Basic Time Concepts For International Comparisons of Time Study Reports

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FOREWORD

At the symposium of IUFRO WP 3.04.02 (Work Study, Payment and Labour Productivity) in Thessaloniki 1988, a group was appointed to prepare a proposal for an international forest work study nomenclature. This paper contains a proposal for basic time concepts to be used for international comparisons of time study reports. The group preparing the proposal had the following composition:

Prof. Reidar Skaar (chairman), Norwegian Forest Research Institute, Ås, Norway
Prof. Sigfried Häberle, University of Göttingen-Weende, Federal Rep. of Germany
Prof. Jeremy Rickards, University of New Brunswick, Fredericton, N.B., Canada
Mr. Karl Apel, Forest Service ofHessen, Weilburg, Federal Rep. of Germany
Mr. Rolf Björheden (working secretary), Sw. Univ. of Agric. Sc., Garpenberg, Sweden

I would like to thank the members for the effort they have made to bring this work to conclusion.

ABSTRACT

In this paper, a proposal for a system of basic time concepts is presented. The lack of uniformity of time concepts was identified by the group preparing this proposal as the single most important obstacle when trying to make international comparisons of time study reports. The aim of the proposal is to set standards for scientific presentations so that international comparisons and analyses of results are simplified. The proposal is **not** aimed at defining a terminology for practical time study, nor does it contain suggestions on what methods to use (or not to use). It simply contains a number of **basic concepts for time measurement of work** that should always serve as a basis for any study claiming international significance.

It is the suggestion of the 'terminology team' that study results should either be published using the terms defined by the proposal or in such a way that a transformation into the proposed concepts is possible.

INTRODUCTION

Work science is that part of science dealing with technical, psycho-social and organizational development of work. Work science utilizes the theories and the knowledge gained by other sciences to the extent they are related to work. One of the most important branches of work science is work study. Both work science and work study are very much oriented towards the application of produced knowledge. It is important to remember that, from a scientific point of view, work science and its subdisciplines should be free of subjective values although the different work study techniques - such as method study and work measurement - almost by definition are employed to "improve" the utilization of human and material resources. Work science performs critical examination of existing and proposed ways of doing work based on objective and unbiased observations and prognoses. The subsequent choices and decisions of "best" alternatives, "just" piece rates etc. are political or managerial issues and has little to do with science as such.

Work measurement may be defined as measurement of the input of human and material resources into production and/or the output of the production process. The measured variables are the consumption of resources and the products of work. For man at work, time consumption, movements and working motions, physical load and psychic load may be measured. For machines and equipment the measurement may involve time consumption, movements and working motions, wear and energy consumption. In addition, the operation (work object, workpiece), the production environment and the quantity and quality of products are described.

Time study is one of the most common practices of work measurement. It is used world wide, in most types of production to determine the input of time in the production process. In forestry, results from time study have been used to set "just" piece rates and, most important, to rationalize production. When

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time study data are used to rationalize production it is usually applied with one or several of the following four goals:

1. Improvement of work organization and planning
2. Control and follow-up of operations
3. Improvement and comparison of working methods, tools and
machinery
4. To create data for performance and cost calculations.

Time is thus regarded as a resource and the measurement of time is used to establish the productivity ratio as **product output/time input** for a given production system. Qualitative differences of studied production systems are often translated as varying costs per time unit. The time cost is commonly based on the "market price" of the studied system, in its turn a resultant of demand and supply interactions of a "free market".

The use of time costs is, in reality, an effort to estimate, in a common measure, the total input of resources per time unit into the production process. It is based on the assumption that the "market price" reflects the objective utility of a certain combination of resources. If this assumption is correct, the combination of time consumption and cost per time unit will be the ultimate measure when comparing alternative production systems. The shortcomings of this measure occurs when we wish to compare data from segregated markets. Because of market dissimilarities, the relative cost of different resources will also differ and direct comparisons will be of little use. Further, the pricing behaviour of the real market deviates from the rather mechanistic models proposed by classical economies. Markets will change with time and the "freedom" of the market is also commonly restricted. Thus, the use of cost per produced unit as a comparative measure is only possible within the same market or, maybe, between similar markets and only for data originating from the same period of time. We may conclude that the only measures that are possible to use when comparing production systems operating in different markets are those that may be objectively measured, such as time and energy input per produce output.

