

**Author's Dedication to International Journal of Forest Engineering Founding Editor Jeremy Rickards**

*This paper is published in honour of Jeremy Rickards, the enthusiast behind the International Journal of Forest Engineering. Jeremy is profoundly interested in people, both privately and as a researcher. His expertise lies primarily within the field of ergonomics and man at work. Therefore it seems appropriate to dedicate to him the following paper, dealing with man, the most central and — from the researcher's point of view — the most difficult factor of production.*

— Rolf Björheden

## **Learning Curves in Tree Section Hauling in Central Sweden**

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### **ABSTRACT**

Payload development in truck hauling of tree sections was studied, using production statistics from central Sweden. An increase of payload weights over four years was observed.

Factors influencing productivity may be divided into groups connected to a) technology, b) human skills, c) work object properties and d) working conditions. Apart from varying weather and seasonal climactic change, no productivity change or development could be observed associated with technology, work object properties or working conditions during the course of the 49-month study. The operators studied were all experienced roundwood hauling contractors, but had no previous experience with tree section hauling. Their experience of the work studied and on the equipment increased during the study.

Under the stable conditions of this study, the most important factors influencing payload variation are increased operator skill and varying weather and climate. Meteorological data explained more than 70 per cent of the variation but a logarithmic increase of payloads along with a decreasing sensitivity to weather conditions remained unexplained. Hypothetically, this is accredited to growing operator skill including an increased ability to judge and compensate for varying characteristics of tree sections handled. If so, the learning phase might be longer than generally assumed. To shorten this low-productivity period is an important aim for vocational training for workers and contractors in forestry.

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Some methodological problems connected with the interpretation of production studies are also discussed.

**Keywords:** *productivity, tree section, full tree, hauling, climatic influence, operator influence, learning curves, production study, Sweden.*

### **INTRODUCTION**

Worker productivity increases as they become more familiar with a new task. This increase is initially rapid and later tails off as the worker approaches full potential productivity for a particular task. This relationship between productivity and experience is called a "learning curve". In this paper, an attempt is made to investigate the quantitative relationship between a measure of productivity, truck payload mass, and human skills. The investigation is based on production statistics from hauling of tree sections in central Sweden over a 49 month period. 'Tree sections', in Nordic forestry, denote 'undelimited shortwood' i. e. cut-to-length but not delimited pulp wood.

The introduction of tree section harvesting was a result of energy price increases following the first oil crisis in the 1970's, sparking an interest in the potential of forest biomass as a source of energy [15]. The tree section method and various production systems connected with it are examples of this. In tree section harvesting and transportation, trees are felled, cross cut, forwarded and trucked without first delimiting stems. This results in the production of stem sections with branches still attached and poses particular technological challenges due to lower bulk density and potential safety risks associated with branches that extend beyond the normal dimensional envelope for highway trucks. As a result, it was necessary to find methods and technology suitable for handling new assortments in an efficient and cost effective way (c.f. [5], [8]).

Productivity denotes the long-term average performance of a production system. The productivity level ( $P$ ) may be seen as a resultant of four main factors:

- a) technology, including both the 'hardware' as well as the method by which it is engaged.
- b) human skills, (e.g., experience, aptitude, motivation)

- c) work object properties (e.g., size, weight, texture)
- d) conditions of work (e.g. weather, road net standard, legislation).

Accordingly, the assumed production function can be written:

$$P = f(a + b + c + d) \quad (1)$$

This causal approach to performance and productivity study is traditional to Nordic forest work-study [11], [12], [17]. It has also found advocates in other European countries [20] as well as in North America [4] and can thus be regarded as generally accepted. Many papers have been published contributing to the knowledge of the correlation between productivity and factors of the groups *a*, *c*, and *d*, while only few studies systematically describe the influence of *b*, human factors, on productivity.

In hauling, when all other factors are kept constant, there is a direct connection between payload weight and performance [3]. In this study, payload weight is therefore taken as a measure of productivity. The hypothesis tested is that if the influence on payload weight of technology, work object and working conditions can be isolated, any unexplained development of productivity may be attributed primarily to the development of human skills.

