



Institutionen för skogens produkter och marknader

**The Machine Operator Current Opinions and
the Future Demands on Technical
Ergonomics in Forest Machines**

Mike Walker, Rolf Tobisch, Günther Weise



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Abstract		
<p>This report present results from 113 interviews, 300 returned questionnaires and 10 seminars about the technical ergonomics in forest machines. The report presents a lot of details useful for the manufacturer. The report is also a base for the development of the European Ergonomic Guidelines for Forest Machines.</p> <p>Operators are content with many of the ergonomic issues of their machine. However, most operators are discontented with maintenance, and to a some extent with cab access, information and vibration. Forwarder operators are explicitly discontented with noise, climate control and with instructions and training. Harvester operators are dissatisfied with the cabin, seat and external lighting. Examples of solutions easy to introduce are lamps giving white light, self-cleaning steps and storage space for personal belongings. The possibility to stretch out the legs in the cab is desired.</p> <p>A self levelling of the cab and is seen as a useful in the harvester , as well as a non touch measurement of the log and an anti-slip function when feeding the log through the harvester head. A stability system for faster driving is desired by many operators. Surprisingly many, 35 – 40%, are positive to an automatic boom-tip control and functions following that development. A fit-in function controlling the gripping of the stem is desired by 39% of the harvester operators.</p>		

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Summary

This study is a part of the ErgoWood project, carried during 2002 – 2005 and financed by the EU-commission and partners.

The report analyses the results from 113 interviews and 300 (from 359) returned questionnaires from forest machine operators and from 10 seminars with all parts involved in mechanised harvesting. The aim of the study was to obtain an overview of the current technical ergonomic problems associated with the forest machine workplace and demand for future automation needs. This work is a base for producing a “European Ergonomic Guideline for Forest Machines”.

The interview data and questionnaire results were categorised according to harvester, forwarder and skidder and age of the machine (older or newer than five years). The interview answers were then classified according to the contentment of the operator with the relevant ergonomic aspect. The responses were classified according to the general opinion voiced by the interviewee about the particular aspect. Then the technical problems cited by the operators were analysed and ranked according to the frequency of citation. The seminar contributions were scrutinised and all opinions and suggestions sorted into the ergonomic topics as laid down in the “Ergonomic Guidelines for Forest Machines”.

The results show that some aspects such as work posture, operating the machine, exposure to gases and particulate and brakes and operator safety are of minor concern to the operators. Maintenance is a problem to all machine types. Forwarder operators are explicitly discontented with noise, climate control and instructions and training. Harvester operators are specifically dissatisfied with the cabin, seat, noise and external lighting.

The lack of storage space for personal belongings as well as tools and other equipment is also a common problem in harvester cabs. Operators from non-English and non-Swedish speaking countries state that the manuals, instructions and spare parts lists are either not available in their language or badly translated. Some frequently mentioned simple measures for improvement of the machine workplace are white light (Xenon light), self-cleaning steps and room for storing personal belongings in the cabin are. The interviews strongly under-line that the skidder operators are most discontented among the operators.

Comparing old and new machines indicates that many ergonomic aspects have been improved. In new forwarders this is particularly evident for maintenance, the seat, noise external lighting and vibration. However, the most notable problems in new harvesters are cab access, the cabin and visibility from the cab. Most operators want to be able to stretch their legs in the cabin. Maintenance is still problematic in over half of the new harvesters, although there is some evidence that this is improving.

All operators express a need for an electronic stability system for faster driving. Harvester operator desired a non-touch stem measuring system and an automatic stem slip avoidance control for the harvester head. Surprisingly many of the harvester operators, 35 – 40%, are positive to an automatic boom-tip control and functions following that development. A fit-in function controlling the gripping of the stem is desired by 39% of the harvester operators. Most harvester operators agree that a levelling system contributes to better working conditions in the machine. They prefer a levelling cab. Forwarder operators are less specific in their preferences.

However, automatic processes must be reliable and support productivity. Many see no necessity for automation, since it cuts the amount of control an operator want to have has over the work process. Many operators feel that the automatic felling could lead to dangerous situations. Most operators agree that automatic unloading of the bunk may be a good idea in uniform stands and single grade logs. However, most operators in the study works in mixed stands and deals with irregularly shaped trees or need to sort differently graded wood while unloading.

1. Introduction

The following report is based on 10 seminars, 113 interviews and 300 returned questionnaires distributed amongst a sample of forestry contractors and their employed machine operators in six European countries (France, Germany, Poland, Sweden, Norway and United Kingdom). A selection of participants who responded to the questionnaire was also interviewed.

The participants in the study include both forestry contractors and machine operators employed in forest companies, public organisations or with forestry contractors. The machine operators may in some cases be self employed, but operating a machine belonging to a company.

Mechanised forest operations have in the recent decades taken over more and more of the forest operations in European countries. The development started in the US and Canada, but already in the 1960s the Nordic countries were involved in the development of logging machines, resulting in a rapid increase of mechanised forest operations in this area, especially in Finland and Sweden. In Central Europe the introduction of harvesters and transport machines, especially in France and Germany, was boosted by the damage caused to the forests by frequent storms in the late 1970s early 1980s. In more recent years, advanced logging equipment has been introduced at an increasing rate in the United Kingdom.

The introduction of mechanised forest operations also increased the awareness of the effects of this workplace on the health and well-being of the machine operators. The combination of an ever-growing trend towards increasing the productivity of forest operations, the complexity of the machine operation as well as the physical conditions of the in-cab workplace leads to a wide range of ailments and long-term health problems. As a consequence of this, the ergonomics of the forest machine workplace need to be assessed and continually improved in an endeavour to reduce these ill effects.

The aim of the present paper is to review and analyse the operator opinions about the existing technical ergonomics of their machines (forwarders, skidders and harvesters) as well as needs for new automation. These opinions were gathered in 118 standardized interviews and 359 questionnaire surveys, as well as in ten seminars that were carried out in the participating countries.

2 Methods

2.1 Experimental Design

A questionnaire was developed through a co-operation of the different partners of the ErgoWood-project. The work was co-ordinated by The National Institute of Working Life / West in Sweden. Also an interview protocol was developed parallel to the work with the questionnaire.

A pilot version was tested out in the different countries, and the final version of both questionnaire and interview guide was finished in October 2003. The questionnaire was translated into the actual languages (French, German, Polish, Swedish and Norwegian) before distribution.

Those who had filled in the questionnaire were asked to volunteer to take part in an interview. A total number of 118 interviews were carried out.

The questionnaires were inspected and text translated into English. The interviews which were in most cases taped, were transcribed and if necessary translated into English. The questionnaire forms and the transcribed interviews were copied and the original sent to The Forestry Contracting Association for coding and further processing. All the processed material was organised into two databases as for the questionnaires and condensed into six text files as for the interviews.

The questionnaire was structured as follows:

- A. Personal background
- B. Work background
- C. Typical workday
- D. Current work
- E. Work organisation
- F. Technical ergonomics*
- G. Sickness and fatigue
- H. Physical symptoms
- I. Psychosocial factors I
- J. Psychosocial factors II

In the interview-guide was structured as follows:

- A. Bonding questions
- B. Work background
- C. Current work
- D. Work organisation
- E. Future work stations*
- F. Health
- G. Psychosocial factors
- H. Concluding question

2.2 Evaluation of the interview data

The interviews formed one part of the field studies carried out in each of the countries participating in the ErgoWood project.

The interview itself covered questions on all aspects of ergonomics, ranging from work organisation to psychosocial factors. For clarity only those questions will be reproduced in this paper, which relate to technical ergonomics.

Each participant was asked to specify the age and type of the machine he operates. In those cases, where participants specified more than one machine, the operator was classified according to the primary machine.

One part of the interview was aimed at obtaining an opinion for each of the technical ergonomic aspects included in the "Ergonomic Guidelines for Forest Machines (SkogForsk)".

In the first part of the present analysis of the responses, each interview was categorized according to the type and age of the machine. In order to obtain some statistical data, the interview answers were

* Questions of primary interest for this analysis

then classified according to the contentment of the operator with the relevant ergonomic aspect: class OK if the operator was satisfied and class NOK if he was dissatisfied with that particular aspect. The classification of a response was made according to the general opinion voiced by the interviewee about the particular aspect. Phrases such as “I like it”, “I’m satisfied”, “good”, “no complaints” and similar were classified as OK. Phrases such as “awful”, “needs improvement” etc., were classified as NOK answers.

The results are presented for the overall group, the group of operators with old machines and the group of new machine operators. The new machine group comprises all responses from operators handling machines less than 5 years old. This allows a direct comparison of the opinions of operators with old and new machines. Such a comparison gives some indication whether the ergonomics of the new machines has improved or deteriorated.

The next part of the analysis is a detailed examination of the contributions for each ergonomic aspect. The technical problems cited by the operators were scrutinized and ranked according to the frequency of citation. This gives some indication of the most important problems encountered by the operator in relation to the particular ergonomic aspect. This part also includes a table of the results for this particular item. Also included is a ranked list of the most frequently expressed problems and improvements suggested by the operators for that item. This is followed by a list of abridged contributions. Most of these are from operators expressing dissatisfaction with the particular item. The full, unabridged set of comments and answers is located in the appendix.

The interview results were sorted according to the type and age of the machine operated by the interviewees. Of the 118 interviews carried out in the participating countries, 113 were completed and used in the next stage of the analysis. This involved classifying the answers according to machine type and age of the machine. Table 1 summarizes the results of this classification. The column No Answers includes all those interviews, which could not be linked to a machine type or where the age of the machine could not be determined.

Table 1: Number of interviews from machine operators

Machine type	All machines	New machines (less than 5 years)	Old machines	No Answer
	<i>Number</i>			
Harvester	63	35	22	6
Forwarder	33	19	11	3
Skidder	10	4	6	0
Others (tractors, excavators, trucks)	6	0	2	4
Total	113	59	41	13

Most of the interviews (56 %) were carried out with harvester operators, followed by forwarder and then skidder operators (Table 2). 52 of all interviewed operators work with a machine that is less than 5 years old and 36 operated an older machine. The analysis also shows that 56 % of the harvesters and 58 % of the forwarders are classified as new. Table 2 also shows that most of the participating skidder operators (56 %) work with a machine over 5 years old.

Table 2: Distribution of interview answers

Machine type	All interviews	Proportion of new machines	Proportion of old machines	No answer
	<i>%</i>			
Harvester	56	56	35	9
Forwarder	30	58	33	9
Skidder	9	45	55	0
Others (tractors, excavators, trucks)	5	0	33	66
Total	100	52	36	12

2.3 Evaluation of the Questionnaires

The questionnaires form the second source of data for obtaining an overview of the forest machine operator’s opinion. The questions were aimed to cover the broad spectrum of ergonomic topics including specific aspects of technical ergonomics: level of process automation, cab access, seat adjustment, cabin size and the nature of a self levelling system.

In the present assessment, the relevant results of the questionnaires were sorted according to the type and age of machine operated by the participants. The responses are expressed as a percentage of the total number of responses in each group and summarised in a table. For a better overview of the differences between operator groups and machine age groups, the responses are displayed in a bar chart.

2.4 Evaluation of the Seminar Results

Technical ergonomics was not always a major topic in the seminars held within the framework of the ErgoWood project. This topic was discussed in the four seminars held by the KWF in Germany, the three seminars organised by AFOCEL and «Entrepreneurs du Territoire» in France, and in the seminar held in Scotland. Some aspects were also briefly considered in the two Swedish seminars. Safety officers, representatives from the forest industry, forest machine sellers and manufacturers, as well as forest machine operators, attended the seminars.

The results of these seminars were put on the ErgoWood internal website and analysed by the different partners. For this report the seminar contributions were scrutinized and all opinions and suggestions sorted into the ergonomic topics as laid down in the “Ergonomic Guidelines for Forest Machines”. For a better overview of the problems discussed and the improvements suggested by the participants, the summaries of the contributions were presented in a table.

3. Results

3.1 The Interviews

All opinions were collected for each aspect and ranked according to the number of citations. Only those with multiple citations are included in the text. Only a fraction of interviewees also gave an opinion or suggested a means for improving the machine. Thus the lists of opinions and remarks that are included in the results must be understood as a qualitative guide to the needs and problems of the operators.

In the first part of the results all opinions were collected and a summary of the OK and NOK responses presented as percentages in tables. These results can be used as a guide to the severest ergonomic problems faced by the operators. The raw data containing the absolute numbers of responses are found in the appendix. The data was then sorted according to the age of the machines. This enables a comparison between new and old machines in order to evaluate the ergonomic progress in machine design.

In the next part of the results from the interviews, each section is analysed separately. In order to obtain an overview of the most commonly cited problems, the opinions presented by the interviewees were ranked according to the number of citations. There has been no correction of grammatical and orthographic errors in the answers. This is followed by a full list of abridged comments and suggestions the particular ergonomic aspect. The last part of this section analyses the answers to the questions about the necessity of a self-levelling system and automation of the work process.

3.1.1. Overall contentment

Table 3: Operator responses, classified according to their contentment with particular technical ergonomic aspects.

Machine	All operators			% of total		
	OK ¹	NOK ¹	NA ¹	OK	NOK	NA
Ergonomic Aspect						
Cab Access	40	39	33	36	35	29
Work posture	51	17	44	46	15	39
Cabin	36	41	35	32	37	31
Visibility from cab	48	36	28	43	32	25
Seat	46	43	23	41	38	21
Controls	53	27	32	47	24	29
Operating the machine	52	25	35	46	22	32
Information	45	37	30	40	33	27
Noise	43	49	30	38	44	18
Vibration	41	36	35	36	32	32
Climate control	49	36	27	44	32	24
Gases & particulates	52	20	40	46	18	36
External lighting	51	35	26	46	31	23
Instructions & training	44	42	26	39	38	23
Maintenance	35	52	25	31	46	23
Brakes and operator safety	58	11	43	52	10	38
NB Dark grey – most problems						

¹: OK= good, NOK=not good, NA=no answer

Table 3 compares the number of OK and NOK responses by all operators for each particular ergonomic aspect. The results show that between 18 and 39 % of the operators did not voice an opinion in the interviews. The largest proportion of No Answers (NA) was registered for the sections work posture, exposure to gases & particulates and brakes and operator safety, which are also the items where operator views are clearly positive. Other largely positive aspects of the forest machine

are visibility from the cab, controls, operating the machine, information, climate control and external lighting. Thus the evidence indicates that the majority of operators who voiced an opinion are content with most ergonomic aspects of their machines.

There are also a number of negative aspects that are revealed in the results. The largest proportion of negative opinions is found in relation to maintenance. Although the evidence is not as explicit, the aspects cabin and noise also received more negative responses than positive ones. In the case of the other issues such as instructions & training, the seat, vibration as well as cab access, the differences between OK and NOK are very small. However, at least 30 % of the operators have problems with these areas.

Table 4: Summarized responses of the operators of new machines and old machines, classified according to their contentment with particular technical ergonomic aspects (%).