OBJECTIVE

The internationalization of trade, enterprise and research increases the need for international information flows, not least in the forestry sector. In this context, the lack of an international standard for presenting results has become a major obstacle. If a free and meaningful flow of information is to be obtained, it is essential that a set of standardized terms be agreed upon.

An analysis made by the group indicated that the major obstacle when making international comparisons is <u>not</u> terminological or methodological. The confusion was rather a result of the great variety of measures and units used for the presentation of study results. The standardization of operate measures, such as the volume of wood etc. seemed to be a question primarily concerning other sections of IUFRO. Therefore, the group chose, as a first step, to create a simple set of time concepts which could serve as a basis for an internationally agreed way of comparing time study reports. First of all, it was decided in what areas these terms were to be used. Three levels were identified:

<u>Firstly:</u>
The nomenclature should enable international and - maybe also - interdisciplinary comparisons of data and results. This was considered to be the most important demand.

<u>Secondly:</u>
The nomenclature should be adequate for scientific studies on the national level. By this we mean that terms and definitions given by the new nomenclature should be usable when presenting results. It has not been the purpose to present a terminology to be used in practical studies conducted in the respective countries.

<u>Thirdly:</u>
The nomenclature should contain terms and definitions usable in the normal operations of forestry companies, forest owners associations etc.

Further, the set of concepts should be applicable under different external conditions as well as different degrees of technical development; be easy to adapt in practical forest operations; and as coordinated with established standards 'outside' forestry as possible.

A PROPOSAL OF BASIC TIME CONCEPTS

After effecting a compromise of the partially conflicting demands outlined in the previous sections, the terminology group agreed that the proposal of a forest time study nomenclature should be held extremely simple. It should list only some basic time concepts and definitions. The varying need for more detailed definitions that is bound to occur on the operational level and for specific research projects may then be decided by the individual company, research organization or research officer. **The main thing is that all such further developments of the IUFRO-nomenclature must be defined in such a way that it is possible to transform any time concepts used for a specific purpose into the basic terms defined in the IUFRO-nomenclature**. This means that all publications not directly using the proposed terms should contain a guide providing the information needed to make the transformation into the terms of the IUFRO-nomenclature.

The structure of the proposed basic time concepts is shown in figure 1.

Definitions of the Basic Time Concepts

Control time (C t)

Control time denotes the time elapsed between two readings of a clock. Thus it consists of the absolute, calendaric time (all available time of a period, e.g. 24 calendar hours/day) and is used, in the suggested system, as a control time on which utilization and performance measures of systems, machines and components are based, directly or indirectly.

Unutilized time (Un t)

Unutilized time is the part of control time that is not used for the completion of a specified work task.

Utilized time (U t)

Utilized time is the part of control time that a production system or part of a production system is occupied, directly or indirectly to complete a specified work task.

Direct Work time (D W t)

Direct work time is the portion of utilized time that directly adds to the completion of a certain work task.

Main work time (M W t)

Main work time is the part of the Direct work time that changes the work object with regard to its form, position and state within the definition of the work task.

Complementary Work time (C W t)

Complementary work time is the part of the Direct work time that does not change the work object with regard to its form, position or state but is needed to complete the work task.