Little effort has been spent on studying and developing operator skills, although vocational training for forest workers and contractors has been identified as an activity of great importance for the overall efficiency of forestry [13]. Studies of learning curves for machine operators performing complex forest work [14] indicate that the learning phase may be several months. This study describes the learning curves observed in complex operator work when tracking tree section payload mass, while controlling and quantifying influencing factors other than human skills (i.e., factors *a*, *c* and *d*, listed above).

## MATERIAL AND METHODS

### Payload weights

The primary data of the study consisted of production statistics from February 1984 to December 1987 for four trucks equipped for tree section transportation, working in a loosely organised 'transport group' for the transport company ÅKERISKOG AB. In total, almost 7000 loads - over 200 000 metric tonnes - of tree sections were included in the material. Payload weights were registered by regular scale measurements conducted by the wood measurement station at Norrsundet, a forest industry site approximately 30 km north of Gävle, operated by the independent Swedish Wood Mea-

surement Organisation. The original data were collected during a student's research project [2].

The use of individual payload weights was problematic from a statistical point of view, because of the relatively high occurrence of 'sweep' loads. One out of seven loads result from 'sweeping' a residual pile of tree sections before moving to a new logging site. The sweep load is often, but not always, transported to the scaling station in spite of the low weight. Statistically, sweep loads are not part of the same population as the 'normal' full loads. Sweep loads may be treated as outliers and excluded if they fulfil certain requirements of deviation. However, many sweep loads will be insufficiently different from normal loads to meet these criteria and will therefore be retained in the sample population. This will create a downward bias in payload weights. Further, to estimate overall productivity, 'sweep' loads also need to be taken into account. Computing monthly averages for each of the four trucks in the study solved this problem. Each month was then considered as a systematically taken random sample and each truck as a replicate.

### Factors influencing payload weight

Data were collected for factors that had been variable during the studied period and could thus potentially explain any payload weight development. The influence of each factor was determined by analysis of variance combined with regression analysis. Factors that remained unchanged during the observed period such as average diameter, tree species composition and average hauling distance were not included in the analyses. They will not be discussed in this paper, although they may be of great importance under other conditions.

### Technology

Information on production methods and equipment was collected through interviews with the drivers and the logistics officer at ÅKERISKOG AB. The technical specifications issued by the manufacturers of the trucks and trailers were also studied. The forester in charge of introducing tree section logging in the area was also interviewed. Interviews were conducted to establish if and how the methods and/or technology of hauling, loading and unloading had changed during the period. According to the interviews with the drivers and their employer, no deliberate, articulated changes in method had occurred.

The most important technical factors are the cargo space and the tare weight of the truck and trailer. The same trucks were used during the entire period of observation. The service tare weight of the trucks (VOLVO F12 6x2 A-RIDE) was approximately 8.3 metric tonnes. "Boden" brand roundwood

trailers fitted with aluminium sides and weighing 8.2 tonnes were used for tree section hauling. The available cargo volume was 110 m<sup>3</sup>. Other than repairs and, in one case, replacement of a trailer with an identical model, no modifications were made to trailers during the study period.

The study was thus carried out on a production system characterised by technological stability and continuity, which is rare under the dynamic conditions associated with large-scale industrial forestry. The technological factors were therefore considered stable and not included as independent variables in the analyses of payload development.

#### Human skills

The skill level developed by an operator is a complex function of a number of factors listed in Equation 2 [6], [7].

$$\text{Skill} = f(E_w, E_e, S, M, A, T) \quad (2)$$

Where:

E = Experience at the work studied

E<sub>e</sub><sup>w</sup> = Experience on the equipment

Experience (for both E and E<sub>e</sub>) is here defined as knowledge, gained by observation or trial, that enables operators to maintain a certain level of quality and performance in spite of varying properties of the work piece, the equipment or the conditions of work.

S = Shape of the day

M = Motivation

A = Individual aptitude

T = Training, in this context is not a level of formal schooling, but rather a level of motor-sensory ability, achieved through practise, to perform a particular type of work.