Ergonomic Aspect	Operators of new machines			Operators of old machines		
	OK	NOK	NA	OK	NOK	NA
Cab Access	47	39	14	24	24	52
Work posture	58	17	25	32	15	53
Cabin	39	42	19	20	36	44
Visibility from cab	47	44	9	32	24	44
Seat	54	34	12	27	46	27
Controls	54	27	19	44	24	32
Operating the machine	58	24	18	39	24	37
Information	46	34	20	34	37	29
Noise	47	42	11	32	46	22
Vibration	47	36	17	24	37	39
Climate control	54	34	12	37	37	26
Gases & particulates	59	17	24	37	22	41
External lighting	61	25	14	41	34	25
Instructions & training	46	44	10	37	32	31
Maintenance	42	49	9	20	54	26
Brakes and operator safety	69	7	24	44	12	44

NB Dark grey topics remain problems in new machines

The interview results vary considerably between old and new machine operators. A much greater proportion of operators of older machines did not respond to the interview than new machine operators. Between 9 and 25 % of the new machine operators failed to answer the questions. In contrast, between 22 and 53% of the operators with old machines did not provide an opinion. This large proportion of NA introduces a large degree of uncertainty into the interpretation of the results. At best certain trends can be observed.

A comparison of the proportion of content operators of new and old machines suggests that some aspects may have improved substantially in newer machines. This is the case for the seat, information, noise, and vibration where dissatisfied operators outnumbered content operators in the old machines. In new machines the operators rated these aspects more positively. Other aspects such as cab access, work posture, cabin, visibility from the cab, controls, operating the machine, climate control, exposure to gases and particulates, external lighting and brakes and operator safety may also have improved in new machines. Main problems remaining are the visibility from the cab and instructions and training and maintenance.

Table 5: Summarized responses by forwarder, harvester and skidder operators, expressed as a fraction of the total number of responses (%).

Machine	Forwarder			Harvester			Skidder		
	OK	NOK	NA	OK	NOK	NA	OK	NOK	NA
Cab Access	33	36	31	46	30	24	0	80	20
Work posture	48	15	37	54	18	28	10	10	80
Cabin	42	33	25	35	46	19	0	70	30
Visibility from cab	52	24	24	49	33	18	0	70	30
Seat	52	21	27	46	43	11	0	90	10

Controls	58	12	30	54	24	22	0	80	20
Operating the machine	55	12	33	52	27	21	10	40	50
Information	39	33	28	49	35	16	10	40	50
Noise	30	55	15	31	38	8	20	70	10
Vibration	36	36	28	44	33	23	10	30	60
Climate control	39	42	19	56	27	17	10	50	40
Gases & particulates	45	18	37	59	19	12	0	20	80
External lighting	58	15	27	49	38	13	10	60	30
Instructions & training	33	42	25	52	33	15	0	70	30
Maintenance	36	42	22	36	49	15	0	70	30
Brakes and operator safety	45	15	40	42	6	27	10	20	70

NB Topics in dark grey are the most unsatisfactory

Table 5 categorizes the responses according to the type of machine operated by the interviewee. When compared to table 3, these results show that the key issues as well as the borderline issues are not generally applicable to all machines, but concern particular machine types. The results in table 5 show a clear difference of contentment between the different machine operators.

The results identify the major ergonomic shortcomings of each machine type. The main problems registered by forwarder operators are noise, instructions and training, and maintenance. The results for cab access and climate control are less clear-cut but seem to indicate that there are problems associated with these aspects. The opinions for vibration are equally divided, but clearly 36 % of the forwarder operators have a problem with this aspect. Forwarder operators seem to have less problems with work posture, the cabin, visibility from the cabin, the seat, controls, noise, operating the machine, information, exposure to gases and particulates, external lighting and brakes and operator safety. The aspects work posture, exposure to gases and particulates and brakes and operator safety also generated the greatest proportion of no answers (NA).

Harvester operators are clearly not content with the maintenance of their machine and the cab. Although the results are not as clear-cut, over 30 % of the harvester operators are discontented with the aspects cab access, cab, visibility from the cab, seat, information, vibration, external lighting and instructions and training. On the positive side, work posture, controls, operating the machine, climate control, exposure to gases and particulates and brakes and operator safety seem to be less of a problem for harvester operators.

Although only a small number of skidder operators were included in the interviews, there is strong evidence suggesting that cab access, the cabin, visibility from the cabin, the seat, controls, noise, climate control, external lighting, instructions and training and maintenance are associated with severe problems. While the results for information, vibration and operating the machine also indicate that the operators are not content with these aspects, the number of unanswered interviews for these sections is large. Between 70 and 80 % of the skidder operators did not put forward an opinion about work posture, exposure to gases and particulates as well as brakes and operator safety, possibly indicating that these are of little concern to them.

The maintenance of the machine seems to be the only common issue that needs improvement in all three machine types.

Table 6: Summarized responses by operators working with new and old forwarders expressed fraction of the total number of responses (%).

Ergonomic Aspect	Forwarder					
	New machines			Old machines		
	OK	NOK	NA	OK	NOK	NA
Cab Access	37	47	16	18	27	55
Work posture	58	16	26	36	18	45
Cabin	47	33	0	27	27	45
Visibility from cab	58	21	0	36	27	36
Seat	87	7	6	27	45	27
Controls	63	11	26	45	18	36
Operating the machine	89	5	6	36	18	45

Information	32	47	21	45	18	36
Noise	42	42	16	9	73	18
Vibration	53	26	21	9	64	27
Climate control	42	42	16	36	45	18
Gases & particulates	53	21	26	36	18	45
External lighting	68	5	27	45	27	27
Instructions & training	37	47	16	36	27	36
Maintenance	47	32	21	18	64	18
Brakes and operator safety	68	26	6	36	18	45
NB Topics in dark grey are the most problematic						

Table 6 summarizes the contentment among operators of new and old forwarders. There are several pertinent differences between these groups. New forwarder operators are clearly discontented with the aspects cab access, information and instructions and training but noise and climate control are also problematic areas. Operators of old forwarders tend to be more dissatisfied with the seat, noise vibration and maintenance. There is some evidence suggesting that they are also discontented with climate control and cab access. A comparison of the answers between new forwarder operators and operators of old forwarders suggests that cab access, instructions and training and information are larger problems in new machines. However, most other aspects have clearly been improved, notably maintenance, the seat, noise, external lighting and vibration.

Table 7: Summarized responses by operators working with new and old harvesters expressed fraction of the total number of responses (%).

Machine	Harvester					
	New machines			Old machines		
Ergonomic Aspect	OK	NOK	NA	OK	NOK	NA
Cab Access	37	54	9	36	14	50
Work posture	66	25	9	36	18	45
Cabin	40	49	11	23	32	45
Visibility from cab	49	46	5	41	14	45
Seat	54	40	6	36	45	18
Controls	57	31	12	59	14	27
Operating the machine	49	29	22	50	27	23
Information	60	17	23	36	55	9
Noise	54	46	0	45	32	23
Vibration	51	40	9	36	32	32
Climate control	69	29	2	45	27	27
Gases & particulates	71	17	12	45	27	27
External lighting	63	37	0	45	41	14
Instructions & training	57	43	0	50	23	27
Maintenance	43	57	0	27	50	23
Brakes and operator safety	80	6	14	59	9	32
NB Topics in dark grey are perceived as the largest problems						

Operators of new harvesters are particularly discontented with the aspect cab access, cabin and maintenance. There is also evidence that the visibility from the cab, seat, controls, noise, vibration, external lighting and instructions and training are problematic aspects, accounting for over 30 % of the operators. However, as was observed for forwarders, some ergonomic aspects seem to have been improved in new machines. This is particularly noticeable for the seat, information, vibration, and external lighting. While over half of the operators of new and old machines are discontent with the maintenance of their machine, the proportion of satisfied operators has increased in new machines.

3.1.2 Cab Access

Cab Access				
Machine	Number of answers			
	OK	NOK	NA	% NOK
Forwarder	11	12	10	36
Harvester	29	19	15	30
Skidder	0	8	2	80

Most cited technical problems:

- Forwarders: Access is too dark at night (light required)
Ladders inadequate or not present
- Harvesters: Access is too dark at night (light required)
Ladders inadequate or not present
Inadequate handrails
First step too high
- Skidder: First step too high
Cab access too high
Straps and chains inadequate for mounting

Operator opinions:

Forwarder

- retractable stairs . a little dangerous frost or specially undercooled rain not so much to be done with that.
- SOGEDEP forwarder: the exhaust pipe is the only thing you can grasp when you climb on the stair!
- A remote control for lighting the access to the cab on mornings when it is dark.
- too high The first footstep should be lower and mounted on a hydraulic jack.
- better stairs .
- There should be lighting when arriving in the mornings.
- use of wheels for mounting, too dark
- better access means greater the chance of knocking the step off.

Harvester

- flexible solution good.
- Better handle placement . It was even worse on the old machine, it has become better.
- OK ladder and handles I think the access to that is very easy. big door no objects that you knock against. .
- A lift
- Automatic foldable ladder better and more stable.
- External lighting sensitive to the operator approach (sensors?)
- But there is still no lighting system for accessing the cab when it is dark (I need a torch as I can switch on the light only when I am in the cab).
- too high The first footstep should be lower
- A direct access to the cab.
- Better handrail & stair / Have lightened steps.
- should not have to use wheel A ladder all the way from the ground to the door
- A ladder all the way from the ground to the door
- Access too high retractable ladder OK handrail.
- better step into cab, risk of slipping, dark.It is often dark when coming to the job and leaving the job. ladder mostly need improvement, dangerous
- bands and chains on Valmet undesirable
- Could improve having a ladder that is not damaged easily.

Skidder:

- too high solid and rigid step instead of a flexible strap.
- doors are too heavy and they can't be kept open, dangerous when you climb in or jump out especially when you work in slope.
- Lower the cab floor. Doors should be more easy to close (in slope, as doors are heavy, it is not easy to close them).
- Hydraulic stair. A lower and telescopic bottom step.

3.1.3 Work posture

Work posture				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	16	5	12	15
Harvester	34	11	18	18
Skidder	1	1	8	10

Most cited technical problems/solutions:

- Forwarders: Tilting or swivelling seat required
Fixed posture required
- Harvesters: Automatic levelling
Forearms on armrests

Operator opinions:

Forwarder:

- Need system so that you had to leave the cab once each hour, walk around the machine or something Usually you drive three hours without a brake, and that is not OK.
- too monotone
- monotonous while seated. The boom control could be in some sort of pointer or be controlled with one hand or something. harvester occupy same posture all day
- improvement e.g comfortable sitting position expensive.
- Harness for seats, work done on armrests.

Harvesters:

- Body restraint to avoid unhealthy seat positions
- More exercise required
- OK when level. NOK when sloped produced tensions.
- uncomfortable. It's a problem to sit the whole day.
- would like forearms lying on the armrests and fingers falling directly on the controls (relaxed forearms and wrists).
- legs bent too much (need to stretch them) à the seat should be more forward.
- arm rests could be improved.
- more comfortable to stand upright.

Skidders:

- avoid twisting the body and the neck when we have to move the machine backwards.

3.1.4 The cabin

Cabin				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	14	11	8	33
Harvester	22	23	18	46
Skidder	0	7	3	70

Most cited technical problems:

Forwarders: Cab too small

Harvesters: Cab too small

Not enough storage space

Skidder: Cab too small

Operator opinions:

Forwarders:

- more storage space. Space for my bag.
- Selflevelling required
- too small. It should be possible to open the windows.
- A better protection system against the sun
- too small Presently, if you want to stretch your legs, you have to open the door.
- too small for persons over 1,80. if you want to stretch your legs, you have to open the door Upwards and to the sides very
- more storage space for meal bag.
- forwarder digger too small for sitting in all day, 48 hrs wk in a digger/harvester is quite rough (he's 6'2").

Harvesters:

- more protection from sun. But without losing visibility Sunscreens
- too small, more storage space required when you sit there and have your meal, you want to have more space around you. In exactly that cab.
- need to have feet higher optional to use fingers so avoid sitting in a fixed position the whole day: Move your feet and do everything with the fingers. I have spoken with many who would like to be able to have the feet in a high position.
- cupholder would be OK
- Windows reflect a lot. Antireflection windows better.
- more storage space Central locking for cab doors and storage compartments. Remote control for the circuit connection system, cab lighting and doors locking.
- tiltable and selflevelling
- pneumatic suspension of the cab.
- No more problems of water infiltration.
- too small uncomfortable. Limits movement

- too small, not enough room for the legs.
- more storage space for binder for written material.
- too small in Rottne 2004. It is the smallest Rottne machine.
- too small, more storage space for meal bag. Ponsse room is OK
- too small. little refrigerator more food storage space.

Skidder:

- too many sharp edges dangerous in rough terrain.
- too small, more storage space
- too small stretch the legs
- Improve insulation (as on farm tractors). Have doors mounted on jack (for an hydraulic closure).
- improved design to increase protection from sun.
- use of unbreakable glass, not LEXAN which produces static electricity (which keeps dust).

3.1.5 Visibility from the cab

Visibility from cab				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	17	8	8	24
Harvester	31	21	11	33
Skidder	0	7	3	70

Most cited technical problems:

Forwarders: Crane/boom obstructs view
Posts obstruct view

Harvesters: Install a rear view camera
Crane/boom obstructs view
View obstructed by the base of the crane

Skidder: Inadequate rear visibility

Operator opinions:

Forwarders:

- The crane should be out of direct sight
- boom annoys.
- reverse view camera screen isn't correctly placed in my cabin; on the outdoor camera problem with condensation mornings (night humidity). Another problem: when I work with the front decking blade in a low position, I cannot see it from the cab!
- The posts of the cab obstruct the visibility in thinning.
- cab posts should be in a transparent material
- rear view camera required
- rear view obstructed There are some dead angles on the cabs of today backwards where the posts are.

Harvesters:

- A helicopter Plexiglas bubble
- The front window should start deeper.
- Windscreen wipers should be added on side windows
- A front camera should be added to be able to see what happens in first thinning for example, the base of the crane obstructs visibility and it is a problem to see well and process the trees in the row which has to be removed.
- in first thinning: the base of the crane obstructs visibility and it is a problem to see well and process the trees in the row which has to be removed (then I have to move a little my harvester on the side to continue to work).
- Selfcleaning windows.
- crane pillar obstructs view (it just in front of the operator!)
- rear view camera required
- You have a boom in front of you. The boom could be at the side instead or behind or on the top. I have no experience from having the boom on the side.
- Snow and dust may give sight problem.
- only one way to look out terrible
- Could always have more visibility.

Skidder:

- reverse visibility should be improved (the winch is an obstacle so I have to open the door to have a look back when I have to drive back!) and on the sides, in the lower part.
- visibility problem in rear direction
- Reverse view, A 360° automatic rotation seat, for a reverse driving. Improving the position of the windscreen wipers. Deicing windscreen. Improving lights protection (to avoid condensation).
- Reverse view, Need to have 2 real driving stations (1 forward, 1 backward)

- Increase glazed surface.
- windscreen wipers with intermittent movement. I want windscreen wiper on back glass.
- Have sliding doors that we can keep open during the work for a better visibility.

