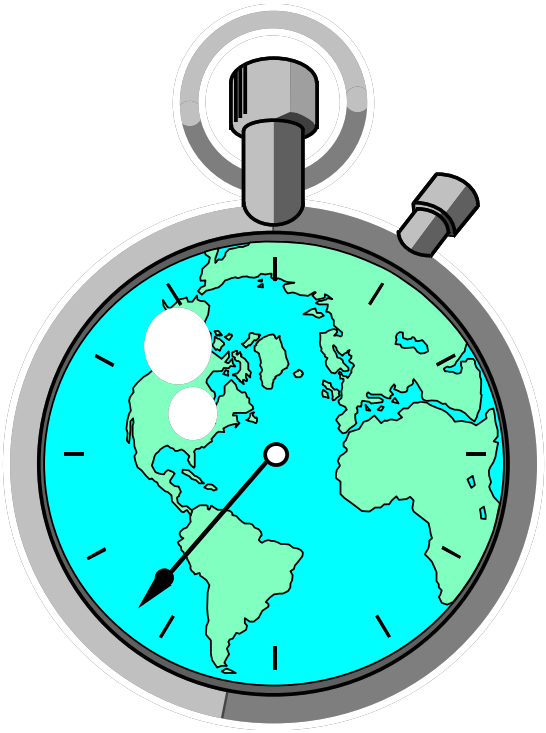
SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES
Department of Operational Efficiency
Garpenberg,

International Union of Forestry Research Organisations
WP 3.04.02

FOREST WORK STUDY

NOMENCLATURE



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FOREST WORK STUDY NOMENCLATURE

The participants of the S3.04.02 at IUFRO Tampere World Congress 1995 agreed to launch this nomenclature for **practical testing** aiming at refining it for **final acceptance** in at the next World Congress in Malaysia, 2000. It is hoped that *all IUFRO members will either use this nomenclature in technical reports or communicate to this subcommittee why they cannot*. It is envisioned that internationally-accepted practices for collecting, analyzing, and reporting results of forest work studies will be the next logical development in this initiative. The development and use of an internationally accepted nomenclature and work study practices is critical to the compatibility and ultimate usefulness of forest work study information.

Anyone interested in working in this area is encouraged to discuss this interest with the leaders of IUFRO S3.04.02 (see list below).

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Foreword

The level of complexity represented by the sylvan operating environment requires serious study. The purpose of forest work study is to provide a method for developing the knowledge needed to make good decisions in this complexe environment. The goals are to determine the most efficient, economic, and environmentally acceptable machine systems and operating methods for a given set of operating conditions. Internationally, the use of a common language with precise terms, measures and procedures would simplify communication and highly increase efficiency in the pursuit of these goals.

The first step in developing a standard forest work study methodology is to develop a standard forest work study nomenclature. Before evaluation personnel can be expected to use compatible evaluation methods, they must all first have a common understanding of the terms being used. 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. The group initially had the following composition:

Prof. Jeremy Rickards, (chairman), University of New Brunswick, Fredericton, N.B., Canada
Prof. Reidar Skaar (chairman 1988-90), Norwegian Forest Research Institute, Ås, Norway
Prof. Sigfried Häberle, University of Göttingen, Göttingen-Weende, Rederal Rep. of Germany
Mr. Karl Apel, Forest Service of Hessen, Weilburg, Federal Rep. of Germany
Mr. Rolf Björheden , (secretary), Swedish Univ. of Agric. Sciences, Garpenberg, Sweden

A first draft proposal was issued in 1989, discussed by the group and remitted to anumber of interested people in various countries. Based on the subsequent reactions, a modified proposal was presented at the XIX IUFRO World Congress in Montreal, 1990. At this congress Skaar left the group and was succeeded by Rickards as chairman. The group also made a number of valuable contacts for the continued work. One of the most important was **Res Eng Michael Thompson**[1] who was doing a similar work aiming at standardization within ASAE (American Society of Agricultural Engineers). Thompson was appointed a member of the group and has contributed greatly to the completion of the nomenclature. Further, the group is indebted to a great number of colleagues in various countries for encouragement and valuable suggestions which have made it possible to bring this work to a succesful conclusion.