Throughout the study period, each of the four trucks was driven by the same owner-operator who also loaded the tree sections onto the truck at the landing. The Operator skill level was not measured, but the components determining operator skill level were assessed as follows: *Motivation* was considered to be high throughout the studied period since the truck owner operators were acting as subcontractors to the forest enterprise and paid by incentive. The *Individual aptitude* for the job was also high, the drivers had been chosen for this work based on their performance. The operators' *Shape of the day* certainly varied (as did *Motivation*) but such variations are normally short-term occurrences which may be assumed to even themselves out in long term studies such as this one. Since the skill factors mentioned above are considered constant during the study period, they were not included as variables in the analyses. Instead, of the factors listed in Equation 2,

three factors were identified as being of particular interest, since they can be expected to change significantly and systematically during this lengthy study:

- Training
- Experience at the work
- Experience on the equipment

When the study began, the four studied operators were all seasoned professionals, each with many years experience of roundwood hauling. Thus, the levels of *Training* with and *Experience on the equipment* are considered to be high. *The experience at the work studied* was practically negligible at the beginning of the study. (The four drivers had made a short study visit to a company in northern Sweden, where they could talk to drivers with experience in hauling tree sections). Therefore, it was considered probable that skill would increase with increased practice and experience, both of which are included in the analyses through the proxy of the variable *time*.

#### Work object properties

Tree sections originated from early thinning in stands of mixed pine (*P. silvestris* L.) and spruce (*P. abies* Karst.). Bucking was aimed at a standard length of 5.5 m. Interviews and analyses of stand data indicated that methods and choice of stands for tree section logging had not changed in such a way that hauling might be affected. The work object properties were regarded as stable and are therefore not included in the analyses of payload variation.

#### Working conditions

Hauling distance strongly affects the productivity of transport work. Since the average hauling distance remained the same throughout the study and the number of loads hauled is large, it was not necessary to include data on hauling distance in the analyses.

Traffic legislation on maximum gross vehicle weight (GVW) may be seen as a condition of work, delimiting the allowable mode of operation. The four trucks studied were all allowed maximum GVW, the definition of which (51.4t) did not change over the study period. This resulted in a constant permissible payload of 35 t.

Another important factor is weather, particularly variables such as cloud cover, temperature and precipitation. Their effect on payload weight was determined by regression analyses using weather data as independent variables. Climatic data were extracted from the official weather bulletin of the Swedish Meteorological and Hydrological Institute (SMHI) [23]. Monthly averages for wind and daily and monthly averages for temperature and precipitation were available from

two weather stations situated within the timber supply area where the operators studied worked. Detailed data concerning wind and cloud coverage were obtained from SMHI's main office in Norrköping. Figures 1-3 show prevailing weather patterns in the study area during the study period. Seasonal climatic changes were normal for the area and followed similar patterns for all four years.

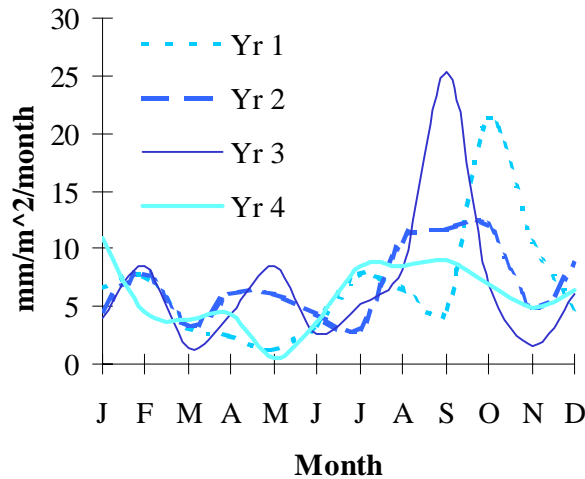


Figure 1. Average monthly precipitation for the studied 49-month period ( $\text{mm}/\text{m}^2$ , month).