3.1.6 The seat

Seat				
Machine	Number of answers			% NOK
	OK	NOK	NA	
Forwarder	17	7	9	21
Harvester	29	27	7	43
Skidder	0	9	1	90

Most cited technical problems/solutions:

- Forwarders: Increased comfort
Electrical adjustability
- Harvesters: Memory seats
Better adjustability
Improved shock protection
Provide a harness
Levelling seat required
Provide back support
- Skidder: Improved shock protection
Swivel seat
Improve durability

Forwarders:

- When it comes to the Valmet NOK. The levers ... It does not fit. Many have complained about that.
- A large ventral belt is very good, for safety but above all for comfort (the back is fixed into the seat better for back health). But a complete belt (like in cars, or a kind of harness) would probably be even better.
- More height adjustment I would like to have my feet "in suspension in the air" when I operate the machine
- Have a seat that automatically adjusts to the operator weight (aircushion)? (Airsuspension?). Have a harness .
- seat should have a lot of adjustments. It should be possible to varies so you sit comfortably and reduce pressure on the arm.
- OK when new but after time they start to wear as you are rocking and bouncing around you get slap in the seat and sometimes it fairly jolts your body. I don't see any way to improve this problem except renew the seat.

Harvesters:

- "rolling" chair so you have a more stable position when you sit down, more support on the sides.
- more side padding. Support in the small of the back. So you are not flung around.
- It should be possible to adjust seat to suit your back air cushions in the seat adjusted individually.more possibilities for adjusting armrests and also a memory system. When we are two operators, and not two persons are similar when it comes to construction. .
- Ventilated seats are a must.
- better shock protection
- Seat should be electrically adjustable. More possibilities of adjustment. A "memory".
- Should have better shock protection, tilt system. self-levelling system if the cab is not.
- Should have a headrest and harness to have the back tight in the chair.
- Should have bucket seat / a harness for steep terrain.
- Personal made to measure seat. Anti jerk system to avoid shakes when the crane is working. Have a harness.
- more adjusting possibilities similar to truck seats.
- It is possible for us to get what seat they like and change. If the seat is not OK you have to change it. You change chair after about a year.
- too weak. The possibilities of adjustment, the spring system, the pads. If you want to pay you certainly could get better, but that should be standard equipment.
- They have situp from Gustafs. There is a problem that there is not any real risen and lowering chair but only the shock absorbing being adjusted.

Skidder:

- Should be softer and more comfortable.
- The seat deteriorates quickly with time.
- Should be more ergonomic and more adjustable.
- Add safety belt. Seat too low. Use more resistant fabrics.
- Should have a 180° swivel chair.
- Should have better shock protection
- Should have a hydraulic or air-suspension seat (similar to farm tractors)

3.1.7 The controls

Controls				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	19	4	10	12
Harvester	34	15	14	24
Skidder	0	8	2	80

Most cited technical problems/solutions:

Forwarders: Nothing outstanding, some would like minilevers others complain about them

Harvesters: Better to group important commands

Reduce the number of buttons

Bigger joysticks

Skidder: Radio control

Joysticks on armrests

The problems or suggestions for improving the controls vary considerably, indicating that there is no one outstanding problem associated with the controls. Many of the answers show that personal preference plays an important role here. The preference for “joysticks on armrests” was put forward by operators of new skidders.

Operator opinions:

Forwarders:

- Hard to operate.
- Any suggestions for improvements? Caterpillar, steering of the machine in two different ways. Valmet, only one. No possibilities to vary. When it comes to turning.
- I don't like mini joysticks: with them, movements of the crab aren't so soft.
- Have more sensitive controls (to just move the wrist and not all the arm).
- Could be better, too delicate and too small.
- Before we operated one being all flat. Then we angled it up and it became much better. It became much better as you reach there with the fingers in all another way. It is a small thing.
- NOK I have bear paws, prefer mini levers

Harvesters:

- The number of buttons that are operated all the time ought to be reduced.
- prefer “a negro scull”
- You need warm hands.
- Ok big levers, I find them better.
- too complicated (to avoid having to press 3 buttons in the same time)
- commands should be grouped in the same place, for an easier and permanent check.
- Have a sensitive and AZERTY type keyboard, a mouse very close to the joystick (as on PONSSE), a better visibility of all the controls / components (some controls are too far away from others).
- controls should be grouped on the joystick
- pedals should turn with seat / command by voice system for the horn, the stair, the lights, the helpbrake, etc...
- movable mini joystick for steering so that I don't always have to reach for it in the same direction.
- Many controls are monotonous. Monotonous positions.
- Moment could be improved, fewer buttons.
- controls need to be standardised.
- Better access to tuning/graining control systems.
- Could be better. better layout of buttons

Skidder:

- Should have integral radiocontrol (= a remote control for operating the winch and moving the machine) but the system is too much expensive.
- NOK better arrangement, In the cab, the winch commands are very bad situated.
- Distance between controls and seat should be reduced.
- Joysticks (even the one controlling gears) should be on the armrests.
- All the controls (including the steering wheel) should be grouped on the joystick.

3.1.8 Operating the machine

Operating the machine				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	18	4	11	12
Harvester	33	17	13	27
Skidder	1	4	5	40

There is no one outstanding suggestions for improving machine operation among forwarder and harvester operators. Almost every dissatisfied participant has an own individual solution. Skidder operators all agree that they would prefer the operation to be “smoother”.

Operator opinions:

Forwarder

- First gear is too slow; the second gear is too fast.
- Have both a normal clutch and a hydrostatic system (choice). Have a levelling system for the woodbasket (but manually controlled, not automatic).
- In my machine you get movements into the cabin. It is not very stable and the movements easily transfer to the controls.
- . It's a frame steered machine which is not as OK as the county especially on steep banks.
- a lot of computers on board these type of machines and you can tune the controls quite easily nowadays. To set the controls was quite hard, because you don't know what they do, there are that many functions to alter you didn't know which ones to alter. You pick it up as you go along

Harvester

- should have measurement system
- need a head up display
- Suspension system for cabin would allow better driving on roads. Regulation of wheel pressure does not work. To hard for driving on road.
- When I drive back the harvester (seat in inverted position), I can't see the notice board and the control panel.
- self levelling system required
- Crane movements should be “smoother”.
- “walking machine” would be good
- A better grip on the ground in steep terrain (larger tires, stronger axle).
- should be more powerful.
- More automatic reverting to original position of e.g., crane.
- foot pedal for steering, differs between different operators. At least you have the opportunity to choose.
- You have a boom in front of you. The boom could be at the side instead or behind or on the top. I have no experience from having the boom on the side.
- Preferably I would like to have a hovering machine. It is always difficult when finding your way in the terrain.
- There is too much movement in the controls.

Skidder

- Require smoother steering and operation

3.1.9 Noise

Noise				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	10	18	5	55
Harvester	31	24	8	38
Skidder	2	7	1	70

Most cited technical problems/solutions:

Forwarders: Too noisy
Improve soundproofing

Harvesters: Too noisy
Improve soundproofing

Skidder: Improve soundproofing

Operator opinions:

Forwarders:

- NOK 98-99 model forwarder. Too noisy. Valmet harvester OK The Valmet runs fairly silently because motor is at the rear and you sit in the front, but the Caterpillar, the forwarder, is noisy.
- Should be lower, Vent should be more silent
- Sound insulation almost too perfect: if there is a suspect noise (from the crane for example) I am not sure I will be able to hear it and then detect some trouble
- It is acceptable but could be improved.
- Too high.

Harvesters:

- too noisy
- Could from time to time be lower. It is not annoying. Far from that.
- Improve noise insulation of the cab. It is not much noise, but it can be better.
- It could have been lower. Has it been measured? No, that has not been done..
- vent should be more silent
- Should be lower
- Too high, especially on roads
- Could be better. It makes too much noise

Skidder:

- cab is very noisy.
- improve soundproofing, fumes pipe should be moved away from the cab.
- more efficient silencer on exhaust pipe.
- improve soundproofing.

3.1.10 Vibration

Vibration				
Machine	Number of answers			% NOK
	OK	NOK	NA	
Forwarder	12	12	9	36
Harvester	28	21	14	33
Skidder	1	3	6	30

Most skidder drivers are not satisfied with vibrations in their machines. Here it would be interesting to know whether the low number of answers to this question indicates that the problem is not of importance to skidder operators.

Most cited technical problems/solutions:

Forwarders: Needs improvement (air suspension, etc)
8- wheels

Harvesters: Needs improvement

Skidder: Needs improvement

Operator opinions:

Forwarders:

- Shaking when you drive, when you drive on a poor road or in the terrain. I have been driving six-wheeler and eight-wheeler, the eight-wheeler is much more stable. It is a big difference..
- Problem is underestimated and causes diseases. Problem not well analysed and lacking information for the operators.
- Suspension should be improved, especially for periods driving on forest roads or skidding paths.
- Too many vibrations especially in the seat.
- Should be reduced, cab should be mounted on a kind of air suspension system.
- pendulous cab better.
- Increase number of silent blocs. Reduced tyre pressure.
- part of the job. jolting as you are driving in the wood, shock when you are tapping up the load and stacking on the trailer, so I suppose you are getting vibration then. make cab mountings shock absorbent. New machine no problems, everything was tight, after 6000 hours things are starting to wear. Changing cab mounting rubbers has helped the vibration.

Harvesters:

- Some sort of damping and have the cabin on a horizontal level.
- Require suspended cabin.

- Could be improved, e.g. by suspension system
- depends how you drive..
- Cab suspension should be improved (too rigid)
- Pendulous cab.
- A system against jerks that occur when crane is working.
- Have pneumatic suspensions/better seats/Stop the jerks due to crane with special systems on seat or on crane articulation/ lower pressure tyres.
- I hope that they have got rid of vibrations now that they build the machines eight-wheeled. The current machine stand shakes all the time, as soon as you move the boom the cab shakes.
- Vibrations could be better. A stand operating machine you move a lot. Since it is light it easily becomes a little unstable when driving long distances.
- The vibrations are too big..

Skidder:

- Increase number of silent blocs.
- too many vibrations when engine turns at low rate (have to accelerate to limit them).

3.1.11 Information

Information				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	13	11(9)	9 (11)	33 (27)
Harvester	33	22 (17)	10 (50)	35 (27)
Skidder	1	4 (1)	5 (8)	40 (10)

The data indicate that most forwarder and harvester operators are satisfied with the information they receive from the machine. However, some answers suggest that the question was not always understood in the intended sense. Subtracting these answers reduces the discontented forwarder and harvester operators to 9 and 17 respectively (number in brackets), thus increasing the proportion of contented operators.

Once again there is no outstanding problem concerning the information provided in the machines. Among harvester operators from Poland there is a definite problem with understanding the English computer program. Some harvester operators also expressed an interest in GPS as a means of providing information about the working site.

Operator opinions:

Forwarder

- Should have an integrated phone that doesn't interfere with onboard computers.
- However good the computer works, it doesn't help in a situation where meters give a wrong reading. Measurements must be right .
- up to date and regular information required
- Some information (pressure, temperature, water level...) is visible only when the chair is in the driving position.
- better marking of buttons
- Luminous alarms and indicators turn less and less visible with time.
- A weighing system should be added
- machine computer program not translated.
- small things. the alarm does not set off until the levels are so low that it locks. It sounds, but then you do not get the time to read what is written. On the former we had to attest the alarm.
- The computer could be better at telling what is wrong when alarming

Harvester

- Most of the information you have on the PCscreen. Things I miss voltmeter there are also other things, but I think these are on the new model.
- You have access to information when you bring the instruction manuals to the machine. There you can find the information yourself.
- More, long term, acoustic signals, more diagrams are better to read
- They are also very OK concerning electronics and hydraulics.
- Would like permanent information about important controls as gauges, before the emergency signal sets off
- computer should record and print details of operating time (effective work, time of displacement of the machine, time of displacement of the crane, maintenance time, breakdowns...)
- Information on the screen is not easy to read on the TIMBERJACK 1110 (black and white screen! No colours!)

- Alarm sound too loud. When driving in reverse (seat in inverted position), I can't see the notice board and the control panel
- Be regularly provided with information on new machines.
- A powerful integrated phone (8 watts), with the hands free system. GPS to see limits of the working sites, water catchments, streams, etc.
- A projection system ("retrovision"?) to read on the windscreen important information like temperature of oil and water, oilgauge, etc... / GPS to calculate distance between landing area and working site, etc...
- The computer should indicate the location of electric lines, steep terrain, or other important points on a drawing (pre established by the supervisor for example). A "bip" should be emitted every time the machine process a log of a different grade than the precedent one.
- onboard walkie talkie required to communicate with colleagues working on the same forest site (better planning).
- fault finding Computer.
- machine computer program not translated.
- I get the information from the machine. sometimes a little bit too much. Superflous info
- enough information simplified would be better.
- better manual and information for the machine, like monitoring fuel usage and more accurate of level of estimating production.

Skidder

- The manual should me more detailed and illustrated.
- More information should be provided for "classical" breakdowns (with figures of the hydraulic and electrical system).
- more information about new machines on market.

3.1.12 Climate control

Climate control				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	13	14	6	42
Harvester	35	17	10	27
Skidder	1	5	4	50

Most cited technical problems/solutions:

- Forwarders:** Require automatic temperature control
Improved adjustability
Need an air conditioner
Needs improvement
- Harvesters:** Require automatic temperature control
Needs improvement
Poor cooling
Need an air conditioner
- Skidder:** Require automatic temperature control
Need an air conditioner

Operator opinions:

Forwarders:

- Require a sophisticated airconditioner with real temperature control.
- Caterpillar airconditioning is very poor. It gets extremely hot on warm days. Special sun blinds help. But you get very hot.
- Better adjustment
- risk that it is too warm or cold.
- ok but the access to change the filter is uneasy
- would like programmable system for preheating engine and other before I come and start my job in the field
- Temperature control should be automatic..
- Require a sophisticated air conditioner..
- It should be possible to have ECC – electronic climate control.
- During summertime you would prefer it cooler. It is difficult to cool when there are so big windows. Sun blinds
- I do not like blinds and try to work with my back to the sun
- Never heard of it, draughts under the door. Could be warmer.

Harvesters:

- Would like cooling fans in the chair, both seat and backrest. In the summer you have airconditioning.

- In the summer too weak.
- That also works, anything else would not be possible. If it doesn't work, it is repaired..
- Would like a proper air conditioning system, with automatic temperature regulation.
- Airconditioning, which is essential during several months of the year, really needs to be improved! .
- Temperature control should be automatic.
- A sophisticated airconditioner / Have a protection film against the sun that does not interfere with phones and the electronic.
- problems with reliability when the system is working

Skidder:

- would like air conditioning system for summer
- Not very important for a skidder: important to be able to close door in winter.
- very important for a skidder must be improved.

