Work Study Techniques to Tree Planting

A. H. Vyse

Pacific Forest Research -
Canadian Forestry Service
Victoria, B. C.

In recent years, Tree Planters' Notes and other forestry publications have published information on new reforestation systems, most of which embraced the container concept. Unfortunately, the plethora of new ideas is contributing to confusion among foresters who plan and run reforestation programs, because good information on the *performance* of those systems is not available.

Collecting such information is only partly a research function: the reforestation forester must also assume some responsibility for collecting performance data because realistic appraisals of any new system will depend on field tests under a range of conditions.

Apart from the challenge posed by innovation in reforestation, there is also a need for foresters to exert some control over the rising costs of on-going reforestation programs. This, too, requires performance data.

A method of obtaining performance data for the planting phase of reforestation has been derived from the basic concepts of Work Study 1 commonly used in industry to effect improvements in work situations. Work study principles have been applied before in forestry: Worley *el al.* (1965) analyzed many forestry costs; Cottell *et al.* (1971) examined the performance of skidders; McIntosh and Wright (1970) studied balloon logging, and Danatt and Wittering (1967) analyzed weeding in forest nurseries. Appelroth (1971) and Vyse *et al.* (1971) have applied work study techniques to planting operations in Finland, and British Columbia, respectively.

1 An often used but now inappropriate synonym for Work Study is "time and motion" study. The scope of analysis is considered to he much broader with Gilbert (1968) defining Work Study as "the systematic study of human work in all its contexts, leading to the investigation of all factors which affect efficiency and economy in order to effect improvement."

A Work Study technique for planting operations

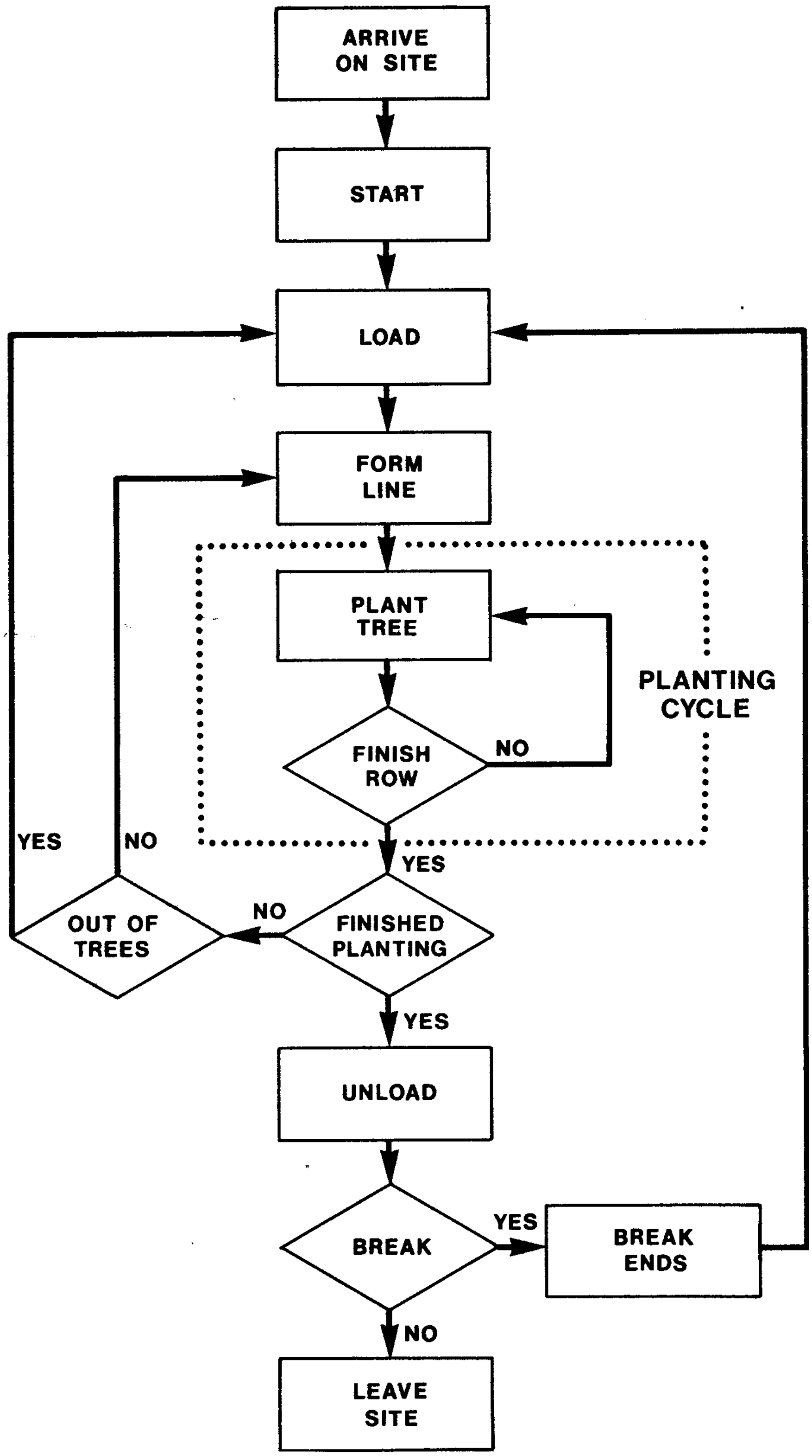
Any planting operation is made up of a number of readily identifiable activities. A hand planting operation (fig. 1) has one central activity, identified as the *planting cycle,* and a number of supporting activities that keep the cycle in motion. The objective of the Work Study technique described in this article is to assess the contribution of each activity to productivity.