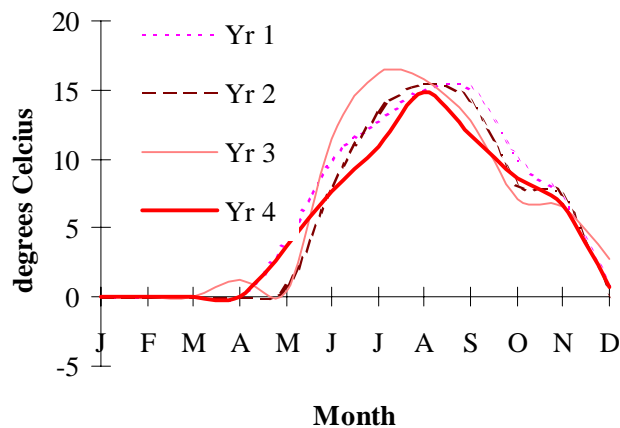


Figure 2. Distribution of monthly average temperatures above  $0\text{ }^{\circ}\text{C}$  for the studied 49-month period ( $^{\circ}\text{C}/\text{month}$ ).

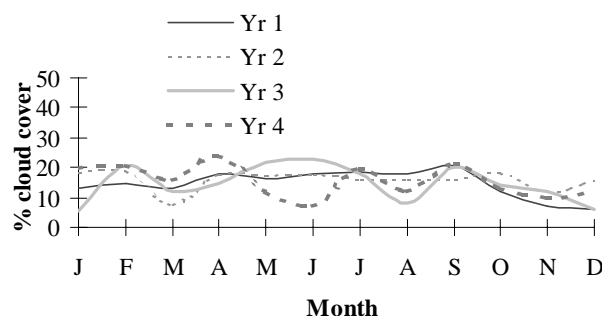


Figure 3. Average monthly cloud cover for the studied 49-month period (percent coverage/month).

## Analyses

Data were explored using analysis of variance (ANOVA) and linear regression techniques. The dynamic effects presupposed by the hypothesis that productivity is a resultant of technology, human skills, work object properties and working conditions imply that auto-correlation is likely to occur. Therefore, to explain the highest proportion of overall variance, time series analysis using ARIMA software [21] was employed.

## RESULTS

### Time trend analysis of payload weight

A steady payload increase was observed through almost the whole period of investigation (Fig. 4). A simple linear model (Equation 3) accounted for 33 per cent of the variation in the data, with time (i.e. the variable *Month*) as a statistically significant ( $p < 0.001$ ) independent variable.

$$\text{MPLW} = a + b \cdot \text{MONTH} \quad (3)$$

Where:

MPLW = monthly mean payload (tonnes)

a and b = constants determined by regression

MONTH = number of months since the drivers started hauling tree sections

### Analysis of correlation between mean payload weight and climatic factors

Most of the variation in the data remained unexplained by Equation 3, (Fig. 4). Climatic data were tested to control this variation. The available data on temperature and precipitation during hauling did not significantly improve the regression models, but testing the influence of climatic data for the month before hauling proved more successful. In the model tested (see Table 1), a strong correlation ( $p < 0.001$ ) was found between monthly mean payload weight (MPLW), mean precipitation (AVPRC) and positive temperatures (PLUST) for the month preceding transport. Data on cloud coverage were transformed into a 'cloudiness' variable (SKY in Table 1). Figure 5 presents a graphical view of the estimate and the residual variation. As shown, payload weight is strongly correlated to climatic data. Regressions including these variables ( $p < 0.001$ ) explained 73 per cent of the variation.

