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Science of Forest Labour, its Objects, Methods, Application in Sweden and Present Position at the Royal School of Forestry

Skoglig arbetslära, dess föremål, metoder, tillämpning i Sverige och nuvarande ställning vid skogshögskolan

Av

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Science of Forest Labour, its Objects, Methods, Application in Sweden and Present Position at the Royal School of Forestry

by

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1. *The present status and role of the Swedish science of forest labour.*

In recent years a considerable interest has been shown in the science of forest labour in Sweden. The Royal School of Forestry has entered it as a special subject into its curriculum. Recently, two professorships in this subject have been established at the Forest Research Institute of Sweden. One of them is financed by state means and another by private means on an initiative of the North Sweden Forest Employers' Association. The latter is assuming the main responsibility for teaching at the Royal School of Forestry. This is most likely the only educational professorship in this subject in Europe. Besides this, private forest industry companies have established three job study institutions, viz. SDA (Föreningen Skogsarbetens och Kungl. Domänstyrelsens Arbetsstudieavdelning — The Job Study Department of the North Sweden Forest Employers' Association and the Swedish Forest Service), VSA (Föreningen Värmlands Skogsarbetsstudier — The Society for Värmland's Forest Work Studies) and MSA (Mellan- och Sydsvenska Skogsbrukets Arbetsstudier — Central and Southern Swedens's Association for Job Studies in Forestry). The SDA and VSA have been working for more than 15 years, while the MSA is of a younger date. Their staff comprises some 60 persons and their annual turnover amounts to about 1.3 mill. kronor. It is obvious that this is a field worthy of further consideration and a field, that will yield important results which, in fact, it already has done.

The importance of the labour science to forestry may be illustrated by an estimate of the labour requirements in forestry. The National Forest Survey in 1925—29

showed that the total increment of exploitable tree species was then 54 mill. cu. m. (solid measure) over bark. According to NÄSLUND (1947) this increment has since then risen. If the bark comprises 15 %, the above increment corresponds to 46 mill. cu. m. (solid measure) under bark. If this quantity is felled and transported by horse, about 21 mill. days' work or a total cost of 500 mill. kronor will be required annually.

According to WAHLUND (1946) the labour supply in forestry will decrease by ½ % per year during the nearest 20-year-period. This decrease must be compensated by a higher efficiency, which is one of the goals we wish to achieve by furthering the development of the labour science and making use of its findings.

With this background in mind it seems justified to try to determine, what the labour science is, what it deals with, which methods it is using, how its findings are best utilized, and how it is taught at the Royal-School of Forestry. The presentation of this subject at this school will be of conclusive importance to the further development of the labour science. This is the place where the future experts and scientists are to be trained, and where impulses to future achievements are to be given.

2. *Forest technology*

The easiest way to understand the concept of the labour science is to observe the fact, that some parts of the older subject, forest technology, have been replaced by this new science at the Royal School of Forestry. The forest technology was a great conglomerate of different subjects. In its earlier shape it comprised both ditching and house construction as well as felling and wood technology. It was a mixture of subjects, which only a polyhistor could master. By and by some parts were detached as special subjects.

These special subjects are now as follows:

safety service	draining of forest land
house construction	estimation of drainage expences and
administration	water supply
current problems of administration	road construction
forest fire protection	wood chemistry

All the special subjects combined represent as many as 130 hours of lectures and 30 days of field work.

The remaining, more central parts of the forest technology have been subdivided into wood technology and science of forest labour — the former, since 1948, with one professorship at the Royal School of Forestry, the latter, since 1949, with two professorship at the Forest Research Institute of Sweden. This paper will deal with the science of forest labour.

3. *The definition of the science of forest labour*

The term. »science of forest labour» appears first in connection with the organization of the above mentioned two professorships at the Forest Research Institut and the Royal School of Forestry. The concept as such has successively been fixed by several authors, each using different names for the branch. FLODMAN (1942) speaks of »skogsarbetslära», WESSLÉN (1943, s. 11) states a »skogsbrukets arbetslära». The difference between the two names can not be rendered in foreign language. Now the science of forest labour is named »skoglig arbetslära». It designates the group of subjects, represented by the two professorships. The science of forest labour deals with all work in the forests with regard to production and harvest of the raw material wood. It covers primarily what the labour science does in the manufacturing industry (f. i. SÄLLFORS 1949 s. 16). The science of forest labour dates back to HILF in 1927 (1941).

Regarding the labour science as a knowledge of work we have to keep in mind, that other sciences deal with this work although from different angles. A closer definition of what we mean by »work» is therefore necessary. The first field we come in contact with the concept »work» is physics. From the physical point of view the work is the energy, required to move an object. We are dealing here with a subject, that from the point of view of labour science may be regarded as an auxiliary science. The labour science is to a great extent making use of the physical and mechanical doctrines, f. i. when studying tools, their structure and maintenance or questions of tensile force.

Another field where we come in contact with the work is economics. Primarily this seems to be more or less outside the labour science, but cannot be so for there are many connecting links between these two sciences. It might be justified to illustrate this a little more.

From the viewpoint of economics the labour is one of the two original productive factors — the actively working. The second of these original factors consists of the natural resources, land, and represents the passively working factor in production. Human ingenuity, combined with the two primary factors, has yielded a third, a produced factor, the capital goods — the produced means of production, equipment and tools. Human labour, combined with these capital goods and used on the natural resources, has finally given the great productivity in our modern community. In this development, the inventive genius of anticipating men may have left the greatest part of the requisite increase of capital. Under the concept capital we then collect the capitalized value of all the future income, human beings may expect (FISHER 1930, s. 12—13). Another source of increasing capital is the more quiet saving. — One of man's most inherent ambitions is to achieve the best relationship between the sacrifice needed and the result obtained. The whole community system is usually described in economics on this basis, the law of the least means.