The planting cycle comprises the actions or elements that make up the act of planting a tree (fig. 2) and the several interruptions that occur as planting proceeds. Some of the activities that break the flow of planting are essential if planting is to continue. For example, in bullet planting, the planter often halts to take a full tray of 50 bullets from his back pack, replacing his empty tray. This activity is an integral part of the current bullet planting system. Other activities that interrupt planting are less desirable from a productivity standpoint. Again using bullet planting as an example, the planting guns sometimes jam, thus causing delay. Better equipment design might reduce or eliminate this problem.

The range of essential to undesirable activities is also found outside the planting cycle. Clearly, some portion of the time available for planting is needed to load or unload trees and equipment. Also, some allowance for personal needs must be made throughout the day. Work breaks are frequently a negotiable item between supervisor and planting crew. In British Columbia, planting crews take regular breaks both morning and afternoon, as well as shorter ones, especially during "turnarounds" (called "base line change" or "line change" in table 1) on the road. How much of this time is needed for the crew to recuperate, and for the supervisor to maintain high morale and high productivity, is open to question.

Each activity in the planting cycle is

Figure 1.—A flowchart of hand-planting activities.



observed in the following way. A selected planter is followed for a full day and, during periodic 10-minute samples (selected systematically), the following items are recorded:

- number of trees planted;
- "interruptions" to the planting *cycle by type,* and their duration estimated to the nearest 5 seconds by stopwatch or wrist watch (special clipboards with three linked stop watches are available if more accurate timing is desired);
- planting elements in five complete cycles recorded to the nearest second;
- external factors considered likely to in fluence the planting cycle (e.g. desired spacing, vegetation, slope, slash, weather, time of day, disposition of planters).

All activities outside the planting cycle are measured each time they occur, with a wristwatch or stopwatch.

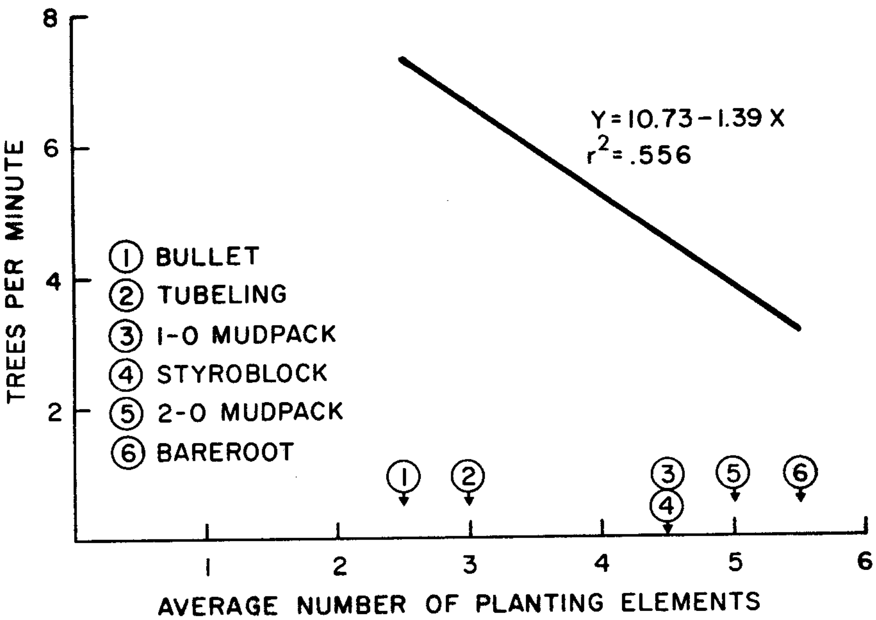
Application of Work-Study output

How can the data collected by the techniques described be put to use?

