion will be confined to it in this instance.

The sequential steps in two-stage logging are:

(1) Felling.

(2) Semi-processing (heading-off, trimming, etc.).

(3) Hauling (tractor, winch or other).

(4) Final processing (log-making at skidway).

(5) Loading on to truck.

(6) Transportation to point of utilization.

The fact that these steps are sequential requires that productivity at any stage be equivalent to and in harmony with that of all others. To effect this harmonious relationship, the *elements* of logging must be recognized, measured and evaluated so that the step of critical capacity may be identified. Prior to this, however, it is necessary to assess the conditions under which logging will take place.

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ASSESSMENT OF BACKGROUND FACTORS

These factors include:

(1) The extent and distribution of stands.

(2) Topography.

(3) Distance from resource to utilization plant.

(4) Climatic factors.

The first step is to evaluate the timber resources — *e.g.*, by using normal forest mensuration procedure in a manner that will give, in addition to pure volumetric data, information to enable the work content inherent in any stand harvest to be determined.

Initial study of topographic maps, portraying salient land forms and also showing limits of forested area, provides an accurate area base for assessment of standing volume. Subsequent sampling methods follow the identification of stocking differences as they appear on aerial photographs.

Differing topographic types are identified by map interpretation and their extent determined by map measurement. The volume standing upon each of these topographic types must be modified by the percentage loss that is expected through breakage during felling, as slope severity increases. This requires further modification because the topography will cause reductions of net realization as yields become impossible to extract economically in areas of difficult topography.

Net forest yield can now be stated, as it is dispersed through various topographic types. The extent and location of these types have been determined by map measurement.

The effect of topography on productivity is determined by map study and measurement. Related to the primary transportation stage, topography determines the types of hauling machinery that may most profitably be used and, in the secondary transportation stage, the location of truck roads, gradients, etc.

These two factors initially determine the productivity, machine and labour components of an individual production unit.

On completion of this preliminary analysis, it is possible to identify that step in the logging process which is the critical or governing factor.

Each machine or labour unit will have its productivity limited by the piece-size it must handle and, in the case of labour, also by the effort needed to transform trees into acceptable log form.

Productivity of the labour and hauling machine components of a logging crew will vary according to number of men and the distance of haul. Composition and output of the crew are usually adjusted so that the loading unit will be operated at full capacity. The productivity of this machine, as stated previously, is determined predominantly by the piece-size it must handle — this being influenced primarily by standing tree size. It may be significantly modified again by the demands of mill input.

Accepting that the loading unit is operated at capacity, the productivity and numbers of the other constituents necessary to a logging crew are phased to its output. Assessment of the labour required to fell, breakout and process; of the machine type to be employed; of the distance of allowable haul, and of the density and spacing of roads necessary to effect the efficient harvest of standing forest within a given set of circumstances is then made.

ASSESSMENT OF LOGGING ELEMENTS

To this stage discussion has centred on one particular situation. However, should one factor be altered, it will be necessary to re-evaluate the new set of circumstances, causing a new balance of labour and machinery and often a new governing factor to be calculated. As this will be a most frequent occurrence when the harvest of extensive forest areas is being planned, it is essential that the mean values of any area be known and thoroughly appreciated by logging management. On the basis of this understanding, the following overall components of the logging sequence are calculated:

(1) The balance of machine types: their numbers and capacities.

(2) Labour requirements.

(3) Transport requirements.

To illustrate:

Hauling equipment

To find the number of skyline haulers required to extract the prescribed net yield on the steep areas of a forest:

let N = number of haulers required

Y = prescribed annual yield per acre

A = topographic type area, in acres

C = daily productive capacity of hauling unit

D = working days per year

then $N = (Y \times A) / (D \times C)$

Similar exercises may be conducted for each topographic type and the hauling machinery demanded by it.

Labour requirements

Assessments of labour (determined by tree size, form and the topography on which it is standing) required to feed capacity volume through the stages of hauling and loading, enable the labour content of any production unit or type to be determined. When related to the machine type incidence and productivity balance, this permits calculation of the total labour force necessary.

Transport

The machinery required for secondary transportation is determined by three factors: distance, yield dispersal, and load size. Distance to each yield unit is obtained by map measurement, the distance in miles being weighted by the productivity of that unit. This exercise is aggregated for all such units and then divided by allowable cut to give mean hauling distance or average lead. This may be expressed as:

$$L = \Sigma(A \times Y \times D) \mid C$$

where L = average lead.

A = area of any yield unit

Y = yield (net) of any unit

D = distance in miles of that unit from point of utilization

Σ = sum of all units

C = prescribed annual cut

Load size is generally arbitrarily decided by available truck type and by restrictions on public highways. However, in the case of operations conducted wholly within a forest, maximum load size is determined by topography in so much as it affects vertical and horizontal alignments.

When load size has been defined, milage to be run annually is given by

$$M = C \mid U \times 2L$$

where C = allowable cut

U = truck load size

L = average lead distance in miles.

