LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

PROJECT REPORT

ERGONOMICS AND LOGGING

A report on an international conference in Austria and associated visits

INITIAL RESEARCH INTO ERGONOMICS FOR N.Z. LOGGING BACKGROUND EXPERIENCE IN ERGONOMICS

Prepared by:
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New Zealand Logging Industry Research Association (Inc.)

P.R.27 APRIL 1986

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION (INC.)

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SUMMARY

In 1983 the author attended a conference on "Ergonomics Applied to Forestry" in Austria. Visits to field operations and research and testing organisations in Austria, Sweden and Finland followed. This report is a summary of papers presented at the conference, and information and impressions gained from the visits and contacts.

In the last two years LIRA has been developing its research work in the safety and accident prevention area into a more comprehensive approach to the ergonomics of logging work. This report is therefore a good background summary of information already available in the forest industry overseas. It also identifies areas where further research is required.

Comprehensive accident prevention measures as applied in Sweden are an effective means of lowering the accident rates. But to get results in the field supervisory personnel need to be suitably motivated. International collaboration of accident statistics would be desirable and improvements in the construction and design of protective equipment are necessary to make them more acceptable to wearers.

Regular medical examinations of loggers would provide useful information for medical researchers when investigating the frequency and severity of occupational diseases. Vibration induced Whitefinger was identified as still being a major problem even with the introduction of anti-vibration handles on chainsaws. One of the most promising avenues being explored is a pre-employment test to determine worker susceptability to the disease.

Ergonomic studies provide essential information on work related stress and should be used to ensure that a logger's workload does not exceed his or her long term tolerance limit. The results of these ergonomic studies should be integrated into training schemes. Further investigations into psychological and sociological problems are recommended. New Zealand's position should be to monitor the development in overseas countries and implement the results where applicable.

Organisations in Austria, Sweden and Finland were visited to ascertain the influence of ergonomics in their forest work. Generally ergonomics is most effectively applied through worker training, rather than being introduced independantly. Periodic medical checks do provide management and researchers with valuable information but further investigation into psychological and sociological problems is going to be expensive and harder to instigate. Accident awareness and good quality protective equipment are the most effective ways of improving the safety record of the forest industry.

INTRODUCTION

You've heard the story about the logger who knocks his knee on the blade control when climbing into the skidder cab? He first expresses his discontent with a string of invectives, puts up with the inconvenience for a month or so, then takes to the damn thing with a gas torch! That, in its crudest form, is ergonomics - adapting work to man.

The science of ergonomics is relatively new to the New Zealand logging industry although there is considerable material published on the investigations done in other countries and the term is now starting to appear in the advertisements for various machines, equipment and techniques.

In order to find out more about just how ergonomic principles can be applied in logging, LIRA sent a representative to a seminar entitled "ERGONOMICS APPLIED TO FORESTRY" during 1983 (refer to Ref. 1 for proceedings). The seminar was held at the Forest Research Institute and a Forestry Training School in Austria and involved 74 participants from 22 different countries. It was organised by the Austrian Government in collaboration with the FAO/ECE/ILO Joint Committee on Forestry Working Techniques and Forest Worker Training, and the IUFRO. The main objectives of the seminar were to :

- Present the findings from the latest research into ergonomics in logging.
- Update on the latest experience and knowledge in investigating accidents and Accident Prevention.
- Review the recent developments in assessing the Occupational Health of Forest Workers and the Medical Services available to them.
- Demonstrate and discuss the use of work clothing and personal protective equipment.

For a more detailed assessment of the practical application of ergonomics in equipment design and worker training, the trip to attend the seminar was extended to include extra time in Austria, and visits to Sweden and Finland. During this time the following organisations were visited :

In Austria

(i) Forstliche Bundesverschsanstalt - The Forest Research Institute - Vienna
(ii) Allgemeine Unfallversicherugnsanstalt - Accident Insurance Organisation - Vienna

In Sweden

(i) Skogsarskolan - Royal College of Forestry - Garpenberg
(ii) Skogsarbeten - Bo Pettersson - Sunnansjo
(iii) Nordforest AB - Equipment Supplier and Technical Advisory Organisation - Sater
(iv) Stora Kopparberg - A large Forest Company - Falun
(v) Kockums Industri - Machine Manufacturers - Soderham

In Finland

(i) Vakola - Finnish Engineering Institute for Agriculture and Forestry - Olkkala
(ii) Tyotehoseura - The Work Efficiency Association - Helsinki
(iii) Tehdaspuu Oy - A Large Forest Company - Kouvola
(iv) Metsateho - Logging Research Foundation - Helsinki
(v) Tyoturvallisuuskeskos Institute for Work Safety - Helsinki

This report reviews the papers that were presented at the seminar and includes relevant parts of the other visits where applicable.

SECTION I

AUSTRIA

BACKGROUND TO AUSTRIAN FORESTRY

Approximately 44% of Austria's 8.385 million hectares is covered by forest. This is divided up into commercial forest, high forest (74.2%), protection forest without yield (12.8%), commercial forest, coppice (2.3%), and forest areas without yield (1.7%). Over 4/5ths of the land is in coniferous forest and the majority of that is Norway spruce with smaller quantities of Scots pine, European larch and what is known as Silver fir. Beech and oak seemed to be the most common broad leafed trees and some production is taken from these forests. Nearly 54% of the land ownership is small woodlot owners, usually managed in conjunction with agriculture. Just over 30% of the forest area is owned by enterprises with more than 200 hectare holdings and a small 15.7% of the forest area is owned by the Austrian Federal Government.

According to Austrian law, clearfelling in Austria is prohibited, unless a special exception has been made. Even this exception only allows a two hectare area to be cleared. Up to .05 of a hectare can be cleared without approval, but above that special permission must be sought. The commercial forests in Austria cover 2.837 million hectares and the average volume felled per year is between 12 and 14 million m3. The trees range from 80-130 years old, depending on species. The logging is mostly done by independent workers who are paid per cubic metre. The targets for daily output are based on guide tables which sets out with a points system, the estimated times for each facet of the logging operation. These targets use the guide tables as a basis and then prices are individually negotiated according to the varying conditions of the trees and terrain.

Average daily production of individual chainsaw operators can be between 6-10 m3/day, depending again on terrain and tree type. The most common chainsaws used are Stihl and a high percentage of the land is logged with cable cranes (haulers), the most common being Steyr and Koller. The bulk of these machines are made to fit on farm tractors so they can be detached and the tractor used for other purposes. Skidders are manufactured in Austria by Hinteregger and Steyr. Firewood is a commercial venture in Austria and oak is the most popular species logged for this purpose.

Training in Austria is carried out by the training centres in Federal Provinces and the Federal Forestry Training Centres. The Federal Forestry Centres are located at Ossiach and Gmunden. They are administered by the State. These schools are set up to train the workforce, along with two District Schools, one in Villach and the other close in Innsbruck. These school run continuous courses and most forest workers are expected to attend at least one during the year. These courses range from 1-2 weeks long and cover such things as hauler operation and chainsaw operation. The main purpose of them is to update operators with the latest in new equipment or techniques developed. Foresters go through a five year course in one of two schools at either Badvoslau or in Bruck an der mur. Every school, both the training centres and the technical forestry high schools, puts through about 200 pupils a year.

WORK OF FOREST RESEARCH INSTITUTE (FORSTLICHE BUNDESVERSUCHSANSTALT) - ENGINEERING SECTION

There appears to be a two-way interchange of information between the Forestry School and the Engineering Section of the Forest Research Institute. The training schools feed back information to the Research Institute on what type of research work would most beneift the industry. These directives come from senior pupils with 3-5 years experience. The F.R.I. then carries out work in the recommended areas, where possible, and then introduces it back into the forestry training schools. This work is also published and made available to manufacturers, but it is found difficult to influence them and although the F.R.I. might be able to identify a good machine or method for a particular job, it is in no position to be able to recommend that to an end-user. Most projects require experienced workers with 10-20 years behind them to carry out this research. In the field of ergonomics, it has been established that the maximum time a chainsaw should be used in any one day is 3-4 hours, with one 10 minute recreational break every hour. This is recommended, but certainly not practical.

Two German researchers, Dr D. Rehschuh and D. Tzschockel, have developed an ergonomic checklist for forest machines which is based on a plus/zero/minus recording system for the various characteristics of the machine that affect ergonomics. The checklist is intended for the use by institutions engaged in the testing of forest machines. It is hoped that this would enable researchers and potential end-users to be able to evaluate a machine and compare it directly with another which has undergone the same evaluation, to decide which one would be ergonomically the best. The principles of this checklist are summarised in a paper by Mr J. Wencl entitled "Introduction for an ergonomic checklist as a tool in forestry work".

The latest developments in the use of computerised ergonomic measurement devices have been summarised in a paper, by Mr J. Wencl entitled "The use of telemetric and computerised ergonometric measurements for determining and evaluating physiological parameters in mechanised wood harvesting". This paper summarises how the new equipment enables the pulse rate of a machine operator, chainsaw operator, etc., to be monitored remotely from a distance. It also simplifies the data evaluation process because it is linked directly to a mobile computer. The recording and monitoring equipment is considerably smaller than previously used components. The telemetric system consists of a small transmitter and a module-type receiver. The transmitter is located either on the helmet, belt or in the pocket of working clothes, and pulse is measured by chest electrodes. The telemetric system is also able to record respiratory rates, skin surface temperature etc., if other transmitters are included. It has a range of up to several kilometres. The receiver unit has a separate 19" oscilliscope which can be linked with electrocardiographs, taperecorders and analog digital convertors to monitor signal conversions. The equipment manufactured by Messerschmitt Bolkow-Blowm (GMBH) (MBB) is all mounted in a Vokswagon bus and therefore is fully mobile. A digital computer, PDP11/3, using the RT11 system, services as an evaluation unit, enabling multi-function recording to be done at the same time.

ACCIDENT INSURANCE ORGANISATION (Allgemeine Unfallversicherungsanstalt)

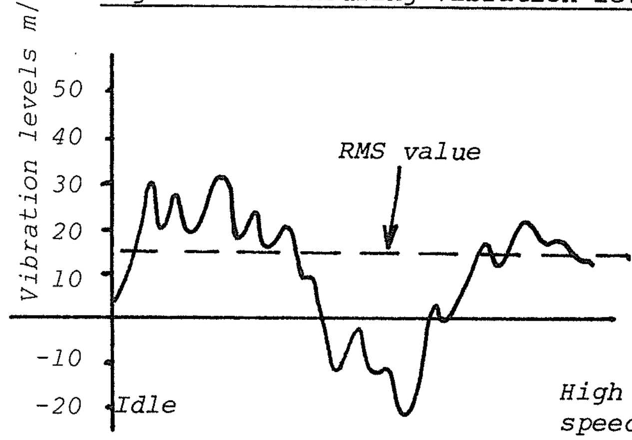
The Accident Insurance Organisation is like a combination of the ACC and the DSIR in New Zealand. They are the body that governs the compensation which is paid out to workers who are injured or acquire a disease from their occupation. They also have test facilities to evaluate various hazards in the operations. The three areas of particular interest to us were; the evaluation of vibration in hand tools, monitoring of noise levels of various parts of the work environment, and the evaluation of exhaust emissions.

(i) Vibration

A scientist by the name of Helmut Brusl was the man in charge of testing for vibrations in hand tools. With chainsaws, they test the vibration from three different points, but the one of most importance is that which occurs vertically from the bar of the chainsaw through to the handles. Magnetic recorders are used to measure this vibration, which is then analysed by an FFT analyser. This piece of equipment is very exact (1-2 Hz).

When tested, a chainsaw is run at idle at maximum revs unloaded and at maximum revs loaded, and the vibration levels for each situation are recorded. From them, an average RMS* value is obtained, which is then calculated to produce a loaded RMS value, otherwise known as a K value, for every frequency (Refer Fig. 1). The recommended desirable level for K value is 15 metres per second^2. The Accident Insurance Organisation recommends that for a saw with 20 K value its use should be restricted to 3-4 hours per day with ten minutes rest on the hour and for a chainsaw with a 60 K value it should not be used more than half an hour.

Figure 1 - Measuring Vibration levels



K value = 15m/s^2

K = 20 - 60

Use = 3-4 hrs ½ hour

The graph in Fig. 2 plots the K value against time for the various effects that the vibration has on the human body. The lower line indicates when comfort levels are effected, the middle line when fatigue is accelerated and the top line shows when the vibration is detrimental to health.

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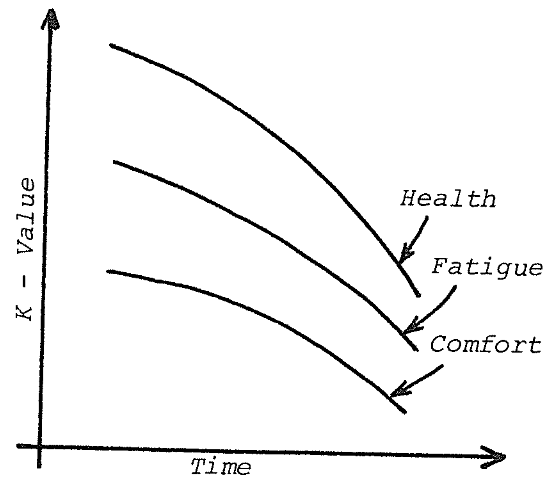
* RMS = Root Mean Squared

It has been found through this testing that K values are almost invariably directly related to kilowatt power output. Saws from 1.5 to 5 kW have been tested. The test procedure includes both vertical and horizontal cutting techniques. When quizzed about the other factors influencing vibration, such as chain sharpness, saw conditions, etc., Brusl said that all chainsaws tested were brand new. The objective in these tests were to reduce the variables and really to show the relationship between the power spectrum and vibration frequencies.

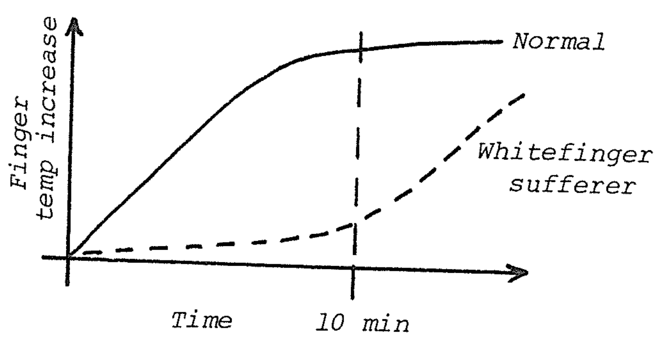
Figure 2 - The effect of K value on workers



The symptons of a white finger* were discussed and Brusl maintained that few operators could work a chainsaw for ten years without having some symptoms of white finger. The method of testing is based on a Japanese system where the time taken for the fingers to return to normal body temperature after being dipped in cold water (10-12°) for 15 minutes is recorded (Refer Fig. 3). This system has been improved by the Austrians by using an infra-red telemeter which has a far more exact recording.

The Accident Insurance Organisation can direct, through a Doctor, that a worker should no longer be performing a particular task, if it is proven that he is suffering from a disease as a result of his work. Employers are levied at 1.5 schillings per employee and this money goes into research and testing facilities. It is found that in some areas the response to this concern for occupational health is very good and people are keen to seek ways of overcoming the problem. In other areas, however, bushmen have refused to be tested and Doctors are not prepared to force them to have tests done. The Accident Insurance want

Figure 3 - Test for Whitefinger disease



* White finger = Vibration induced White Finger (VWF) is commonly known as Raynaud's phenomena

the method they use standardised throughout Austria. In the areas where good response is received, 20-30% of the people tested have Raynaud's phenomena.