### Payload, tonnes

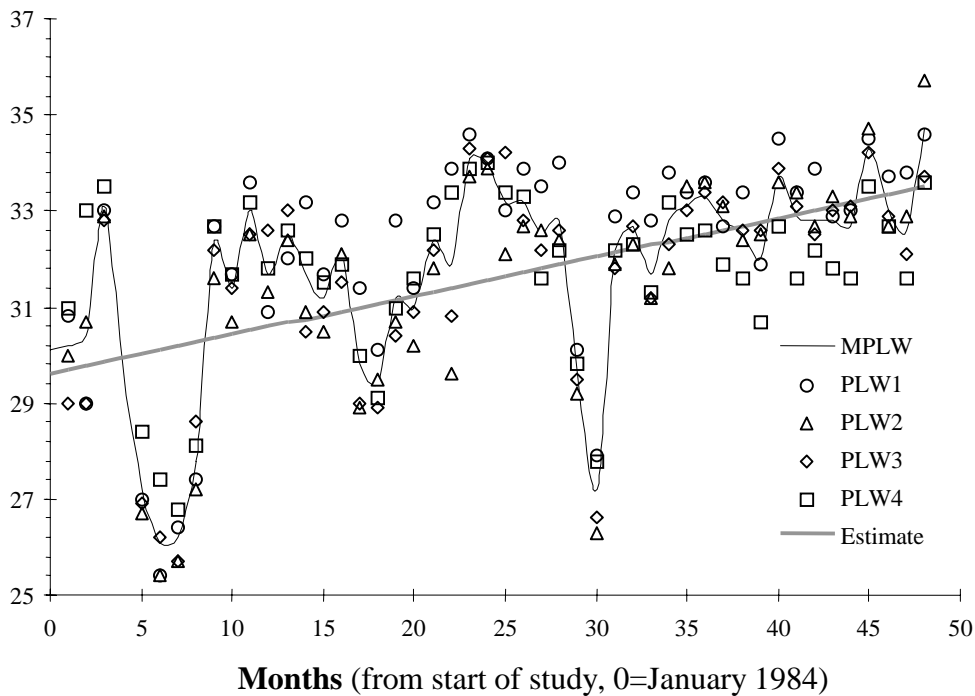


Figure 4. Payload development as a function of time for the trucks studied. PLW1-4 denote monthly mean payload per truck, MPLW is the total mean payload weight for all four trucks.

Table 1. The exploratory linear regression model used to determine the influence of climatic conditions and trends correlated with time on payload weight

$$\text{Model: } MPLW = a + b_1 \text{ 'LOGM} + b_2 \text{ 'AVPRC} + b_3 \text{ 'LRNT} + b_4 \text{ 'SKY, } R^2 = 0,81$$

Variable	Variable definition	Coefficient (b) <sub>n</sub>	Std. error	t-value	significance
<i>MPLW</i>	Dependent variable; monthly mean payload weight in tonnes				
<i>a</i>	Constant	30.750	0.635	48.46	***
<i>LOGM</i>	Logarithm of current month no (1-49)	2.130	0.350	6.09	***
<i>AVPRC</i>	Monthly mean precipitation in mm for the two included weather stations	0.013	0.003	4.16	***
<i>LRNT</i>	Previous months mean temperature, > 0°C, divided by square root of current month number	-0.876	0.088	-9.964	***
<i>SKY</i>	1 ' sunny days - 1 ' cloudy days + 0.5 ' partly cloudy days for previous month	-0.097	0.027	-3.59	***

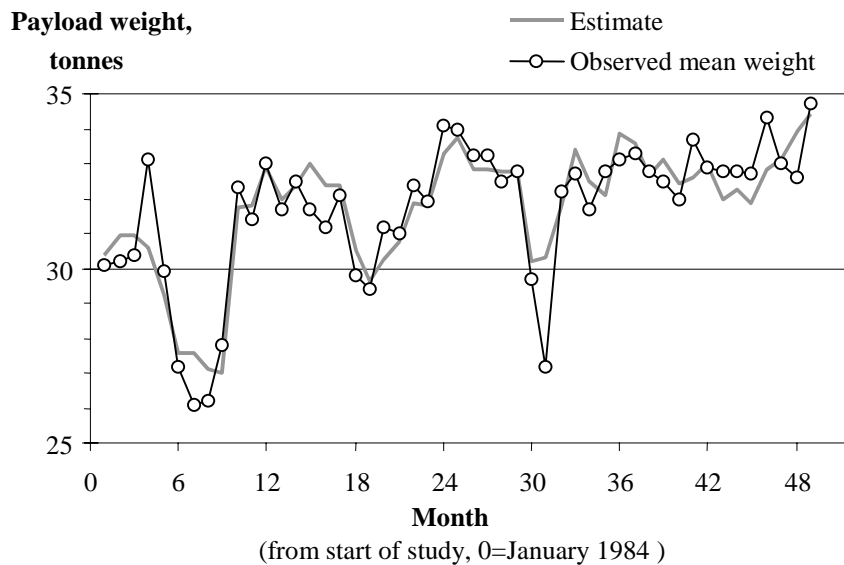


Figure 5. Payload development, observed mean payload weights and estimate according to the model presented in Table 1 for the four trucks studied .