The labour science, like economics, carries out research upon the labour concepts in their direct as well as indirect form, the former referring to the manual

work, the latter to the capital goods. It describes, measures and checks critically the different forms of work. Being a science it tries in the first place to obtain pure knowledge of the work. Its experiences are used in applied form to improve working conditions and techniques. Economics deals with the labour and its share in the result of the productive process, the wage. Only the theoretical economy can explain, how the wage level is established and varies.

The application of the experiences and results of the labour science can affect the wage only within the limits of the general economic laws. The easiest way to obtain a survey of these relationships is to distinguish between two natural functions of a modern community, viz. consumption and production, both of them fastened in the frame of a pricing net on the basis of equilibrium (WALRAS, CASSEL).

According to subjective judgements the consumption is distributed among the consumable services and so forms the demand side in the pricing equation. On the production side this demand is spread, according to optimum calculations, among the productive factors. They are mobilized against human sacrifices. The enterpriser is the most essential factor on the production side. The labour science gives him most of the technical data, required to reach an optimal construction of his enterprise.

Every price, quantity or other detail, in general, every point in this equilibrium system is tied up to any similar point by connecting threads, wich keep each detail of the equilibrium system informed and affected of any change, wether great or small, in any single another point or thread. These threads — CASSEL's technical constants (1918, s. 115) — might often represent purely psychological relationships, which may be dealt with only by using common modes of expression or mathematical symbols. In some cases, however, they might undoubtedly be subjected to a detailed analysis. The need of reaching the final goal in such an analysis is often not so urgent to a pure economic theorist. The applied theory, an establisher of an enterprise or its manager, who might base his further measures on the results of the analysis, cannot go round them.

According to a closer examination the lines of relationship above discussed, seem to be of varying nature. Disregarding the afore-mentioned psychological details it is rather advantageous to classify these relationships into some apprehensible categories. Mathematical functions are f.i. those functions, which join the yield to its value. After explaining these lines of relationship we arrive at the problem of measuring the capital value. Technical relationships or technical constants in a more restricted sense refer to the relationships in absolute figures between the investment and the product. The enterpriser must have these data f. i. in the form of empirical tables and use them as a basis for his business management. In the great entanglement of such technical relationships there is to be found a special category that has been very difficult to approach, viz. the category dealing with human labour and its varying performance under varying conditions. One of the most important tasks of labour science is to elucidate these details.

The labour science must try to have the labour supply made clear. This leads us to demographic problems. It must also consider the fact, that human beings are the source of labour and members of society. Here we are dealing with physiological, psychological and sociological problems of great importance.

From the demographic point of view the labour science elucidates the labour' supply. Especially in recent years with their quick changes in the labour market, this side of the labour science, in the form of prognostication, has been of great importance and has aroused much interest (SVENNILSSON 1946, WAHLUND 1946, WALLANDER 1948, etc.).

From the physiological point of view the labour science analyses the terms of human performance and how labour affects man. Problem concerning the most suitable working time, fatigue, physiologically correct working position, etc, belong to this category (AFU 1948).

From the psychological point of view the labour science deals with problems, relating to the workmens individual personality structure, the personal mode of adjustment etc. (jfr. MILLER and FORM 1951, s. 17, HAMMAR and AHLBERG, 1950).

From the sociological point of view the labour science studies work groups and work relations, the role the worker plays in workgroups and the social organisation of the work plant society (MILLER and FORM 1951, s. 16, BOALT and WESTERLUND, 1953). It deals with problems about scientifique research in the human relations in the workgroup, the problems of mans adjustment to and interest in work, the problems of leadership etc. From the results, gained by this science, the very great question about management, how it generally is theoretically thought and practically applied, and how it ideally must be built with reference, not only to economic facts, but even to psychological and also to sociological views (WALPOLE 1950/1944, WAALER, 1946).

When defining the scope of the labour science we have to keep in mind what just is stated. It will accordingly become a science of the productive factor labour in all respects, that concern this factor, with the exception of the purely theoretical rules, determing the absolute wage level. The labour science may be regarded as an applied productivity doctrine of economics

When the new term, science of forest labour, was introduced in swedish literature, it was made clear that one of the most essential branches of the old forest technology, describing the actual methods, had been made independent. Simultaneously the new name pointed out a new trend of the subject, this trend being a result of the extended possibilities of the research. This may be called longterm-planning. It is a conscious attempt to improve the working conditions. The labour science is searching for the best tools for these improvements. The most profound task of the labour science, in this case, is to find and disseminate the methods which in the quickest way further improvements. One of the main points in this approach is the use of a critical and constructive analysis. The method of carrying out this analysis must be developed and stabilized, i.e. an improvement technique as such must be developed.

However, it must be pointed out, that this trend towards conscious methods improvement existed already in the old, swedish forest technology. When, f. i. LUNDBERG (1912) tried to discuss wage lists for felling on purely theoretical basis, he was using the same approach as our present research sections, but he did not have the same facilities. When KINNMAN (1920) made his test sawings, he wished to find a background for improvements in cross-cutting. Thus, the effort aiming at improvement technique is nothing new. There has only been a sharper accentuation of the conscious moment in the work.