First, from the planting cycle samples, a measure of net planting time is obtained which then can be converted to net planting speed expressed as trees planted per minute per man. This measure is useful for comparing the potential of planting methods (fig. 3), studying the effect of external factors on productivity, and comparing actual performance with some established standard. Gross planting speed is the number of trees planted divided by the total sample time and can be useful for a quick performance check. No activities need be recorded in this case.

Second, the identification and measurement of planting elements can be used to describe planting methods, to compare them, and to pin-point needed improvements in equipment, or. when training planters. Figure 4 shows the effect of improving bullet planting equipment. Strips of 12 bullets were used at first for handling ease (Walters 1968, 1969) but this proved awkward when planting. The strips had to be separated with a special cutter, and the time required for this action not only lengthened the planting cycle but contributed to a general slowing down in all activities. Development

Figure 2.—Example of planting elements recorded in work studies of bareroot and styoplug planting.

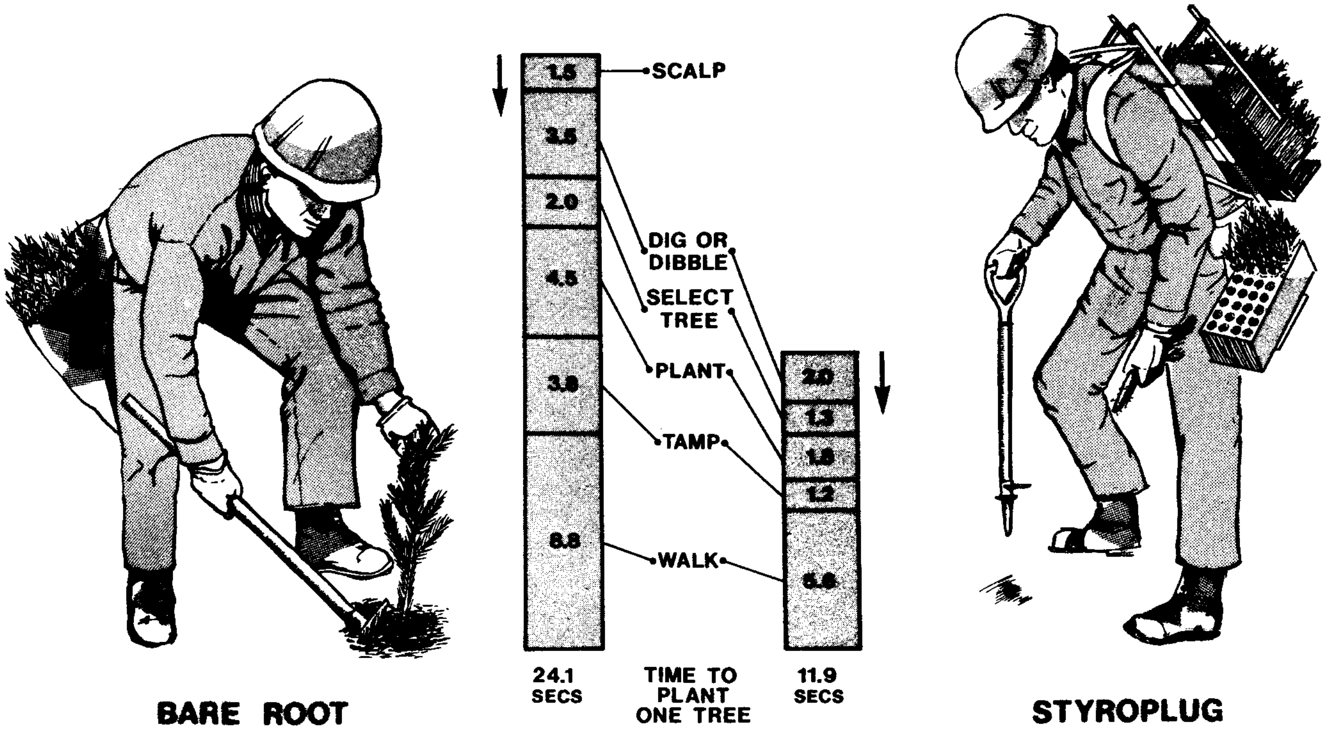


work continued until the present single bullet and side tray concept evolved (Vyse 1971).