Truck operating units required may then be stated after measuring round trip times for differing distances, allowing for loading and unloading time and relating them to total milage run.

$$T = M \mid (V \times D)$$

where T = truck units required

M = annual milage

V = vehicle capacity (miles per day)

D = operating days per year.

By simple calculation, annual fuel, tyre and maintenance costs may also be arrived at.

Roading

Roads are of three categories: Arterial; sub-arterial or secondary; and tertiary or spur.

Arterial roading, as its name suggests, is centrally located to the forest as a whole. Detailed location is determined by through-route principles and it grants no cognizance to forest areas peripheral to it.

Sub-arterial roading is located in a manner designed to collect the tertiary or spur roads and feed them to the main artery. Only in this manner are roading considerations allowed to supersede those of logging.

Tertiary or spur roading. This category includes only those roads on which logs may be hauled *to* bush transfer points. These are primarily egress routes from skidways to the higher order roadways. While their detailed location is normally topographically dictated, their density is arranged where possible to effect the harmonious productive relationship of hauling to loading unit detailed earlier.

At this stage the planner has an awareness of the equipment, labour and development needed to harvest the prescribed or allowable cut. He can fix the locality where varying types and combinations may be deployed, and he may schedule shifts of production units within the forest to deliver to the mill threshold an intake that will be uniform in quality, quantity and cost.

RELATIONSHIP OF LOGGING TO OTHER FOREST PRACTICE

Logging both suffers and benefits from history. Until relatively recent times, logging *was* forestry in New Zealand — as indeed it still continues to be in some countries overseas. The harvesting or *mining* of the indigenous resource was followed in most instances by the cutover being converted after burning to agriculture, or left in a state of neglect. The unfortunate legacy of this past practice is that logging has been regarded as a *terminal* act and thereby gained an inflated status. This has given rise to practices which, while justifiable when viewing logging costs in isolation, are often detrimental in an economic sense to forest practice as a whole. This attitude was stimulated because logging directly produced revenue, which promoted the setting-up of logging divisions and even subsidiary companies (where this was not done for other facets of forestry), highly capitalized and with aims sometimes at variance with other forestry needs.

The modern logger, however, is cast in a different mould. Integrated thinking permits logging to be fitted to its correct link status. Nowhere is this more graphically illustrated than in the more advanced indigenous forest operations, where land clearing and site preparation for species conversion has a priority not far removed from that of log production. Although these operations lack some of the mechanical sophistication of the larger logging organizations, their position as leaders in the field of modern logging practice is widely recognized.

Within the field of exotic logging operations some compromise is required between logging costs and those attendant upon other facets of forest practice. Although "creaming" will allow a lower logging cost, a severe "clean up" prescription will increase net yield — thereby decreasing wood growing costs and leaving the cutover areas in a state that will enhance the prospects of adequate regeneration. Increased net yield may also allow a utilization plant to be lifted to a higher operating level, with attendant economies.

Integrated thinking is als‹› required of the forester charged with siting and tending the cro/›. He must shed his "vandal" attitude to utilization organizations and adopt his siting and silvicultural prescriptions to facilitate the extraction of the raw material produced. He must be appreciative of the side benefits emanating from their presence, especially in the field of improved access, fire protection and the management flexibility inherent in the ability to salvage produce that would otherwise be lost to natural catastrophe — fire, windthrow, depredations of pathogens, etc.

EFFECT OF LOCAL ENVIRONMENT ON LOGGING PRACTICE

The nature of logging operations varies greatly throughout the country. This occurs through virtue of size and complexity — whether indigenous, exotic, terminal or fully integrated with forest management. What is apparently theoretically correct must invariably be modified by local environmental factors.

In the Bay of Plenty district, large forest areas, established initially by a transient labour force, were scheduled for large-scale utilization with no local labour available to perform the necessary task. It was therefore necessary to assemble a labour force by creating artificially a population where none previously existed. This required heavy capital outlay per employee and it became necessary to construct dormitory towns and to provide sophisticated on-site accoutrements. Investment was forced into the social field of providing civic, cultural and recreational amenities — in an attempt to emulate the diversity and facilities available in established centres competing for the same labour resource.

Wages, bonuses and other fringe benefits (housing subsidies, deliberate overtime, etc.) keep fiscal payments at a premium compared with available alternative avenues of employment. This added up to a high labour cost, both in direct and overhead payments, and forced management to obtain and maintain high labour productivity rates. This was accomplished usually by appending labour to high cost, highly productive machinery operated under fine control, so as to produce maximum output at low overall unit cost.

In other regions, typically those where the indigenous resource is waning and existing organizations are re-orientating to the exotic scene, many of the criteria enunciated in the skeletal outline in the first part of this paper are difficult to apply. Labour force and utilization facility are present in sufficient quantity, if not in quality, and overhead payments are minimal. Traditional small operators — normally on a contract basis — produce an end product at competitive cost. This situation can only endure while a regional labour surplus exists and until market conditions force the coalescing of small conversion units into large centrally located plant.

In other cases a forest may possess a variety of topographic types, none of which has a volume yield sufficient to cover the productive capacity or economic life of a specialist machine. More versaile equipment and methods then become necessary.