One flaw or problem in the system, however, is that the worker's medical history is often unknown and exposure to certain types of drugs can have a similar effect on the incidence of vibration disease. The obvious way around this is to ensure that all saws used satisfy a minimum level. Consequently, the Accident Insurance Organisation propose to introduce a K value limit of 15 m/s^2 in approximately half a year. Enforcement of this law is, as of yet, unknown, but they propose to use propaganda means to convince workers to be aware of the problem, that is, they will suggest or recommend certain saws that are within the law. It is planned that if the worker is found using an outlawed saw that there may be some means of penalising the employer. Incidentally, employers supply the workers with all their tools.

The Accident Insurance Organisation will be used as a mediating body to determine the outcome of a dispute should an employer claim that his saws are quite acceptable, but a Bush Inspector deem that they are not. There is, however, still the underlying problem that bushmen, as appears to be everywhere in the world, are inclined to cover up their injuries and consider them part of the job. An international standard for measuring the vibration transmitted to the hand has been drafted by the FAO/ECE/ILO Joint Committee.

(ii) Noise Levels

Scientist Ahmen Gaafar showed us through the testing facilities for noise levels at the Accident Insurance Organisation. These noise level recording rooms are chambers with linings that affect the acoustics, i.e. two rooms are without any echo whatsoever, achieved by the use of polystyrene baffles and two rooms have sound deflectors and lined with materials that attenuates the effect of an echo. These rooms are used to test the sound outputs of various motors, tools, etc., and an electrically operated brake is able to load motors to record sound levels under working conditions. The rooms have sophisticated sound recording devices which are used to test the effectiveness of hearing protectors (85 db is the limit for noise exposure without hearing protection). It appears that the facilities are available to test all types of machines to be able to outlaw extremely noisy machines, but the Accident Insurance Organisation has little power to enforce any rules that may be made.

One of the rooms has a facility to free-field test the effectiveness of hearing protectors. In other words, the protector's ability to cut out high noise levels but not low frequency noise such as speaking. It is also possible, through using bone exciters, to tell whether hearing loss in a victim is in the transmission or in the inner ear. Some losses are caused by antibiotics used in drugs against hepatitis, hence it then again becomes difficult to define whether an employee's work environment has caused his occupational disease. With the echo rooms, it is possible to measure reverberant conditions to test sound proofing of various materials, such as padding used in machine cabs, etc. The deflectors, hanging from the ceiling, are used to change the nature of the sound. In Austria, a mere 1,500 people are receiving compensation for a hearing loss disease. From the work that the Accident Insurance have done, 250,000 - 300,000 people are in over-exposed conditions.

(iii) Emission Control

This session was plagued with problems of communication and comprehension with the language differences. However, from what could be preened out of it, the testing equipment was an emission control tester, using a chemical system which measures the amount of carbonmonoxide, nitrogen etc, in the exhaust gases of various machines. However, it can only measure the substances and not quantities. It is possible, however, to calculate the emission quality by analysing the mixture ratios and calculating consumption over time, but I did not understand how this was done. Apparently there is another international standard in draft form, specifying the maximum amount of chemical elements allowable in the exhaust emission of various machines.

Not so much was gained from this session.

The address of a German research organisation at the University of Stuttgart was given to me and it was suggested that I write to them for information on their testing of chainsaw noise levels. Apparently they have done a comprehensive series of tests on all different brands of chainsaw to monitor noise levels under idle conditions, under maximum revs, both loaded and unloaded, and the results are summarised in what appeared to be an excellent report. The contact at the University is a Mr W. Nusser.

SECTION II

SEMINAR ON ERGONOMICS APPLIED TO FORESTRY

INTRODUCTION

This seminar, organised by the ECE-FAO-ILO-IUFRO joint committee on Forest Working Techniques and Training Forest Workers was held in Vienna and Ossiach from 17-21 October 1983.

It was introduced by Dr A. Kastner, who was a representative from the Federal Ministry of Forestry and Agriculture, Austria. He mentioned that in 1956 the industry realised the importance of the workforce and that over the last decade most of the recent developments have been aimed at improving machinery. He claimed that the main hazards were vibration and noise (over 60% of the occupational health diseases according to the Austrians). He also outlined the need to review wage structures.

Dr Kastner was followed by a Dr H. Redl from the same ministry, who mentioned that this ergonomics seminar was closely aligned with training and this was the first priority within the industry. He also issued an introduction and welcome to the participants in the seminar.

Dr B. Strehlke, Secretary of the joint committee, thanked the Federal Ministry of Forestry and Agriculture for their hospitality and also introduced participants and welcomed them to the seminar. He mentioned that this was the sixth event of such a meeting - the first being in 1965, based on accident prevention, the second in 1968 which involved a very large number of participants. In 1975 the seminar was held in Germany, in 1978 in Poland and in 1981 (this was the first joint committee) held in Canada and concentrated on mechanised logging, and now, in 1983, the conference in Austria. Mention was also made of the possibility of holding a conference in Finland in 1985.

Mr T. Vik from Norway was then asked to speak briefly on the objectives of the seminar and he mentioned that we should aim to keep technical aspects in touch with practical workers.

It was then time to proceed with the formal part of the meeting and election of the following officers were made :

Chairman : Mr A. Trzesniowski
Deputy Chairman : Mr T. Vik
Project Leader, Economics : Mr F. Staudt
Project Leader, Training : Mr M. Lipoglavsek
Project Leader, Accidents : Mr D. Bardy (first safety delegate)
Project Leader, Occupational Health : Dr P. Dietz
Project Leader, Sociology : Miss E. Teikari

The Austrian Forest Research Institute

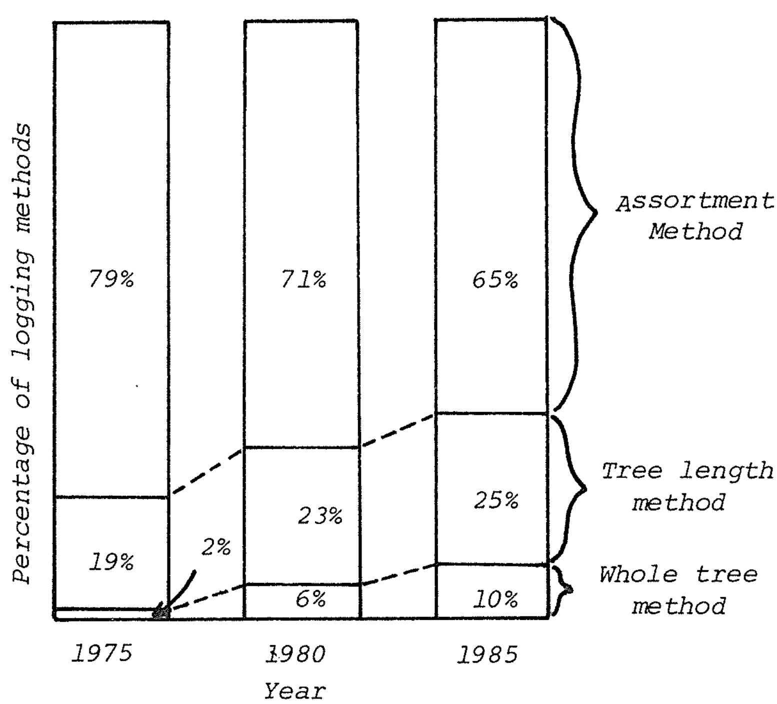
Dr H. Egger, the Director of the Forest Research Institute, Austria, gave an overview of the importance of forestry in Austria, mentioning the early development of forests in conjunction with agriculture and the use of shelter belts, particularly in the northern region. The growth rate appears to be best in the southern area, where heights of up to 50 metres have been recorded. A national policy of protection forestry was established as early as 1875 when the need to protect this natural resource was recognised. This policy was redefined in 1975. The primary concern being to maintain stands. The main type of tree grown in Austria is the Norwegian spruce, but some Douglas fir is grown as a secondary species. Some interest has also been shown in poplars, but this is still very much in the development stages. Of the native trees the broadleafs and the oaks are the most common, but small in scale when compared with the Norwegian spruce. Attempts to improve site index have included fertiliser trials, but generally these appear to be conservative by nature. Currently, in 1983, Austria is suffering from fairly dry conditions and this is causing many problems within the forest stands. There has been considerable research effort gone into training and into ergonomics, which is the main theme of the seminar, but Dr Egger did not dwell on this point. He also mentioned one other relatively serious problem - acid rain - which is causing quite a bit of mortality within the forest areas of Austria.

ERGONOMIC RESEARCH

(a) Present Situation and Tendencies of Mechanised Logging in Austria

This paper was presented by Mr R. Meyr, Head of the Engineering Section at the Forest Research Institute in Austria. He mentioned enquiries that had been done into mechanised logging practices in Austria and suggested that the accumulation of information was very difficult because of the diverse nature of ownership, and consequently, operation in the forests. From 1975 to 1980 the comparison was done by F.R.I. to predict the expected requirements of the industry by 1984. These were based on the existing three methods of log extraction : A sort method, which includes felling, delimbing at the stump and was favourable from the ecological point of view. Tree length extraction, which is delimbing at the stump and extraction of log length. And the whole tree method, which is extraction to the roadside or landing for later processing with mobile processors. Ecologically, the latter was not considered quite so acceptable. Costs are higher and damage is greater with this method, but ergonomically it was better for the workers. Whole tree extraction was only used in big forest enterprises where contractors lease the machinery. Fig. 4 shows the predicted increased in mechanised felling.

Figure 4 - Overall production in Austria



Some larger companies have higher production in whole tree logging methods.

The delimbing methods are predominantly motor manual, and there is an anticipated increase in the use of power saws. (Ref. Fig. 5).

Mechanised delimbing is limited to small diamaters of up to 20 cm.

Integrated cable/processor units, i.e. one power unit powering extraction and processing operations, has been evaluated in the Austrian situation. It was recommended that when using such a system the workers should be able to swap responsibilities during the day, otherwise it could become very monotonous.

The graphs shown, are based on larger companies with over 200 hectare holdings to give an indication of, firstly, the delimbing method, and secondly, the extraction method used.

Figure 5 - Delimbing methods, Austria

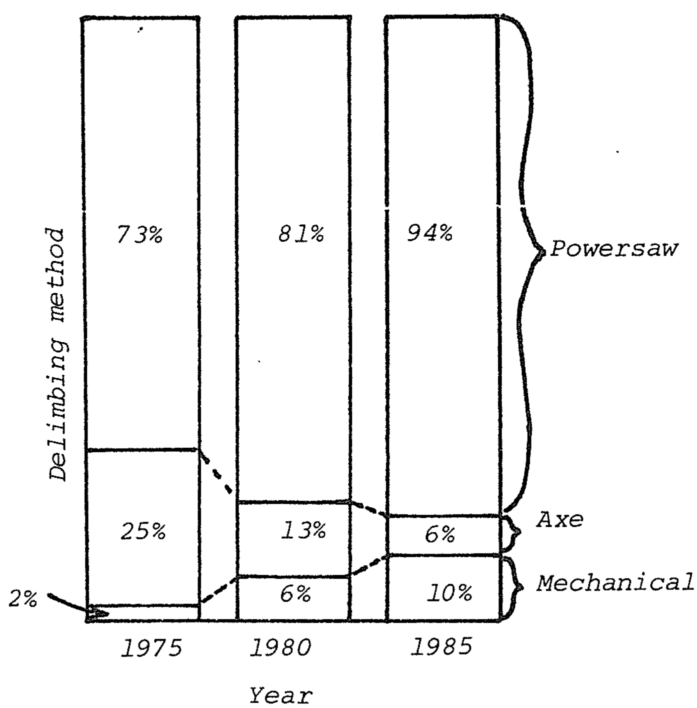
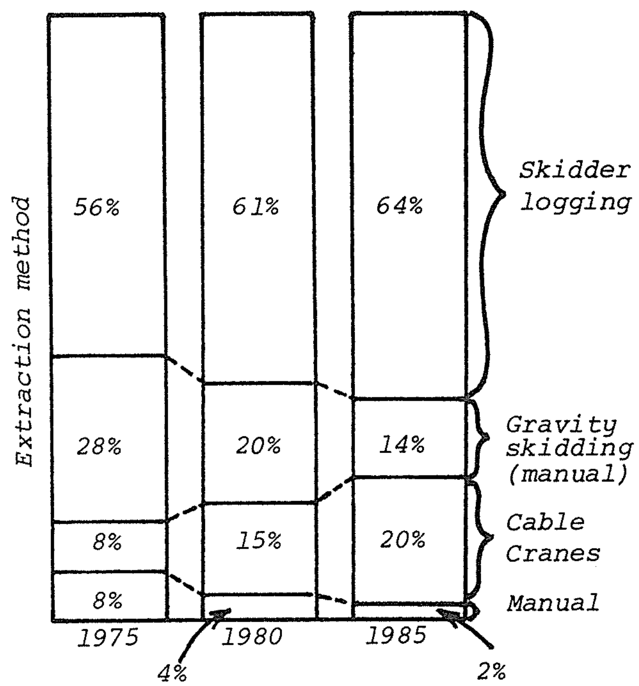


Figure 6 - Extraction methods, Austria



Road location and design are top priority in Austria. A 50% gradient is the maximum limit for ground-based extraction on hillsides. It is preferable for mobile towers to be used in these situations because they have less energy consumption. Because of the high number of farmer logging operations, most of the equipment used in Austria is adaptable to agricultural tractors. This is very important for the farming contingent. Depending on the type of operation, 40-80 kW skidders are used (with one or two drums), particularly in the larger companies (areas in excess of 200 hectares). Remote control of winches has been found to be most popular on both small and large machines. The reduced damage with this system is desirable when you consider the protective nature of the forests. Grapples are only used under special circumstances, normally when either bunching for long distance hauler operations or when a separate machine is used to bunch for them. Normally they are considered too expensive. Some helicopter logging has been done in

Austria, but mostly on a trial basis. It is used in areas where roading is either not possible or would be extremely expensive to introduce and where extraction distances get out about 300-400 metres.

In the State areas the Federal Forest Research Institute are using Nordfor winches for bunching and for short distance extraction. They are using grapple extraction machines only when processors are included in the system. The haulers available include the Hinteregger, which has approximately a 100-200 meter span, the Koller 300 up to 300 metre span distance, the Urus, which is a bigger model again, the Andritz which is used primarily for downhill logging and the Steyr, which is the biggest machine manufactured in Austria and claimed to be too big for the Austrian situation.

(b) Ergonomic Studies Related to the Assortment System of Wood Harvesting

This paper was presented by J. Wencl of the Federal Forest Research Institute, Austria. The work done by the Engineering Section of the Forest Research Institute is governed by a predetermined plan which, through a series of meetings and communication with the main forest landowners, i.e. the farmers and the companies, decides on the directions of the research effort. Firstly, an analysis was made of the most common methods (assortments) and that was chosen for the investigations. The methods were predominantly motor-manual, using a skidder. It was decided to look at the two main parts of the operation :

1. The felling work.
2. The skidder use.

Over 69 work days were used as a sample survey and the workers observed had an average of ten years experience. An attempt was made to keep site conditions as similar as possible and the diameters in the 29-39 cm range, but some were included in the above 40 cm range. To do this, 100 workers were analysed using chainsaws and a further 37 skidder operators were also analysed.

To begin the testing, a worker is put on a bicycle ergonometer and expected to do a set period of cycling on the ergonometer. The incresae in pulse rate from complete rest to the amount of effort exerted on the ergonometer is recorded. These results were to be presented later in the seminar. The tree diameters were found to directly affect the energy demands in an operation. Bringing down hang-ups caused the maximum peaks in pulse rates and delimbing was more demanding in small diameters where the energy effort was much greater. Overall pulse rate was recorded as increasing during the afternoon's operation.

Recordings in the skidder operations indicated pulse rate increased during breaking out and winching. The high pulse rate for winch operation was considered to be related to the mental load required to winch in the logs which resulted in an increased pulse rate and, consequently, an increase in stress.