A third application of the data is shown in the planting activity time analysis table (table 1). The information collected on activities in the planting cycle samples and the times of activities occurring outside the cycle are summarized, and the percentage of available planting time (generally 8 hours in British Columbia) taken up by each activity is displayed.

Planting supervisors, studying variations in production while seeking means of controlling costs, can use activity analysis tables to compare crews and operations. As a simple example, a forester may have before him two planting reports, one showing an average planting production of Crew A as 1,500 trees per man day, the other with Crew B planting 1,200 trees per man day. He may expect this if the first crew is more experienced than the second, but if the sites were much the same and the proportion of net planting time was higher for Crew A (75 percent) than for Crew B (60 percent), the activity time analysis directs him to search for factors other than experience that might explain the difference in production. One of these factors may be poor field coordination and supervision.

Figure 3.—Comparing planting speeds of reforestation systems.



level of accuracy desired. In the N. Interior region of British Columbia, first-stage data are being collected over the 1972 planting season (May-July) using 4 man-months to cover the planting of 4 to 5 million trees.

After the first stage is completed, the production standards set can be used for cost estimates and cost control. To implement cost control, however, a second much less intensive data collection stage must be introduced. At most, this requires the planting crew foreman to submit each day a production total (trees per planting crew), effective crew size, standardized data on operation conditions, an estimate of net planting time and, if possible, five planting cycle samples. Actual performance can then be checked against expected performance; and, when necessary, previously-set production standards can be adjusted to meet new or changed conditions.

To apply the two-stage procedure, equipment and training requirements are minimal, and only clear study objectives and keen observation are necessary to produce useful results. The recommended procedures, tested and proved in British Columbia, should be applicable wherever planting is employed as a means of forest regeneration.

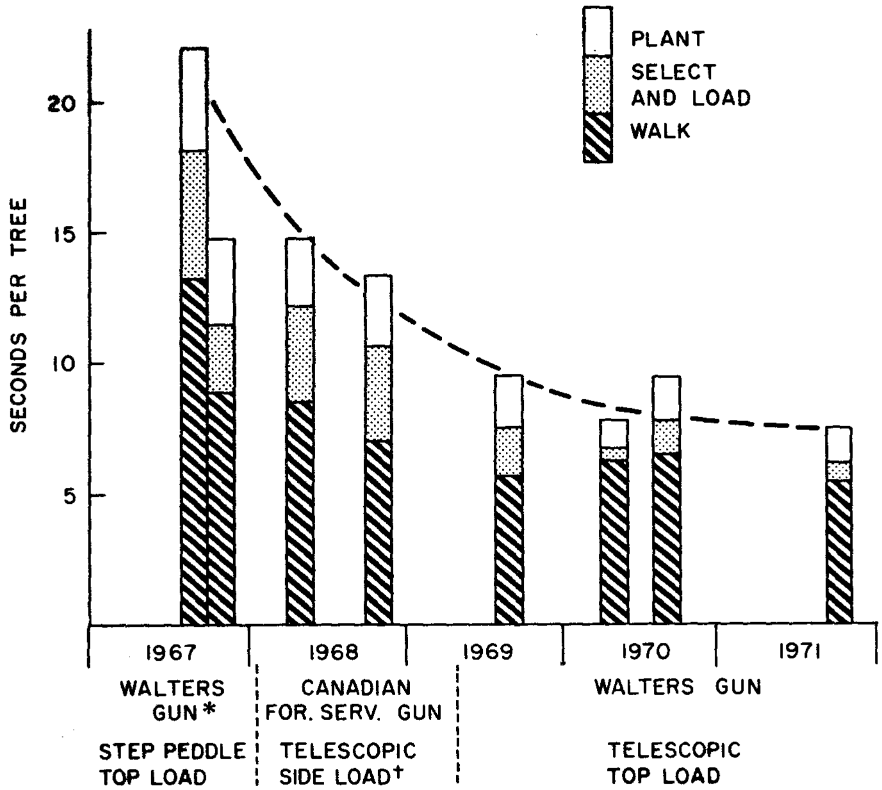


Figure 4.—Development of tools for bullet planting. *(Note:* *** Strips of 12 bullets were separated with a knife attached to the planting gun; all other operations use single bullets. + Bullets were fitted into a breech on the side of the gun. When loading, Walters' gun bullets droppped down the barrel.)**