### Analysis of payload trends

A decreasing variation of payloads over time would support the hypothesis that increased operator skill led to higher precision in attaining desired payload. An analysis of standard deviation (ANOVA) indeed showed declining variation. The decrease was estimated at 0,4 % per month, totalling almost 20 per cent over the whole studied period. This decrease was, however, not statistically significant ( $p=0.282$ ).

Two other trends in the payload data time series are not explained by available climatic data but showed correlation to 'time' (= numeral order of MONTH). Time series analysis was applied, where time is treated not as a variable but as a seasoning factor, used as a symbol of the parameters that changed with time (tentatively human skills). The two trends were:

1. a non-seasonal linear increase of payloads with time ( $p<0.001$ ).

This increment was modelled by converting MONTH to a logarithmic parameter, LOGM, defined in Table 1 [10].

2. a decreasing amplitude, with time, of seasonal variation ( $p<0.001$ ).

The residuals of the analyses described in the previous section pointed at auto-correlation ( $\text{corr} = 0.65$ ). The effect of high temperatures was underestimated in the beginning of the studied period and overestimated towards the end. The decreasing amplitude of the principally sinusoidal seasonal vari-

ation was captured through nesting PLUST (mean positive  $> 0^{\circ}\text{C}$  of previous month) with the inverse square root of 'time'. The LRNT-variable (Table 1) depicts this phenomenon.

The final model ( $R^2 = 0.81$ ) is presented in Table 1. The two trends are hypothetically attributed to increased operator skill. To quantify this, a model consisting only of climate variables, was constructed. The constants of this model are based on data from only the first year, when experience was limited. The aim is to simulate 'expected payload' without the presence of time-dependent variables. An estimate with this new model was then subtracted from the estimate of the model described in Table 1 and the residual was used to create the graphs in Figure 6.

### DISCUSSION

The correlation of monthly mean payload to climatic conditions of the month prior to hauling was strong in this study. This is in concordance with previous work by Kokkola [9]. In tree section handling, climate and weather constitute important conditions of work, strongly influencing payload weight. Weather conditions during storage at roadside directly impact on the density of woody materials [9], [16], [22], resulting in dry material with a low density or wet or snowy material with a higher density. The best explanatory climatic factor proved to be the temperature of the period before hauling, but precipitation may be equally or more important.

The data found in the weather bulletin are only valid for the

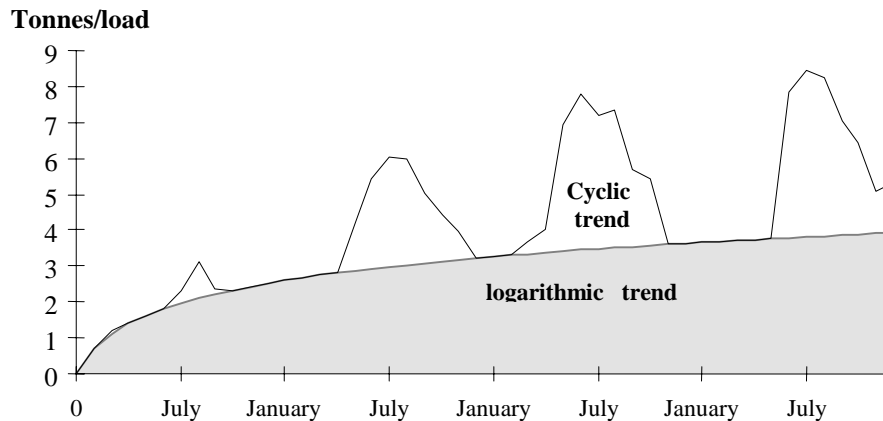


Figure 6. The effects of observed cyclic and logarithmic trends on monthly mean payload according to the model presented in Table 1. The area above the logarithmic line represents the variation not explained by weather.

two weather stations within the supply area. The temperature varies less over the area than precipitation, which is more stochastic and unevenly distributed due to variations in altitude and degree of forestation [1]. It follows that temperature data for the two weather stations are likely to be fair indicators of the conditions at a landing within the supply area, while precipitation data can be expected to be less precise. The influence of climatic factors may thus be underestimated in the present study. With high-resolution data on storage times and weather conditions at the actual landings, it is probable that a more valid model could have been constructed.