Extensive investigations of these rates have revealed that pulling winch rope is difficult to quantify and there is no clear pattern to the energy demands. Indications were that more energy was required to pull winch rope downhill than to pull it uphill, which seems highly irregular to me, but this fact was recognised by the researchers and they plan to do considerably more studies on these two situations to try and get a clearer result.

(c) Integrated Measurement of Time Requirement and Physical Workload for the Establishment of Piece Rates in Logging

A paper presented by Dr P. Dietz, Federal Republic of Germany, on similar work done by the Germans on measuringthe pulse rates and pulse rate increases of workers during various phases of the operations. Mention was made of the time requirements for various aspects of logging and also the wage system in which payment was made in the Federal Republic of Germany. Standards were set for these wage rates over a sample of 6,000 trees, conducted in two separate studies. The second study was necessary to make the standard suitable for general use. It is claimed that workers and employers have problems in agreeing on the rest time allowances. Ergonomic research and heartbeat rates have been used to help this argument and the Germans consider that the Austrians are well advanced in this field. However, the strain recorded of the work requirements proved that the new rates had almost the same values as the original rates set earlier in the piece. It also showed that the rest allowances in force were in line with what was indicated as necessary, according to the ergonomic data recorded.

During the question and answer session, the question was asked by Butora, Canada, on the fact that the afternoon work showed a higher demand than the morning work and was this reflected in the production rates. The answer given was that in the afternoon the recording period was much shorter and consequently production rates would be lower so no direct comparison was possible. This was added to by Mr Dietz who concluded that the stress can be alleviated by strategically placing breaks at suitable times in the afternoon. Stress was much higher when no breaks were recorded and this was substantiated by the fact that afternoon stress was considerably higher.

A further question was asked about the workers output and whether it remained steady during the studies. The answer suggested that there is a limit on the amount of stress that could be sustained by the worker. Tests have been conducted by Engineer Wencl to determine the effects of the frequency of breaks and this was included in the report. A question was later directed to Mr Dietz on whether the ergonomic studies can be used to create standards without first applying the statistics to the field and in fact this should be done first and the ergonomic studies applied after the other parameters have been considered.

(d) <u>Perspectives for International Collaboration of Forestry Ergonomists</u>

This paper was prepared by Mr O. Slama from Czechoslovakia and was presented by Dr Strelkhe. The Czechs had started a heartbeat study procedure two years ago in a research project in Brno. The application of the data was anlaysed for foresters, medical doctors, as well as loggers and planners and these were incorporated in the training schemes. There are seven schools in Czechoslovakia which run three year courses and there are also 14 rehabilitation courses to find alternative work for existing workers who are no longer able to work in their current jobs becaue of health diseases or accidents. In the Brno study, workers were physically evaluated before being allowed to work. A medical department is used to conduct these tests.

(e) <u>Towards the Humanization of the Forest Utilisation Systems from the Viewpoint of Greece</u>

A paper from Greece, presented by Mr P. Efthymion, mentioned the need for humanization of logging and stated that workers in Greece work between 13-14 hours per day. They use no protective equipment, so their working environment is not good; their diet is not suitable for the energy demands of their body; and the forests are generally on steep areas. Although adequate rest allowances are allowed for in the wage deals, they are often not adhered to because the worker is striving to make more money to improve his standing in society. Diseases noted in Greece were mentioned as follows :

- white finger
- headaches
- joint stiffness
- physical stress

Mention was made of the negative approach to the use of protective equipment, which has resulted in high accident rates and many fatalities. Pride often comes before health considerations and production levels are getting higher while concern for health is remaining at the same level. The feeling of the authorities is that aptitude tests should be instigated to make sure that workers are suited to their work environment. This should be followed by periodic checks to ensure the worker's health is maintained and improved training techniques to make his working practices safer. It was suggested that the diet of the workers should be improved and the hygiene of the work site should also be investigated. Only when environment and training is improved by ergonomic standards can the current situation be changed. When queried about the effect of slope on energy consumption, the answer given was the measurement of this cannot be related. A question was put by Mr G. Hippoliti from Italy as to whether log length methods change the techniques employed in bunching and extraction. It was mentioned that changing the cutting pattern had up to 50% effect on production and that the performance levels increased as the volume of logs increased. Consequently, it was difficult to relate but man power demands tended to decrease as piece size increased.

(f) Complex Research on Working Conditions in Wood Harvesting in the USSR

Paper from the Russian, Mr V. Obliwin, who mentioned the USSR practices in logging. He considered there were three areas to it; the man, the machine and the equipment. An analysis of accidents and occupational diseases and consequent research has resulted in a 16% reduction in accidents. It was considered that four to five hours in the operations exposed the worker to excessive strain on the neck, eyes, ears and joints. Psychological and ecological research had also been conducted and 2-6% efficiency improvements have resulted from published instruction material and more awareness of occupational health by medical inspections of the workers. This is done free of charge, and the forest enterprises offer medical care to employees on a regular basis. These regular checks have reduced the health hazards.

During the working week, the workers remain on-site and are fed on mineral waters and a controlled diet. They are made to periodically exercise and forced to use suitable clothing and footwear, which are provided free of charge. Both winter and summer garments are used. The trousers are made of wool and weather-tight jackets are used to protect from the cold and the wet. Underwear and extra rain protection are also provided. Free issue of this equipment has substantially reduced the labour turnover. There are some 10,000 machine operators in Russia and research is trying to develop semi-automatic machinery. When asked how cold the conditions get, the reply was to minus 40 and minus 45 degrees centigrade. Workers would work in these conditions, depending on humidity.

TRAINING IN ERGONOMICS

(a) Training in Ergonomics at the Forestry Training Centres of the Federal Republic of Germany

Mr K. Hiel of Germany talked about the application of ergonomic findings in the form of standards, which must be applied to the field in the form of training and there are three levels for this training :

- university
- colleges
- vocational schools.

Training is offered in lectures or practical instruction. It was maintained that continued exposure to it makes a correct technique become second nature. Ergonomics cannot be expressed in terms of value figures, because it costs a lot of money and consequently has a negative effect on an operation as far as the person paying the bills for that operation is concerned. Ergonomics should be taught in an integrated training programme in which motivation would be imperative and the worker must be in a state of mind to accept these ergonomic principles. Wage rates, unions, etc., must make allowances for ergonomic considerations and training is only part of the reason why ergonomics are not fully accepted.

(b) Teaching and Training in Ergonomics for the Needs of Forestry in Poland

This paper presented by Dr J. Jozefaciuk traced the evolution of ergonomics in the training of forestry workers since 1945. Although it wasn't recognised as ergonomics at the time, the early programs of Work Safety and Hygiene introduced the basic principles through a set of safety rules. From 1965 onwards, teaching began in the field of work science and work safety which involved a more extensive investigation into why the rules were needed.

Recent studies have concentrated on the strains of forestry work and have produced tables of the energy expended, emergencies produced by the work environment, causes of accidents, suitability of the equipment and the methods of work organisation. Instruction in ergonomics is given at three levels, at the forestry faculties of Agricultural Universities, at the Technical Forestry High Schools and at the training courses organised by the industrial enterprises. As an obligatory subject at the Universities for instance, ergonomics takes up 30 hours of lectures and 45 hours of seminars in the 4th year.

The ergonomical education at high school levels is different, concentrating more on the practical side especially information about mans stress at work as well as the impact of the work environment on the course of forest operations.

(c) The Consideration of Ergonomics in Czechoslovakia Forestry

This paper was by Mrs Zackova from Czechoslovakia and it discussed the research work done by the Institute of Forestry Economy in Zvolen. Their programme, research on ergonomic parameters in wood production, has been concentrating on evaluation and analysis of 4 types of machine.

- Tractor extraction (LKT-120A)
- Processing (OSA Processor)
- Forwarding (Volvo BM)
- Chipping (Trelan)

Physical stress has been measured through calorimetry and pulse-rate measurement and this information is related to noise and vibration levels of the machines. The recommendations made from the research were that regulations should be established to limit the levels of noise and vibration and that job profiles were needed for the selection of machine operators and appropriate training should be given.

(d) Question and Answer Session

Dr Strehlke - asked Petterson about the success of ergonomic training right through the supervisor levels in Sweden.

Petterson - replied that he tends to agree with Hiel. There is a conflict between economy, efficiency and ergonomics. There was communication between the work site and machine constructors to try and improve designs, but this adds to the cost and the market place is where a machine sells. Ergonomics is considered a constraint everywhere in the world. It is not the main goal in production forestry and only when the situation is very bad does the industry turn its attention to ergonomics.

Question - Author unknown - to Hiel - In motivating training programmes, where in the levels are the breaks. Training cannot go in one form from the top to the bottom of employment.

Mr Hiel answered - The one thing missing in ergonomics training is practical training. For example, posture in power saw use. These principles are not understood at higher levels so the only reason to do this is to make managers and supervisors undergo training the same way the workforce has to. It was added that this does not necessarily meet with approval with all managers and supervisors.

Dr Dietz added - They do not have the optimum situation in Germany. Ergonomics is not considered an essential part of the forest work. It is just one field. Training, whatever training it may be, has to be improved and this advanced training must be understood by all those who are involved in it. Where this has been tried on a small scale, results so far have been successful. The whole approach however, has had to change and it goes right back to the recruitment stage. Forestry workers, when employed, should receive a full medical check and then subsequent checks later through their working career to ensure that there are no adverse effects of employment showing through.

Dr Seha commented - The claim that economically ergonomics are not on, is wrong, because a reduction in accident rates when you consider the extremely high costs of forestry accidents must mean that ergonomics does pay for itself.

Mr Petterson - Added that he couldn't agree more. However, only if one could foresee the problem, the benefits be recognised before, rather than in retrospect, then it would be so much easier to sell this ergonomics field. For example, we are all doing good research but not getting the results applied. Manufacturers don't listen to researchers - they respond to market demands. Therefore, we must influence the people who create these market demands.

Mr Egger - Austrian Federal Forest Service - suggested that tradition also causes a hindrance and this is a problem that is facing any introduction of something new. The approach taken by the Austrians was to train the managers firstly, as they are the most difficult to convince. Once the managers are convinced that improving the work site of workers is going to decrease costs, then lower level training becomes much easier. In Austria there are roughly 3000 people put through the training centres every year. The courses concentrate on group work and work organisation in the operations. It also goes through the detail on closely controlled targets, making sure that the production level is realistic if all safety measures are adhered to, which means that all operations must be intensively planned and people doing the operations must be correctly motivated.

Mr Butora said that - Financial support for research projects is not good enough. The industry as a whole must realise that ergonomically superior work techniques are economically viable.

Mr Egger - Continued to say that cost comparisons have been taken in Austria and they can quite confidently state that there is a reduction in costs with improved training.

Dr Strehlke - Concluded that it didn't solve the problems of those workers who are suffering now from serious disability or injury resulting from forestry work. Consequently the ILO are planning to hold a seminar in Finland in 1985 on the rehabilitation of forest workers.

FOREST ACCIDENTS AND ACCIDENT PREVENTION

(a) Experiences from an Accident Prevention Program in Sweden

Paper by Mr B. Pettersson from Skogsarbeten in Sweden. Since the late 1960s intensive research into the occupational health and safety of forest workers has been undertaken. The objective of the research was to reduce the incidence and severity of the accidents by :

- identifying and anlaysing accident causes
- developing technological and organisational remedies
- disseminating the results of the projects.

It has been possible to reduce both the incidence and severity of accidents in the forestry sector by up to 50% mainly through

- improved production technology
- mechanisation of forest work
- new wage forms
- better protective equipment
- intensive vocational training :
  - safety and health services
  - greater awareness
  - intense research and development.

Identification and analysis of the nature and cause of accidents and the development of technical and organisational aids to enhance safety in forestry has been applied. The dissemination of the results through the forestry sector has required the co-operation of equipment manufacturers, forest workers, forest enterprises and employee organisations.

As a result of a widespread strike in 1975, piecework was abolished in 1975 and regular salaries along with production bonuses were introduced. It was found that fixed wage forms did reduce accidents but abolishing piece work also meant lower productivity so it could be assumed that only a small percentage of the reduction in accidents should be attributed to the lower productivity.

Protective equipment, although successful in reducing the affects of an accident, was often not used because it was not comfortable to wear. To overcome this the project group examined existing protective equipment available, specified user requirements, consulted and advised manufacturers, and publicised findings.

The introduction of intensive mechanisation during the 1970s has, by straight reduction in man house per m3, resulted in fewer accidents per year, but motor manual methods still account for more than half the manhours worked in logging.

Increasing safety is not the prime concern of managers or manufacturers. It can be considered a constraint. The market place therefore, is the most influential factor governing safety in equipment (machines). Mechanical changes are easy to make, organisational changes are much harder. Research can contribute if the forces that can influence the changing of the work environment are applied, i.e. market demands.

(b) The Situation and the Need for Future Action in Accident Prevention in Finnish Forestry

This paper by Dr P. Harstela from Finland demonstrated how the work of the

National Board of Labour Protection, (who implemented legislation for safety boards and protective equipment), had resulted in a reduction of the accident rate but hadn't made significant inroads on the real problem of high accident frequencies. Intensive research in 1979-80 indicated that a major contributing factor in the serious accidents was lack of work site organisation, and improper supervision, e.g. working too close or working alone.

It was also found that Human Factors are important considerations in the chain of events that lead up to an accident. For example, inexperienced workers are more prone to accidents, but experienced workers tend to have more serious injuries. Workers also tend to take more risks when using protective equipment.

A possible reason for this was suggested by Mrs Kanninen of the Finnish Forest Research Institute who came up with the inner model theory.

The inner model theory is a reactionary thing within worker which directs his or her course of action in different situations. An accident is a result of a lack of suitable model and the possible reasons for this are; fatigue, rushing and unintentional risks. A model exists in these situations but it is not applied. Even with training, inexperienced workers have accidents. However, experienced workers have bad accidents. The reason is possibly taking short-cuts, which are developed after training. Accidents under these circumstances usually happen at the end of the day, "the last tree" situation.

The immediate remedies suggested to minimise this were to organise the work environment, to use protective devices and to improve supervision of the operations.

It was also felt important to impress on workers that protective equipment does not give full security. The previously mentioned possible causes have to be used in training, inner models can be developed through training but they must be refreshed periodically.

(c) <u>Forestry Accidents and Accident Prevention in Finland</u>

A paper by Mr P. Patosaari, Finland, reported on statistics from National Board of Labour on forest accidents. Accident trends were shown by changes in number or frequency of accidents. The chainsaw was the most common cause of accidents amounting to 33% of all logging accidents. Half of the chainsaw accidents were leg and foot injuries.

It was found that a high number of accidents occur to workers with little experience. 39% of the accident victims in 1980 had less than one month's experience.

Severe accidents in felling and delimbing tended to increase with ageing. 35 - 45 year old employees seem to have the highest severe accident frequencies, but the below 30 age group have the most accidents per man hours worked.

In cutting operations, accidents in delimbing have reduced by 17% from 1970 to 1980, however overall felling and delimbing still has the highest number of accidents, but bunching has also recorded an increase in accident numbers. Terrain was considered by operators to be a contributing factor, along with pressure (haste), also climate and fatigue.

To overcome the problems of high accident frequencies hazards should be eliminated at the source. This can be done by introducing new technical measures, ensuring the use of proper safety devices, providing good training and safety information, and planning the organisation of work.

Cutting should be able to be stopped in adverse weather. Pressures on the operator can be reduced and manual handling of the timber in the winter can be stopped. It was found that this is closely related to back pains.

The following points were emphasised :

- Technical installations, such as chain brakes, must be used and should be operational.
- Hearing protection must be worn.
- Protective equipment does not prevent accidents occuring but can reduce or eliminate injury severity.
- On-the-job training is essential.
- Better understanding of the whole operation is desirable.