3.1.13 Exposure to gases and particulates

Gases & particulates				
Number of answers				
Machine	OK	NOK	NA	% NOK
Forwarder	15	6	12	18
Harvester	37	12	14	19
Skidder	0	2	8	20

Again this does not seem to be an important problem among forwarder and harvester operators. The majority seem content with their machine in this respect. The very low number of responses from skidder operators suggests that this is not a major problem.

Most cited technical problems/solutions:

Forwarders and harvesters: Better filters
Dust in the cabin

Operator opinions:

Forwarder:

- Have read that particulates are a risk for the lungs.
- special filters for dust and pollen.
- It is only a question of changing the air filters when you are supposed to.
- We have filters for particulates in the cab. The problem is dust. We clean the machine once a week at least inside the cab. You get clay on your feet. These things come through the door.
- If you are exposed to gas then something is wrong with the exhaust and get it sorted.
- You do get smells coming through the cab. at the moment I am using biodegradable hydraulic oil, I think it's leaking through the spool valve which is right in front of the rear forwarder window, so it must be coming through the cab vents. It's noticeable when she gets hot. When it's cold or windy you don't get it. It does stink but not as bad as diesel.

Harvesters:

- It smells when you have a small leakage of hydraulic oil, but that is an advantage because then you have the chance to do something with it at once. Particles. They have made some studies in Sweden on filters, and it turns out that some particles get through, but is not possible to take note of it. It is a big difference of the types of filters.
- Sometimes you smell exhaust. It could have been better quality of the filtration of air entering the cabin. You can have better filters, but I have heard that the price is extreme.
- I have more problems with dry air inside, my eyes are itching
- Air filters could be better accessible.
- No gasses. The air conditioner blows dust around..
- Ventilation on the SIFOR should be improved: the air flows from the motor to the cab and pollutes the driver
- During the summer, dust enters into the cabin à it would be necessary to improve the sealing of the cabin
- Add filters (against pollen).
- There were bad air filters from the beginning, but they are bad maintenance as well. a lot of dust can enter in the summer when there is a lot of dust.
- The filters are bad positioned. Operators do not sweep the cabs.
- The filters are bad.
- Air conditioning sucks air in at the side of the cab which is on top of all the hydraulics and you have a constant smell of hydraulic oil which can't be very OK for you

Skidders:

- The cab is very badly isolated from gases and particulates.

- With a proper air conditioning system, it would be possible to keep the doors closed when working in summer, and then to reduce the exposition to gases and particulates.

3.1.14 External lighting

External lighting				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	19	5	9	15
Harvester	31	24	10	38
Skidder	1	6	3	60

The overwhelming majority of forwarder operators are satisfied with the external lighting of their machine. The answers indicate that the installation of xenon lights has greatly improved matters. While most harvester operators are also content with the external lighting, there is more dissatisfaction than among forwarder operators. Skidder operators seem to be most dissatisfied with their lighting system.

Most cited technical problems/solutions:

Forwarders: rear lights
 Harvesters: needs improvement
 xenon lamps
 number of lights
 Skidder: number of lights
 Better protection
 Arrangement

Operator opinions:

Forwarders:

- Xenon lights required
- Ok but you should not work in times when it is necessary to use it. (exception: autumn) Bad for operator and forest. Operator should sleep, forest is easily damaged. In Sweden lighting would not be sufficient because there are more monocultures and clear cuttings.
- Extra lights should be mounted on the sides and in the rear of the machine frame, to lighten the path.
- Require lights at the back of the woodbasket for reverse motion.
- The back lighting should be improved. The visibility in the night is too much limited.
- probably OK if you have gas discharge lamps.

Harvesters:

- I can get gas lamps as extra, but it is a question of costs. But you don't have that? No, it is 40000 extra, and I drive most of the time when it is daylight, and therefore I did not invest in that..
- It could be better. There are many solutions on the market. We operate mostly in daytime.
- Xenon lights should be used on all machines Better lights
- Xenon lights standard, the boom should reflect less light
- Spot lights fixed on the machine would be useful, you don't have to remove every time. But light is bright enough.
- Extra lights should be mounted on the frame at the rear of the machine.
- more lights, we have to work when it is dark: we had to add lights on the base of crane and on the second pivoted arm of the crane.
- Have lights at the top of the crane to see the grapple.
- Mount lights on the 2 external front corners of the cab, to lighten the area around 45° right and left (presently we have lights in the front and on the sides of the cab).
- We should have powerful lights and more lights on the first part of the arm crane.
- Could be better with better lamps. Today we have combined halogen lamps and gas lamps has improved, but could be little better.
- Maybe lights right on the tail end of your trailer. Reversing in the dark it is very difficult to see.

Skidder:

- number of lights should be higher. Lights should be added on the rear frame (on the fairlead / butt pan).Improving lights protection (to avoid condensation).
- Light glass should be changed (less opaque) to increase the distance of visibility.
- Lights should be added to lighten the wheels (à to see the ground we are moving on) and also to lighten the way (in the front)..
- Lights should be mounted in better locations and more resistant (regarding shocks etc).

3.1.15 Instruction & training

Instruction & training				
Machine	Number of answers			% NOK
	OK	NOK	NA	
Forwarder	11	14	8	42
Harvester	33	21	9	33
Skidder	0	7	3	70

Most cited technical problems/solutions:

- Forwarders: inadequate training
More courses and special training
- Harvesters: inadequate training
Inadequate instructions e.g. for computers and aggregates
- Skidder: Inadequate instructions

A number of machine operators also pointed out that the translations of the guides and manuals are insufficient.

Operator opinions:

Forwarders:

- very bad. The contractor was with me for an hour, and then he left. Had a little follow-up the next day, half an hour. Have you any suggestions how this could have been organised in a better way? 1. start with being a "passenger" for one day. 2. next day you could start driving part of the time with an instructor who could give you tips about your driving. 3. start operating the machine more and more, but still have someone to follow you up. When I had been driving some weeks, then an instructor was with me some hours, and that was of great value. Many things that I was wondering about that he could give me ideas about. But you learn by trying for yourself, and the skill develops all the time. And you find out which questions to ask. However, if you start driving forwarder, it goes fairly fast to learn how to operate the harvester. I operated harvester one or two days first and then I operated forwarder one and half a year. Then it was much easier to start with the harvester again. Then you have developed the movements how to operate of the crane, and that is easier to learn on the forwarder because the grip is easier to operate than the processor head.
- That can always be better. Regardless how OK it is, you can always learn something new when you have the chance to attend a course or similar things. No one can say that he is totally educated. Then he has nothing more to do here..
- Once you have been in a machine for long enough you know the basics and most machines are very similar except new controls and training branch are more than capable of showing you
- NOK - Instruction manual with it, we bought it and picked it up as we went along really, with support from forestry operators with regards to this frame steering, guidance on where to turn and move. I'm afraid we learnt as we went along.
- Instructions and training from the machine manufacturers could be much better. At Timberjack you may choose to have a training program when buying a new machine. It is the only manufacturer the contractor knows having anything like that. From Gremo there came a guy one day when I bought the new machine.
- Instructions in the book are incomplete. The list of spare parts references should be translated in French.
- The manual for users and the manual for maintenance should be translated in French.

Harvesters:

- The training of the drivers should be improved so that they can control all the functions of the working station (the computer).
- insufficient instructions It was a mechanic who was with me when we started up, and that was it. Else we have had contact over the telephone if it has been anything special. Do you find it was sufficient? It was Ok then and there, but you never get enough information. Especially when it comes to the use of the data system. How to adjust the aggregate and other things. They could be better to inform you.
- Machine dealers should carry out a better follow up of the machines they sell.
- Needed for the in-board computer utilization.
- Improve training of the drivers, especially on on-board computer (to detect breakdowns) and maintenance.
- The training of the driver should be improved so that he feels more at ease when operating the machine, and in order to avoid problems.
- Always room for improvement.
- Have a better training on the computer and about the maintenance when we buy the machine
- Cat has bad books. They are in English. Education is possible to buy. We bought computer training to the harvester. Otherwise we have had the same machines for a long time..

- Sometimes it's difficult to understand the technical guide instructions as the translation in French is not correct
- The manual is sometimes bad translated and difficult to understand..
- Questionable. But it is also a question of price. I had an instructor for two days to learn how to handle the computer and other things, but mostly you have to learn by yourself. You don't remember everything either. In Sweden they have a course lasting a week, but when you have to pay for it yourself

Skidder:

- Bad translation in the technical guide + all caution stickers (on the machine) are in English!
- The technical guide should be more detailed. Instructions concerning maintenance should be more detailed in the guide.
- The buyer / user of the machine should be given the same detailed technical guide than mechanics of the repair shops.
- Bad translations and not enough explications in the manual guides..

3.1.16 Maintenance

Maintenance				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	12	14	7	42
Harvester	23	31	9	49
Skidder	0	7	3	70

This seems to be problem area for all forest machines

Most cited technical problems/solutions:

- Forwarders: Centralized greasing system
Access to maintenance points is too difficult/dangerous (esp. filters, sumps)
- Harvesters: Access to maintenance points is too difficult/dangerous (esp. filters, sumps)
Centralized greasing system
Reduce frequency of periodic maintenance
Ground-level access to maintenance points
General improvement
- Skidder: Access to maintenance points is too difficult/dangerous (esp. filters, sumps)
Operators should not have to screw away metal plates for accessing maintenance points

Operator opinions:

Forwarders:

- You have to be aware. dangerous when you are going to lubricate the crane. You climb over wheels, jump here and there - dangerous. There should be a safer way.
- The access to high pressure filters and lubrication points should be easier.
- automatic lubrication system like on public work machines. But this would perhaps bring a risk: if I do less maintenance, I will perhaps miss to detect the beginning of breakdowns.
- Centralized greasing system. Better protection for all the hosepipes.
- There is lack of instructions in Polish language.
- Have a better access to the sump plug.
- There are always some parts placed narrowly.
- You have to climb on the back wheels in order to fill it up. Better from ground level. Risk of accident sooner or later.
- central lubrication needed

Harvesters:

- Require central lubrication, but I don't know if it is possible. We have central lubrication on the top of the crane. Big advantage, don't have to climb to the top of the machine.
- Certain mechanical parts should be improved, as their accessibility and their replacement process (filters for example).
- Some components could be better located so that it is easier to reach them: oilfilter, diesel filter, the filling in of motoroil. More open ...often very narrow where you have to stand. You need treefour extra joints on your arms and fingers. maintenance, that could be better. Where the components are located.
- NOK position of the diesel filter. Each week you must empty the water separator in the diesel filter. It is situated in such an awkward way, that when you finally have loosened the screw it pours down and inside your jacket. Things like that should have a better location. system for central lubrication. Instead of climbing about on the

machine. When it is snow and ice on the machine, it is a little bit unpleasant to operate alone in the forest when the others have left.

- maintenance points should be located so that you could reach them when you stand on the ground. It should be possible to have them lowered so that you don't have to climb on the machine.
- Access to gauges, tanks and lubrication points should be easier on the TIMBERJACK 1110
- too much climbing on the one we have now, when we change filters and similar things. There has been large improvement in new machines. Our machine we have now is only two years old, but much has happened.
- Just one difficulty: climbing on the top of crane.
- central lubrication. Frequency of periodic maintenance should be reduced.
- The access to the maintenance points should be easier.
- Make easier the maintenance of the crane (today I have to climb in the crane! Make easier the access to the hydraulic filters and hosepipes too
- The machines could be maintenance free, if I had to wish. The machines could be more operationally reliable..
- accessibility. The placing of filters. Belly sheetings you have to move. better if operated hydraulically or electrically. The positions often are stupid laying on the ground under the machine taking up heavy things by hand.

Skidder:

- A few greasing points are very badly located. I also have to move a very heavy sheet of metal when I have to change the oil.
- The access to sump plugs is not easy. Fill up (with fuel) isn't easy either.
- The accessibility to the maintenance points is very bad. These maintenance points should also be centralised.
- The access to the maintenance points should be easier. The frequency of service should be reduced.
- central lubrication. We should not have to take apart sheets of metal to change the oil.

3.1.17 Brakes and operator safety

Brakes & operator safety				
	Number of answers			
Machine	OK	NOK	NA	% NOK
Forwarder	15	5	13	15
Harvester	42	4	17	6
Skidder	1	2	7	20

Most forwarder and harvester operators are content with this aspect of the forest machine. The very low number of responses from skidder operators suggests that this is not a major problem.

The problems cited by the operators are often related to the inferior quality of the brakes in older machines or in very specific models. No ranking of the answers was possible.

Operator opinions:

Forwarders

- A large ventral belt is very good, for safety but above all for comfort (the back is fixed into the seat - better for back health). But a complete belt (like in cars, or a kind of harness) would probably be even better.
- sometimes unreliable
- stability of the machine could be greatly improved.
- Should have better brakes: they really bad on this Bell forwarder when I work in slopes.
- The safety needs to be increased. Windows too thin. chain shoots have been more of immediate interest now. It works well. It is the chain shoots that are debated today but I have never had such problems

Harvesters

- More powerful brakes.
- Should have an alarm system in case we reverse.

Skidders

- Cables should be more resistant and less heavy.
- Brakes should be more powerful and more resistant.

3.1.18 Responses to the additional technical questions

Q1: Have you a self-levelling system on your machine? Do you think it is necessary?

Table 8: Summary of responses categorized according to type of machine

All machines	Possession of self levelling system			Necessity of self-levelling system		
	Yes	No	NA	Necessary	Not necessary	NA
Forwarder	2	30	1	13	5	15
Harvester	32	29	2	29	7	27
Skidder	1	9	1	0	0	11

The responses to these questions reveal that most forwarder operators do not have a levelling system, although most do see the usefulness of such a system. About half of the harvesters have a levelling system, most operators want it.

The high proportion of No Answers to the second part of the question, suggests a degree of uncertainty among the operators of whether levelling is necessary or not. Approximately 40 of the forwarder and harvester operators state clearly that such a system is necessary.

Table 9: Summary of the responses by operators of new machines

New machines	Possession of self levelling system			Necessity of self-levelling system		
	Yes	No	NA	Necessary	Not necessary	NA
Forwarder	1	17	1	9	2	8
Harvester	26	9	0	21	3	11
Skidder	1	2	2	0	0	5

Table 10: Summary of the responses by operators of old machines

Old machines	Possession of self levelling system			Necessity of self-levelling system		
	Yes	No	NA	Necessary	Not necessary	NA
Forwarder	2	9	0	5	1	5
Harvester	12	10	0	7	4	11
Skidder	1	5	0	0	0	6

Comparing the results between old and new machines (tables 9 and 10) reveals that most new harvesters are equipped with a levelling system. Only about half the older harvesters possess such a system. This trend towards equipping new machines with levelling systems is not followed by forwarders. Most old and new forwarders do not have a levelling system. Operators in new machines are more keen to have self-levelling systems.

When regarding the results from this type of question it is necessary to bear in mind that the responses depend on the terrain the operators usually work. Experience shows that many who do not have a self-levelling system or who do not think it is necessary work in level terrain.