Garpenberg and Frederickton, 1995

Jeremy Rickards, chairman

Rolf Björheden, secretary

1) USDA Forest Service, North Central Forest Experiment Station, Houghton, MI

Section A. General Terms

Relational descriptive text	Term	Term number
The department of systematized knowledge, facts and principles concerning *work* (section B) and the pursuit of such knowledge is known as.....	**Work Science**	**A1**
In short, work science examines the working human being, work conditions and technology including tools and machines, working methods and techniques and organization of work. The most important means of performing this examination is.....	**Work Study**	**A2**
carried out as.....	**Organization study,**	**A3**
	Method Study,	**A4**
or by	**Work Measurment**	**A5**
often including a.....	**Time Study**	**A6**
or a	**Motion Study**	**A7**
For thorough investigation, it is common to combine these study procedures.		

Definitions

A1	Work science	The branch of knowledge associated with work and its measurement, including the work itself, man at work, the machines, tools and other equipment employed in work and the organization and methods of work.
A2	Work study	The systematic study of technical, psychological, physiological, social and organizational aspects or work providing for critical examination of existing and proposed ways of doing work. Work Study is based on objective, unbiased observation and analysis, and is applied to establish or improve the efficiency of production.
A3	Organization study	The systematic and critical analysis of organizational structures and relationships in order to describe and improve the organization.
A4	Method study	The systematic and critical analysis of ways of doing work in order to make improvements.
A5	Work measurement	The application of techniques designed to measure the input of resources into the productive process, the methods and motions of work and the output of production. For *man at work* the measurment may include e. g. time consumption, movements and working motions, physical and mental workload etc. For *machines and tools*, time consumption, wear, movements and manouvres, energy consumption etc. may be measured. In addition to this, it is common to include descriptions of the *work object* (tree size

		etc), the *working environment* (terrain, weather etc) and the *quantity and quality of production*.
A6	Time Study	The measurment, classification and subsequent systematic and critical analysis of time consumption in work with the purpose of increasing the efficiency of the study object by eliminating useless time consumption.
A7	Motion Study	The systematic and critical analysis of working motions with the purpose of describing the motions, eliminating useless motions, and arranging the remaining motions in the best sequence for performing the operations.

Section B. Activities and conditions of work

Relational descriptive text	Term	Term number
The mental and physical effort developed by man for a productive purpose is known as.....	**Work**	**B1**
When man is engaged in work he is considered as a...	**Production factor**	**B2**
which combined with other production factors, such as materials, equipment and facilities forms a.....	**Production System**	**B3**
aiming at.....	**Production**	**B4**
i. e. the creation of a..... in the form of goods, services or ideas	**Product**	**B5**
The geographic boundaries within which production is planned totake place constitute the.....	**Production Area**	**B6**
which may be subdivided further into.....	**Work places,**	**B7**
and.....	**Storage places**	**B8**
consisting of one or several..... organized into *production lines* or *production groups.*	**Production Units**	**B9**
A physical form upon which the specified.....	**Work Task**	**B10**
requires that work is performed is called a.....	**Work Object**	**B11**
A sub-division of the work object is the.....	**Work Piece**	**B12**
A production system is in..... when one/several production factors are functioning.	**Activity**	**B13**
If no production factors are functioning, the system is in a state of	**Interruption**	**B14**
If activity is performed by man it is called.....	**Action**	**B15**
while activity carried out by facilities and equipment without direct human contribution is called.....	**Process**	**B16**
Such action that is partly restricted through an ongoing process is called.....	**Process Action**	**B17**

Definitions

B1	Work	Any exertion of energy (physical or mental), effort or activity directed to a purpose as defined by a *work task*. When the intended output of production is material, work consists mainly of efforts applied to change a physical object with reqard to form, position or state.
B2	Production factor	A technical, personnel or other prerequisite of production
B3	Production system	An arrangement of production factors required for production
B4	Production	The manufacture of something material or immaterial. Note that production may comprise goods, services, administrative and artistic production
B5	Product	The result of production, also output
B6	Production Area	The area within which a certain product is produced and where the production factors used in the specified production are located. The production area may be subdivided into *work*