(d) Logging Accidents Among Farmers - Statistics and Accident Prevention

A paper by Mrs E. Teikari from Finland. The differences in recording methods related to insurance payouts has made statistical analysis of accidents somewhat difficult. In the felling area, professional loggers had a higher accident rate than farmers, but farmers had more accidents during hauling and silviculture. Work involving the chainsaw, i.e. felling and trimming combined, had the highest number of accidents but bunching was the highest individual component of the job causing accidents. Work environment causes most accidents in forestry. However, powersaw accidents are less frequent on farms because a lot of farmers use hand tools. Legs and feet are the most accident prone part of the body and the average serious accident results in over two months off work. Invariably, in both farming and forestry, suitable protective equipment would have reduced injuries.

Short timber hauls are of most concern to insurance organisations. Farmers are prone to different kinds of accidents to professionals, being hit by the falling stem was considered of particular importance. Remedies suggested are as follows :

- preventative measures should be concerned with hand tool accidents
- safety boot use could be stressed in occupational safety
- dislodging hung-up stems and the techniques to handle them required attention.

(e) Work Safety in Small Private Forests of the Federal Republic of Germany

The paper presented by Miss R. Fuchs from Germany commented on a survey taken at 105 small scale privately owned forests in 1979 and 1980. The most hazardous part of the operations were felling and delimbing with the chainsaw. The main reasons for this were seen as the general lack of knowledge of correct working technique due to the spasmodic requirements to carry out logging practices, and, the workers not using suitable safety equipment or taking advantage of the available technology. The remedies suggested were :

- improving distribution of information on correct work techniques
- better means of training and some way of obligating these employers to undertake the responsibility of training.

(f) Extract of the Annual Report of the Safety Engineer for the Regional Forest of Rhenish Hesse Palatinate for 1982

Introduced by Mr E. Glatz from Germany. No paper presented.

The introduction of regional safety experts in the State Forests has reduced the frequency of accidents there. The main responsibilities of the experts were to ensure compliance with work safety acts.

Methods used to do this included :

- visiting work site, checking on protective equipment
- looking at work techniques used
- receiving reports on accidents.

These reports are the base on which compensation is made. Safety experts sometimes are expected to adjudicate disputes where argument arises over the use of protective equipment. From the reports, it was found that helmets were becoming more accepted by forest workers but ear muffs were only popular with younger workers. The visors were not so popular, although goggles proved to be satisfactory. The use of safety boots was almost 100%.

About half the workers wore protective trousers, although most have them issued.

February and March have been found to be the worst months for accidents and the afternoon is always an accident prone time.

Frequency peaks in accidents were in the 21-30 year old age group, which is most likely related to enthusiasm, i.e. the influence of money, that is, piece rate. The other area of peak was the 41-50 year age group. During 1982, 53 leg injuries were prevented by the use of protective trousers and a further 25 could have been avoided.

An average of ten days was lost with every accident which amounted to DM2,800 in wages and social costs plus DM6,500 in insurance payouts.

(g) Registration of Chainsaw Accidents in the Netherlands

Introduced by Mr F. Staudt from the Netherlands. Research has shown that the reporting system used in Holland is too generalised to get good statistics, and coverage of small companies is not good. Felling and delimbing were again found to be the major causes of injuries.

The main reasons identified as causes were loss of control of saw and loss of control of parts of the body.

Losing control of the saw were the results of :

- kickback
- sawing too far through cut
- breaking free a jammed saw
- losing grip of saw.

Loss of control of body were the results of :

- slipping
- stumbling.

Of the above, losing control of the saw and falling were the main causes of accidents, in fact, more than kickback. The left hand side appeared to be more accident prone than the right. The reasons being :

- chainsaws are used asymmetrically
- most people are right handed.

The left hand was the part of the body most commonly injured, then the left leg (mostly upper thigh), and the left foot. The majority of accidents occurred in February. Monday was the most dangerous day of the week and the 20-24 year old age group had the highest rate. Conclusions were that a special designed accident report form would be desirable and there should be standardised safety and accident terminology.

(h) Chainsaw Accidents and Their Prevention in Austria

A paper by Mr H. Stadlmann from Austria. Farmers have a higher overall frequency rating than forest workers in Austria and the chainsaw was recognised as the most common cause.

Occupational diseases were also identified as a serious health problem, but the difficulty is that the effect is slow and therefore is hard to convince a worker that his health is being affected.

Kickback was the most frequent cause of chainsaw accidents - and they were usually severe, up to 25 days lost.

Some reasons suggested for high numbers are :

- weight of chainsaw - most are still too heavy
- noise - sociological aspect - monotony
- vibration - levels still high (exposure time is important)
- mechanical - improper idling - bad tuning
- chainsaws slow to slow down when the trigger is released.

The left leg was found to be the most accident prone part of the body. The left hand was next, then the foot.

The recommended ways of reducing the high incidence of chainsaw accidents were :

- legal dispositions for the use of safety devices on saws
- more training of users
- the use of suitable personal protective equipment
- further development of safety techniques

(i) Search for the Reasons for Forest Accidents

Presented by Mr Z. Jablonkay from Hungary. In spite of the detailed accident reports that are collected, the records don't really specify the reason for the accident. An eye witness or even the victim's own account is usually subjective rather than objective. Research has indicated that the three main factors surrounding an accident are :

- circumstances (physical, weather, terrain etc)
- technical errors (machinery, techniques)
- momentary conditions (personal).

With the use of a video recorder, it was possible to record the working conditions and the intensity of risks that are taken. The easiest way to identify the areas of concern was to break the working cycle into elements. Most risks were found to emerge from the violation of technological and safety instructions. Many risks were also found to be derived from a lack of training but some could be attributed to a worker paying insufficient attention or the employer overestimating an employee's capacity. Inadequacy of tools and poor organisation at the felling site were also recognised as risk causing agents.

Suggestions for reducing risks were; improved supervision, better technology (equipment better suited to worksite), careful selection of the workforce before employment, and more effective training on a broader basis.

(j) Work Safety Programme for Swiss Forestry

From Mr V. Butora, Canada. Forest work has the highest accident rate of all industrial enterprises in Switzerland. Direct and indirect accident costs add $F12.80 to the cost of every cubic metre of timber produced.

Accidents result from various factors including such things as; physical conditions that are unchangeable, technical matters like faults in machinery etc, human errors such as not using protective equipment, and physchological conditions, for example a man's attitude towards work.

To improve safety, a systematic and practical application of basic work principles is necessary. A safety programme is based on the present standards of safety and is aimed at a target situation. An exact knowledge of the existing situation is necessary before a programme can be designed. An internal safety programme must consider the legal responsibilities of employing company, and the safety of machines and possible improvement of them. It must also ensure correct planning of operations so that they are performed safely, and consider the behavioural situation which has a positive influence on workers.

Ways of achieving these responsibilities are :

- identify legal responsibilities
- plan the operations
- analyse the work place hazards
- use of checklists
- selection and recruitment of workers.

(k) Latest Experience and Knowledge Related to Forest Accidents and Accident Prevention

This paper was presented by Mr E. Craig from Canada. Health and safety take a fairly low priority in production functions, except when a crisis occurs. A slogan, "Safety First" is really a fallacy because industry cannot survive under this strategy. Industry traditionally purchases machinery on a cost basis. Manufacturers are therefore reluctant to spend money to improve ergonomic environment, hence management can have an important role to play in this by its equipment purchasing policy, i.e. only purchasing ergonomically approved equipment, even at a higher price. The need in doing this is to increase management awareness of the cost factors relating to poor equipment design and the high and often unknown cost of injuries. There is also the loss of production because of accidents to consider, and the poor attitude and morale of the workers resulting from fatigue and discomfort.

Applying sound ergonomic principles and design would reduce the frequency of accidents. One type of programme is the total loss control system which considers the interaction of people, material and the environment in a system of controlling all losses. These losses include :

- delays
- downtime
- lost wages on income
- reduced production
- damaged goods and below standard products
- premature repairs and maintenance
- loss of goodwill
- public liability, etc.

Principle applied is based on a national study which showed that for every lost time accident there are ten minor injuries, 30 property damage cases, and 600 near misses.

The total loss control concept provides a management system that :

- establishes standards
- measures performance
- evaluates results
- defines objectives for control.

Principle of determining basic cause of accident rather than immediate cause gives a clearer objective to work towards.

(l) Research and Development in the Area of Logging Accidents in New Zealand

Prepared by Mr R. Prebble from New Zealand. Research effort only recently has been able to turn attention to ergonomics. Recommendations accepted by an industry working group were as follows :

- use of lighter saws with shorter bars
- introduction and instruction on the use of felling aids
- development and use of personal protective equipment
- implementation of superior felling and delimbing techniques
- improved accident reporting.

Felling and delimbing were recongised as having highest percentage of accidents and a high number of these were chainsaw accidents. Both legs, particularly the left leg, and hands, again the left, were the most accident prone part of the body. Improved accident reporting has greatly assisted the understanding of the nature and extent of these accidents.

(m) Question and Answer Session

Question

Author unknown	-	Accident prevention is seen as a constraint in most forest organisations, according to Sweden. Can we elaborate on this from other countries ?
Mr E. Craig	-	Canada, answered - safety coming first is just lip service paid by many companies to satisfy themselves that they are doing the best to provide a safe working environment for their employees. The business of being in business, however, is to make a

profit, therefore safety must be related to a dollar value and even when it is related to a dollar value and people are aware of that, it is still very difficult to appreciate because of the time span needed to make people understand the benefits. Craig's suggestion was that it may not necessarily need to be called safety, but somehow this point must be proven to management.

Dr Strehlke - commented that cost elements must be emphasised in dollars and cents, and it was considered to have been effective in the United States and Canada. This proof of success is possibly the only way to achieve this end.

Dr P. Harstela - said that the points on safety were well taken, but consideration must be given to the worker, who has to use the equipment.

Mr H. Stadlmann - from Austria suggested that, people who have already had an accident are the easiest to persuade in these situations. There are two ways of making people aware :

1. Simulation of an actual accident, and this requires, to some degree, a shock treatment.
2. Actual experience of having had an accident.

The second way is the most undesirable, but also the most effective.

Mr O. Holzwieser - from Austria said that from the records that they have kept in their organisation, if no accidents had occurred in one year of production, a 400,000 cubic metre increase in production would have been possible. Holzwieser felt that making available protective equipment is one way or one attempt to cut down on accident frequencies, but the other was equal training for all workers in timber harvesting. This has been most effective in their company.

Dr G. Kjellstand - Sweden, said it is difficult to get access to commonly used machinery to understand ergonomic circumstances and even then this machinery is found to be bad, the ergonomic principles take second place to productive efficiency, reliability and cost. Using a sample of ten good and ten bad machines, maintained over a period of years, a comprehensive record of production levels, repairs and maintenance records etc was kept. From this it was calculated that in 1978 alone 3-4 million Swedish Kroner was lost due to bad machine design.

Suggestion
Author unknown - We must study work itself. It is possible to reduce the input effort of work and consequently the energy requirements by studying it carefully and breaking it down into elements, therefore, improvements can be made to specific elements to reduce the overall input effort to a particular job.

Dr P. Harstela -	from Finland; sees the roles of supervisors as a priority to keep the job safe. In many cases he claims workers know how to work safely, but ignore this in the face of production. Supervisors need better training in working techniques to be more aware of the situation regarding the stresses and strains on a worker so that when they are setting production levels, and controlling operations, they fully understand what's involved in doing a particular job.
Dr Strehlke -	pointed out that it seems to be the same all over the world, foresters are getting far too academic. Not enough understanding of actual application on the job means that they set unrealistic goals or expect unrealistic production levels from workers. Strehlke suggested that academics should undergo at least a one year practical experience training period during their academic studies.
Mr S. Tomanic -	from Yugoslavia had been listening for some time to this conversation and decided to comment that the equipment workers are being expected to use, is overburdening his personal environment, and felt that it was important that researchers understood this. The more gear a man has to carry in to a work site the more chance he has of losing it, and the more he has to shift it during the felling operation. It was felt that researchers should take the tool in hand themselves before criticising workers who refuse to use the recommended practices and recommended safety equipment. An example he quoted was the use of felling levers, turnbands etc.
Dr Seha -	Canada, said that accidents will happen if we do not make a cure. It was therefore suggested that training should aim firstly at the new generation of workers so that they are brought up with the correct techniques. A second programme should be a retraining of older workers and a third point for consideration is a programme for engineers who design equipment. A fourth training programme would be for managers who press for production. They must understand too what it means to operate a machine or a chainsaw for eight hours a day.
Dr Strehkle -	Mentioned a training programme in industrial premises introduced by colleges. This programme was a self training affair based on slides and when every new employee was subjected to this, accident frequencies plummeted.
Mr A. Trzesniowski -	from Austria said that differing work habits need varying safety programmes. For example, working alone or in pairs. He cited that the average age of Austrian forestry workers was 48 and more. The reluctance of them to change with new technology was understandable. He suggested that the reason

for the comparatively old age in the forests was the attraction of the cities and industrial jobs with high incomes which enticed youths away, so workers in the forest areas, up until recently, were employed off the street. Consequently, recent training programmes have indicated that there are considerable gaps in the level of skill of the workers, therefore a retraining course has been set up. Trzesniowski felt that the use of protective equipment must be understood. There is no sense in trying to make people use equipment that is not necessary, for example gloves. He said that the cost of protective equipment was high, (4-5,000 Austrian Schillings) which makes justifying buying them very difficult. Therefore, the training centre at Ossiach have a policy of actually supplying equipment during the training courses so that everybody has them.

Mr E. Gladtz - of Germany suggested that the legal position can be used to force people to wear equipment in spite of psychological resistance, therefore you can legislate to make people wear the gear. But the most effective method is to lead by example and influence young workers. The point was made that during the field excursion, on both occasions a seminar, talking about ergonomics and safety in forestry, appeared on a work site with over 60 people and not one of them was wearing a safety helmet.

Dr P. Efthymiou - from Greece said that as the owner or manager of a large 10,000 hectare area in earlier years, the workers, when employed, were given a crash course in methods, but the most important thing about this course was the presentation of it. He said that it must be simple and appeal to the psychological feelings of the workers and that it also must be constantly repeated, and within it's content must have constant repetition. Researchers, he felt, must become more active and make the findings of their studies and conclusions from work investigations be used. Research therefore must become more active. At present we are far too passive. We must get hold of the manufacturers and force them to improve their products.

Dr Strehlke - asked why the equipment manufacturers were not present. The seminar was widely publicised and many people were officially invited. The machinery manufacturers had equal opportunity to come and they should have been there.