A possible influence of a systematic ‘drift’ of seasonal weather conditions during the study period was ruled out. There was no such development, but there are other possible explanations. Tree section piles may have been built higher towards the end of the period, leading to increased compaction, or storage times may have decreased, leading to less drying during summer. Drivers may have systematically intensified hauling during rainy spells, or a gradual increase of logging tract size may have reduced the number of ‘sweep’ loads. Also, average tree size or piece lengths of tree sections may have changed systematically. Interviews with drivers and forest officers stated that no such external changes had occurred. Even so, in the absence of hard, objective data, one must be open to the possibility of such changes.

Productivity of hauling may be expressed as transported goods per time unit. While the average hauling distance was reported to be unchanged, the terminal times (loading and unloading) decreased slightly during the period. Given that productivity is the quotient of payload and time respectively, not only payload but also productivity improved over the study period

Measures of productivity development will, normally, include the effects of new or modified technology. This study was, however, performed on a production system that was stable with respect to technology and methods during the period of observation. The increase of productivity documented in this study must be attributed to other factors.

In spite of the many possible explanations listed above for the steady increase in payload weights, a likely hypothesis is that increasing operator skill accounts for most of the observed increase in payloads. If this holds true, it is of interest to discuss the details of the improved performance. Although all drivers had several years of experience hauling roundwood prior to the study, both Training and Experience (c.f. Equation 2) will increase during the course of the study. The logarithmic trend illustrated in Fig. 6, may hypothetically be seen as an increased ‘mechanical’ ability to load tree sections efficiently. Further, the operators demonstrate a decreasing sensitivity of payload mass to climatic factors. The cyclic trend evident in Fig. 6 may be interpreted as an effect of increased experience with the task. Seemingly, the drivers have learned to adapt over the study period so that when tree sections are dry and light, they compensate by loading more.

For most forest fuel assortments, the most promising area to optimise production is to minimise hauling cost [3]. The great number of technically oriented R&D projects carried in forest biomass harvesting and transportation in the 1980 to 1990 period implies that the initial problem with low payloads was thought to be primarily due to inadequate technology. This study indicates that it may also have been caused by the inexperience of the truck drivers with the new and more complex work material that full tree sections comprise.

Although the change from roundwood hauling to loading full tree sections may seem like a small step for a trained log truck operator, the operators continued to improve their performance over the four year study period. This implies that the effect of practise and experience may be more extended in time than is normally supposed when conducting work and time studies [14]. Other authors have observed similar phenomena. For example, Samset [19] briefly describes how a harvester showed a strong increase in productivity for the first 1,5 years of operation and a slow but steady increase during the following four years. This study adds to such observations. The importance of purposeful work to shorten the period until maximum performance is reached may thus overlooked although its rationalisation potential can be just as important as technical R&D. We need to find out more about how the operators acquire the increased skill. The existence of long learning periods also indicates that it might also be advantageous to assess what organisational and personal factors to lead to reduced operator turnover.

Continued development of theories concerning operator productivity development is valuable. Obviously, long observation periods are needed to follow productivity development in a 'new' method or operation. Such lengthy studies are not often performed [18]. If production statistics primarily gathered for other purposes than work-study could be put at the disposal of operational researchers, this desired development could be started. The problems connected with the quality and reliability of such data may be solved in collaboration between researchers and the practitioners of forest operations. Thus, if production statistics can be used as a cheap and reliable data source, the need for long observation periods and large data sets may be fulfilled. The recent developments in the areas of information technology, data processing and telecommunication make it possible to accomplish this at little extra cost.