Unavoidable delay time (U D t)

An inevitable interruption due to the nature of

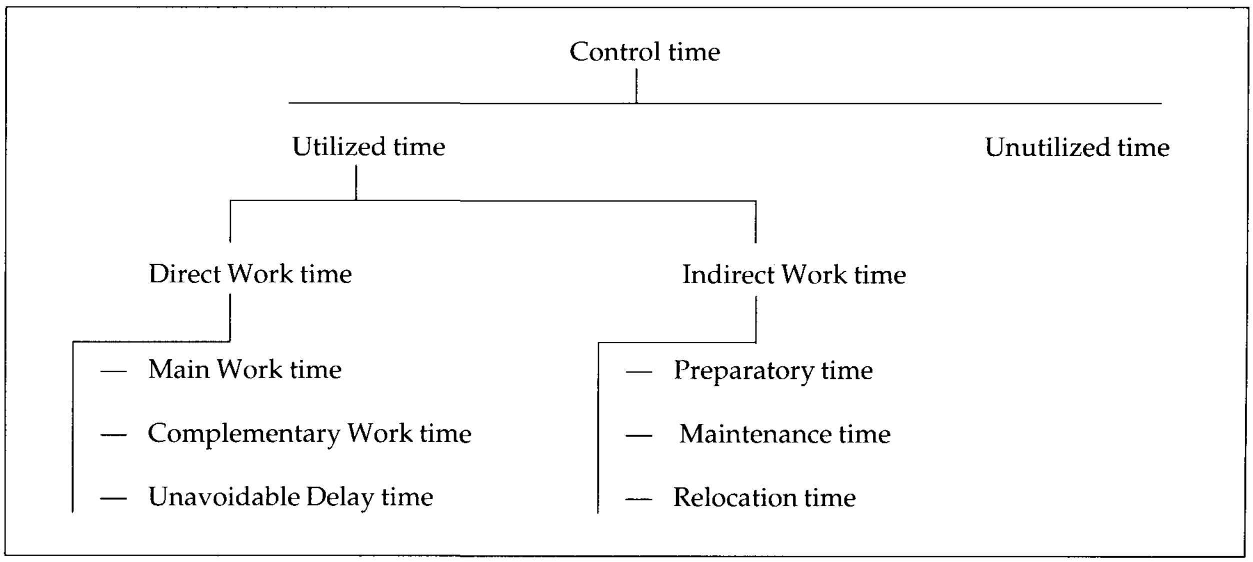

Figure 1. The structure of the basic time concepts.

the work cycle, the design and choice of tools, machinery, organization, etc.

Indirect Work time (I W t)

Indirect work time is the part of utilized time that does not directly add to the completion of the work task, but is performed in order to support it.

Preparatory time (P t)

The time used for the preparation of machines, equipment and the conditions of the work place when beginning and after finishing a work task.

Maintenance time (M t)

The purpose of these interruptions are to maintain the working capacity of men, machines and other parts of the production system. For tools and machines **M t** may be divided into **Repair time (Rep t)** denoting inevitable, non-cyclic interruptions that are needed to repair damaged components and **Service time (S t)**, i.e. principally cyclic interruptions that occur in order to compensate for the successive degradation of tools and machinery employed at work.

Re-location time (R t)

The portion of utilized time that is used in order to transport men, machines, equipment etc. so that the work task may be completed.

Examples of Machine and System Performance Measures

Degree of utilization:
  (U t/C t)*100
Effective time factor:
  (D W t-U D t)/U t
Productive time factor:
  D W t/U t
Preparation time factor:
  P t/D W t
Service factor:
  Service time/D W t
Repair factor:
  Repair time/D W t
Maintenance factor:
  M t/D W t

General Definitions

Work task — a clearly defined and limited amount of work performed in order to change the work object from a clearly defined original state into a fixed end state

Work element - a sub-division of a work task that is defined and given limits

Work cycle - a sequence of work elements repeated for every work object or work piece. A work cycle of higher order may consist of a number of work cycles of lower order

Work object - the physical form that is changed within the definition of the work task. The work object may consist of several work pieces

Work piece - a sub-division of the work object characterized by repetitive or cyclic properties.

AN EXAMPLE OF THE USE OF THE BASIC TIME CONCEPTS

1. Description

1.1 Work object

A 30 year old spruce stand with an annual yield of 11.5 m^3stem volume o.b. The stand has 2000 st/ha with an average diameter of 14 cm and a basal area of 30 m^2/ha.

1.2 Work task

To thin the stand described in 1.1. The basal area should be reduced to 22 m^2/ha by thinning "from below" which means that about 1000 stems (~50 m^3) are to be removed. The strip road width is not to exceed 4 m and the strip road distance should be ~ 25 m.