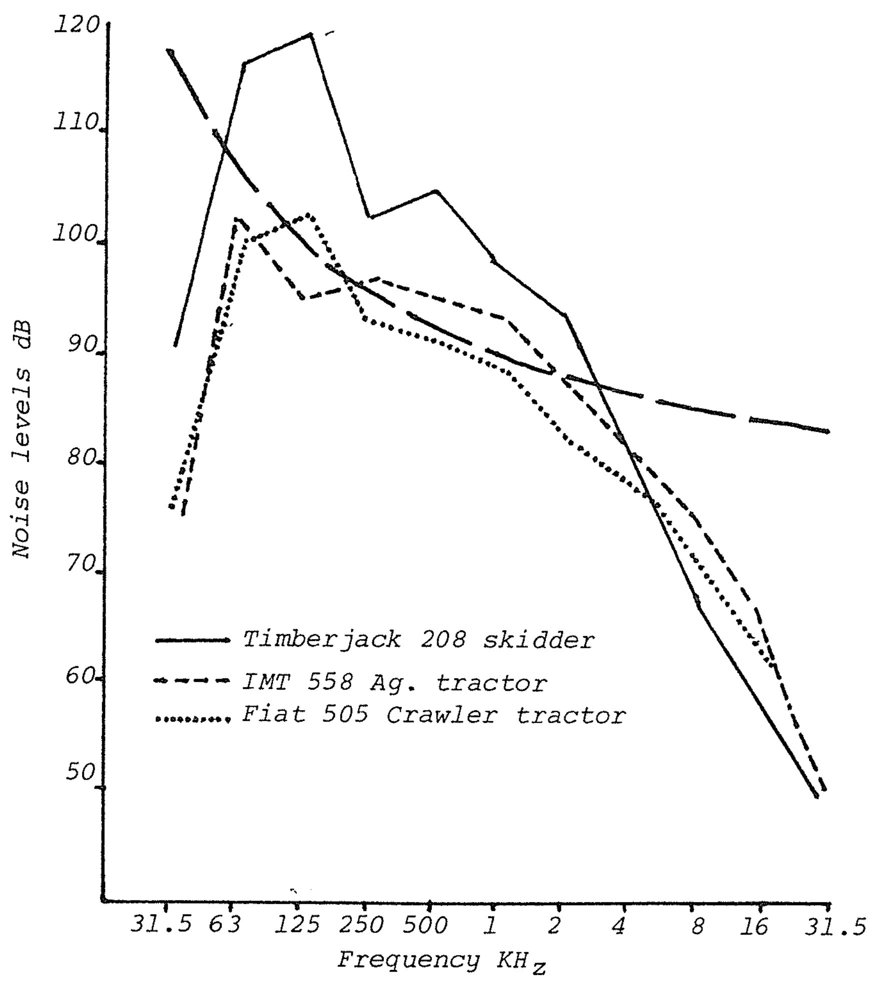
Mr J. Hartfiel - Germany, mentioned a survey that was conducted where questionnaires were given out to managers, supervisors and workers. From a survey of roughly 30 managers, only one had the attitude that the work environment must be made so that the worker can have a long working life and then enjoy a long retirement. It is important that all managers are aware of this.

OCCUPATIONAL HEALTH

(a) Ergonomic Properties of Skidders - Adapted Agricultural Skidders, Crawlers and Timberjack-type Skidders

A paper by H. Lipoglaveck from Yugoslavia. The Yugoslavs have created an ergonomic check list. Three skidding machines, namely a tracked tractor, an agricultural tractor and a skidder, were evaluated in a series of controlled situations. The best ergonomically was found to be the articulated skidder because it was specifically designed for forest work, rather than adapted to the work. The noise levels (shown in Fig. 7) measured at the ear and shows how the levels are related to the work element, inhauling or bunching with a winch.

Figure 7 - Noise levels and frequencies of the machines when winching



Overall levels for all machines was marginally over 100 db limit. Noise levels are therefore related to the distance of haul and the size of the load. Also the gradient of the terrain. Operators of machines without soundproofing in cab should use ear-muffs.

Vibration - 98 examples of vibration measurements were taken. The horizontal axis was found to be twice as high as the vertical axis and the crawler tractors were found to have much higher vibration levels than the rubber-tyred models. This too was related to speeds and travel loaded distance, plus load properties. Under these conditions skidders are around the maximum level acceptance. The crawler, however, is considerably above this level. Seat comfort does affect the vibration factor. This was particularly noticeable in the analysis of vibrations on the vertical axis. With bad seats, the maximum vibration levels for all machines often exceeded vibration limits. This vibration is directly related to strain. Heart rate measurements had proven this, hence the Yugoslavs can conclude that ergonomic designs of skidders in their country are not acceptable.

It was suggested that to overcome this, the manufacturers must be taught to consider ergonomics in the design of their machinery. The best way to do this is to completely understand each function that a machine is supposed to carry out and be subjected to the type of stresses and strains that workers are. By the same token, users should be influenced to consider ergonomics in their machine purchase.

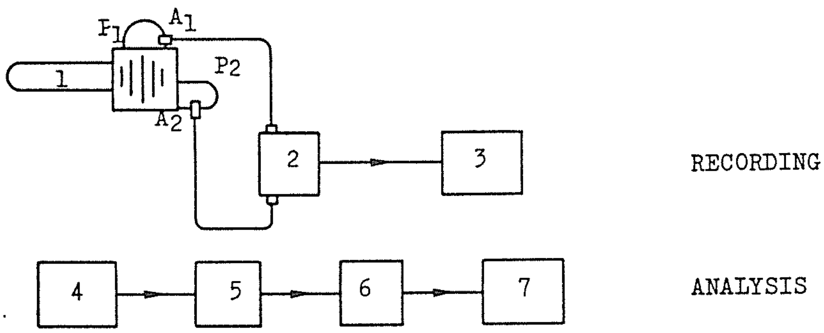
(b) Chainsaw Vibration Spectral Analysis and the Raynaud Syndrome

Prepared by Mr F. Seha from Canada. Vibration is principally caused by parts - components not being perfectly balanced.

There are two categories to this subject. The whole of body vibrations caused by machine, and, specific parts of the body exposed to and affected by vibration, namely the hands and arms. Raynauds syndrome is described as the numbness of fingers and the hand and blanching of the fingers because of a reduction of the circulation in the blood vessels of the fingers. The symptoms are progressive and can be classified in four stages, the first being the blanching of one or more fingertips with or without tingling and numbness. The second being blanching of one or more fingers with numbness, usually during winter. The third is extensive blanching as frequent in summer as in winter, and the fourth is extensive blanching of most fingers occurring in both summer and winter and which may cause gangrene of the fingers. 22.8% of the workers surveyed in Quebec suffered from these syndromes and the number of workers affected increases by 3.38% per year. Of the chainsaw workers who had worked 20 years or more, 49% were suffering from advanced stages of Raynauds phenomena. The cause of this can be as little as 6 months exposure to chainsaw use, but normally under these conditions there are some other factors which make a victim susceptible to it. Usually, operators have symptoms after about 12 years use.

A comparison was made between 10 chainsaws, five with vibration dampeners and five without. The method of recording vibration is shown in Fig. 8.

Figure 8 - Arrangement of aparatus used for testing and analysis

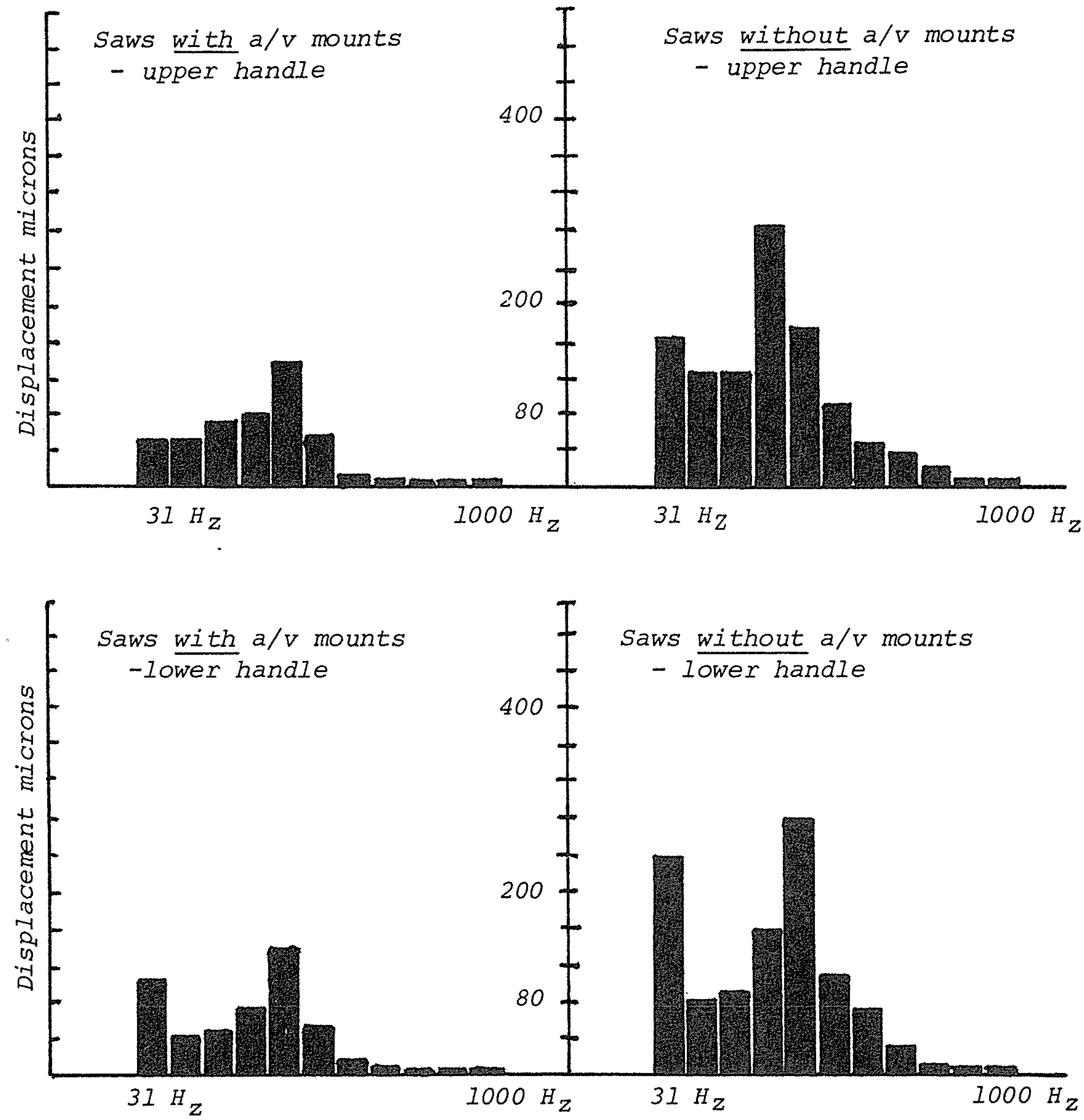


A_1A_2	tri-axial accelerometers, B and K 4321		
P_1	upper handle	4	B and K tape recorder
P_2	lower handle	5	filter (10-1000 Hz)
1	chain saw blade	6	micro processor
2	preamplifier	7	printer
3	B and K FM tape recorder	B and K	Bruel and Kjaer

Acceleration levels showed that 125 HZ is the frequency most liable to cause vascular constriction. The level of vibration within that frequency therefore, was tested on the 10 chainsaws and the results are shown in Fig. 9.

The average noise levels during these tests ranged from between 104 and 116 db and this apparently can also be a cause of vascular constriction. There is a very real need for a greater awareness and more research effort into reducing the occurrence of vibration induced white-finger disease.

Figure 9 - Histogramme of frequency and displacement for the mean value of all chainsaws tested



(c) Improvement of the Methods of Diagnosing Vibration Disease and Examination to Detect Susceptibility

Presented by Mr Z. Jablonkay from Hungry. The range of the acceleration at which vibration occurs in the average professional chainsaw is 15-80m/sec^2. The dominant frequency is between 125 and 250 Hz, while amplitude is above 100 um. Vibration in this range leads to functional problems in the peripheral blood flow of the upper limbs. It can also causes diseases of the nervous system and in the odd instance, locomotor disorder. The diseases of the vein and nervous system are hard to detect particuarly in the initial stages, and it has been found to be difficult to establish a workers susceptibility to the disease.

Research began in 1976 by the Hungarian Research Institute to try and determine susceptibility and the various stages of the disease. The results have shown that there is a correlation between the rate of temperature increase of fingers and the likelihood of a worker either contracting the disease or already having it. This is related to the blood flow (plethsmagraphy) of the fingers which indicates whether the worker is suffering from increased vascoconstriction. The graphs, in Fig. 10, show the different between a healthy person (V-shaped curve) and someone suffering from vascoconstriction (U or L shaped curve).

Figure 10 - Graphs showing re-warming time for fingers after being immersed in 12° - 14° water for ten minutes

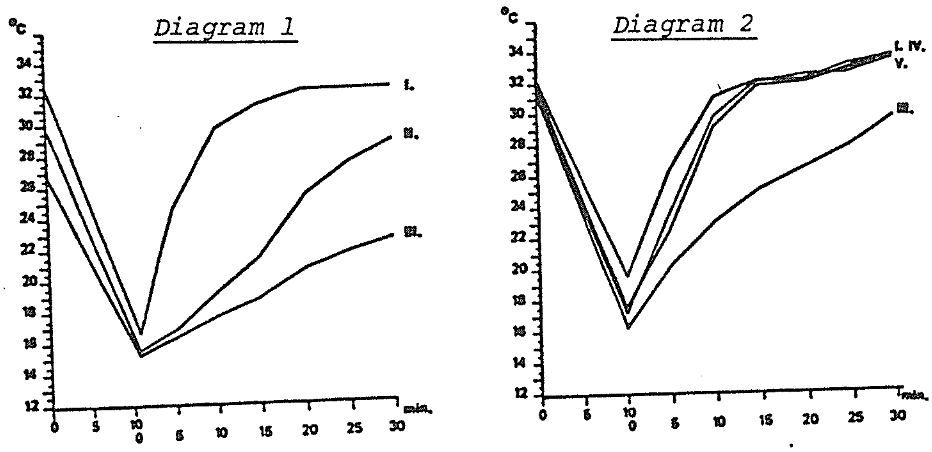


Diagram 1 - Curves showing the rate of the rewarming of the fingers after cooling. I - "root-sign"shaped i.e. quick rewarming of the fingers. II - "U" shaped i.e. after the initial slow rewarming the temperature of the fingers reaches the "before -cooling" temperature (exceeds 25°C in half an hour.) III - "L" shaped curve i.e. rewarming is slow from the beginning to the end and the skin temperature is lower than 25°C even in the 30th minute after rewarming.

Diagram 2 - shows the difference between the rewarming of the blanched finger and the unblanched fingers on the right hand of the chain saw operator suffering from Raynaud phenomenon. The subject complained of blanching of the third finger.

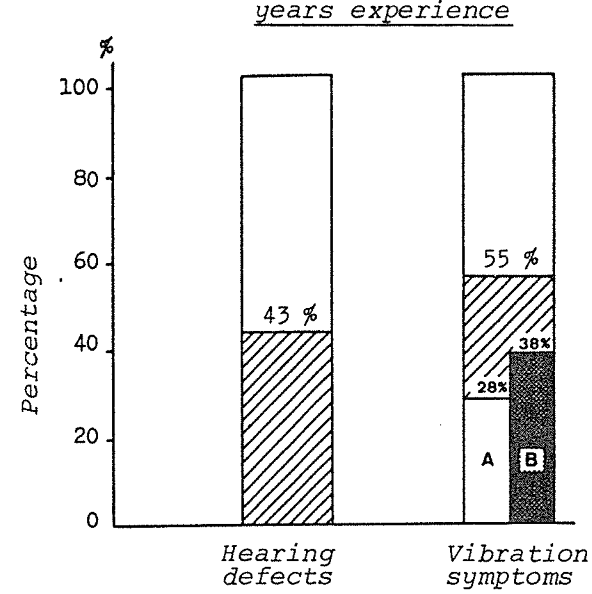
It was found that results were not so conclusive in the under 21 age group. In spite of this it was recommended that an internationally accepted method of testing be established using calibrated equipment to determine the susceptibility to the disease of workers over the age of 21.

(d) Noise and Vibration Hazard for Sawyers Employed in Forestry and the Direction for Ergonomic Activity in this Field

A paper by J. Bielski from Poland. Noise and vibration effects were measured on 94 workers with average length of experience from 4 to 37 years. They received medical examinations which looked at circulatory problems and problems with joints. The aim was to study the effect of chainsaw work. Appendix 1 in graphs shows that powersaws all exceeded the vibration limits and workers using them were put under considerable physical and mental stress, e.g. 2745 kilocalories were used in each shift. This, therefore, has psychological and social effects.

The graph in Fig. 11 shows the results of audio metric studies of these workers and it was found that most joint problems were cartilage related.