		places where one or several specified *operations* are carried out and *storage places* where material and equipment are kept for future use or consumption. The work place may be divided further into separate *operation units* while coordinated operations on a work place may be recognized as *operation groups* or *operation lines*.
B7	Work Place	A part of the production area within which a specified operation (work cycle) takes place and the work object is changed with regard to form position or state
B8	Storage Place	A part of the production area within which material or equipment is stored prior to or between use
B9	Production unit	A unit of equipment (tools, machinery etc) and operator(s) used for a specified operation (work cycle). A *production group* consists of two or more coordinated production units and a *production line* consists of two or more production units organized in a line with a one-way flow of work objects (or work pieces).
B10	Work task	A clearly defined and limited amount of work. When the output of production is material, the work task specifies the change of a physical form, the *work object*, from a clearly defined initial state to a clearly defined end state.
B11	Work object	A physical form upon which work is performed.
B12	Work piece	A sub-division of the work object upon which repetitive or cyclic work is performed.
B13	Activity	The functioning of one or several production factors in a productive work process.
B14	Interruption	The part of production when no production factors are functioning.
B15	Action	The part of activity that is carried out by man. Action may be divided into three main types; *movement* carried out by the physical (mechanical) apparatus, *thoughts* carried out by the intellect and *perception* carried out by senses.
B16	Process	The part of activity that is released through machines and other capital factors or through natural processes. Man arranges the prerequisite conditions of the process which runs without other action from man than maintenance of these conditions.
B17	Process action	An action whose performance is partly dependant on a simultaneously ongoing process, also *indirectly restricted work*

Section C. Work measurement - techniques, procedures and classification of work elements.

Relational descriptive text	Term	Term number
An important part of work measurment is the.....	**Time Study**	**C1**
aimed at establishing the time consumption for a certain part of production. This is done through.....	**Timing**	**C2**
carried out as.....	**Snap-back Timing**	**C3**
	Cumulative Timing	**C4**
or.....	**Selective Timing**	**C5**
A pilot-type time study designated to yield preliminary information on certain statistical properties of a population under observation is called a.....	**Check Study**	**C6**
If only the relative proportion of activities is needed, the study may be performed by.....	**Activity Sampling**	**C7**
which may also be combined with a timing procedure.		
A time study combined with measurments of the output of production may be carried out as a.....	**Productivity Study**	**C8**
or as a.....	**Performance Study**	**C9**
and used to evaluate the.....	**Productivity**	**C10**
and.....	**Efficiency**	**C11**
of the studied system. If the influence of productivity affecting factors is also investigated, such studies can be used in a variety of applications as production forecasting and planning, piece-rate setting etc.		
A sequence of work repeatedly applied to every work object or work piece constitutes a.....	**Work Cycle**	**C12**
The work cycle consists of a regular sequence of.....	**Work Elements**	**C13**
divided by distinct.....	**Break Points**	**C14**
Depending on its relation to production, a work element may be defined as a.....	**Fixed Element**	**C15**
	Variable element	**C16**
	Repetetive Element	**C17**
	Occasional Element	**C18**
or.....	**Foreign Element**	**C19**
Also, an element may be defined depending on agent;.	**Manual Element**	**C20**
	Motor-manual Element	
	Machine Element	**C21**
	Process Element	**C22**
	Robotic Element	**C23**
or.....		**C24**

C1	Time study	The measurment, classification and subsequent systematic and critical analysis of time consumption in work aimed at increasing the efficiency of work (cf A6).
C2	Timing	The observation and recording of time taken to complete an element by the use of a watch or other chronometric device.
C3	Snap-back timing	A method in which the chronometric device is reset to zero at the end of each element and allowed to restart, the time for the element being obtained directly. (Also: fly-back timing.)
C4	Cumulative timing	A method in which the chronometric device is not returned to zero at the end of a work element, the time for each element being obtained subsequently by subtraction.
C5	Selective timing	A method in which the chronometric device is stopped at the end of a selected element but not returned to zero. If the selected element recurs, timing is allowed to continue. Element time may be obtained by dividing the total recorded time by the number of occurrences.
C6	Check study	A time study of relatively short duration often performed to establish the variance of the population under observation in order to create a basis for decision of sample size. Check studies often form important parts of *pilot studies* performed to test study methods, layout etc before the full scale study.
C7	Activity sampling	A technique for measuring work in which the activity is observed at fixed or random intervals. For each observation, the work element at that instant is recorded, resulting in a frequency of occurence for each defined element. *Stratified activity sampling* means that the total time of the study is divided into periods (strata) so that sampling may be carried out at different frequency and interval for each stratum. (Also: work sampling, frequency study.)
C8	Productivity study	A study, often of lengthy duration aiming at establishing the rate of productivity within the specified scope of the study.
C9	Performance study	A study aiming at establishing the rate of output per chosen time unit. In addition to timing, measurement of the quantity and quality of the products is part of the study.
C10	Productivity	The rate of product output per time unit for a given production system. The productivity ratio may be established also over resources other than time.
C11	Efficiency	The rate of time input per produced unit for a given production system. Efficiency may also be measured based on input of resources other than time, such as energy.
C12	Work cycle	A sequence of work elements repeated for each work object or work piece. A work cycle of higher order may consist of a number of work cycles of lower order.
C13	Work element	A sub-division of a work task that is defined by limiting break points.
C14	Break point	The limits between defined work elements.
C15	Fixed element	An element for which the time remains the same independent of the quantity of output (quantity fixed) and/or length of