Q2: Would you like to have automatic functions in the forest machine such as automatic felling by the harvester or automatic unloading of the forwarder?

Table 11: Distribution of responses by all operators (% of total)

Machine	Yes	No	NA	Total
Forwarder	37%	50%	13%	100%
Harvester	26%	68%	5%	100%
Skidder	18%	64%	18%	100%

Table 12: Distribution of responses by operators of old machines

Machine	Yes	No	NA	Total
Forwarder	27%	45%	27%	100%
Harvester	27%	64%	9%	100%
Skidder	0%	83%	17%	100%

Table 13: Distribution of responses by operators of new machines

Machine	Yes	No	NA	Total
Forwarder	42%	53%	5%	100%
Harvester	26%	71%	3%	100%
Skidder	40%	40%	20%	100%

One third of forwarder operators are in favour of automation, one fourth of harvester operators. Scrutinising the responses given to this question (found in the appendix) reveals that many forwarder operators think that automatic unloading is useful in theory but will not be practical where more than one type of timber is involved. Typical critical answers are:

“I can't really envision that it could work, prefer to do these things manually.”

“I am doubtful about automatic functions. It may be expensive to keep running and much could be faulty. Some single moments may be reduced, but it probably is difficult to have it to work in thinning and seed tree standings. It could give some relief. In forwarders it probably is difficult to get it to work as you make such blended loads with many assortments”

“If they had automatic unloading they would want you to do more. If you have not reached your capabilities after 10 years I don't think you should be on a machine”

“No, I can't understand how that should be, to say it like that. Felling is so simple as it is now, I would say. It is only to position the processor head against the tree and press a button, and the tree falls down. Automatic unloading, what do you mean by that? That the crane goes by itself? Explanation. You have so many strange landings, so that would not function ... and so we drive so many loads with different assortments, so that would create many strange situations.”

“No, you're taking the challenge out of the task, you need control, and you need something to do.”

Some forwarder operators who welcome more automation also voice some doubt, whether automation will always be of use:

“Something that would do it for you do you mean? It would be great, it sounds OK, it would be less work for the operator. I don't know how it would work, especially when you have to grade timber.”

“Would be great but it is not possible with our number of assortment.”

Many forwarder and harvester operators feel there is too much automation of work processes already. Some think that the felling process is too dangerous and unpredictable to be carried out automatically. An operator can react to problematic situations. Among harvester operators there is a general feeling

that automatic systems are more likely to breakdown and that the ensuing repairs will be costly. Some also think that increased automation will take the fun out of the job:

“No, I don’t think so. We must have some control with the felling. But we have some automatic devices on the machine we have now, among others on the crane. The tower is automatically tilted – it is level all the time. We can turn it off when we operate with manual control – but we use it most of the time. It is only when we work with windthrows, then it is an advantage to use manual control. Then you can reach a little longer upwards on the slopes. It seems that very few harvester operators are interested in automatic felling. No, so much happens during the felling: If the trees are not too big, everything runs smooth, but when something seems to go wrong, you have to have the control.”

“It’s difficult to imagine more automation because here we have to process a lot of different products per working site (logs with different lengths, different grades...).”

“No I don’t want too many automatic commands, I prefer keeping the manual control.”

“I think automatic felling by the harvester is very dangerous. I talked to many operators and they think the same. Automatic unloading of the forwarder is a very OK solution if you have only one kind of forwarded wood.”

“No. It would take the fun out of the job, and be unsafe, I wouldn’t like to rely on automation to do the job for me.”

“Even more? No, no, there are enough.”

Similar arguments are also voiced by the skidder operators. The majority of machine operators, who answered the question, did not qualify their negative standpoint on automation.

3.2 Evaluation of Questionnaire Results

3.2.1 Response rate

Table 14: Total number of responses to the questionnaire

Machine type	Total number of responses	Responses from operators of old machines	Responses from new machine operators
Forwarder	95	39	56
Harvester	180	73	107
Skidder	25	19	6
Total	300	131	169

Although 359 operators returned the ErgoWood questionnaire, 59 interviews did not fulfil the basic requirements to be considered in this section. All questionnaires where the participant failed to provide information about the age of the machine and type of machine were not included.

This table summarises the number of responses from the various forest machine operators. The total number of responses can be a useful basis for estimating the importance of a particular aspect to the operators. A low number of responses to a question possibly indicate that this question is not considered important to this group of operators.

3.2.2 Ranking of measures to improve work related health

Question. *Based on your current practices, which of the following aspects offers the best potential for improvement in work-related health?*

- ergonomics
- technology
- organisation of work practices or employment conditions
- my own behaviour
- others, namely _____

Table 15: Preferred measures to improve work related health

Operators	Ergonomics	Technology	Organisation of work	Own behaviour	Others
Forwarders	56	48	31	53	More variation, work rotation, high performance demand
Harvesters	115	89	66	91	Thought processes, ensure reasonable payback, well-being, train sports, profitability, variation, economy
Skidder	10	16	11	11	Pay, better wages
All	181	153	108	155	

The forest machine workplace consists of a variety of aspects that each contributes to the well being of the operator. Multiple answers were therefore possible to this question (total number of responses therefore in excess of total number of respondents). The answers indicate that the operators generally feel that improving the ergonomics and the technology are most likely to lead to an improvement in the workplace. However there is also a high degree of self criticism in the answers, since a large proportion of the operators are also aware that changing their own behaviour is very likely to also enhance their well-being. The operators also suggested other aspects that would improve this workplace. All answers are listed in the table. According to these operators, economical issues as well as a less monotonous workplace are most likely to contribute to improved health.

3.2.3 Ranking the need for automatic functions

This set of questions is aimed at assessing the degree of process automation required by the forest machine operators. The absolute number of responses are found in the appendix. For a better overview of the results the numbers were converted to percentages. Tables 16, 17 and 18 summarise the overall responses by the machine operators.

A comparison of the number of unanswered questions gives some indication of the relevancy of the corresponding processes in the everyday work of the operators. Most forwarder operators responded to the parts related to locomotion and the boom/grapple, while less than half responded to the questions about the harvester head. Skidder operators mostly answered those parts related to machine locomotion. Less than half responded to boom and grapple questions and only a quarter answered the harvester head questions. In contrast to this, the majority of harvester operators expressed an interest in all three aspects.

Table 16: Forwarder operators responses to question “rank your need or wish of automation of the following functions of a forest machine” in %.

	No need	Some need	Great need	NA	Total
The locomotion					
Automatic detection and avoidance of hindr./obstacles	54	29	8	9	100
Advanced steering system (by vision, voice or other)	61	20	6	13	100
Electronic stability system for faster driving	31	43	14	13	100
The boom and the grapple					
An automatic boom tip control instead of today’s manually operated functions in the boom	55	28	8	9	100
Automatic boom-out to next tree/log pile by use of a pointer	55	28	7	10	100
A fit-in function controlling the gripping of the stem	49	33	6	13	100
Automatic return of the grapple to last position	48	30	9	14	100
Automatic unloading from the bunk at the landing	51	23	15	11	100
The harvester head					
A reliable non-touch measuring of the stem	13	17	14	56	100
Automatic felling of the tree	19	14	9	58	100
Automatic slip avoidance control when feeding the tree through the harvester head	6	16	22	56	100
<i>NB Dark grey, least needed innovation.</i>					

About one third of the forwarder operators expressed some need for automation, mainly an electronic stability system for faster driving.

Table 17: Harvester operators responses to “rank your need or wish of automation of the following functions of a forest machine “ in %.

	No need	Some need	Great need	NA	Total
The locomotion					
Automatic detection and avoidance of hindr./obstacles	63	28	6	3	100
Advanced steering system (by vision, voice or other)	58	30	7	5	100
Electronic stability system for faster driving	27	46	24	3	100
The boom and the grapple					
An automatic boom tip control instead of today’s manually operated functions in the boom	57	26	10	7	100
Automatic boom-out to next tree/log pile by use of a pointer	61	27	7	6	100
A fit-in function controlling the gripping of the stem	48	30	13	9	100
Automatic return of the grapple to last position	60	21	7	12	100
Automatic unloading from the bunk at the landing	53	20	13	13	100
The harvester head					
A reliable non-touch measuring of the stem	17	22	48	13	100
Automatic felling of the tree	50	26	9	15	100
Automatic slip avoidance control when feeding the tree through the harvester head	12	30	46	12	100

NB Dark grey topics, least needed innovation.

To the harvest operators the most demanded areas of innovation is an electronic stability system for faster driving, a reliable non-touch measuring system, and an automatic slip avoidance. Areas least in need of development are automatic detection systems for driving, automatic boom-out and automatic return of the grapple to the timber pile.

Table 18: Skidder operators responses to “Rank your need or wish of automation of the following functions of a forest machine” in (%) .

	No need	Some need	Great need	NA	Total
The locomotion					
Automatic detection and avoidance of hindrance/obstacles	36	29	11	25	100
Advanced steering system (by vision, voice or other)	43	18	18	21	100
Electronic stability system for faster driving	29	25	25	21	100
The boom and the grapple					
An automatic boom tip control instead of today’s manually operated functions in the boom	11	7	18	64	100
Automatic boom-out to next tree/log pile by use of a pointer	18	11	7	64	100
A fit-in function controlling the gripping of the stem	18	11	7	64	100
Automatic return of the grapple to last position in ...	18	7	14	61	100
Automatic unloading from the bunk at the landing	14	7	14	64	100
The harvester head					
A reliable non-touch measuring of the stem	7	0	7	86	100
Automatic felling of the tree	7	4	4	86	100
Automatic slip avoidance control when feeding the tree through the harvester head	7	4	4	86	100

Skidder operators are mostly interested in the aspects concerning the locomotion of the machine and 50% expressed a need for an electronic stability system for faster driving. This need is thereby shared by operators of forwarders, harvesters and skidders.

3.2.4 Means of entering and leaving the cabin

How do you want to enter and leave the cabin?

- Answer 1 By a proper stair with a handrail
 Answer 2 By a ladder directly to the door
 Answer 3 I can walk and climb on tyres or tracks

Table 19: Means of entering and leaving the cabin, operators of old machines

	Answer				Total
	1	2	3	NA	
Forwarders	19	16	1	3	39
Harvesters	32	37	3	1	73
Skidders	10	8	1	0	19

Table 20: Means of entering and leaving the cabin, operators of new machines

	Answer				Total
	1	2	3	NA	
Forwarders	27	24	0	5	56
Harvesters	39	60	7	1	107
Skidders	2	2	1	1	5

The answers to this question indicate that the preferred means for accessing the cabin is by stair with a handrail or by a ladder. There is some indication that forwarder operators prefer a stair to the ladder, whereas harvester operators seem to prefer a ladder. The table of the results also indicates that skidder operators agree with these trends. The operators' preferences do not depend on the age of the machine.

3.2.5 Seat elevation

Question. How high do you wish to elevate your chair?

- 1 I want to work sometimes in a stand up position
 2 I want to be able to sit higher than normal sitting
 3 I prefer sitting with my thighs in a horizontal position
 4 I prefer sitting in a lower position

Table 21: Seat elevation preferred by operators of old machines

Old machines	Answers			
	1	2	3	4
Forwarder	3	12	27	3
Harvester	10	18	60	5
Skidder	3	7	9	2

Table 22: Seat elevation preferred by operators of new machines

New machines	Answers			
	1	2	3	4
Forwarder	5	17	34	2
Harvester	5	23	77	7
Skidder	0	2	2	1

Operators were able to express several preferences when answering this question. The following graph shows the distribution of responses on the basis of the total number of responses for each group (Table 14, page 22). The responses indicate that forwarder and harvester operators prefer to sit with their thighs in a horizontal position. However, over 30% of the forwarder and skidder operators also stated a preference for a higher than normal sitting position when operating the machine. There is no real difference between old and new machines.

3.2.6 Cabin space

Question. *Is it important for you to be able to stretch your legs out straight when sitting in the cab?*

- 1 No, it is not important to stretch my legs out straight
- 2 Yes, but it is enough if I can do that into a corner of the cab
- 3 Yes, it is important to stretch my legs straight out in front of me in the cab

Table 23: Cabin space needed, old machines

	Answers				Total
	1	2	3	NA	
Forwarder	3	18	17	1	39
Harvester	7	17	46	3	73
Skidder	3	6	9	1	19

Table 24: Cabin space needed, new machines

new	Answers				Total
	1	2	3	NA	
Forwarder	2	29	23	2	56
Harvester	11	36	58	2	107
Skidder	0	3	2	1	6

The vast majority of operators want to be able to stretch their legs in the cabin (Answer 2 and 3) Most harvester operators would like the possibility of stretching their legs out in front of them. A large proportion of skidder and forwarder operators would also be content with being able to stretch their legs into the corner of the cabin.

3.2.7 Horizontal leveling preferences

Question. *What kind of horizontal levelling of the work place do you prefer?*

- 1 None
- 2 The seat
- 3 The cab only sidewise
- 4 The cab only lengthwise
- 5 The cab sidewise and lengthwise
- 6 The whole machine only sidewise
- 7 The whole machine only lengthwise
- 8 The whole machine sidewise and lengthwise

Table 25: Fraction of responses to question F4 by operators of new and old machines (% of total)

	1		2		3		4		5		6		7		8	
	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New
Forwarder	28	18	28	34	5	5	3	0	10	20	0	5	0	0	23	11
Harvester	7	2	11	12	8	4	0	5	47	45	1	5	0	0	22	22
Skidder	26	0	16	17	5	17	0	0	5	0	5	0	0	0	16	33

NB Shaded areas represent preferred means of horizontal levelling

The responses to this question indicate that most forest machine operators require some form of levelling. The general overview of the results shows that most operators reject a unidirectional levelling system (lengthwise or sideways) of the cab or the seat. Harvester operators clearly prefer a levelling cab or machine. Forwarder operators do not appear to have a clear preference for a levelling system. A levelling seat, cab or machine are acceptable options. However, there is a significant fraction of forwarder operators who do not see a need for a levelling system at all. There is also no clear preference for a levelling system among skidder operators. A levelling seat or machine are practical options.

Comparing the results between operators of old and new machines illustrates a difference of opinions. The proportion of forwarder and skidder operators who do not require a levelling system is higher among those with older machines. New skidder operators all agree that a levelling system is necessary and over 30% state that the system should level the whole machine. Even taking into consideration that the sample numbers are low, this seems to indicate a change of opinion among the operators. There is also an increase in the proportion of operators with new forwarders who would prefer a levelling cab. However, these still represent less than 20 % of the all answers. Over 30% would prefer a levelling seat.

3.3 Seminar Results

Because of the different scope of the topics dealt with in the various seminars, the results summarized here are mainly a reflection of the opinions voiced in the French and German seminars which focused specifically on technical ergonomic matters.

This section attempts to review the opinions voiced during these seminars. The following table summarizes these opinions. In most cases the first viewpoint concerning a particular aspect corresponds to the opinion that was mentioned most frequently. The succeeding opinions are usually only mentioned once and are often related to specific problems in the particular country (for example, deficient French translations of the manuals).