Figure 11 - Percentage of chainsaw operators suffering from hearing defects and vibration symptoms - 94 workers ranging from 4 to 31 years experience

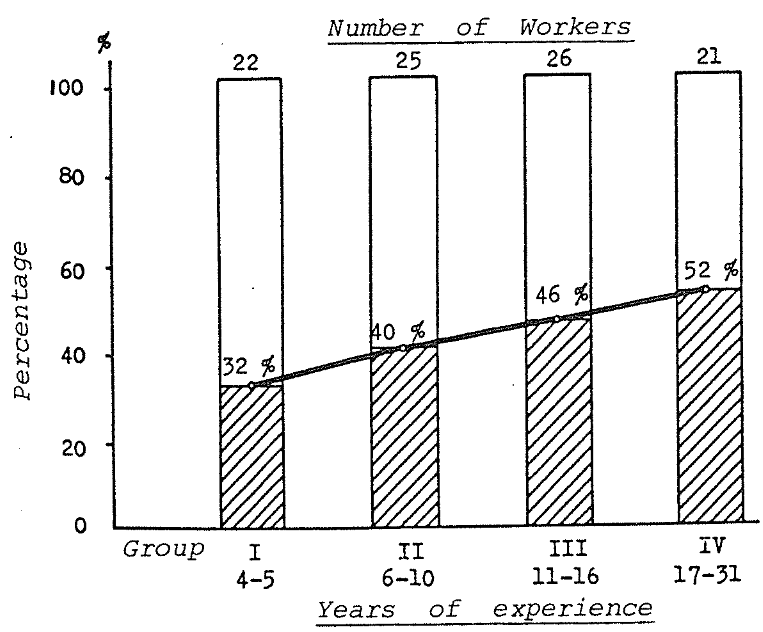


A = Joint problems
B = Vascular constriction

Pathological changes to arms and hands were also recorded during these studies.

Workers in the forestry occupational groups were found to be at high risk. Fig. 12 shows how the effects of noise from the chainsaw worsened over the period of exposure.

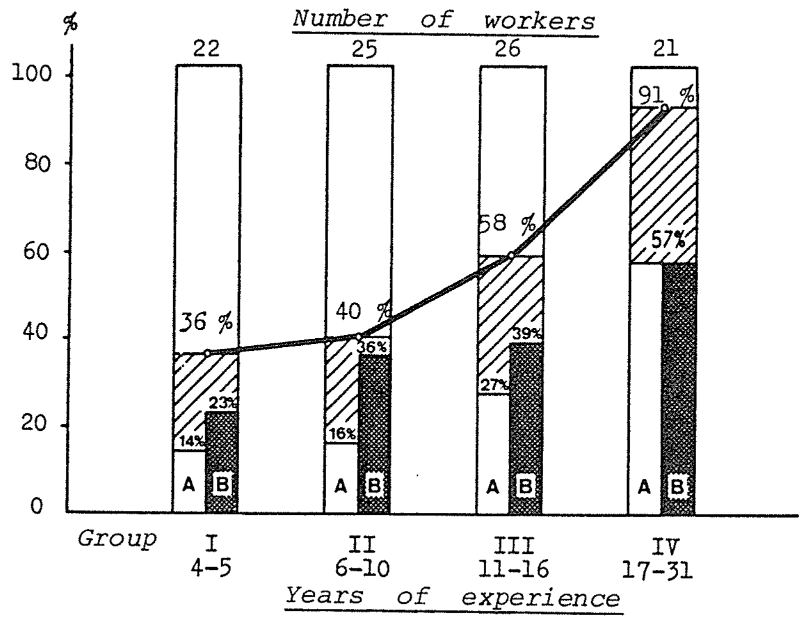
Figure 12 - Percentage of chainsaw operators suffering hearing defects according to the time exposed to the noise from a chainsaw



- 94 workers ranging from 4-31 years experience

It was clearly demonstrated in this survey that vibration worsened the situation in the course of time. Refer Fig. 13.

Figure 13 - Percentage of chainsaw operators suffering vibration symptoms according to the length of time they had been working



A = Bone and joint problems
B = Vascular constriction

Felling work was considered highly dangerous and ergonomic resolutions should be introduced, i.e. chainsaws should be replaced with shears, or improve the protective devices of, and for, chainsaws. Smoking is considered bad for the health. It has a restrictive effect on many of the vital functions of the body. Protective equipment must be used by all workers. It is maintained that hands should be kept warm at all times. Also, the calorie intake of workers has to be high and rest conditions improved, i.e. better facilities for eating lunch etc. Time exposure to chainsaws should be thought about with the objective of reducing the length of time they are used. Periodic medical checks are essential.

(e) Prevalence of Vibration Induced White-Finger in Forestry Commission Chainsaw Operators

Prepared by Mr D. Bardy from the United Kingdom.

In 1970 a survey of workers showed that 85% were suffering from symptoms of vibration induced whitefinger (VWF). In 1972 obligatory anti-vibration handles were introduced. Research effort began in 1970 and information was recorded on workers from then. The table below shows how the incidence of VWF had declined since anti-vibration handles were introduced in 1972.

Year	Mean Saw Usages (years)	VWF Prevalence (%)
1970	6.4	85
1972	8.4	87
1976	10.1	50
1980	11.2	37
1981	12.0	35

The next table below compares the incidence of VWF between workers who had been exposed to saws without anti-vibration (A/V) handles and the younger workers who had only used saws with A/V handles.

Table of Workers who Suffer VWF According to Age and Years of Exposure to Chainsaws with and without A/V Dampening

Within the sample frame of 22 forests, workers were classified according to the following occupational groupings :

a) full time operators with exposure to non-A/V and A/V chainsaws

b) full time operators with exposure only to A/V chainsaws (i.e. those recruited after 1971)

c) occasional chainsaw users

d) ex-chainsaw users no longer exposed to vibration

Occupational Group	Mean Age (Years)	Mean Saw Usage (Years) Non-A/V	A/V	Number	VWF Stages 1-4
a	43.4	7.5	9.4	79	49%
b	27.3	NIL	4.6	91	8%
*c	40.5	9.0	7.7	102	42%
d	44.5	4.2	7.3	66	39%
all groups	38.5	7.2	6.9	338	34%

* Some workers in this group had previously been full time

Although the years of exposure for the first group was somewhat longer, the difference in the prevalance of VWF was 41% of the 91 workers who had used A/V saws only, 61 had no symptoms at all, 15 experienced tingling which is the first stages of VWF, 8 had felt numbness and 7 showed positive symptoms of VWF in the first and second stages.

It is considered that although anti-vibration measures do reduce the effect of vibration, they do not eradicate this disease. Conclusions were drawn as follows :

1. The reduction possible is considerable.
2. It would be impossible to eradicate.
3. For existing chainsaw models, a maximum of four hours per day of exposure is recommended.
4. Climatic factors do not appear to affect this phenomena.
5. The use of gloves could reduce the occurrence of VWF.

(f) Health Consequences of Forestry Work

By J. Buchberger from Switzerland.

The Research Organisation has created a draft for the requirements for occupational health services. They hope to concern and motivate employers in reducing the problem of poor medical histories of the workers. A series of enquiries were done to substantiate this claim. These enquiry results were based on studies only just completed. A total of 1527 workers and 602 rangers completed questionnaires and of 540 personal interviews conducted, 365 resulted in medical checks. The survey looked at the number of retirements and the reasons for retirement of all the above-mentioned people. In that period, three fatilities had occurred, not necessarily related to work though. Injury accounted for a fair number of reasons why people were leaving the work, and it appears to be related to work conditions (high stress factors) but these must be studied with caution because ealier life histories could have contributed to retirement. Some reasons for premature retirements were : health-related - (40%). Another reason was that the people had some opinions that their health was being affected. White-finger was one of these.

The chart below shows the occurrence of white-finger in a detailed survey undertaken.

		Experience	
Symptoms	2-3 Years	4-10 Years	Over 10 Years
No symptoms	81	61	42
Tingling	14	23	16
Blanching	3	9	15
Serious	2	7	27

Figures tend to remain constant after 20 years, not only related to the kind of vibration but also the susceptibility of the worker and the weight of the saw being used. Operational experience also has an influence on this disease, particularly the problem of people gripping the handles too tight. This next chart indicates the number of productive hours worked in a year by a sample of the people surveyed.

Number of Hours per Year	Percentage
Under 400	10
400 - 800	37
800 - 1200	36
Over 1200	17

The bulk of people surveyed were professional workers and many of them, in their own opinion, were suffering from hearing losses. This aspect can be divided into two categories - subjective and objective.

Age	16-19	20-39	40-54	55-69
Subjective	4	20	35	45
Objective	-	25	-	33

The records indicated that exposure to excessive noise exceeded the standards in most cases. It was found that the younger workers were more prepared to admit fatigue during work than older workers and that back problems were higher than most types of employment. The other elements recorded, were;

blood pressure, gastric disorders, etc - these, in particular, were higher in the older people, 40-70 years old. Damage to the locomotive systems were also high in this age group and a lot more of the people surveyed were under medical care. As far as breathing difficulties go, not too many people complained of this problem. Nervous disorders, apparently, were quite frequent and believed to be related to the pressure of production, but when asked about working in the forestry environment, most workers claimed that they preferred to work alone. High blood pressure and overweight is surprisingly prevalent in the older forest workers. This seems to be related to alcohol consumption and subsequent liver ailments. One-third of all the workers in the 55-69 age bracket suffered from this problem.

In a question on their judgment of work conditions, 84% of the Forest Rangers believe the conditions were bad and most of the problems had not been improved on.

(g) Results of the Medical Examination of Forest Workers in Baden-Wurttemberg

Presented by Mr I. Sabel from the Federal Republic of Germany. This paper reviewed a programme where four medical officers, using a large vehicle, conducted a series of tests on 3197 workers. They had laboratory equipment and were able to conduct audiometric tests. Workers who suffered from complaints were sent to medical rooms where further tests were conducted for liver condition, etc. It was mentioned that there was a restriction on the periods in which the vehicle can be used because it is fairly sensitive to correct temperatures. Medical checks were as follows :

- indepth enquiries into accident records and social habits
- simple medical checks performed, urine tests, eye tests, lung and auditory tests - the group tested were all forestry workers in the Baden Wurttemberg area.

All this material was used to compile a medical history of each worker. The health measures, such as diet, were recommended to workers. It was surprising to find the number of overweight peole able to do the jobs in the forests. Most of the workers tested were receptive to the testing procedures. Quite a number suffered from diabetes, blood pressure, etc. It was found that log length handling created a lot of stress, particularly on hip joints and, consequently, problems evolved. The use of protective equipment was studied as well during the survey and, again, this problem of reluctance to wear protective equipment came through. After three years this is changing, not so successfully with the older people, but the younger workers are the target group and they can influence these older workers eventually.

Many of the problems were not realised by the workers, or if they did realise it, they often didn't admit it. Few people in the survey qualified for compensation for diseases because infection levels were high and the causes hard to identify. For the cold conditions, gloves are not really considered a solution because they get wet and wet gloves can worsen the problem. Many forest workers considered that the backache that they had was normal and did not seek medical help for it. Hip joints and neck joints were other parts of the body which suffered problems. Spine deformations were frequently caused by the forestry work, but lack of earlier history makes it difficult to prove this. Alcohol consumption was also a problem and many of the workers consumed between 4 and 6 bottles a day as it was considered necessary for their recovery from the day's work.

(h) Health Control of Various Categories of Forest Workers

Presented by Dr G. Kjellstrand from Sweden. 100 workers in the forest district of Molubacka were given a full medical check during 1974 followed soon after by a questionnaire about the usefulness of the check. In 1978, 84 of the original 100 workers were examined again. A mobile clinic manned by a Health Nurse was used to carry out the checks.

In the earlier examination, it was found that previous neck and back pains were the most common ailments. PVD and hearing deficiencies were also a common complaint as was fatigue and nervousness. Most workers found it beneficial to have the medical checks and following the 1978 examination 66% received some form of help for their problems. Often these problems, or more accurately the source of the problems, were unknown prior to the check.

It was concluded that the health check done in the Molubacka area paid off in terms of diagnosing problems before they got too bad. Further, medical checks on a four yearly basis were recommended as it was felt that the regularity of such examinations would combat somatic and social medical problems at an early age.

(i) A Method for Health Problem Identification in Forest Work

A paper prepared by Mr B. Pontein from Sweden. The Forestry Faculty of the Swedish University of Agricultural Sciences has collaborated with company health services to develop a uniform method for identifying health risks and health complaints among the workers. The method is based on a detailed questionnaire used in conjunction with health checks with the information being compiled and analysed on the Faculty's computer. Once this has been done, the information is directed to three levels :

1. The individual where a company health service may be offered to a person suffering from a particular complaint.

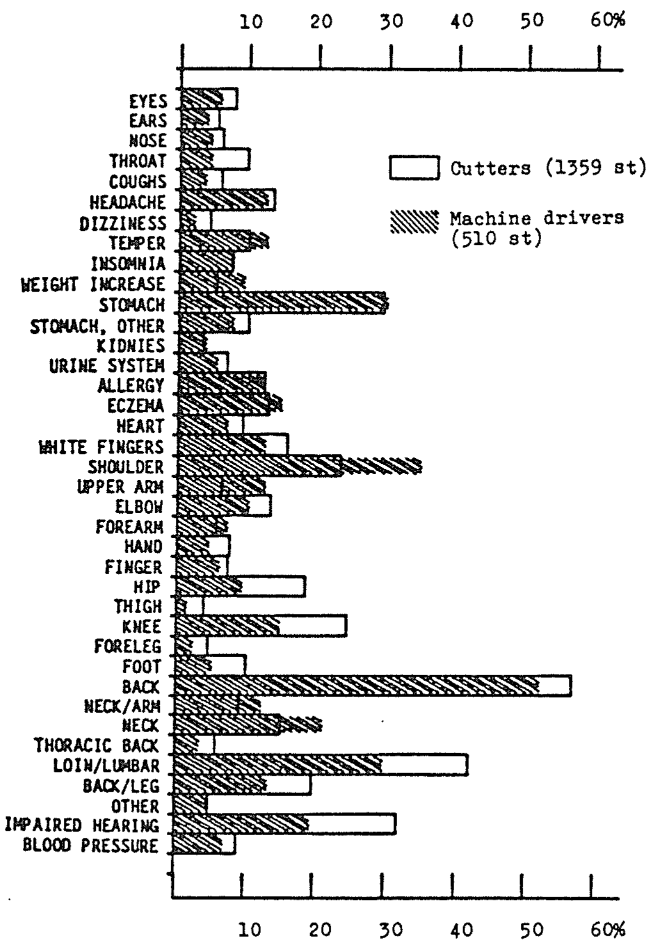
2. The company level so that the problems arising from a particular part of the job can be diagnosed.

3. At a trade level so that the health risks of various occupational classes can be compared.

An example of the Health Complaint Profile for cutters and machine operators is shown in Fig. 14.

PVD = Periferal Vascular Disease

Figure 14 - Health complaint profile for cutters and machine operators surveyed in Sweden



"HEALTH COMPLAINT PROFILE" Frequency in percent of stated health complaints, during the last 12 months. The complaints need not necessarily have any relation to the working conditions. The figure shows the frequency of the total number of cutters (1359 st) compared to the total number of machine drivers (510 st), that have so far been involved in the method.

In 1976, a Working Environment Agreement was formed between Employers and Unions to ensure that safety arrangements were properly organised at the work place. This agreement includes the provision of company health services, or joint health serives in the case of small organisations, and these people have an advisory function in the safety of work.

(j) Question and Answer Session

Question - to Mr Seha - Is there significant difference between chainsaws with anti-vibration and those without?

Answer - A considerable difference was noted.

Question - to Mr Seha - Where was the main area of vibration.