		working period (period fixed).
C16	Variable element	An element for which the time varies with the quantity of output (quantity variable) and/or the length of the working period (period variable).
C17	Repetitive element	An element that occurs in every work cycle.
C18	Occasional element	An element that does not occur in every work cycle, but at regular or irregular intervals.
C19	Foreign element	An element that can not, after analysis, be considered as necessary to complete the work within the definition of the work task.
C20	Manual element	An element performed and powered by the muscular effort of a worker.
C21	Motor-manual element	An element performed by motor driven handtools.
C22	Machine element	An element performed by a worker directly operating a machine.
C23	Process element	An element performed by machines etc (cf B6 Process) where the worker only sets and maintains the conditions of the process.
C24	Robotic element	An element performed by means of a predetermined automatic process of a machine.

Section D. Classification of time in forest work study

1. TOTAL TIME (TT): The total elapsed time of the period under consideration (also calendaric or control time).

1.1 NON-WORKPLACE TIME (NW): The portion of the total time that is not used for the completion of a specific work task.

1.1.1 Unutilized Time (UN): The portion of the non-workplace time that the worker is away from the job; such as time off, etc.

1.1.2 Travel Time (TR): The portion of the non-workplace time that the worker is travelling to and from the job site before and after the work period; such as travel to the job site, travel away from the job site, etc.

1.2 WORKPLACE TIME (WP): The portion of the total time that a production system or part of a production system is engaged in a specific work task (also scheduled time).

1.2.1 Non-Work Time (NT): The portion of the workplace time that no work is being accomplished on the work task.

1.2.1.1 Disturbance Time (DT): The portion of the non-work time that is considered an interruption in the work with no direct or indirect connectionto the completion of the work task; such as gathering information, inclement weather, visitors, injuries, etc.

1.2.1.2 Work-Related Delay Time (WD): The portion of the non-work time that can be related back to the organization of the work.

1.2.1.2.1 Meal Time (ME): The portion of the work-related delay time used to refuel the workers or animals in the production system; such as breakfast, lunch, dinner, etc.

1.2.1.2.2 Rest and Personal Time (RP): The portion of the work-related delay time used to sustain the working capacity of workers or animals in the production system; such as breaks, rests, personal needs, etc.

1.2.1.2.3 Interference Time (IT): The portion of the work-related delay time in which no work activity is occurring due to the interference of a necessary operation within the production system; such as waiting for the completion of other tasks upon which this task is dependent, etc.

1.2.2 Work Time (WT): The portion of the workplace time that a production system or part of a production system is directly or indirectly involved in completing a specific work task.

1.2.2.1 Productive Work Time (PW): The portion of the work time that is spent contributing directly to the completion of a specific work task, typically occurring on a cyclic basis (also direct work time).

1.2.2.1.1 Main Work Time (MW): The portion of the productive work time used to change the work object with regard to form, position, or state within the definition of the work task; such as felling, delimbing, bucking, skidding, loading, etc.

1.2.2.1.2 Complementary Work Time (CW): The portion of the productive work time that does not change the work object with regard to form, position, or state but is needed to complete the work task and is an integral part of the work cycle; such as positioning the machine or worker, clearing the work area, assessing the situation, dragging cable, etc.

1.2.2.2 Supportive Work Time (SW): The portion of the work time that does not directly add to the completion of the work task, but is performed to support it (also indirect work time).

1.2.2.2.1 Preparatory Time (PT): The portion of the supportive work time used to prepare the machines and conditions of the work place at a single work site or landing location.

1.2.2.2.1.1 Relocation Time (RL): The portion of the preparatory time used to transport machines, workers, etc. to a new work site.