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## REFERENCES

- [1] Ager, B., 1964. Studier över klimatet i Norrland, Dalarna och Värmland. [Studies of the climate in North and Central Sweden.] Studia Forestalia Sueciae 19.
- [2] Ankarling, O., M. Bergman. and C. Ranvald. 1991. Produktivitetens utvecklingen i vidaretransport av träddeklar. [The development of productivity in tree section hauling]. Students report. Available at Swed. Univ. Agric. Sci., Dept. For. Manage. and Products, Ultuna, Sweden.
- [3] Björheden, R. and J. Axelsson. 1991. Truck Systems for Transportation of Small Trees and Forest Residues. Proc. of the IEA/BA Workshop in Oregon/California, 1991.
- [4] Boyd, J. H. and W.P. Novak. 1977. A method of comparing logging system and machine concepts. For. Eng. Res. Inst. Can., Special Report No. 2.
- [5] Dahlin, B. 1989. Cradle type multi-stem delimeter. Swed. Univ. Agric. Sci., Dept. Oper. Eff., Garpenberg. Results 162.
- [6] Gellerstedt, S. 1993. Arbete och hälsa vid skogsarbete - En multivariat studie av huggare och maskinförare. [Work and health in forest work - A multivariate study of cutters and machine operators]. Doct. thesis, Chalmers Univ. of Technology, Gothenburg, Sweden.
- [7] Harstela, P. 1975. Työajan menekiin ja työntekijän kuormittumiseen vaikuttavat tekijät eräissä metsätyömenetelissä. [Factors affecting the consumption of working time and the strain on the worker in some forest work methods]. Comm. Inst. Forestalia Fenniae 87(2).
- [8] Jonsson, Y. 1986. Great potential for tree section logging when demand for energy wood increases. Swed. Logging Res Inst. Report 1986 (2).
- [9] Kokkola, J. 1993. Drying of pulpwood in northern Finland. *Silva Fenn.* 27 (4): 283-293.
- [10] McCleary, R. and R.A. Hay. 1980. Applied time series analysis for the social sciences. Sage Publications, Beverly Hills, USA.
- [11] Makkonen, O. 1954. Metsätöiden vertailevan aikatatkimuksen periaate. [The principle of comparative time studies in forest work.] *Acta Forestalia Fenn.* 61:14.
- [12] Mattsson-Mårn, L. 1945. Skogsarbets-studier i Sverige [Forest work study in Sweden], *Metsäteho Publ* 1, 1946, (SDA III:19).
- [13] Moser, U. and B. Strehlke. 1996. Professions, Skills and Training in Forestry. Joint FAO/ECE/ILO Committee on Forest Technology, Management and Training. Report, Bern, Switzerland. 1996.
- [14] Parker, R., P. Kirk and M. Sullman. 1996. Learning curves of mechanised harvester and forwarder operators. *N. Z. Logging Ind. Res. Org.*, Report Vol. 21 (29).



- [15] Project whole tree utilisation. 1977. Final summary report. Swed. Royal Coll. For.
- [16] Rixon, A. 1983. Studier över betydelsen av snö för vikten av trädelsvältor. [The influence of snow on the weight of tree section stacks]. Swed. Un. Agr. Sci., Dept. For. Prod., Reports 121. Uppsala, Sweden.
- [17] Samset, I. 1990. Some observations on time and performance studies in forestry. Comm. of the Norwegian For. Res. Inst., 43(5).
- [18] Samset, I. 1992. Forest operations as a scientific discipline. Comm. of the Norwegian For. Res. Inst., 44(12).
- [19] Samset, I., 1995. 150 år i Forsøksskogen. [150 years in the experimental forest]. Norw. Inst. For. Res., Report 9/95. Ås, Norway.
- [20] Steinlin, H. J., 1955. Zur Methodik von Feldversuchen im Hauungsbetrieb [On the methodology of performance studies in logging]. Mitt. Schweiz. Anst. Forstl. Versuchsw. 31(2):249-320.
- [21] U. S. Census Bureau. 2000, Seasonal adjustment papers. <http://www.census.gov/srd/www/sapaper.html>.
- [22] Wadsö, L., 1993. Studies of water vapor transport and sorption in wood. Doct. thesis. Report LUTVDG/(TVBM-1013)/1-102/(1993). Lund Techn. Univ., Sweden.
- [23] *Väder och Vatten*. [Weather and Water]. Swed. Meteorol. and Hydrol. Inst., Norrköping, Sweden 1984-1987 (48 monthly issues).

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