Answer - It differed between brands. Some had the front handle and others had the rear. The research organisation tested the acceleration of vibration with each model and the frequency band seemed to determine the degree of vibration.

Question - What effect did fitting anti-vibration handles have?

Answer - Three of the five brands tested were above the acceptable vibration levels.

Question - The problem is not solved by anti-vibration systems, do you agree with this?

Answer - Not entirely, but rubber cushions between the motor and handles are a step in the right direction. They have significantly reduced the problem, if not eliminated it in some cases.

Comment - Raynauds disease is different from Raynauds syndrome. Raynauds disease is a medical condition not related to vibration.

Comment - Seldom does white-finger disease prevent the worker from working, but it does affect his social life and comfort on the work site and elsewhere.

WORK CLOTHING, PERSONAL PROTECTIVE EQUIPMENT

(a) Demonstration of Work Clothing and Personal Protective Equipment

Firstly, a description of protective equipment available and used in Austria was given by Mr A. Trzesniowski. He began with boots and there were three types shown. The first one, a light-weight boot suitable for hunting, (in his own words), the second high-top boot in black leather, very smart looking but no protective toe cap and no apparent protection from the chainsaw. The third boot shown was a heavyweight boot with protection around the front of the foot. It is unsure whether this protection was steel or not. Also shown were some spikes which strap onto the boot for use in snow. They are not entirely suitable for walking on logs because they stick into the wood or bark and can cause more risk than not wearing any spikes at all.

Two types of gloves were demonstrated, both mitten design and each with an independent forefinger on the right hand, for chainsaw operation. Both pairs had padding on the top of the left hand glove. One was more a gauntlet style which came somewhat up the arm, while the other was a short wrist-high glove. Strap-on leather shields which were used to cover the top of boots when walking in snow were displayed, along with various types of underwear available, thermally designed to keep warmth in. One particular pair of undertrousers designed for skidder operators looked okay.

Protective trousers with nylon charmeuse padding were among the array of articles demonstrated. The padding extended from the ankle up to mid-thigh and incorporated 28 layers of charmeuse. Light raincoats with highly visible patches on the rear of the shoulders were also part of the attire that Austrian loggers were expected to wear. The cape looked to be an extremely well made garment.

Helmets, with replaceable lining, were shown and these helmets included a weathershield made of nylon to stop water and snow going down the operators neck. He looked something like an arab when wearing it, but the weathershield did work. All helmets had retractable ear muffs and visors.

Mr J. Hartfiel, from the Federal Republic of Germany, commented on the protective equipment that had been demonstrated. He mentioned that he had conducted comfort and safety level tests and expounded the need for ferntight type boots, rather than the ones that were shown. He mentioned cut resistance of boots and trousers and said that it was very difficult to estabish protection levels. They have developed their own test rig in Germany for this purpose. The minimum level of protection required is at least a .05 second cut-through time for the material. This rig runs at a speed of 6,500 rpm and on it they have tested most of the garments that are available on the world market. They have found polypropylene padding unsuitable for leg protection because it does not have sufficient cut resistance. Most of the other materials on the market do satisfy the criteria. A pair of overalls, with sewn in leg protection, were also shown during this discussion, but they did not include the full arms, just the cross-over straps over the back. Padding was the same as for the Austrian trousers. Hartfiel stressed that with the extra padding in the front of the leg it was necessary to ventilate the top of the trousers to make them comfortable.

A contribution from a Frenchman, name unknown, then followed. He outlined the role of the Social Insurance Company in France and said that it wanted to know where accidents with chainsaws occurred in the operations. They also needed to know :

- how serious the injuries were (and these were normally bad)
- was protective equipment available and how effective was it, (that is with a chain speed of 15 m/sec. and a downward force of 13 grams, cut-through times for protective garments range from .05 seconds to 1.2 seconds)
- they believed there is a need for an international standard governing leg protection
- Kevlar has showed good cut resistance.

The floor was then open for questions and the Frenchman was asked one question on whether protective equipment was being used. He replied that in general there was a reluctance to wear the equipment and it was mentioend that it was all very well for research to find these protective measures, but research does not stop until they are being used in the field.

Comment from Mr Hartfiel, Germany, - Kevlar had excellent protective capacity, i.e. over 1.5 second resistance in cut-through tests, but it is difficult to cut and sew, and very expensive, i.e. over 50 Deutschemarks per cubic metre. Like the N.Z. standards, the Germans award a quality label to identify garments that have passed their standards.

(b) The Eye Protection of Loggers in Finland

A paper by Mr K. Ojanen, Finland.

Eye protection in Finland is compulsory in most forestry work, but only one-third of the operators use them. The main reason for this was the fact that the type of protection available (i.e. visors), were difficult to use and poorly designed.

The main complaints were :

- They became frosted in winter,
- There was poor visibility through them when conditions were rainy or dark,
- They caused glare in sunshine.
- They were not durable.
- The loggers were not familiar with their use.

From a questionnaire that was conducted, 1.5% of the saw operators reported that loss of vision through the visor had caused an accident. The type of materials used influenced the loss of vision suffered. The PVC plastic was found to be better than the wire for mesh and a dark colour superior to the lighter colours. The research organisation has recommended a standard mesh size, and construction dimensions. This size was established by studying chip sizes of the various species being cut by different types of chainsaw and measuring the effect of these chips being blasted under air pressure against each screen. It was also pointed out that eye shields not only protect the eyes, but also the face, nose and part of the mouth, etc. It was made quite clear however that existing designs still need a lot of improvement.

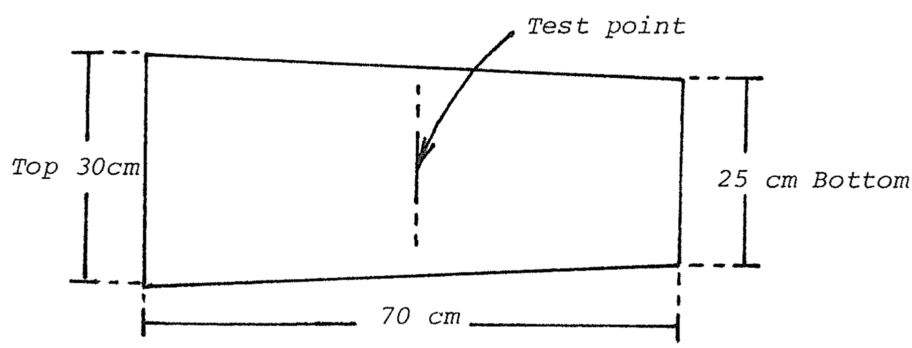
(c) Protective Effect of Leg Shields in Finland

A paper by Mr K. Turtiainen from Finland which described the testing procedure used for cut resistance of protective trousers and boots. The first rig was set up using a conventional chainsaw at 6,000, 8,000, 10,000 and 12,000 rpm. The saw was dropped from 5 cm above the pad and the cut through time recorded. These earlier test results were not considered accurate so the Vakola organisation developed a proper test rig using an electric motor. The specifications for this testing are as follows :

1. Pressure on bar, 15 Newtons.
2. Sprocket speed, 6,000 rpm.
2. Chain speed, 13 metres/second.
4. Dropping speed, 0.2 metres/second

Each pad tested has a small thread of wire on the top and bottom of the pad. Timing starts when the top wire is cut and finishes when the bottom wire is cut. Test point is in the middle of the pad, at only one point. The leg shield size recommended by Vakola is shown in Fig. 15.

Figure 15 - Dimensions for protective leg shields



When testing boots, five test points between the steel toe cap and the top of the boot are tested for cut resistance. It was concluded from the testing that 100% protection at full 20 metres/second chainsaw speed is not practical because all padding configurations available do not offer full protection. Therefore, it is important that loggers realise this and do not become complacent when using protective gear. Limit values can be set for the cut-through time and the resistance force for each garment. Additionally, safety shields should protect against cuts in all directions, not just one direction. Laundering ability is also very important, but perhaps of the most importance are the comfort levels. From the testing and the accident reports the incidence of trousers twisting around the leg has been rare. A summary of test results for boot and trouser padding is as follows :

Type of Boot	Cut through Time
Rubber with nylon cord padding	3.08
Rubber with rubber padding	1.50
Leather with nylon cord	0.42
Leg protection in trousers	0.16
Rubber boots without protection	0.02

(d) Discussion

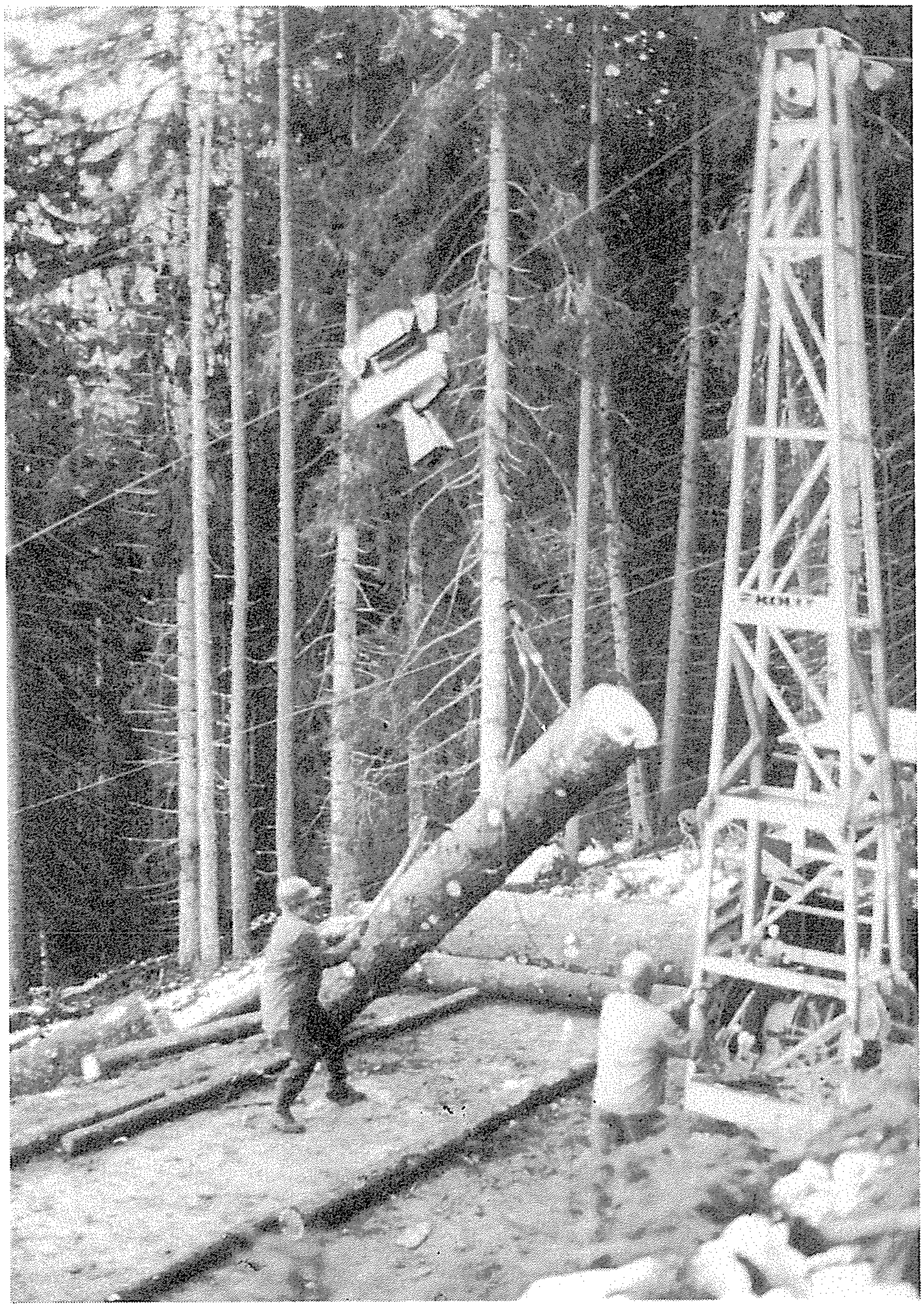
Stadlmann - from Austria - suggested that protective equipment in many cases is available to operators, but is not used because comfort levels are not suitable. In other words, they have the same problem all over the world, regardless of how well a piece of safety equipment is designed and manufactured, it is not going to suit everybody. Comment from Stadlmann was that designers and people expecting workers to wear the gear should go out into the forest and try them themselves.

FIELD EXCURSIONS

(a) Excursion to Himmelberg - Lodrom Private Forest

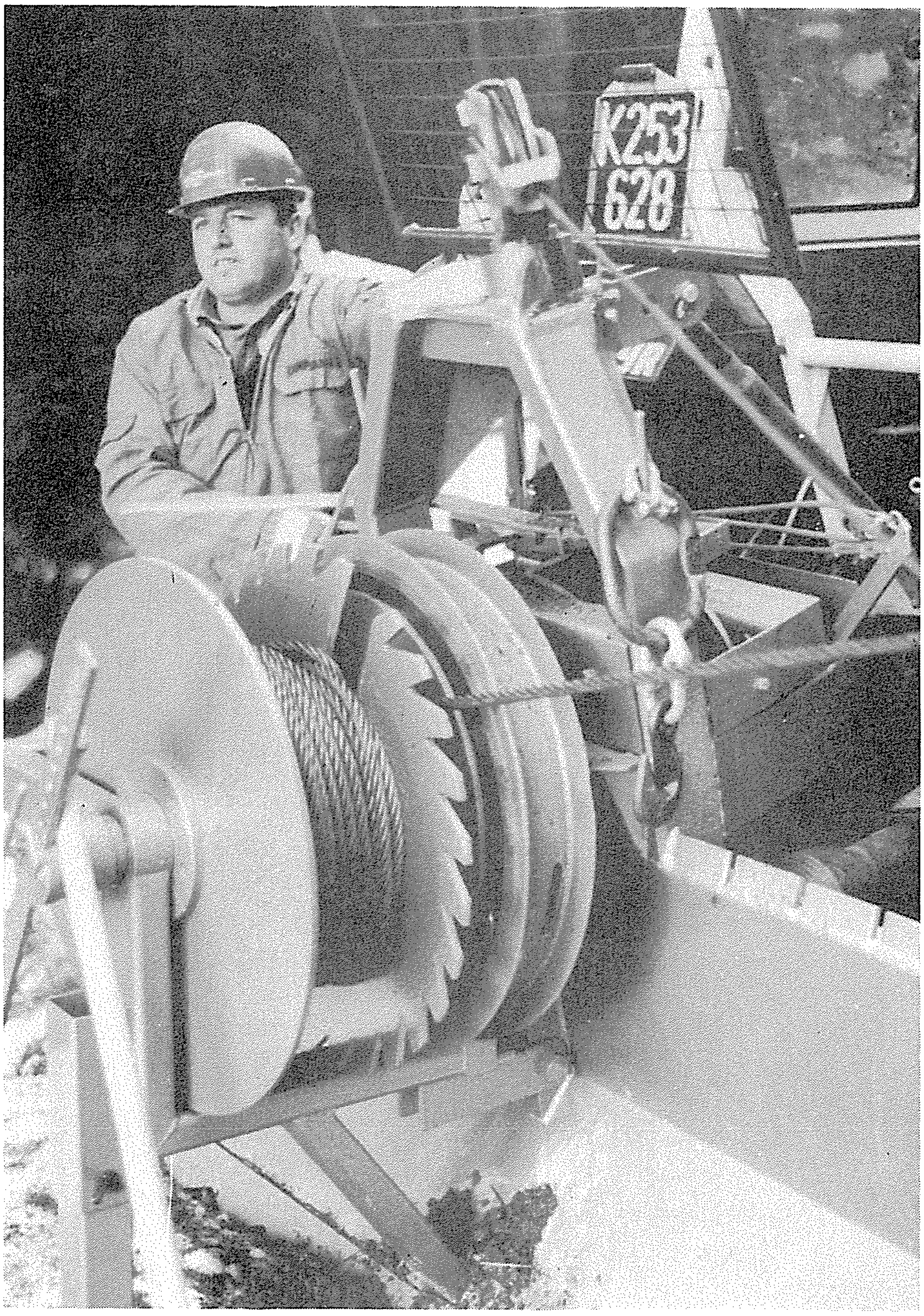
The first system observed was a Koller 300 with a Koller gravity return carriage hauling short lengths to a manual stacking process on a road (refer fig. 16). Little production information was available.