1.2.2.2.1.2 Planning Time (PL): The portion of the preparatory time used to develop operational strategy; such as cruising and planning a harvest area, marking off skid trails and sensitive areas, etc.

1.2.2.2.1.3 Operational Preparatory Time (OP): The portion of the preparatory time used to ready the harvest system to continue operating at a particular site; such as changing operators, moving into the stand, changing the rigging (same landing location) for cable systems, etc.

1.2.2.2.1.4 Change-Over Time (CO): The portion of the preparatory time used to set-up and take-down the production system.

1.2.2.2.1.4.1 Set-Up Time (SU): The portion of the change-over time used to ready the production system for operating at the new site; such as stationing and stabilizing portable equipment, setting up rigging for cable systems, etc.

1.2.2.2.1.4.2 Take-Down Time (TD): The portion of the change-over time used to ready the production system for moving to a new site; such as mobilizing portable equipment, taking down the rigging for cable systems, etc.

1.2.2.2.2 Service Time (ST): The portion of the supportive work time used to sustain the working capacity of machines in the production system.

1.2.2.2.2.1 Repair Time (RT): The portion of the service time used to repair damaged components, occurring as principally non-cyclic interruptions; such as repairing; waiting for repair parts, mechanics, or facilities; transporting for repair; etc

1.2.2.2.2.2 Maintenance Time (MT): The portion of the service time used to compensate for the successive degradation of tools and machinery, occurring as principally cyclic interruptions; such as maintaining; waiting for parts, mechanics, or facilities; transporting for maintenance; warming up equipment, checking equipment function, etc.

1.2.2.2.2.3 Refuel Time (RF): The portion of the service time used to refuel the machine; such as transporting to refuel, refueling, etc.

1.2.2.2.3 Ancillary Work Time (AW): The portion of the supportive work time used to perform ancillary work functions that allow the work to continue in the production system; such as assisting another machine or worker, blading skid trails, laying boughs in wet spots, etc.

Figure 1. Time concepts´ structure

Section E. Checklist for describing the work task, work object and the conditions of work

Work study is applied as a mean to investigate or improve the efficiency of production. An important tool in this process is work measurement, by which data can be gathered concerning the *efficiency* relation, (input/output) or its inverse *productivity* . This information becomes irrelevant to the evaluation process, however, if prerequisite conditions and content of work are not known. To become meaningful, the data on resource input and produce output must be complemented with descriptions of the ***study object*** (workers and equipment), a clear definition of the ***work task***, initial and final state of the ***work object***, and the ***conditions of work***.

To enable evaluation, the descriptions must be relevant, clear and comprehensive. Due to the complex and variable nature of forest work it is has not been possible at this time to give exact definitions of the parameters in question. The following checklist should essentially be regarded as a list of examples of the type of information that can be useful. Note that ***only parameters that are judged to have an impact on the performance of the study object need to be specified***.

Description of the study object

Work organization
The operators´ general level of training, skill and experience.
The operators´ degree of accustomedness to the studied work
The operators´ physical fitness and motivation
Types and state of equipment used

Description of work task and work objects

Comparisons between different studies are often made difficult or impossible due to unknown differences in work object properties or different work tasks. To increase the possibilities of comparisons such properties of the work object that affect the amount of work needed must be described. In addition to this description of the initial state, the work task must be clearly described. Such descriptions makes the adjustments possible, that are needed for comparability.

The relevant factors for the description of work object depends on the choice of equipment and the defined work task. For motor-manual felling in clearcutting, tree size (i. e. stump cross-cut area), species, buttresses etc may be important in describing the initial state of the work object whereas other factors influencing productivity, as understorey, terrain factors, snow depth etc are considered as conditions of work. For planting, plant type, spacing and terrain factors become essential parts of the description of the work object etc.

Description of the conditions of work

Conditions that affect the maneuverability and agility of the study object, e g

- *Terrain properties* such as ground surface roughness, slope and supporting capacity.
- *Visibility* of the work place, affected by light conditions, canopy, understorey, stand structure before and during work, precipitation etc.
- *Climatic and weather conditions* such as temperature, wind, precipitation, snow depth and type.

Section F. Classification of machine costs and other investment-related costs

Cost-Related Terms:

Initial Investment: The purchase price of the machine, including options, sales tax, and delivery.

Economic Life: The projected period over which the machine can operate at an acceptable cost and productivity.