4. *Characteristics of forestry pertaining to labour science.*

The science of forest labour has the same task and seeks the same goal as the general labour science within other manufactures. Under these conditions we in the forestry branch should of course be able to make use of industrial job study methods. It should be noted, however, that it is often difficult to apply experiences from other fields to forestry. This may easiest be exemplified by the problems of forest economics. It has been very difficult to apply the economic theory to forestry because of the special characteristics of forestry. It has f. i. an entirely different length of production time than most other branches, the result being, that the interest problems in forestry receive a rather different scope and importance. We must be fully convinced of the truth of the economic doctrines, before we can draw the right conclusions in forestry. We must be thouroughly cognisant of the characteristics of forestry before we try to fit the economic doctrines into it.

It is exactly the same thing when we try to approach labour science in forestry. We must know the special features of forestry, pertaining to job study technique, above all, the existing differences between forestry and other branches. By using this reasoning we must conclude, to which extent the methods of other industrial branches may be directly applied to forestry and to which extent new methods must be developed. It is necessary to explain this in a few words.

The forest workers are scattered over large areas and work often alone or in rather small crews. For this reason it is more difficult to carry out studies and investigations and to make arrangements for instruction and training. The forest work is very heavy. Every possibility to ease this burden must be considered. At the same time the work — despite its ostensible simplicity — requires much technique. In this connection, great attention must be placed upon training. Since the manual work is still to a great extent dominating forestry, relief, obtained from machines by studies is not very great. Besides the great variations of the workpiece we must also consider the great individual differences between the forest workmen. Utmost consideration therefore must be given investigation material. The variations of the working conditions increase the need of great investigation material and at the same time the need of exact and efficient mathematic-statistical mehods of analysis. It is no exaggeration to say, that the Swedish development in this field in recent years is

based upon an intensive use of such methods. This development has been especially promoted by the SDA. (MATTSSON MÅRN 1942, 1945 a, 1953 a, ALMQVIST 1945).

These difficulties are counteracted to some extent by a few positive factors. There are few trade secrets and, as a result, the studies may be carried out with the joint effort of several forest owners. The extensive use of piece work payment has also been of importance. This results automatically into so-called comparative studies. This, specifically Swedish and SDA-form of study, has proved to be a good basis for establishing full confidence between the employers and employees in questions, pertaining to job studies. It should be understood that this is just the point where great values are hidden. Comparative studies have been extensively used in the past and they must be well taken care of in the future.

If we try to combine the forestry characteristics of the job study technique we get a picture of a complicated field with great, both local and regional, variations. Because of this the investigation material must be comprehensive, unless it is chosen and analysed most carefully. The need for instruction in this field is urgent but very difficult to realize. A number of forest companies have established job study institutions of their own. It has also been possible to establish good terms between the employers and employees.

5. *Different forms of study. Comparative studies.*

The science of forest labour carries out its work to a great extent in the form of different kinds of job studies. There has in other manufactures always been argument from the employee side against this most essential tool of labour science. To achieve a full success in the work it is necessary, that the job studies be set up so that all the parties agree about the terms. The principal methods of study used in forestry are presented below.

The first studies tried to find a price basis for obtaining equal income from each particular work. They were carried out in the form of comparative studies. They resulted in a series of performance relationships. The detailed final price lists were set up on the basis of these relationships and on the so-called key-piece-work prices, which had been discussed and approved by the both parties at the bargaining table. In contrast to the conventional methods of job study the performance rate was never measured nor expressed in absolute figures. These methods, which were put to use in northern Sweden, by the SDA, proved to hold their ground on questions of both price-fixing and improvements of methods. They were also acknowledged by the representatives of the employees (ANDERSSON 1946, WINROTH 1946). A report on the initiation and development of the Swedish, especially the north-Swedish job studies, was prepared in English (SIMONEN 1948, 1951). Reports are also given at the Congress of the International Union of Forest Research Organisations in Rome in Sept-Oct. 1953 (MATTSSON MÅRN 1953, a-c). Conventional job study cf. LOWRY (1940), MAYNARD (1948). REFA (1936), IVA (1936 and 1949).

The price regulations must be such, that they enable an honest compensation for the amount of work done, when the working method is changed. This principle must be stated and agreed in the agreements between employers and employees. This is the first prerequisit for succesful introduction of methods improvements. The employee must know, that he will under all conditions obtain an equal income, at least generally speaking. This eliminates a great deal of the fear, attached to the change of methods.

The general wage level and the latent performance and income level of the price lists are crystallized as a result of free negotiations between the parties at the bargaining table. The agreements are made separately for each year. A misjudgement may result immediately or in the next few years in a shortage or excess of labourer. As long as no official measures are taken it seems that we have here a free, yet somewhat organized market of the kind, described by the price theory of economics. Any attempt to interfere with this free market has been considered by the forestry organizations unnecessary and is foredoomed to failure. Any interference with this free formation of prices, whether it comes from authorities, one of the two negotiation parties or a job study man, is also declined. Such an essential detail of an economic measure as the work study must follow the economic laws and must not counteract them. Simultaneously, the psychological aspects of the work must be fully considered. It cannot be right to determine such a delicate factor as the absolute performance level by measuring time only.

These comparative studies showed how the ordinary methods were constructed. These experiences were supplemented by using direct studies of methods. Considering the afore-mentioned great need for material it was necessary to plan every detail of the research work most carefully. The time studies are necessary but they should not be used without criticism. We can advance very far by studying job sequences, measuring walking distances, and recording moment sequances by graphical and statistical means. Even when more detailed time studies are made they must be preceded by less complicated statistics.

In regard to felling, considerable quantities of material have been collected. The SDA has in its bulletin no. 37 (SDA, 1949, 1953) published a list of the most essential articles on the Swedish job study technique in the past 15 years (cf. also SIMONEN 1948, 1951). Although the progress in research, made in the field of transportation, has not been as fast as in the field of felling, the results obtained in the last few years are to be appreciated (LEIJONHUFVUD 1949, 1950, LIDSTRÖM 1946, SUNDBERG 1949, 1953, MATTSSON MÅRN, 1946 b).