1.3 Production system

The production system consists of two workers and a pulp chip harvester with a felling head (d_{max} 30 cm) mounted on a 9 m crane, a processing aggregate which limbs banks and chips trees in a continuous process and a bin (16 m^3) for transportation of the produced pulp chips.

1.4 Work organization

Both workers have a working time of 8 hrs a day, excluding a lunch break of one hour. They are working on a job rotation schedule with overlapping shifts where worker A starts at 6:00 in the morning, runs the chip harvester until 9:00 when worker B comes to work and drives the machine until 12:00. During his ground-shift (from 9:00 to 12:00), worker A fells the trees that cannot be reached by the harvester from the strip road. These trees can then be reached and pulled to the processing unit with the crane. From 12:00 to 15:00 when his working day ends worker A operates the machine again. During this period worker B has a similar ground-shift as worker A.

From 15:00 to 18:00 worker B has a final shift of operating the machine.

The workers leave the work place when their shifts are ended. For this specific thinning, worker A has to travel 20 minutes per day and worker B has to travel 40 minutes per day in order to get to and from the working place.

2. Application of the basic time concepts

2.1 Time study

We chose to do a time study along three tracks:

A: The machine is studied
B: The mechanized felling is studied
C: The worker on ground-shift is studied.

The work task must be identified for A, B and C separately in order to apply the basic time concepts, since the choice of appropriate terms mainly depends on this definition.

2.1.1 Work tasks for the studied system components

A: The task of the harvester unit is to select fell and process the trees in and near (< 9m) the strip road as well as pulling in and processing the trees manually felled between strip roads. When the chip bin is full, the harvester transports the chips to the landing and empties the bin into transport containers.

B: The task of the felling head is to fell trees and to hold trees when they are pulled in and fed into the processing unit.

C: The task of the worker on ground shift is to fell trees that cannot be reached by the harvester. Also he takes a lunch break during ground shift.

2.2 Harvester and felling head: application of basic time concepts

Time Activity	Harvester	Felling Head
- None	Un t	Un t
- Worker A driving to work[1]	Un t	Un t
- Moving harvester to stand	Ut, IWt, Rt	Ut, IWt, Rt
- Checking function of felling head	Ut, IWt, Pt	Ut, IWt, Pt
- Checking function of chipper	Ut, IWt, Pt	Ut, DWt, UDt
- Moving into stand	Ut, DWt, CWt	Ut, DWt, UDt
- Crane out	Ut, DWt, MWt	Ut, DWt, UDt
- Positioning	Ut, DWt, MWt	Ut, DWt, MWt
- Felling	Ut, DWt, MWt	Ut, DWt, MWt
- Pulling tree to machine a	Ut, DWt, MWt	Ut, DWt, MWt
- Feeding tree into chipper b	Ut, DWT, MWt	Ut, DWt, MWt
- Controlling start of chipping c	Ut, DWt, MWt	Ut, DWt, UDt
- **Cycle a repeated**		
- Moving machine	Ut, DWt, CWt	Ut, DWt, UDt
- Cycle b repeated		
- Transporting chips to landing	Ut, DWt, MWt	Ut, DWt, UDt
- Unloading	Ut, DWt, MWt	Ut, DWt, UDt
- Cycle c repeated		
(- Worker B driving to work, Un t[1])		
- Changing operators	Ut, DWt, UDt	Ut, DWt, UDt
- Cycle c repeated	Ut, DWt, UDt	Ut, DWt, UDt
- Welding broken delimbing knife	Ut, IWt, Mt (Rept)	Ut, DWt, UDt
- Changing felling saw chain, etc.	Ut, IWt, Mt (St)	Ut, DWt, Mt (St)

[1])Driving to and from work site is regarded as Unutilized time analogous to the corresponding transport of the machine from manufacturer to user.