Standardizing data

Many of the uses of Work Study data involve the comparison of production under several different conditions: planting methods, spacing, slash density, slope, ground vegetation, incentive or day wages, labor quality, are among the more important variables. Unfortunately, a planting operation often does not go on long enough to provide sufficient sample data for conclusions on the effect of each variable. Nor do we know how to quantify all of the variables. We will eventually be able to assess relationships under most conditions, and thus predict performance with some accuracy, but this will require a large data bank. In the meantime, it is important to identify Work Study information by the conditions under which it is collected and, if possible, to standardize data collection procedures. This is essential to minimize misleading conclusions based on inadequate data, and to avoid the confusion caused when a method newly applied to an area does not apparently meet the expectations based on experiences elsewhere.

A two-stage data collection procedure

To use the Work-Study technique described above, foresters might consider adopting a two-stage data collection procedure.

The objective of the first stage is to develop planting production standards for the planting methods desired over a range of operational conditions. These standards would be based on the observed variation of net planting speed and activity times, and thus require full implementation of the procedures outlined in earlier sections. The cost of this stage will depend on the range of methods and conditions faced and the

References

Appelroth, S.E.

1971. Planting tube makes it easy to plant Japanese paperpot planting stock in Finland. For. Chronicle 47: 350-1

Abruzzi, A.

1956. Work, workers, and work measurement. Columbia Univ. Press, New York.

Cottell, P.L, H.I. Winer and A. Bartholomew.

1971. Alternative methods for evaluating the productivity of logging operations: Report on a study of wheeled skidding.

Pulp and Paper Research Institute of Canada.

Montreal. Woodland Report WR/37.

Dannatt, N., and W.O. Wittering.

1967. Work study in silvicultural operations with particular reference to weeding. Paper prepared for Ninth Commonwealth Forestry Conference, Forestry Commission, London.

TABLE 1.—Activity time analysis table [1]

	Minutes	Minutes (%)
Available planting time		480.0 (100)
Less Extra-cycle activity times		
1. Start and finish time loss	10.0	
2. Loading and unloading	15.0	
3. Breaks and extra lunch	22.0	
4. Transfer to new site	—	
5. Base line change	27.4	
6. Line change	9.1	
7. Misc.	—	
	83.5	83.5 (17.4)
Gross planting cycle time		396.5 (82.6)
Less Planting cycle activity times		
1. Alignment	12.0	
2. Tree supply	6.3	
3. Equipment failure, misplants	9.1	
4. Misc.	1.6	
	29.0	29.0 (6.0)
Net planting cycle time		*367.5 (76.6)*

Total no. trees planted = 15,650 trees

Productivity = 2,235 trees/man/day

Average planting speed

(Productivity ÷/net planting cycle time) = *6.1 trees/minute (9.9 sec/tree)*

[1] Based on planting operation, Vancouver Island, 1/9/70, by a 7 man crew, 1 foreman, 1 crew vehicle plus tree trailer

Gilbert, O.
1968. A managers guide to work study. J. Wiley, and Sons, London.

McIntosh J. A., and D.M. Wright.
1970. . Haul roads in the sky. Canadian Forest Industries. Jan. 1970: 46-51.

Nadler, G.
1955. Motion and time study. McGraw Hill Book Co., New York.

Nadler, G.
1969. Work design. R.D. Irwin, New York.

Vyse, A.H.
1971. Planting rates increased in British Columbia with new planting gun and bullets. Tree Planters Notes 22 (1): 1.

Vyse, A.H., G.A. Birchfield, and E. Van Eerden.
1971. An operational trial of the Styroblock reforestation system in British Columbia. Canadian Forestry Service, Pacific Forest Research Centre, Victoria, B.C. Inf. Rep. BC-X-59.

Walters, J.
1968. Planting gun and bullet. Agric. Engineering 49: 336-339.

Walters, J.
1969. Container planting of Douglas fir. For. Prod. J. 19 (10): 10-14.

Worley, D.P., G.L. Mandell, and R.W. Williamson.
1965. Gross job time studies . . . an efficient method for analyzing forestry costs. USDA Forest Service. Rocky Mountain For. & Range Exp. Stn., Res. Note RM-54.