From the logical point of view the motion studies should be the true foundation of the working methods, as they analyze the object of study more in detail. However, this has not yet been the case in forestry. They have been the last in order. They were introduced for the first time by the »Arbetsfysiologiska Undersökningen» — The Swedish Committee of Industrial Physiology (AFU 1948). It seems as if an intelligent combination of the emulation of athletics and the findings of medicine

were able to do much to reduce the number of back injuries caused by forestry work. This combination should be considered in planning vocational training courses. It seems that a better utilization of the modern measuring technique will open new facilities for the physiological research.

Technical testing. This is a field where much is to be accomplished in the near future. The first step is to make an inventory of tools and equipment within a certain field. Then certain models are to be tested preliminarily. If they possess the necessary strength properties, an attempt is made to use them in forestry. A typical example of such testing is an investigation into loading equipment and barking problems.

General aspects of studies. When making a study we must at all times be in search of the essential points. The moments, representing considerable parts of the working time and labour, are naturally the most tempting points in an improvement experiment. Simultaneously, we have to find the key points in the whole production chain, i. e. the details, the solution of which, to a great extent will affect the whole production chain. The essential points and the key points are not always the same.

One of such key details is loading, another is the question of a right road in its proper place, i. e. how the forest roads and road systems should be planned and constructed from the viewpoint of pure transportation economics. The sound development of mechanized transportation, above all in the northern parts of the country, depends upon a proper solution of these problems. We have to find out, when each of the extremely many existing road types, ranging in cost from 10 öre pr. m. (snow-packed road) to 30 kronor or more pr m and year (thoroughfare), may be regarded as the right one and how a proper road system should look from the view point of economics. How should the horse and the motor car meet each other, the manual skidder replace the horse? To what extent the timber be transported by sledge or by lorry? (DANELL 1936, MATTSSON MÅRN, 1942, SUNDBERG 1953).

This is an example of a very important group of forest studies, called coordination studies, these being studies, which attempt to explain how the different kinds of workers or crew of workers, loggers, manual skidders, skidders and hauliers and the mechanized units should be combined in the most efficient manner.

It is hoped that the above outline has given some idea about the forms of work of the forest labour science. The different forms of study have naturally much in common with such in other fields of activity. On the other hand, it should be kept in mind that these different forms often received another significance and shape when applied to forestry.

6. *Labour science as applied to different fields of forestry.*

The question of whether the science of work is dealing with a special kind of forest work must be answered in this connection. We have many different fields of

work in forestry. We have the heaviest details from the energy point of view, viz. felling, horse-drawn transportation and mechanized transportation. We have spent much time in analysing these operations. Furthermore, we are dealing with reforestation, forest valuation and a number of other subjects. How is it with the work, done in this connection? Should it be included in the field of the labour science or that of individual subjects?

We are dealing here with problems, which may be judged in different ways. First we must remember the present concept of the labour science: scientific research upon the forest work with the object of giving thorough knowledge. Then, we must remember that the optimum way of prosecuting labour science involves first an unbiassed investigation into the work itself and the method of doing it, and then on this basis improvement of working methods. With these two aspects in mind there is no reason to limit the scope of labour science. It is evident, that the need of job studies and improvements might exist in any field of forestry, where work is being done. The results through research, a certain field has yielded, could possibly be applied to allied fields. In other words, the experiences from job studies may be applied to felling and hauling as well as to reforestation and mere office work, although the science of forest labour is mainly concentrated on felling and hauling, these latter being those fields which require new forms of work most urgently. — As a summary it may be stated, that labour science is the branch, to which allied sciences must apply for help with the solving of their problems.

7. *Institutions dealing with labour science.*

The institutions, working in the field of labour science are as follows:

The Royal School of Forestry: free research, training of practical and scientists, teaching.

The Forest Research Institute of Sweden: research with a definite aim, even of fundamental nature, intended to solve definite problems.

The central job study institutions: service organizations, receiving impulses from the practical field in their continuous contact with this; main tasks: dissemination of investigation results to member companies and fundamental research only, when such is necessary, in order to fill out actual gaps in our knowledge.

Others, viz. forest companies and the Swedish forest Service: research conducted in co-operation or parallel with the job study institutions.

Depending upon the research body the problems of labour science must, of course, be approached from somewhat different angles. Some comments are therefore made on the institutions above mentioned.

When teaching the labour science at the Royal School of Forestry, the practical aspects of the subject must be emphasized. The instruction must give a thorough and true description of the work. It concentrates mainly on felling, hauling

and floating, such as it is carried out in practical life under varying local conditions in all parts of Sweden. Thus the instruction should aim at giving the students a true picture of the practical work with all its modifications.

This practical labour science has the same function as the logging section of the earlier forest technology. Its basic features will be presented at the field station of the School of Forestry at Garpenberg, located in central Sweden. An outline of the methods used in other parts of the country will be given on lectures and field trips.

Along with this practical labour science we are also dealing with the theoretical labour science. Its function is to give the students a clear picture of the problems of labour science in its entirety and the methods, used in a scientific analysis of these problems. After completing the graduate course the students are naturally not ready to become scientists in this complicated field. They may, however, take the opportunity to post-graduate courses, which lead to a master's and doctor's degree.

As time progresses the most important and fundamental function of the School will comprise these latter studies. It will be responsible for a free and scientific analysis of the subject and also for furthering the theoretical development of the basic factors of labour science. Thus it may be summarized, that the essential function of the Section of Labour Science at the Royal School of Forestry is free research upon the problems of the science of forest labour.