The contributions by the seminar participants were very varied. In some cases the ergonomic aspect was discussed in terms of a problem that needs to be solved, without actually putting forward a means of improvement. Thus there is not always a suggested improvement for each problem discussed. In other cases a problem discussed in one seminar is put forward as an improvement in another, once again highlighting the differences in opinions among the participants.

Work posture and gases and particulates were not discussed at all, indicating that these are not considered priority problems.

Table 26: Summary of problems discussed during the seminars

Aspect	Problems discussed	Improvements discussed
Cab access	Dangerous steps due to dirt Exposed steps are easily torn off Steps blocked by toolbox Inadequate handrails in sloped terrain	Installation of self-cleaning steps Cable steps First step semi rigid and retractable (skidders) Hydraulic ladder
Work posture		
Cabin	Cabin too small Lack of storage space for personal belongings Food is warm by lunchtime Operator dazzled by sun Manufacturers do not react to operator requirements Loss of feel for ground in Pendo cabin	More space in cabin More storage space Cool box required Better sun protection Levelling in all directions/Pendo cabin
Visibility	View obstructed to one side in some machines Crane obstructs in forwarders OPS structures obstruct view Dead angle due to exhaust (Skidders) View of wheels obstructed in some cases View obstructed by added structures View of tree crowns only possible in a forced position	Rear view camera Unobstructed view of wheels must be tested, also in steep slopes Levelling must allow view of all wheels even on steep slopes
Operator seat	Back problems common Complicated seat adjustment Seat belts are rarely used (skidder)	Better seat adjustment Memory seat Safety harness (skidders) Adjustable seat belts Adjustable armrests
Controls	Drivers often ignore adjustability	Integral radio control desired (skidders) Better positioning of camera/computer screen
Machine operation	Automation means loss of concentration Standard pictograms are not used	Suitable automation with possibility of intervention by operator Standardised arrangement of important control elements Weight measuring system/automatic classification of logs (forwarders) Automatic adaptation of saw to measured tree size
Aspect	Problems discussed	Improvements discussed
Information	Computers too complex	Buzzers required for reversing
Noise		needs improvement

Vibration	Operators are not protected from shock vibration Operators are subject to extreme shocks (boom work)	Research on shock tolerance limits specifically for forest machine work Shock absorption for cabin Seat damping reduces driver fatigue Include shock test in machine test procedures
Climate control	Unequal temperature distribution Noisy air-conditioning In some cases high air speed	Improved air-conditioning Fresh air inlets higher up the machine
Gases and particulates	Inadequate air filtering	Better air filter
Lighting	Lighting inadequate in all directions (skidders) Badly protected lamps	Xenon lamps
Instructions and training	Badly translated instructions (France) Spare parts list not translated (France) Inadequate training in fault diagnosis Basic training in hydraulics, mechanics, forestry for operators (France) Replacement parts list and maintenance manual too complex	Improved translation and organisation of documentation Improve information (and training) on the importance of adjustments Better training for computer Brief instructions for maintenance work Use of new generation simulators for training
Maintenance	difficult access to maintenance points (filters, lights, hydraulics) Most accidents happen during maintenance and repair work Too few steps for maintenance work No storage space for ladder Gas springs for floor panels too weak Hoods too heavy Central greasing system leads to reduced machine checking Residual pressure in the hydraulic system is dangerous during maintenance Fuel tanks exceed legal size (France) Fuel barrels transported on the vehicle (France) Changing wheels without crane very difficult (skidders)	More steps for difficult to access parts of the cabin (screens, lights) More steps and platforms Improved gas operated springs More remote greasing points, no central greasing system

3.4 Summary of interview and seminar results

Table 27: Summary of principal interview and seminar results

Ergonomic aspect	Interview results				Seminar results	
	Machine type	Discontented %	Problems	Suggested improvements	Problems discussed	Suggested improvements
Cab access	Forwarder	36	Access too dark Ladders inadequate or not present		Dangerous steps due to dirt Exposed steps are easily torn off	Installation of self-cleaning steps Cable steps
	Harvester	30	Access too dark Ladders inadequate or not present			
	Skidder	80	First step too high			
Work posture	Forwarder	15		Tilting seat Fixed posture required		
	Harvester	18		Automatic levelling		
	Skidder	10				
The cabin	Forwarder	33	Cab too small		Cab too small. Lack of storage space for personal belongings Food is warm by lunchtime	Larger cabin More storage space Cool box Levelling in all directions desired /Pendo cabin
	Harvester	46	Cab too small Not enough storage space			
	Skidder	70	Cab too small			
Visibility from cab	Forwarder	24	Crane/boom obstructs view		Rear view obstructed Free view to wheels improves handling	Rear view camera Unobstructed view of wheels must be tested, also in steep slopes
	Harvester	33	Crane/boom obstructs view			
	Skidder	70	Inadequate rear visibility			
The seat	Forwarder	21		Better comfort Better adjustability	Back problems common Complicated seat adjustment	Memory seat Better seat adjustment Safety harness (skidders)
	Harvester	43		Memory seats Better adjustability		
	Skidder	90		Improve shock protection Swivel seat		
The controls	Forwarder	12			Drivers often ignore adjustability	Integral radio control (skidders) Better positioning of camera/computer screen
	Harvester	24		Group important commands Reduce number of buttons		
	Skidder	80		Radio control Joysticks on armrest		
Ergonomic aspect	Interview results				Seminar results	
Operating the machine	Forwarder	12			Automation means loss of concentration	Suitable automation with possibility intervention by operator Standardised arrangement of important control elements Weight measuring system/automatic classification of logs (forwarders)
	Harvester	27				
	Skidder	40		Smoother operation		
Noise	Forwarder	55	Too noisy	Improve soundproofing	Noisy air-conditioning	Needs improvement
	Harvester	24	Too noisy	Improve soundproofing		
	Skidder	70	Too noisy	Improve soundproofing		
Vibration	Forwarder	36		Needs improvement	Operators are not protected from shock	Shock absorption for cabin
	Harvester	33		Needs improvement		

	Skidder	30		Needs improvement	vibration Operators are subject to extreme shocks (boom work)	Research on shock tolerance limits specifically for forest machine work
Information	Forwarder	41			Computers too complex Forest workers near machine may overlook reversing machine	Require buzzers for reversing
	Harvester	34				
	Skidder	50				
Climate control	Forwarder	42		Automatic temperature control	Unequal temperature distribution	Improved air-conditioning
	Harvester	27		Automatic temperature control	Dust in the cabin	Fresh air inlets higher up the machine
	Skidder	50		Automatic temperature control		
Exposure to gases and particulates	Forwarder	18	Dust in cabin	Better filters		
	Harvester	19	Dust in cabin	Better filters		
	Skidder	20				
Ergonomic aspect	Interview results				Seminar results	
External lighting	Forwarder	15		Rear lights	Lighting inadequate in all directions (skidders) Badly protected lamps	Xenon lamps
	Harvester	38	Too few lamps	Xenon lamps		
	Skidder	30	Too few lamps	Improve protection		
Instruction & training	Forwarder	42	Inadequate training	More courses and special training	Badly translated instructions (France) Spare parts list not translated (France) Inadequate training in fault diagnosis	Improve information (and training) on the importance of adjustments Better training for computer
	Harvester	33	Inadequate training Inadequate instructions			
	Skidder	70	Inadequate instructions			
Maintenance	Forwarder	42	Access to maintenance point too difficult/dangerous	Central greasing system	Difficult access to maintenance points (filters, lights, hydraulics) Too few steps for maintenance work Most accidents happen during maintenance and repair work Weak springs	More steps for difficult to access parts of the cabin (screens, lights) More steps and platforms Improved gas operated springs
	Harvester	49	Access to maintenance point too difficult/dangerous	Central greasing system Reduce frequency of periodic maintenance		
	Skidder	70	Access to maintenance point too difficult/dangerous	Prevent necessity of removing metal plates for access		
Brakes and operator safety	Forwarder	15				
	Harvester	6				
	Skidder	20				

Table 29 summarizes the responses and the solutions provided by the operators in the interviews and the seminars. The evaluation of the data from all sources shows that maintenance is a major problem that affects the forest machine operator irrespective of the machine type.

A comparison of the opinions of operators with old and new machines revealed that many a large proportion of the old machine group did not respond to the questions put forward by the interviewee. The comparison indicates that operators in new forwarders experience less problems regarding seat, operating the machine, vibration, noise and maintenance. New harvesters seem to have improved significantly in brakes and operator safety, external lighting, exposure to gases and particulates, noise, vibration, information, seat, and work posture.

New ergonomic problems emerge. Cab access and information are reported as problematic in new forwarders. In new harvesters the visibility from the cab, cab access, the cab and maintenance are reported as problems.

The detailed analysis of the interview responses, carried out in chapters 3.1.2 to 3.1.17, also supports the observation that contentment with a particular aspect depends on the machine type. The following table summarizes the results from the analysis.

Table 28: Overview of the degree of contentment among forest machine operators

Ergonomic aspect	Forwarders	Harvesters
Cab Access	--	-
Work posture	+	+
Cabin	-	--
Visibility from cab	+	-
Seat	+	-
Controls	+	+
Operating the machine	+	+
Information	-	-
Noise	--	+
Vibration	-	-
Climate control	--	+
Exposure to gases & particulates	+	+
External lighting	+	-
Instructions & training	--	-
Maintenance	--	--
Brakes and operator safety	+	+
NB (-) indicates that over 35% of the operators are dissatisfied (--) means that the majority have problems with this aspect. (+) indicates that over 65% of the operators are content with this aspect		

Forwarder and harvester operators are discontent with maintenance, but to a certain extent also with cab access, information and vibration. Forwarder operators are also explicitly discontented with cab access, noise, climate control and instructions and training. Harvester operators are specifically dissatisfied with the cabin, seat and external lighting.

Many operators, especially of harvesters, criticized the size of the cabin in the interviews and seminars. The questionnaire results confirm this observation showing that most operators want to be able to stretch their legs in the cabin. Interestingly forwarder operators would be satisfied with the possibility for stretching their legs into a corner of the cab, but harvester operators want to be able to stretch their legs out in front. The lack of storage space for personal belongings as well as tools and other equipment is also a common problem in harvester cabs.

The additional question in the interviews concerning automation reveals that most harvester operators do not want automatic felling. Among forwarder operators the opinions are near equally divided between opponents and proponents. When questioned about the possibilities for automation the operators stated that an electronic stability system for faster driving could be beneficial. Most forwarder operators see no great need for automating any other of the work processes. Many harvester operators see a need for a reliable non-touch measuring of the stem and an automatic slip avoidance control in the harvester head.

Many operators from non-English speaking countries state that the manuals, instructions and spare parts lists are either not available in their language or badly translated.

The interview and seminar results also reveal a number of relatively simple changes on the machine that would lead to a significant improvement:

- Installation of Xenon lights (white light)
- More storage space for personal belongings in the cab
- Installation of self-cleaning steps

Discussion

The responses from all machine operators and the analysis in this report is an important contribution in the production of the new ergonomic guidelines for forest machines. On the one hand, the study indicate that a number of ergonomic aspects are of no great concern to the operator. For example work posture, operating the machine, exposure to gases and particulates and brakes and operator safety were generally felt to be adequate. This is probably a result of the recent advances made in forest machine design. From the operators' point of view, manufacturers must modify other ergonomic aspects in the future design of the machines.

Data interpretation

The results from the questionnaire identify a number of problems involved in interpreting the data. The difficulty arises when considering the high number of not answered sections of the interview. The tendency to interpret this as an indication of the unimportance of the particular section to the everyday work of the operator cannot be proven. However, the fact that the aspects that collected the most positive responses (OK), for example gases and particulates also collected the highest number of "no answers" (NA) seems to corroborate this interpretation. However many other factors such as misinterpretation of the question or general disinterest can be the reason behind an operator failing to answer a question.

The interpretation of the results from the comparison between opinions from operators with old and new machines is associated with a high degree of uncertainty. This is due to the fact that a large proportion of the operators with old machines did not respond to the questions. In some cases as much over 50 % of the operators failed to forward an opinion.

Overall contentment

The first result of this study shows that many forest machine operators are content with most of the ergonomic aspects of their machines. Many operators have changed from older machines and can now enjoy the benefits of the newer models with their improved ergonomics. This is also corroborated by the results for the interviews, which indicate that operators rate the ergonomics of the newer machines more positively. However, the responses in the interviews and the seminar contributions show that much still remains to be done. Operators, even those who are content, will often suggest a means for improving aspects of the machine ergonomics. However the majority of opinions and suggestions for improving the various aspects of the forest machine workplace come from the less content operators. Many problems are related to particular machine types.

The universal installation of white (xenon) lamps and self-cleaning steps and platforms are among the relatively simple solutions to the needs of the operators. Other problems associated with the forest machine require more complex restructuring and design solutions, such as increasing the length of the cabin and including more storage space for personal belongings, and improving the maintenance of the machine. Maintenance is a common problem among the forest machine operators.

New harvesters

This study also reveals that new machines still have ergonomic problems. This is particularly so for cab access in forwarders and harvesters, which seem to be better in the older machines. In view of the high risk of accidents when entering and leaving the cabin, the perceived problems of the cab access in new harvesters and forwarders warrants a closer look at the ergonomics of this aspect. The visibility from the cab is also seen as a problem in new harvesters, as is the information available in the cab of new forwarders. One possible explanation for the latter observation may be that the on-board computer are complex to use and that more computer training is required. This would also tie in with the observation that instructions and training is among the aspects that had most negative answers among new machine operators. Badly translated computer programs also contribute to this observation.

The technical ergonomic standard of skidders is extremely low compared with that of harvesters and forwarders. The results from this study suggest that further developments are needed in area.

Translations

A manual, computer program or spare parts list that is badly translated or only available in a foreign language seems to be a source of annoyance among many of the non-English speaking operators. It is easy to see how the stress levels of a non-English speaking operator will increase when attempting to troubleshoot a machine using a manual in a foreign language. An ergonomic test must include a check whether all vital information is presented in the native language of the customer.

Automation

The questionnaire results show that many operators see a need for an electronic stability system, a non-touch stem measuring system and an automatic stem slip avoidance control for the harvester head. Surprisingly many of the harvester operators, 35 – 40%, are positive to an automatic boom-tip control and functions following that development. A fit-in function controlling the gripping of the stem is desired by 39% of the harvester operators.

However, automatic processes must be reliable and support productivity. Many see no necessity for automation, since it cuts the amount of control an operator want to have has over the work process. Many operators feel that the automatic felling could lead to dangerous situations, for example where trees would fall in unpredictable directions. Most operators agree that automatic unloading of the bunk may be a good idea in uniform stands and single grade logs. The large proportion of scepticism among the operators stems from the fact that many work in mixed stands, deal with irregularly shaped trees or need to sort differently graded wood while unloading.