Worked on ground shift: application of basic time concepts:

Time Activity	Worker A	Worker B
- None	Un t	Un t
- Worker A driving to work	Un t	Un t
- Worker A operating harvester (see ex 1)	Ut, DWt, UDt	Un t
- Worker B driving to work	Ut, DWt, UDt	Un t
- Worker changing operators	Ut, DWt, UDt	Ut, DWt, UDt
- Worker A fuelling power saw (B op. harv.)	Ut, 1Wt, Pt	Ut, DWt, UDt
- Worker A walking into stand (B op. harv.)	Ut, DWt, CWt	Ut, DWT, UDt
- Worker A felling tree	Ut, DWt, MWt	Ut, DWt, UDt
- Worker A moving to next tree a	Ut, DWt, CWt	Ut, DWt, UDt
- **Cycle a repeated** b		
- Worker A fuelling power saw	Ut, IWt, Mt (St)	Ut, DWt, UDt
- Cycle b repeated		
- Worker A taking lunch break[1]	Un t	
- Worker changing operator on harvester	Ut, DWt, UDt	Ut, DWt, UDt
- Worker B walking into stand, etc.	Ut, DWt, UDt	Ut, DWt, CWt

[1])The lunch break is not considered to be Maintenance time since the operator may use this time freely for any activity. As it has no direct connection with the work it should be regarded as Unutilized time.

REFERENCES

[1] Anonymous, 1959. The standardization of symbols in forest mensuration, IUFRO, 32p.

[2] Anonymous, 1964. Allgemeine Anweisung für Arbeitsstudien bei der Waldarbeit, Mitteilungen des KWF, Band III, 42p.

[3] Anonymous, 1969. Tidsbegrepp för maskinarbeten (Time concepts for machine work), Swedish Logging Res. Foundation, 12p.

[4] Anonymous, 1971. Glossary of industrial engineering with job evaluation and merit rating terms. Swedish Centre of Technical Terminology Publication No. 49, 99p.

[5] Anonymous, 1978. Glossary of Forestry. Swedish Centre of Technical Terminology Publication No. 71, 676p.

[6] Anonymous, 1978. Forest Work Study Nomenclature, The Nordic Forest Study Council, 130p.

[7] Anonymous, 1979. Glossary of Terms used in work study and organization and methods (O & M), Brit. Std. Institution, BS 3138:1979, 31p.

[8] Axelsson, S-Å, 1975. Logging-machine failure avoidance: identification and measurement of key parameters, Stud. For. Suec., No. 124, 38p.

[9] Berard, J.A., Dibblee, D.H.V. and Horncastle, D.C. Standard Definitions for Machine Availability and Utilization, CPPA/WSI 2428(B1), 2p.

[10] Bjerkelund, T.C., 1979. Nomenclature for forest operations functions, IUFRO Symposium, Seattle, Washington, 13p.

[11] Folkema, M.P., Giguère, P and Heidersdorf, E., 1981. Shift Level Availability and productivity: Revised Manual for Collecting and Reporting Field Data, FERIC, 6p.

[12] Häberle, S., 1988. Begriffe des forstlichen Zeitstudienwesens im deutschsprachigen Raum, unpublished manuscript, University of Göttingen, 16p.

[13] Johansson, S-Å,. 1967. Arbetsstudier, begrepp och metodik (Work Study, terms and methods), Stockholm, 282p.

[14] Kärkkäinen, M., 1975. Metsätyötieteellisen tutkimuksen perusteita. Kriitinen tarkastelu (Foundations of Forest Work Research. A Critical Review). Univ. of Helsinki, Research Notes No. 31, 167p.

[15] Samset, I., 1988. Some observations on time and performance studies of forest operations, IUFRO Symposium proceedings, Thessaloniki, 28p.

[16] Steinlin, H., 1955. Zur Methodik von Feldversuchen im Hauungsbetrieb, Mitt. Schw. Anst. forstl. Versuchswesen, XXXI. Band, 2 Heft, Zürich.

[17] Sundberg, U., 1988. The emergence and establishment of forest operations and techniques as a discipline in forest science, Comm. of the Norw. For. Res. Inst., 41.8, 27p.