The training, obtained at the Royal School of Forestry, may be supplemented by practical work at the Forest Research Institute of Sweden, the central job study institutions or in forest companies. As stated above, the students are not as a rule trained to become scientists, but they must have a good insight into the current problems in this field. They must have such a thorough knowledge of the subject, that they will be able to consult the technical litterature without difficulty. Finally, they must be trained so, that they will obtain positively critical attitude to the methods of work which they meet in practical work.

In regard to the Forest Research Institute of Sweden its work is mainly concentrated on research with a definite aim in sight. The job study institutions of course in the first place seek the practical applications of results obtained. The initiative in establishing job study institutions was taken by larger private forest industry companies and the Swedish Forest Service. At this time, there was no basic research made in this field and therefore, these institutions had to spend both time and money on solving problems of fundamental nature. Without this pioneer work our labour science research would now be far below the level where it is. On the other hand, this work has been an extra burden to them but should not be so in the future, because most of this work will be assigned to the newly established research bodies in this field (the Royal School of Forestry and the Forest Research Institute of Sweden).

This is the reason why the job study institutions may now deal more and more with the applied labour science. Their contact with practical life will enable them to cope

with tasks, that are current at every moment. They will also increase the possibilities of the labour science to concentrate its work on problems of the most urgent nature. This near contact with practical life is necessary and most valuable.

Simultaneously, the job study institutions will be enabled to devote more time to publicity and perhaps also to direct experimental work and the Forest Research Institute and the Royal School of Forestry to spend more time on mere research. Thus the latter may be somewhat relieved from the strain of making their results immediately applicable to practical conditions. In their daily work they also need not be concerned so much with the service facilities which without the existence of the afore-mentioned institutions would be inevitable. This will result in more peaceful working conditions and yet there is no obvious risk of losing the contact with the practical life.

One of the most significant features of the recent development has been the research work conducted by several large forest companies. To take an example, the »Bergvik-Ala Nya Aktiebolag» published in 1938—43 a number of purely scientific documents on topics of common interest. Some of these were dealing with tool maintenance, protection of timber against fire and storm, problems of snow blight, problems of forest regulation etc.

This research has made considerable contributions to the solution of current problems, especially in north-Swedish forestry and in the field of labour science. Similar research work has also been conducted by »Svenska Cellulosaaktiebolaget». These researches have been a direct sequal to the classical works, done by »Mo och Domsjö Aktiebolag». It is naturally desirable that such research work may be pursued by the companies as much as possible. This research work should be fully appreciated by the real research bodies. Those working in the field naturally come in closest contact with most urgent problems, and it is undoubtedly a clever policy to give them the opportunity to solve the problems they themselves are pondering on. It is necessary, however, that this research work be conducted by using appropriate methods of approach and consulting scientists available in this field.

The large forest organizations, private or under state management, assume a great responsibility for a question of utmost importance. They can give the scientists chance to see their investigation results be applied to practice. This can only be done by them. They can employ scientists for shorter or longer time, even if this, in some cases, might involve some sacrifice. The value of measures of this kind may not have always been fully appreciated in the past. This has resulted in recruitment difficulties in most of the research fields in forestry.

8. *Results obtained*

LEIJONHUFVUD (1953) states an increase in the performance rates of the forest work The detailed statistics collected by the SDA show an increase of about 2 % per year in the performance figures in the last 15 years. This increase refers to the manual work in felling and horse-drawn transportation. Every such gain carries over into the

future and involves enormous amounts of money. On the other hand, the work is by far not yet completed. To this must be added the increase of production obtained by mechanization — an increase that is hard to estimate but probably amounts to higher figures. There are many comprehensive tasks which must be analysed in the future. Further on, we seek to illustrate some results that have been attained within certain working fields, the whole time keeping in mind those details that limit our knowledge and that need further basic investigation if development is to be continued.

Bargaining between employers and employees in the middle of 30's demanded good price lists. The institutions, SDA and VSA, were organized by the employers for the purpose of conducting necessary time studies (MATTSSON MÅRN 1942, 1945 a and b, 1946; VSA 1943). While these studies were carried through, the SDA, representing most timber pulp and paper companies in northern Sweden, established new methodics of job studies, adapted to forestry conditions. These methodics have carried the job studies through the most difficult situations and have received unreserved support even from the employee's side (ANDERSSON 1946, WINROTH 1946). Here a private Swedish job study institution has accomplished a basic work on methodics that show new ways to labour science even in other types of industrial branches (MATTSSON MÅRN 1948, 1953 a, b and c). The scientific analysis of these problems is being continued at present, f.i. at the Section of Labour Science (abbreviated to SAL) at the Royal School of Forestry.

In connection with these preparatory studies a number of basic investigations dealing with the construction, maintenance and use of the manual tools have been made (V S A 1943, HULTMARK 1947, BLIDBERG and HULTMARK 1945). At least in northern Sweden the tool and equipment standard has reached a rather high level. Here a basic research and dissemination of its findings were accomplished on private initiative (SDA 1939). The use of power saws was also systematically analyzed by the SDA (CARPELAN, ZIMMERMAN 1948). Norwegian researches on the same object are also made (SAMSET, 1950).

Many problems pertaining to the use of tools have already been solved, but not all. What form should f.i. the saw teeth have for sawing of soft- and hardwoods, green or dry timber, in cold or warm weather, etc. Our Swedish contributions are small links in a continuous research that originated in Germany 100 years back. (ARO 1949). A more definite approach to these studies was, however, established in as late a date as 1929 (STREHLKE). Motion studies along the line of GILBRETH (f. i. 1919) and BARNES (f. i. 1938) have been made by the Swedish Committee of Industrial Physiology (AFU 1948). The motion studies were here coupled to deep-loading physiological studies. The results so far obtained have contributed several new viewpoints on the development of the motion scheme for handling tools in forestry.