Another desired improvement is a self-levelling system for reducing the time spent in an awkward seating position. There is some evidence that once an operator works with a machine equipped with a self-levelling system, he will tend to think that this feature is absolutely necessary. The need of a self-levelling systems are much more prevalent among harvester operators then among forwarder operators. Harvester operators are very clear about their preferred type of levelling. Anything but a levelling machine or cab would not meet with much approval. Forwarder operators are rather more uncertain as to the preferred levelling system. A levelling seat would be acceptable. This may reflect the fact that many do not have experience with a levelling system.

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ISBN 91 7614 093 8

ErgoWood website: <http://www2.spm.slu.se/ergowood/index.htm>. Details of the structure and contents of the seminars, questionnaires and interviews are located on the private area of this website.

Appendix

Summary of absolute numbers of operators categorized according to the age of the machine

Ergonomic Aspect	Operators of new machines			Operators of old machines		
	OK	NOK	NA	OK	NOK	NA
Cab Access	28	23	8	10	10	21
Work posture	34	10	15	13	6	22
Cabin	23	25	11	8	15	18
Visibility from cab	28	26	5	13	10	18
Seat	32	20	7	11	19	11
Controls	32	16	11	18	10	13
Operating the machine	34	14	11	16	10	15
Information	27	20	12	14	15	12
Noise	28	25	6	13	19	9
Vibration	28	21	10	10	15	16
Climate control	32	20	7	15	15	11
Exposure to gases & Particulates	35	10	14	15	9	17
External lighting	36	15	8	17	14	10
Instructions & training	27	26	6	15	13	13
Maintenance	25	29	5	8	22	11
Brakes and operator safety	41	4	14	18	5	18

Summary of the absolute numbers of operator responses to the interview, categorized according to the machine

Machine	Forwarder			Harvester			Skidder		
	OK	NOK	NA	OK	NOK	NA	OK	NOK	NA
Cab Access	11	12	10	29	19	15	0	8	2
Work posture	16	5	12	34	11	18	1	1	8
Cabin	14	11	8	22	23	18	0	7	3
Visibility from cab	17	8	8	31	21	11	0	7	3
Seat	17	7	9	29	27	7	0	9	1
Controls	19	4	10	34	15	14	0	8	2
Operating the machine	18	4	11	33	17	13	1	4	5
Information	13	11	9	31	22	10	1	4	5
Noise	10	18	5	31	24	8	2	7	1
Vibration	12	12	9	28	21	14	1	3	4
Climate control	13	14	6	35	17	10	1	5	4
Exposure to gases & Particulates	15	6	12	37	12	14	0	2	8
External lighting	19	5	9	31	24	8	1	6	3
Instructions & training	11	14	8	33	21	9	0	7	3
Maintenance	12	14	7	23	31	9	0	7	3
Brakes and operator safety	15	5	13	42	4	17	1	2	7

Summary of the absolute numbers of forwarder operator responses to the interview, categorized according to the age of the machine

Machine	New forwarder			Old forwarder		
	OK	NOK	NA	OK	NOK	NA
Cab Access	7	9	3	2	3	6
Work posture	11	3	5	4	2	5
Cabin	9	6	4	3	3	5
Visibility from cab	11	4	5	4	3	4
Seat	13	1	5	3	5	3
Controls	12	2	5	5	2	4

Operating the machine	17	1	1	4	2	5
Information	6	9	3	5	2	4
Noise	8	8	3	1	8	2
Vibration	10	5	4	1	7	3
Climate control	8	8	3	4	5	2
Exposure to gases & Particulates	10	4	5	4	2	5
External lighting	13	1	5	5	3	3
Instructions & training	7	9	3	4	3	4
Maintenance	9	6	4	2	7	2
Brakes and operator safety	13	1	5	4	2	5

Summary of the absolute numbers of harvester operator responses to the interview, categorized according to the age of the machine

Machine	New harvester			Old harvester		
	OK	NOK	NA	OK	NOK	NA
Ergonomic Aspect						
Cab Access	13	19	3	8	3	11
Work posture	23	6	3	8	4	10
Cabin	14	17	4	5	7	10
Visibility from cab	17	16	2	9	3	10
Seat	19	14	2	8	10	4
Controls	20	11	4	13	3	6
Operating the machine	17	10	8	11	6	5
Information	21	6	8	8	12	2
Noise	19	16	0	10	7	5
Vibration	18	14	3	8	7	7
Climate control	24	10	1	10	6	6
Exposure to gases & Particulates	25	6	4	10	6	6
External lighting	22	13	0	10	9	3
Instructions & training	20	15	0	11	5	6
Maintenance	15	20	0	6	11	5
Brakes and operator safety	28	2	5	13	2	7

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ErgoWood

QUESTIONNAIRE FOR FOREST MACHINE OPERATORS

ErgoWood is a co-operation between six European countries: France, Germany, Norway, Poland, Sweden and United Kingdom.

The objective of this project is to give the European logging industry a better competitiveness through development of the organisation of logging operations and its machinery. The project intends to develop guidelines on ergonomic matters for users, buyers and manufacturers of forest machines.

This questionnaire includes the following parts:

- A. Personal background
- B. Work background
- C. Typical workday
- D. Current work
- E. Work organisation
- F. Technical ergonomics
- G. Sickness and fatigue
- H. Physical symptoms
- I. Psychosocial factors I
- J. Psychosocial factors II

You do not have to write your name on the questionnaire. It will be given a consecutive ID number. All answers will be treated confidentially and the results from the survey will be presented in such a way that it will be impossible to identify specific individuals. Note:

- There are questions on both sides of each page
- Please answer all questions
- Sometimes it might be difficult to find a suitable answer – then just tick the one that is closest or add an alternative of your own under ‘others’
- Throughout the questionnaire dot (●) means that you can tick more than one box
- Disregard that some questions seem to overlap each other

THANK YOU FOR YOUR TIME

GOOD LUCK!



To be completed by the ErgoWood field-worker

ID-number

Date (yy-mm-dd)

A. PERSONAL BACKGROUND

A1. When were you born? 19 _____

A2. What is your height? _____ cm

A3. What is your weight? _____ kg

A4. How many persons are there in your household?

_____ persons in total, including _____ under 15 years of age

A5. What kind of home do you have?

- | | | | |
|---|---|---------------------------------|--|
| <input type="checkbox"/> an apartment | ⇒ | <input type="checkbox"/> rented | <input type="checkbox"/> owned by you or your family |
| <input type="checkbox"/> a family house | ⇒ | <input type="checkbox"/> rented | <input type="checkbox"/> owned by you or your family |

A6. To what extent do you exercise regularly?

- Nothing really
- Warming exercise (long, fast walks, bicycling, etc)
- Physical exercise once a week
- Physical exercise more than once a week
- Physical exercise on an elite level

A7. How many years [did you go to](#) the ordinary school? _____ years

B. WORK BACKGROUND

B1. What vocational education and training in connection to machine operating do you have?
(The dots mean that you can tick more than one box)

- I am more or less self-educated/trained
- I have specialist education/training for my job (forestry, technical, etc)
- other, namely _____

B2. If you are a contractor: Have you had any business training?

- yes \Rightarrow _____ times _____ months in total
- no

To be answered by all:

B3. Please specify your professional experience:

(make sure that the sum approximately correspond to your time in working life)

- _____ years as a harvester operator
- _____ years as a forwarder operator
- _____ years as a skidder operator
- _____ years operating another type of machine, e.g. construction equipment
- _____ years as a power saw cutter
- _____ years in other manual work, requiring physical effort, which in itself results in physical tiredness
- _____ years in physical work, requiring very little effort and not in itself normally resulting in tiredness
- _____ years in a sedentary work
- Σ _____ years in total

B4. How long have you been in forestry all together,
including your apprentice time?

_____ years

If employee: How long at present employer?

_____ years

If contractor: How long in business?

_____ years

B5. Do you have any other work, additional to the one as forest machine operator?

- no
- yes What? _____

C. TYPICAL WORKDAY

The following questions are about your typical working day:

C1. Are there usually many interruptions or stops when operating machine?

Many Few

C2. How are working conditions on the whole?

Difficult Easy

C3. Does your work allow physical variation? (e.g. changes between standing / sitting / moving, working with different major parts of the body)?

Little Much

C4. How is the working pace on average during a working day?

High Low

C5. How interesting and stimulating is your working day?

Little Much

C6. Are you able to take breaks during the day when you feel the need to?

Seldom Anytime

C7. Are there possibilities for you to plan and organise your own work?

Few Many

C8. How varied are your work tasks during a typical day?

Little Much

C9. How does your body feel after a typical working day?

Fatigued Fresh

C10. How does your mind feel after a typical working day?

Tired Alert

C11. How is your typical working day from a social point of view?

Lonely Sociable

C12. How stressed do you generally feel when the working day is over?

Tense Relaxed

D. CURRENT WORK

D1. Specify the machine(s) you are mainly operating:

	Machine #1	Machine #2
a) Manufacturer	_____	_____
b) Type & Model	_____	_____
c) Model year	_____	_____
d) Years <i>you</i> have operated it	_____	_____
e) If harvester, which saw head?	_____	_____
f) Specify number of wheels or if it is continuously tracked:	_____	_____
g) Special equipment/extras:	_____	_____
h) Describe modifications, if any:	_____	_____
i) Why this modifications?	_____	_____

D2. In which type of organisation do you work?

<input type="checkbox"/> I am a self employed machine owner ...		
... and my company is/has ...	myself	<input type="checkbox"/>
	1-5 employees	<input type="checkbox"/>
	6-20 employees	<input type="checkbox"/>
	more than 20 employees	<input type="checkbox"/>
<input type="checkbox"/> I am a self employed machine operator running a machine belonging to ...		
... a private company or contractor with ...	1-5 employees	<input type="checkbox"/>
	6-20 employees	<input type="checkbox"/>
	21-100 employees	<input type="checkbox"/>
	more than 100 employees	<input type="checkbox"/>
... a state or other public organisation with ...	1-20 employees	<input type="checkbox"/>
	21-100 employees	<input type="checkbox"/>
	more than 100 employees	<input type="checkbox"/>
<input type="checkbox"/> I am permanently employed by ...		
... a private company or contractor with ...	1-5 employees	<input type="checkbox"/>
	6-20 employees	<input type="checkbox"/>
	21-100 employees	<input type="checkbox"/>
	more than 100 employees	<input type="checkbox"/>
... a state or other public organisation with ...	1-20 employees	<input type="checkbox"/>
	21-100 employees	<input type="checkbox"/>
	more than 100 employees	<input type="checkbox"/>

D3. Which of the following tasks do you do regularly? Which would you like to do in the future?

Task	This I do regularly	This I would like to do
Planning for the year ahead	<input type="checkbox"/>	<input type="checkbox"/>
Environmental concerns	<input type="checkbox"/>	<input type="checkbox"/>
Preparations		
- inspection of sites	<input type="checkbox"/>	<input type="checkbox"/>
- marking of bounds	<input type="checkbox"/>	<input type="checkbox"/>
- calculation of thinning grade	<input type="checkbox"/>	<input type="checkbox"/>
- marking of trees	<input type="checkbox"/>	<input type="checkbox"/>
- grading	<input type="checkbox"/>	<input type="checkbox"/>
- operational planning	<input type="checkbox"/>	<input type="checkbox"/>
Operate the forwarder	<input type="checkbox"/>	<input type="checkbox"/>
Operate the harvester	<input type="checkbox"/>	<input type="checkbox"/>
Operate the skidder	<input type="checkbox"/>	<input type="checkbox"/>
Operate other machines	<input type="checkbox"/>	<input type="checkbox"/>
Calibrating the measuring equipment	<input type="checkbox"/>	<input type="checkbox"/>
Sharpen chains	<input type="checkbox"/>	<input type="checkbox"/>
Maintenance	<input type="checkbox"/>	<input type="checkbox"/>
Repairs	<input type="checkbox"/>	<input type="checkbox"/>
Order supplies and spare parts	<input type="checkbox"/>	<input type="checkbox"/>
Move the machine between sites	<input type="checkbox"/>	<input type="checkbox"/>
Power saw cutting	<input type="checkbox"/>	<input type="checkbox"/>
Measuring the stacked volume	<input type="checkbox"/>	<input type="checkbox"/>
Marking special assortments	<input type="checkbox"/>	<input type="checkbox"/>
Reporting volume to forest owner	<input type="checkbox"/>	<input type="checkbox"/>
Planting	<input type="checkbox"/>	<input type="checkbox"/>
Pre-cleaning/ weeding	<input type="checkbox"/>	<input type="checkbox"/>
Cleaning	<input type="checkbox"/>	<input type="checkbox"/>
Fertilizing	<input type="checkbox"/>	<input type="checkbox"/>
Tree pruning	<input type="checkbox"/>	<input type="checkbox"/>
Control		
- biological/ silvicultural	<input type="checkbox"/>	<input type="checkbox"/>
- ecological	<input type="checkbox"/>	<input type="checkbox"/>
- economical	<input type="checkbox"/>	<input type="checkbox"/>
Discussions about contracts/deals	<input type="checkbox"/>	<input type="checkbox"/>
Contacts with the customers	<input type="checkbox"/>	<input type="checkbox"/>
Contacts with the public	<input type="checkbox"/>	<input type="checkbox"/>
Contacts with supervisors/managers	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>

D4. Do you mostly work with ...

- short wood pole lengths tree lengths
 other, namely _____?

D5. Do you work in a permanent team?

- no, mostly I work alone
 no, the teams change with contracts or jobs
 yes, we are ___ persons and ___ machine(s)
and we have been working together the last ___ years

D6. Which is your remuneration system?

- fixed salary
 fixed salary plus bonus
 hourly payment
 volume based payment
 other, namely _____

D7. If you have any kind of performance based payment, is it based on ...

- individual performance?
 team performance?
 enterprise performance

D8. Please tick the problems you experience in your work, if any:

- physically too demanding
- mentally too demanding
- working hours too long
- no career possibilities
- inadequate pay
- poor health and safety conditions
- organisation problems
- insecurity
- other _____

E. WORK ORGANISATION

E1. How many days do you usually work during a week? _____ days

E2. How many hours roughly do you work during an average working week? _____ hours

E3. How many weeks of holiday do you take during an average year? _____ weeks

E4. How and where do you usually eat your main meal during the working day?

- | | |
|---|---|
| <input type="checkbox"/> alone ... | <input type="checkbox"/> with colleagues ... |
| ... <input type="checkbox"/> at the work site | ... <input type="checkbox"/> at the work site |
| ... <input type="checkbox"/> in a restaurant or similar | ... <input type="checkbox"/> in a restaurant or similar |
| ... <input type="checkbox"/> at home | |

E5. How many nights per month do you spend elsewhere than home, when you are working?

- About _____ nights in a hotel/ boarding house
- About _____ nights in a caravan
- About _____ nights in _____?