Salvage Value: The value of the machine at the time of disposal, with disposal occurring at the end of the economic life.

Average Annual Investment: The average amount of money invested in the machine over the economic life.

Fixed Costs: Costs that will accrue regardless of whether the machine is used or not (depend only on the passage of time).

Variable Costs: Costs that will accrue only as the machine is used.

Cost Factors:

Ownership Costs: Costs associated with owning rather than operating the machine. Most are fixed, but some have a variable component.

Depreciation: The cost associated with the reduction in value of a machine due to normal use (wear and tear) and the passage of time (obsolescence).

Interest: The cost of using capital. If borrowed, this is a direct cost; otherwise it is considered an opportunity cost.

Insurance: The cost of insuring the machine for damages and losses due to accidents, vandalism, theft, liability, and natural forces.

Equipment Taxes: The costs of public fees relating to the ownership and use of a piece of equipment; such as use and property taxes, licenses, permits, etc.

Overhead Costs: Other costs associated with owning the machine, such as shop facilities, tools, bookkeeping, etc.

Operating Costs: Costs associated with operating a machine. Most are variable, but some have a fixed component.

Repair and Maintenance: The costs associated with keeping the machine operable.

Fuel: The cost of consumed fuel.

Oil and Lubrication: The cost of consumed oil and lubricating fluids.

Tires: The cost of replacing worn or damaged tires.

Tracks: The cost of replacing worn or damaged tracks.

Other: The cost of replacing other major expendable items in the system; such as rigging, cable, etc.

Labor Costs: The cost of hiring personnel to perform the necessary work tasks.

Wages: The actual wages paid to the employee (before payroll deduction).

Wage Taxes: Costs paid by an employer to federal, state, and local governments as a direct result of employing an individual; such as social security tax, federal and state unemployment insurance tax, and workmen's compensation.

Fringe Benefits: Costs associated with special benefits provided to the employee, such as paid sick leave, vacation time, and holidays; health and life insurance plans; retirement, investment, and matching contribution plans; uniforms; safety equipment; travel and meals; etc.

Section G. Measures of performance in forest work study

Relational descriptive text	Term	Term number
	Performance	**G1**
and..... are both measures of the useful *output* (cf B5) per measured *input* units, such as working hours, capital etc with performance signifying a long-term, sustainable level while productivity refers to any (also very short) studied periods.The input/output relation.... is the inverse of productivity.	**Productivcity**	**G2**
	Efficiency	**G3**
To determine the..... (or cost per measured *unit production)* is a classical evaluation approach combining the observed measures of productivity with the cost per-hour, e g the..... of the studied system.	**Production cost**	**G4**
	Machine rate	**G5**
Other important characteristics of machinery with great importance to the evaluation process are.....	**Machine utilization,**	**G6**
	Mechanical availability,	**G7**
	Reliability,	**G8**
	Serviceability,	**G9**
	Repairability	**G10**
and.....	**Maintainability**	**G11**
In recent years, it has become important to also evaluate the ..... of the production systems with regard to the forest resource in a broader sense	**Impacts**	**G12**

Definitions

G1	Performance	The quantity of useful work completed in a given time period, along with the associated costs and impacts.
G2	Productivity	The rate of product output per unit of time for a production system. A productivity ratio may also be calculated for resources other than time.
G3	Efficiency	The amount of time required per unit of production for a production system. Efficiency can also be based on inputs of resources other than time, such as energy.
G4	Production Cost	The cost (consumption of production factors expressed in monetary terms) of performing the intended productive function expressed on the basis of the quantity of work completed.
G5	Machine Rate	The per-hour cost of owning and operating a machine.
G6	Machine Utilization	The portion of the workplace time that a machine is being used to perform the function for which it was intended.
G7	Mechanical Availability	The portion of the workplace time that a machine is mechanically fit and able to do productive work.

G8	Reliability	The probability that a machine will function as intended under specific operating conditions at any given time.
G9	Serviceability	A measure of the ease with which repair actions and routine maintenance can be performed on a machine.
G10	Repairability	A measure of the ease with which a failed part, assembly, system or machine can be restored to a state of operational readiness.
G11	Maintainability	A measure of the ease with which routine maintenance actions can be performed.
G12	Impacts	The effects of the operation on the remaining forest resources and values, such as the vegetation, soil, water, air, wildlife, archeology, recreation, etc.

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