Here a considerable progress in basic research was made through mutual efforts of private organizations. A further progress in this field is an absolute pre-requisite for f. i. establishing a vocational training system that is based upon knowledge instead of

belief. To enable this the measuring technique should be developed. Certain proposals have already in the short time that the Section of Labour Science, SAL, at the Royal School of Forestry has functioned, been made in this respect. The methodics of cutting by axe can now be examined by using rapid working research methods that enable a detailed calculation of the energy play about the tool, when cutting by axe. Here the free research, pursued by the SAL, seems to be able to fill the gap in our primary methodics in the extremely important borderlands such as motion — tools — physiology — mechanics. The whole field of tools is in urgent need of similar research (ERIKSSON 1953).

The progress in result from transportation researches has not been so fast as in felling. It should be noted that the field of transportation is filled with complicated problems of detailed nature that must be successfully cleared up before the essential features of the problem complex can be brought forth. The preparatory work completed by the job study institutions on their own initiative and finance has yielded considerable results. Some are apparent from below:

In the middle of the 20's the problems of friction and rolling resistance were wholly uninvestigated. Finland and America had only touched on the problems without reaching the core. Then a problem concerning the friction of runner against snow and ice came up for analysis at the SDA. It resulted in an outline of the factors that dictated the extremely low resistance figures in transportation by sledge (ERIKSSON 1949). This research may be regarded as basic research on unexplored ground and its results as indispensable for forestry practice.

In this connection the SDA constructed exact draught indicators and working gauges for comparing the resistance figures of different roads under varying conditions. Experiments with these constructions have stretched out over a period of 20 years. Now we are finally arriving at instruments that promise an exact continuous registration of the rolling resistance even in wheel-driven transportation. These instruments have been able to give us a better understanding of what is encountered with the wheels rolling in different terrains. This is also direct basic research pursued by the private organizations in co-operation with the Royal Institute of Technology and the State Road Research Institute of Sweden. A future task of importance is an even more exact research upon measuring methods.

A considerable part of Sweden is still wholly dependent upon timber transport on snow. Snow is, from a physical standpoint, an extremely complicated substance. Every attempt at examining transportation questions in the winter season gives new and surprising aspects on what actually occurs when the snow is subjected to certain forms of treatment. Some of these problems have been discussed above but many remain unanswered.

Several years ago a special transportation method, viz. transportation on snow-packed roads, was used in some parts of northern Sweden where the climate was more continental than in adjacent areas. In the past 10 years this method has been revived

again. The level of these roads are about 1 m. above the ground surface and carry loads up to 30 to 40 tons pulled by tractors. The cost for these roads is only a few öre per m. It is not any show-off-method that only is used when condition are favorable. It is a completely safe method that works even in cases of difficult thaw. The excellent results obtained so far may be ascribed to individual energy and perseverance. (LEIJONHUFVUD 1950). What dictates here the favourable results? Which are the most important factors: vibration, pressure or freezing, when the snow becomes hard? These are the problems that are encountered and that must be solved. The facilities provided by laboratory work should also be considered. The program of the job study institutions is so preoccupied with urgent tasks of practical nature that it has no time to deal with the afore-mentioned problems of basic research. This field thus remains unexplored unless free research can make its contributions.

If such research is carefully organized it can certainly answer many questions that arise about the proper use of road types. At the beginning, only the crawler-type tractors and roads were dealt with. Present experience shows that the wheel tractors may be provided with full-length tracks or semi-tracks for packing down the road surface (SAMSET, 1952, SDA). In recent years our work has also included the roads for horse-drawn transportation. The results obtained are encouraging.

Lately, the question of damage caused to timber by transportation has gained in importance. It is known that the second growth timber from our forests is more subject to blue stain than virgin timber. According to later investigations (LAGERBERG-LUNDBERG-MELIN 1927, BUTOVITSCH, NENZELL, SPAAK 1939—45) timber defects are to a great extent caused by mismanaged transportation. This damage involving enormous sums of capital could be easily avoided. In the past we took for granted this kind of damage and accepted it. We did not realize that a thorough examination of the causes was possible and often lead to amazing results.

The defects caused by floating are often so extensive that they must be included in the general estimate of floating costs. So far it is very difficult to make such estimates because the job studies concerning floating are still very few (STAÉL v. HOLSTEIN, SUNDBERG, 1953, MATTSSON MÅRN 1953, d). This field should be studied thoroughly and systematically. At present, only Finland has made contributions in solving these problems of floating.

While studying the transportation questions considerable interest was taken in the horse. Nowadays, this source of power is often too quickly replaced by motors. One who has experienced some trade booms and slums finds it difficult to think that the horse has lost its place in forestry transportation. The care of horses has been thoroughly analyzed in the past (SDA, 1940, 1946). Some points of basic research have also been discussed (LIDSTRÖM 1946). Gauges for measuring the normal and maximum pull of the horse have been constructed. Past experiences have also facilitated the price-fixing of the horse-drawn transportation operations. The measuring technique and the physiology of the horse are the fields where basic research is still necessary.

The trend of transportation is towards even more efficient mechanization; consequently, interest must be concentrated on loads and their transportation. In spite of this mechanization trend in Sweden about 50 % of the whole transportation cost, from the stump to the win, originates from the skidding operations at the upper end of the transportation chain. The transport here on rather simple roads and with small loads causes high costs, 40—50 öre per cu. ft. (solid measure) and km., according to the present agreement. The skidding roads are short. Because of that it is easy to forget the importance of building up a proper skidding road system as the first condition for good transportation economy. The entire system must then be planned and calculated, according to the principle: the right road on the right place.