E6. Specify how much you agree with the following within your company/organisation:

- Use the following codes:
- 5 = Yes, absolutely
 - 4 = Yes, probably
 - 3 = Uncertain
 - 2 = Probably not
 - 1 = Absolutely not
 - 0 = Do not know

STATEMENT	Code
1. When operators are employed, their state of health is considered	
2. Operators are trained in work techniques	
3. Operators are trained to understand and manage all aspects of machine operations as they affect operator health	
4. Managers are trained to understand all aspects of machine operations management as they affect operator health	
5. Senior/upper managers are trained to understand all aspects of machine operations management as they affect operator health	
6. Operators have regular health checks	
7. If operators get a health problem, actions are taken to identify the problem and if possible, to implement a solution	
8. Appropriate shift systems are used to break up machine operating periods when possible, e.g. moving from one machine to another	
9. Tasks are systematically altered to reduce the machine operating hours	
10. Total number of machine operating hours are restricted and controlled	
11. Machine selection and purchase is done with full consideration of operator ergonomics	
12. When maintaining the machines, attention is paid to maximizing operators' comfort/ergonomics	
13. When machine work is organised and planned, all aspects affecting health and ergonomics are taken into account	
14. The organisation at all levels supports change	
15. There is effective and open communication in the organisation	
16. There is long term planning for change and improvement in health management	
17. Operators are able to make decisions to ensure machine operations are managed effectively to maximise health protection	

E7. Does the organisation have systems to monitor and control the effective application of the statements 1–17, in the preceding question E6?

- yes
- partly
- no
- don't know

E8. Are the systems as at E7 effective in ensuring that good standards are achieved?

- yes
- no
- don't know

E9. Have you carried out targeted measures to improve your work organisation?

- yes, it involved people from within the company/organisation
- yes, with advice and/or support from external companies/advisors
- yes, by a continuous improvement programme
- yes, small individual improvements – not as part of a long term plan
- no

E10. Have you experienced any problems or resistance to changes in work organisation?

- no
- uninterested colleagues
- uninterested supervisors
- high performance demands
- lack of skills
- the remuneration system
- co-operation problems
- others, namely _____

E11. If there has been problems or resistance, has it

- prevented change
- delayed change
- not affected change

E12. Based on your current practices, which of the following aspects offers the best potential for improvement in work-related health?

- ergonomics
- technology
- organisation of work practices or employment conditions
- my own behaviour
- others, namely _____

F. TECHNICAL ERGONOMICS

F1. Rank your need or wish of automation of the following functions of a forest machine.

POSSIBLE AUTOMATIC FUNCTIONS	No need	Some need	Great need
The locomotion			
- Automatic detection and avoidance of hindrance/obstacles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- Advanced steering system (by vision, voice or other)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- Electronic stability system for faster driving	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The boom and the grapple			
- An automatic boom tip control instead of today's manually operated functions in the boom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- Automatic boom-out to next tree/log pile by use of a pointer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- A fit-in function controlling the gripping of the stem	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- Automatic return of the grapppler to last position in the timber stack	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- Automatic unloading from the bunk at the landing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The harvester head			
- A reliable non-touch measuring of the stem	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- Automatic felling of the tree	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- Automatic slip avoidance control when feeding the tree through the harvester head	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

F2. How do you want to enter and leave the cabin?

- By a proper stair with a handrail
- By a ladder directly to the door
- I can walk and climb on tyres or tracks

F3. How high do you wish to elevate your chair?

- I want to work sometimes in a stand up position
- I want to be able to sit higher than normal sitting
- I prefer sitting with my thighs in a horizontal position
- I prefer sitting in a lower position

F4. Is it important for you to be able to stretch your legs out straight when sitting in the cab?

- No, it is not important to stretch my legs out straight
- Yes, but it is enough if I can do that into a corner of the cab
- Yes, it is important to stretch my legs straight out in front of me in the cab

F5. What kind of horizontal levelling of the work place do you prefer?

- None
- The seat
- The cab only sidewise
- The cab only lengthwise
- The cab sidewise and lengthwise
- The whole machine only sidewise
- The whole machine only lengthwise
- The whole machine sidewise and lengthwise

G. SICKNESS AND FATIGUE

G1. In your main paid job, how many days over the past 12 months were you absent due to an accident at work? _____ days

G2. And due to health problems caused by work? _____ days

G3. And due to other health problems? _____ days

G4. How many days did you work in spite of the fact that you could/should have been on sick leave? _____ days

G5. Do you feel that working when not feeling physically fit impairs the quality and productivity of your work?

A lot Slightly

G6. Do you suffer from any symptoms like ...

- headache? If so, work related? no yes
- sleeping disorders? If so, work related? no yes
- other _____ If so, work related? no yes

G7. When do you consider yourself fully recovered after a working day?

- after a night's rest
- after a week-end
- after a week off or more
- after a longer vacation
- practically never

G8. Do you consider the balance between your job and your private time to be good?

- yes
- no

I. PSYCHOSOCIAL FACTORS I

How would you describe your work taken as a whole?

- Some questions may not be applicable to your situation -

I1.	Almost never	Seldom	Quite often	Often
Does your work require you to work very fast?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Does your work require you to work very hard?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Does your work require too much effort?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Do you lack enough time to get the job done?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Do conflicting demands occur in your job?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I2.	Almost never	Seldom	Quite often	Often
Do you learn new things in your work?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Does your work require skill?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Does your work require inventiveness?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Do you have variation in your work tasks?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Do you have the freedom to decide how to do your work?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Do you have the freedom to decide what to do in your work?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I3.	Totally disagree	Mostly disagree	Mostly agree	Totally agree
There is a calm and pleasant atmosphere at work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There is a sense of solidarity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My fellow workers support me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
They understand that I can have a bad day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I get on well with my superiors/managers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I get on well with my fellow workers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

J. PSYCHOSOCIAL FACTORS II

How would you describe your work taken as a whole?

- Some questions may not be applicable to your situation -

J1. To what extent can you decide the work pace yourself?

- | | |
|---------------------|--------------------------|
| To a high extent | <input type="checkbox"/> |
| Rather high extent | <input type="checkbox"/> |
| Some extent | <input type="checkbox"/> |
| Rather small extent | <input type="checkbox"/> |
| To a small extent | <input type="checkbox"/> |

J2. To what extent can you decide yourself how to perform your work?

- | | |
|---------------------|--------------------------|
| To a high extent | <input type="checkbox"/> |
| Rather high extent | <input type="checkbox"/> |
| Some extent | <input type="checkbox"/> |
| Rather small extent | <input type="checkbox"/> |
| To a small extent | <input type="checkbox"/> |

J3. To what extent can you influence the division of work tasks within your work-team?

- | | |
|---------------------|--------------------------|
| To a high extent | <input type="checkbox"/> |
| Rather high extent | <input type="checkbox"/> |
| Some extent | <input type="checkbox"/> |
| Rather small extent | <input type="checkbox"/> |
| To a small extent | <input type="checkbox"/> |

J4. How do you assess the contact and co-operation with your immediate superior/manager?

- | | |
|-----------------------|--------------------------|
| Very satisfactory | <input type="checkbox"/> |
| Rather satisfactory | <input type="checkbox"/> |
| Acceptable | <input type="checkbox"/> |
| Rather unsatisfactory | <input type="checkbox"/> |
| Very unsatisfactory | <input type="checkbox"/> |

J5. To what extent do you think your immediate superior/manager takes notice of your viewpoints and opinions?

- | | |
|---------------------|--------------------------|
| To a high extent | <input type="checkbox"/> |
| Rather high extent | <input type="checkbox"/> |
| Some extent | <input type="checkbox"/> |
| Rather small extent | <input type="checkbox"/> |
| To a small extent | <input type="checkbox"/> |

J6. How satisfied are you with the amount of information about your work that you get from your immediate superior/manager?

- | | |
|---------------------|--------------------------|
| Very satisfied | <input type="checkbox"/> |
| Rather satisfied | <input type="checkbox"/> |
| Neither ... nor | <input type="checkbox"/> |
| Rather dissatisfied | <input type="checkbox"/> |
| Very dissatisfied | <input type="checkbox"/> |

J7. To what extent do you think your work is interesting and stimulating?

- To a high extent
- Rather high extent
- Some extent
- Rather small extent
- To a small extent

J8. How would you describe your work?

- Varied and consisting of many different work tasks
- Rather varied
- It can be both monotonous and varied
- Rather monotonous
- Very monotonous

J9. How do you usually feel about your work on your way there?

- Feeling good and content at the thought of the interesting work that awaits me
- Feeling positive at the thought of work
- Feeling neither positive nor negative at the thought of work
- Feeling some uneasiness at the thought of work
- Feeling strong uneasiness at the thought of work

J10. How do you assess your relationship with your closest fellow workers?

- Very good
- Rather good
- Acceptable
- Rather bad
- Very bad

J11. To what extent do you feel that you belong to a pleasant work-team that work well together?

- To a high extent
- Rather high extent
- Some extent
- Rather small extent
- To a small extent

J12. To what extent do you openly discuss the kind of clash of opinions that can occur at your place of work?

- To a high extent
- Rather high extent
- Some extent
- Rather small extent
- To a small extent

J13. To what extent do you feel pressed for time at your work?

- To a small extent
- Rather small extent
- Some extent
- Rather high extent
- To a high extent

J14. What do you think about your job load?

- Just right, never in any way annoying
- Occasionally heavy, bur usually just enough
- Heavy from time to time
- Often annoyingly heavy
- Very often annoyingly heavy

J15. Do you usually have the possibility to take a break and relax when you feel stressed and tired during work?

- Yes, I have many possibilities
- Yes, I have some possibilities
- Doubtful
- No, hardly
- No, not at all

J16. Do you think your work is mentally trying?

- No, not at all
- No, hardly
- To some extent
- Yes, to rather high extent
- Yes, to a very high extent

ErgoWood

INTERVIEW-GUIDE FOR FOREST MACHINE OPERATORS

This interview-guide includes:	Page
A. Bonding question	1
B. Work background	1
C. Current work	1
D. Work organization	3
E. Future work station	3
F. Health	4
G. Psychosocial factors	4
H. Concluding question	5

- It is of the utmost importance that the interview is carried out in accordance with the instructions in the *Intructions-Fieldworkers-FINAL* on the ErgoWood home page.
- The interview is to be taped
- Instructions are written in *italics* and should not be read out loud

ID-number Interview-date (yy-mm-dd)

INTERVIEW-GUIDE FOR FOREST MACHINE OPERATORS

A. BONDING QUESTION

A1. Why have you become a contractor / machine operator?

B. WORK BACKGROUND

B1. Have you ever considered quitting or reducing your efforts as contractor / machine operator?

- *If so:* Specify the most important reasons why?

B2. What changes would be necessary to keep you in forestry?

B3. Did you change to your present work due to health complaints?

- *If so:* Describe the circumstances.

B4. Do you plan any large investments in forestry in the near-medium future, let's say within the next 3 years?

- *If so:* Why are you making these investments?

B5. How do you think these investments or innovations will change the qualification demands on you or (*if any*) your employees?

B6. Which personal qualities and characteristics do you consider most important in order to be a successful contractor / machine operator?

B7. Will changing quality standards demand new qualifications for machine operators?

- Environmental standards
- Machine standards
- Customer demands
- Other

B8. Do you have any outstanding training demands?

B9. Does lack of training cause any problems in performance? What are the deficits?

C. CURRENT WORK

C1. Are you generally full employed or do periods with lack of contracts / employment occur?

- *If low employment periods:* Why?
- How could it be resolved?

C2. How many hours per year is the machine operated?

- On how many hours per year is the calculation based?
- *If uneven: Why?*
- How could operating hours be more evenly spread?

C3. How big is your operational area (e.g. range in km to most distant work site)?

- Do you have any ideas how it could be limited?

If a contractor:

C4. Do you have any long-term engagements with forestry or other companies?

- *If he doesn't have long-term contracts: Is this a problem?*
- Do you have an idea how it could be resolved?

C5. How do you get your contracts?

- Do you send in tenders for jobs?
- How important are personal contacts and mutual confidence?

C6. Do you cooperate with other forest contractors?

- *If he does: What does this co-operation look like? (E.g.: sub-contracting, contracts / payment?)*

C7. How would you describe the competitive situation among contractors? What problems do you see?

C8. What short, middle and long-term goals does your company have?

- *If contractor with employees: Have you informed and discussed these goals with your employees?*

C9. What about your special demands/requirements – for example, in what situation would you turn down a contract?

Questions for all respondents:

C10. How do you estimate your own productivity?

- How could your own productivity improve?

C11. How do you estimate your own quality of work?

- How could your own quality improve?

C12. How do you estimate the profit in the operation?

- How could profitability improve?

D. WORK ORGANIZATION

D1. Please estimate how many hours you spend on the following tasks during an ordinary week?

- ____ hours operating the machine
+ ____ hours doing maintenance and repairs
+ ____ hours doing work on the ground, e.g. planning, follow up, chain saw work
+ ____ hours on office and administrative work
+ ____ hours 'embedded' waste time, e.g. waiting time?
+ ____ hours with other tasks, namely _____
- = ____ hours in total (*check that the sum appears to be plausible*)

D2. How have you reached your current system of organisation of work?

D3. Has anything in your work become poorer in the last years?

- Has something improved?
- What could be done to make it even better?

D4. Does your company or do you have systems to control and monitor effectiveness of work organization, i.e. are there procedures to check that the standards are being applied and are they effective?

E. FUTURE WORK STATION

E1. What improvements in your work station would you like to see concerning ...
... cabin access (mounting and alighting)?
... the working postures?
... the cab itself?
... the visibility from the cab?
... the seat?
... the controls?
... operating the machine?
... information?
... the noise level?

... vibrations?
... the climate control in the cab?
... exposure to gases and particulates?
... the external lighting?
... instructions and training?
... maintenance?
... brakes and operator's safety?

E2. Have you a self-levelling system on your machine? Do you think it is necessary?

E3. Would you like to have automatic functions in the forest machine such as automatic felling by the harvester or automatic unloading of the forwarder?

F. HEALTH

F1. Describe your health right now (*both physically and mentally*).

F2. Do you experience forestry work as a hazard to your physical or mental health?
- *If so* – what could minimize it?

G. PSYCHOSOCIAL IMPROVEMENTS

G1. (*PSYCHOLOGICAL DEMANDS*): What changes would increase your possibilities to fulfil your job demands?

G2. (*DECISION LATITUDE*): Would you like more freedom to make different kind of job-related decisions and thereby carry the responsibility that goes with that?

G3. (*SOCIAL SUPPORT AT WORK*): Are there ways in which your company could improve your contacts with other people in the company (locally or otherwise) to make your work environment more gratifying or supporting?

G4. (*INFLUENCE AND CONTROL*): What could increase your influence in your job?

G5. (*SUPERVISORY CLIMATE*): Is there anything that could improve in your contacts with your supervisors? (*if the respondent is a contractor: your customers?*)

G6. (*STIMULATION FROM WORK*): What would make your job more interesting and stimulating?

G7. (*FELLOWSHIP AT WORK*): What could be done to improve your relationship and contact with your team and other local workers?

G8. (*WORK LOAD*): What changes would make your work load more acceptable?

H. CONCLUDING QUESTION (*voluntary*)

H1. If you had plenty of money and power to change your work situation, then what would you do?

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