This problem has been discussed many times, not only in Sweden but also in many other countries (DANELL 1939, SILVERSIDES 1949). It was not possible to make full use of the data collected, until better methods of analysis were found by the private job study institutions (MATTSSON MÅRN 1942, SUNDBERG 1953). Now, at least the rough outlines are ready. Now, we can make a general inventory of the transportation conditions existing in bigger areas. The concept of »natural transportation area» appears to become part of the public consciusness, and therefore the problem of roads, constructed according to the principles of transportation economics, may be discussed. There is an enormous number of questions, which must be revised, when we attempt to give the different transportation operations their proper place in forestry. This will naturally require considerable financial outlays. Also in this field the job study institutions have made considerable contributions of fundamental nature.

From the economic point of view the development of the transportation system in northern Sweden is still in its primary stage. Therefore, that territory will receive the greatest benefits from the recent findings of transport research, if these are properly applied. But similar problems exist as well in the southern parts of the country as evidenced during the practical work of the students at the Royal School of Forestry. To a great extent the practical men are interested in questions connected with the inventory of transportation problems and wish to get these examined.

The fact that such calculations now may be carried through, is apt to increase interest in collecting data about operating-statistics. Each estimate concerning the economics of transportation in a larger area must be based upon such data. These data refer primarily to the specific transportation costs, arising from different forms of transportation under winter or summer conditions on permanent or temporary roads, etc. (SUNDBERG, 1953).

The facts presented by SUNDBERG give a more distinct picture of the cost items, which are most needed for estimating costs, collecting statistics and making general transportation schemes. This is an enormous field for further research and dissemination of results. The section of Labour Science at the Royal School of Forestry can accomplish much in this respect. It can facilitate a quick, application of the results to forestry practice; it can arouse interest in research work and contribute to a theore-

tical analysis of the problems. We have here a field, where free research and university training can make considerable contributions to a prompt development of the labour science. There are many possible combinations. The specific costs must be used to illustrate these combinations. These costs originate from a number of operations, ranging from transportation by means of directed felling and manual dragging to large-scale transportation on first-class lorry roads. Each of these methods has its own direct and indirect costs which must be analysed.

Among the extremely complicated problems of transportation the use of different kinds of motor vehicles, including also vehicles of trailer type, gain each year in importance. The latest inflation period and its following shortage of labour have contributed to a very prompt and efficient development of mechanized transportation. Private forest companies and the Swedish Forest Service have to a great extent establishd technical sections with their own personal. These sections are in charge of both the transportation operations and the equipment. Sometimes they only provide service facilities to their own vehicles. The transportation sections of the job study institutions serve at all times as connecting links in research purpose (CEWRIEN 1949, LAAGE-HELLMAN 1950).

Sammanfattning

SKOGLIG ARBETSLÄRA, DESS FÖREMÅL, METODER, TILLÄMPNING I SVERIGE OCH NUVARANDE STÄLLNING VID SKOGSHÖGSKOLAN

Här föreliggande avhandling kommer så småningom att publiceras även i svensk dräkt. Det förefaller under sådana förhållanden onödigt att här göra några mera ingående sammanfattningar. Det torde vara tillräckligt påpeka, att arbetet är en utvidgning av installationsföreläsning vid Skogshögskolan i Stockholm. I denna föreläsning försökte författaren att något exaktare, än vad hittills skett, placera in arbetsläran i dess vetenskapliga ram, att i någon mån belysa den skogliga studiemetodikens särdrag och att ge en kortfattad bild av några hittills vunna resultat. Arbetsläran skildras som en tillämpad produktivitetslära, som kan ge väsentliga delar av de tekniska data, på vilka företagens utformning mot optimal effektivitet måste bygga.

Arbetsläran studerar a r b e t e t i dess direkta, manuella, liksom i dess indirekta, genom realkapitalet — redskap, maskiner — uppträdande form. Studieobjektet är detsamma som i den ekonomiska teorin om arbetet och arbetslönen. Den ekonomiska teorin söker förklara arbetets andel i samhällets produktionsresultat, arbetslönen. Arbetsläran granskar villkoren och möjligheterna för produktion, speciellt i den mån dessa villkor dikteras av arbetskraften. Arbetsläran uppställer regler för, hur dessa villkor skola kunna studeras. Den samlar tekniska data ur gjorda studier och bearbetar dessa studier till erfarenhetssamlingar.

Arbetsläran måste se arbetet ur bl. a. fysikalisk-mekanistisk, fysiologisk, psykologisk och sociologisk synvinkel. Den fysikaliska aspekten tar sikte på kraftspelet kring kroppens lemmar och kring redskapen, den tar sikte på motstånd mot rörelsen, antingen det gäller slag med yxa eller kälkens glidande på snö. Den fysiologiska granskningen försöker svara på frågan, hur arbetet påverkar människans kondition — för ögonblicket och för framtiden. Den försöker belysa näringsproblemen och deras inverkan på välbefinnandet vid olika verksamhet.

Psykologiskt studeras människan individuellt beträffande hennes intresseinriktning och dess mätande. Förmågebedömningen har även här sin plats. Den sociologiska aspekten slutligen tar sikte på människan som medlem av gruppen — den intima gruppen, grupperna i arbetet, i företaget, i samhällslivet. Man försöker beskriva och även, om möjligt, mäta dessa ytterst subtila företeelser. Med ledning av dessa psykologiska och sociologiska erfarenheter söker man till slut utkristallisera mätare för människans anpassning till hennes verksamhet. Med hjälp av funna mätmetoder kan denna anpassnings beroende av skilda förhållanden belysas. På denna väg kommer man de rena arbetsledningsfrågorna på spåret.

Efter denna preliminära granskning av arbetslärans arbetsfält vidröras de speciellt skogliga studieformerna. Skogsbruket arbetar principiellt med jämförande studier. Varje form av direkt prestationsmätning avböjes. Ingen subjektiv bedömning av studerad arbetares prestationsförmåga får förekomma. Matematisk-statistiska bearbetningar av direkta, okorrigerade tidmätningar lämna relationsserier rörande prestationsförhållandena. På grundval av vid avtalsbordet överenskomna ackordspriser för vissa nyckelarbeten och dessa relationsserier utformas prislistor, som sikta på lika inkomstmöjlighet från varje arbete. Arbetarpartens positiva förståelse och godtagande av programmet påpekas.

I fortsättningen diskuteras den olika inriktning arbetslärareforskningen måste få vid de många olika typer av organisationer, som nu existera: S k o g s h ö g s k o l a n: fri forskning,

utbildning av driftspersonal och forskare; Statens skogsforskningsinstitut: målbunden forskning även av grundläggande natur, avsedd att lösa bestämda förelagda problem. De centrala, privata arbetsstudieavdelningarna: servisorgan, förmedling till linjen, forskning, då brister i kunnande ej annars kunna fyllas; De stora skogsföretagen och Domänverket: företagsforskning, hjälp för forskare att vinna tillräcklig vidd kring sitt arbete.

Sista delen av avhandlingen antyder några hittills uppnådda resultat — 2 % planförhöjning i prestationsnivån, utan hänsyn tagen till genomförd motorisering, har uppnåtts. I mycket koncentrerad form belysas de viktigaste huvudmål, som nåtts. Som första och viktigaste förvärv betonas den nyutformade arbetsstudiemetodiken och dess betydelse för samverkan på arbetsplatsen och därmed för resultats vinnande. Verktygsstudierna belysas, speciellt trimningen. Mycket återstår här. Våra sågundersökningar äro exempelvis endast en liten detalj i en hundraårig arbetslinje, främst i Tyskland. Motorsågsstudierna refereras. De arbetsfysiologiska undersökningarnas resultat belysas. På detta senare fält har svensk forskning vunnit nya vackra resultat. Erfarenheterna äro långt ifrån slutligt utnyttjade. Nya mätningsmetoder för mätning av kraftspelet vid snabba redskapsrörelser, exempelvis kring yxhugget erfordras och äro under utformning.

På huggningsområdet har resultat utnyttjats i stor utsträckning. Hela Norrland har avtalsbundits med nya avtalsformer och prissystem. På det betydligt mera invecklade transportområdet har man endast kunnat gå långsammare fram. Allra senaste åren ha emellertid många nyförvärv även gjorts här. Grundforskningen kring glidmotståndet på snö betecknar ett sådant vackert tillskott i vår kunskap. Samlat material börjar man nu att kunna intensivare utnyttja. De översiktliga kalkyler, som erfordras för klargörande av frågan: rätt väg på rätt plats dvs. vägsystemets optimala utformande, börja komma inom räckhåll.

Många mycket förnämligare transportmetoder på vinterföre ha sett dagen. Storlass på spårisad väg var en gång ropet. Nu är det körning på den förvånande billiga och effektiva, snöpackade vägen, vilken småningom utformats mot full driftsäkerhet på lämpliga lokaler.

Till slut beröres det stora arbetsfältet kring motoriseringen. Tekniken kring bandtraktorer för snöpackade vägar, vägarbeten och lunning är långt kommen. Halv- och helband för att göra hjultraktorn användbar vid snöpackning skymta. Storlass på fyrhjulsstyrda släpvagnar, kopplade till lastbil börja bli färdiga för praktisk drift. Lastbilen blir mer och mer universalfordonet. Med ökad motorisering är starkt behov av central motorservice påträngande.

Den mycket starka förändringen i transportgång, som kännetecknar metodutvecklingen, har sina risker. Transportskador framträda mer och mer som verkligt allvarliga förlustkällor. De kunna emellertid, med nuvarande kunskaper i frågan och tillräcklig noggrannhet, bemästras. Framförallt är det flottningen, som i detta fall är starkast utsatt. Flottningens brist på arbetsstudieteknisk forskning belyses.

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Abbreviations used

AFU = Arbetsfysiologiska undersökningen (The Swedish Committee of Industrial Physiology).
FS = Föreningen Skogsarbeten (North Sweden Forest Employers' Association).
IVA = Ingeniörsvetenskapsakademien (The Royal Swedish Academy of Engineering Sciences).
IUI = Industriens Utredningsinstitut (The Swedish Institute for Industrial, Economic and Social Research).
MSA = Mellan- och Sydsvenska skogsbrukets arbetsstudier (Middle and South Sweden Forest Job Studies).
NST = Norrlands Skogsvårdsförbunds Tidskrift (The Journal of the Norrland Forestry Society).
SAL = Skogshögskolans institution för skoglig arbetslära (The Section of Labour Science at the Royal School of Forestry)
SDA = Föreningens Skogsarbetens och Kungl. Domänstyrelsens Arbetsstudieavdelning (The Job Study Department of the Forest Employers' Association and the Swedish Forest Service).
SFI = Statens skogsforskningsinstitut (The Forest Research Institute of Sweden).
SIA = Skogsindustriarbetaren (The Forest Industry Worker)
SST = Svenska Skogsvårdsföreningens Tidskrift The Journal of the Swedish Forestry Association).
VSA = Föreningen Värmlands Skogsarbetsstudier (The Society for Värmland's Forest Work Studies)