Figure 16 - Stacking logs on the road edge with the Koller 300



A second machine, a Holzknecht HSO250, on the same road was rigged in an off-set skyline hauling configuration using a gravity return carriage. The machine was actually designed by the Forestry Training Centre in Ossiach and Holzknecht have built it. It fits on the rear of an agricultural tractor and is driven by the power take off unit. The single shaft runs through the main rope and the skyline (it can only be used in gravity returned configuration) and by a series of clutches and brakes the lines can be powered in and locked (refer fig. 17).

Figure 17 - The Holzknecht HSO 250 Gravity Hauler



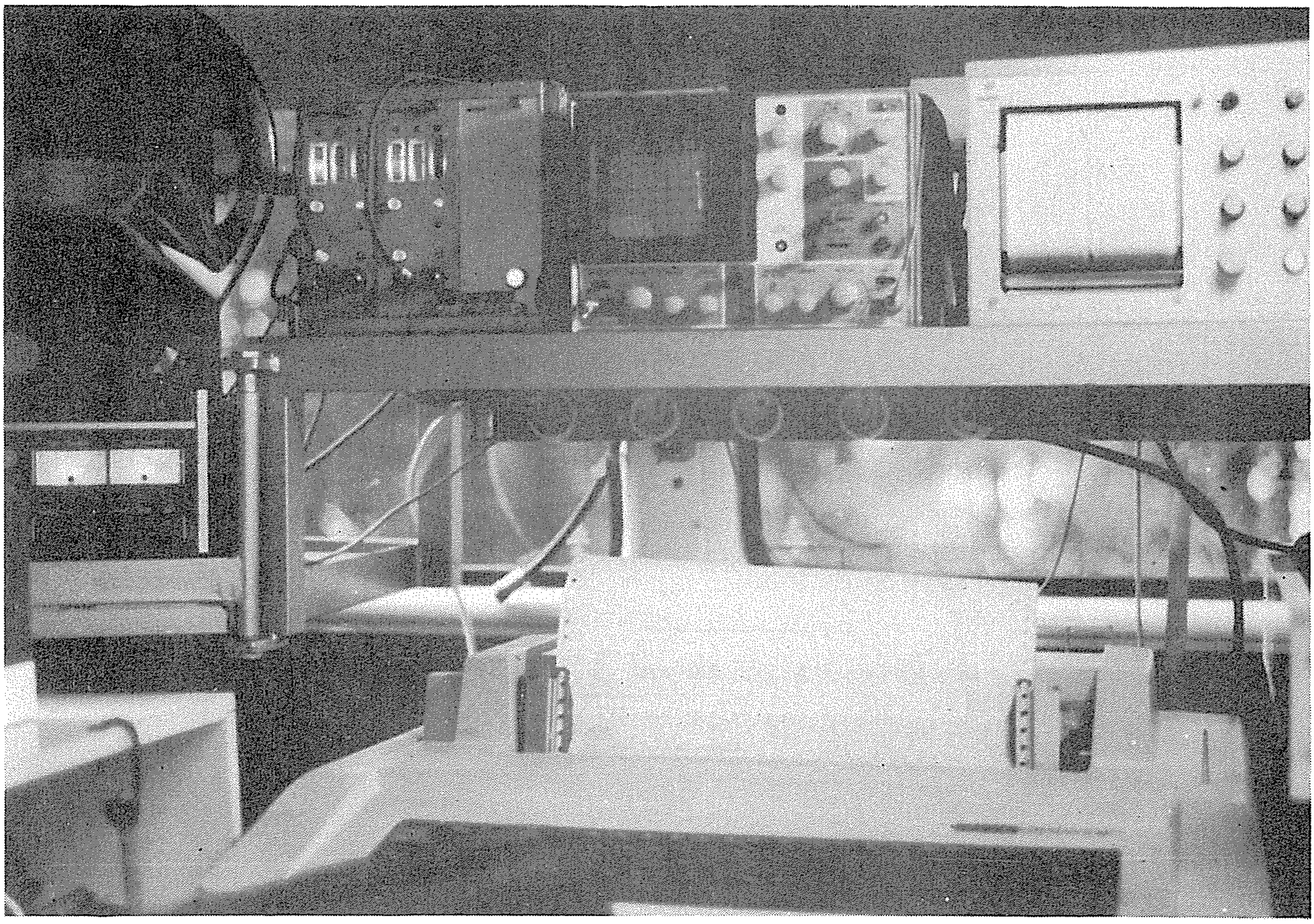
The carriage, a twin-sheaved carriage, running on the skyline runs into a locking mechanism on the skyline at the landing which keeps the carriage suspended above the logs as they are released. This eliminated the problems of the carriage running back down the skyline. The clamping device is released by a hand line from the landing (see fig. 18).

Figure 18 - The Skyline "Mousetrap" clamping device for holding the carriage at the landing

A third demonstration was of using the log line chutes to extract posts and poles. The installation of these chutes on a hillside was studied by telemetric recording, and the increase in heartbeats to install the chutes by hand and by using a winch to pull them into position showed a difference of 30 heartbeats per minutes. Pulling the log line up the hill with the winch showed a 20 heartbeat/min increase. The positioning of individual chutes in section showed about a 35 heartrate increase.

The telemetric recording devices were then demonstrated, or better still discussed. The telemetric recorder requires 220 volts A.C. to run. This can be provided by a generator. The person evaluated carried a transmitter which records his heartrate. This transmitter automatically sends signals to the work study recorder who is recording the activities by simply pushing coded buttons in his transmitter. This information then goes through to the main computer in the vehicle. The main computer has a continuously running clock and divides the elements up into their specific categories. The computer processes this data and then stores it, and can print out the results of a study on demand (refer fig. 19).

Figure 19 - The Telemetric Recording Equipment



The summary is not only of the work study data but also of the heartrate for each particular operation. According to the studies that have been done so far on hauler logging, attaching strops is considered the most strenuous operation with a 40 heartbeat per minute increase over normal. At the moment only one part of an operation can be studied, but it is planned to develop the system further so that the whole operation can be recorded at the one time. The computer has the capacity to do this but has not been developed to do so. The range possible with this equipment is expected to be up to 4 or 5 kilometres. The manpower required to run the system is three. One person in the bus controlling the computer, one doing the study and one measuring the production output at the landing. Radio contact is kept between the whole team and there is a correcting button for the work study officer to correct an error in his input. So if, for example, he changes his mind about a particular element he can push the correct button and the computer automatically changes it to the correct function.

The componentry has proven to be sensitive to climate, so temperatures below 5° are too cold for it to work. The telemetric equipment is designed and built by Messeschmitz in Germany. The computer is a PDP11 bi-digital, programmed in FORTRAN. The generator to power the telemetric equipment was manufactured locally to a specification outlined by the Forest Research Institute. It is hoped that 27 different parameters will be able to be recorded when the system is fully developed and up to 99 elements per cycle could be recorded.

(b) Excursion to Ossiacher Tauern Federal Forests

This block is a 600 hectare forest area which is part of the monastery land that the training school at Ossiach uses for field training. The area runs from 500 metres above sea-level to over 1000 metres above sea-level. The stands have a 10 to 17 m3 per year annual increment, and some of the older stands have 1,500 m3/ha on them. 70% of the forest is spruce and fir, and the rest is broadleaf.

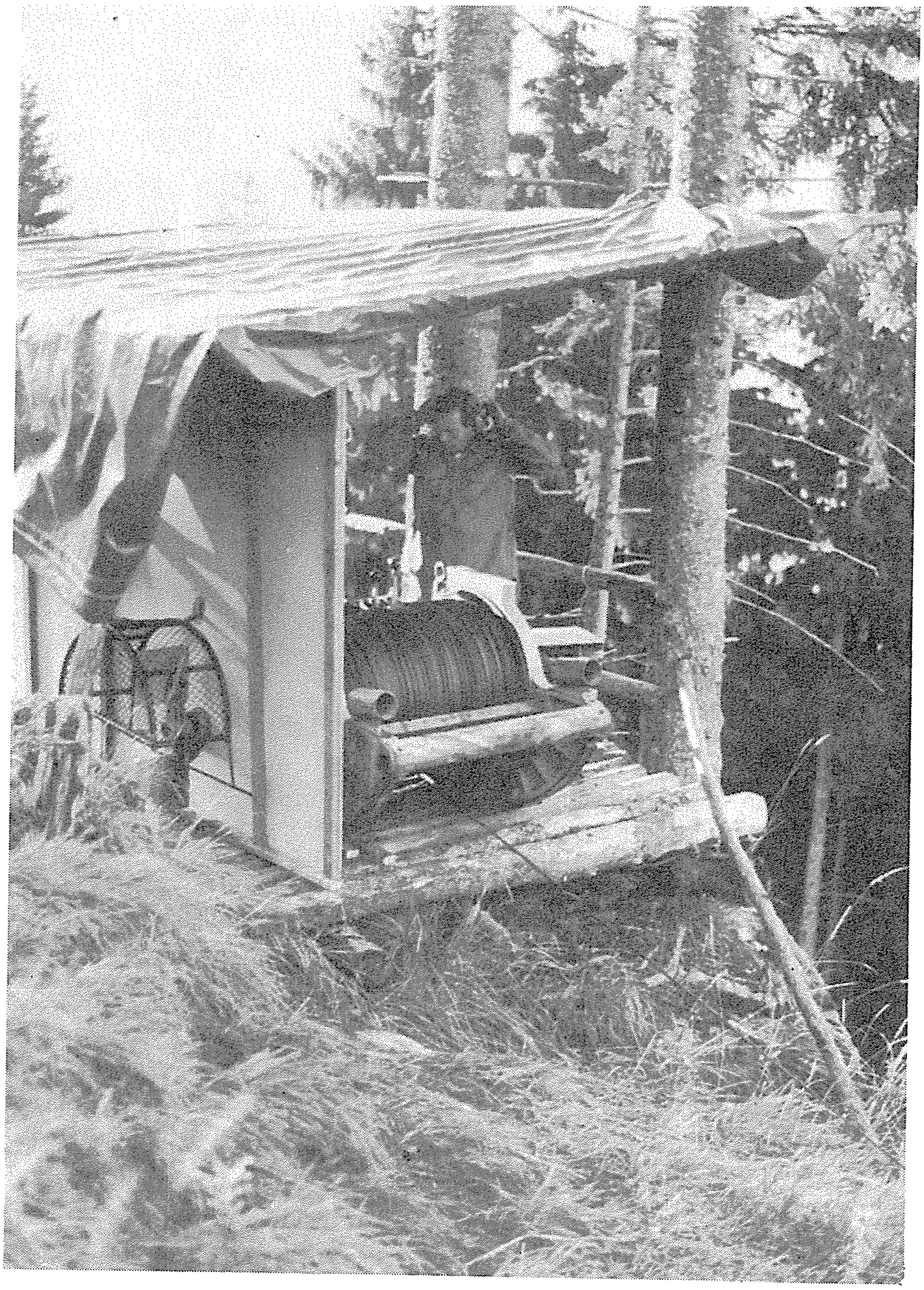
The first demonstration was of an Austrian made 'Fellboy' for use in small trees up to 20 cm. Above this size trees must be scarfed and back cut. Below this it is not necessary. For situations where the crown is tightly bound amongst other trees the fellboy is tied to the stump below where the cut is going to be made. The operator then puts in the front cut and if necessary wedges the tree, and finishes off with the back cut on an angle which will enable the tree to fall into the fellboy. The sled is then untied from the stump and pulled forward. This enables the heavy weight of the stem to be easily pulled from underneath the tree, enabling it to fall to the ground. It can be used on flat terrain but it is most effective on slopes. Fig. 20 shows the Fellboy attached to a tree in preparation for felling.

Figure 20 - The Fellboy Felling Sled

This demonstration was followed by a chainsaw-powered single-drum winch which was used to skid logs up a fairly steep incline using a fibreglass-nosed sled. The unit was used to both skid logs by pulling the rope ahead of it, attaching to a tree and winching in, and also by positioning itself at the top of a slope and pulling ropes down to a stack of logs with a nose sled attached. This type of production is ideally suited to the Austrian logging techniques where light low cost equipment is desirable because usually the land owners are farmers and do not have the need for high investment in forestry machinery.

The next operation visited was a Wyssen winch which was being used in a gravity logging situation, hauling logs from the top of a slope to the bottom by gravity. This machine is fitted with a fan brake using two blades on a propeller to slow the passage of the logs down instead of relying entirely on the hauler's brakes (see Fig. 21).

Figure 21 - The Fan Brake fitted to the Wyssen Hauler



The carriage being used was a Koller locking carriage and the haul distance was approximately 300 metres. The fan brake enables constant braking during the downhill extraction, but this braking is not complete. It is very noisy - up to and above 150 dbh. Originally the revolutions per minutes were over 3,000 but experiments with different blade configurations has enabled it to be reduced. The noise levels to the operator have been further reduced by lining the wall of the hauler shed with sound-proofing material and having the fan mounted outside this shed. It was conceded at this site that improved blade design and blade location would undoubtedly improve efficiency. The main objective though was to demonstrate the method of recording noise levels (refer Fig. 22).

The final demonstration was of a Steyr SK16, the largest tower in Austrian forestry. The Austrians believe this machine is too big for the conditions they have. It weighs over 34 tonne and looked to be an ideally suited machine for second crop logging in New Zealand. It has five drums - three working drums, a slack pulling drum and a straw line.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations were drafted during the seminar and discussed during the last session. The final wording of them was reached through a consensus of opinion.

1. There is widespread interest in the ECE region in the application of ergonomics applied to forestry. Among other things this could be seen from the fact that about twice as many participants attended the seminar as had been expected originally. The same applies to the contributions prepared for the seminar which constitute a valuable source of information on recent research findings and current problems.

2. The numerous participation resulted in a rather tense programme and insufficient discussion. However, there was general agreement that the seminar had been a welcome opportunity for the exchange of information, for establishing useful contacts and for critically examining one's own opinions in the light of those expressed by participants from other countries.

3. The programme corresponded to a large extent to the desires of participants. The excursions - blessed by perfect weather conditions - were considered as very informative. Opinion as to holding the seminar in two places - Vienna and Ossiach - was divided. Both localities were found quite suitable, but some participants regretted the time lost for the transfer from the one to the other.

4. High praise was given to the facilities developed by the Austrian Forest Research Institute for the telemetric recording and computing of heart rate and time study data which were repeatedly shown in operation and which served as a most interesting model to be used for the ergonomic monitoring of forest operations.

5. It was recommended that research workers should continue to collaborate in the development of ergonomic measuring and recording systems which would result in internationally comparable data.

6. High rates of accidents continue to be a major concern in most countries. Comprehensive accident prevention measures as applied in Sweden for a considerable number of years appear to be an effective means of lowering accident rates. Emphasis was given to the necessity of motivating the supervisory personnel accordingly.

7. It was recommended to continue and expand collaboration on the use of an internationally acceptable code list for forestry accidents as established between specialists from Switzerland, Austria, the Netherlands and the Federal Republic of Germany. Furthermore, the need for an improvement of personal protective equiment was emphasised in order to make it more acceptable for the worker.

8. The presentation of the findings of medical researchers and practitioners on occupational health problems of forest workers met with great interest and resulted in the discussion of a wealth of data which were not generally known. It was recommended to reinforce occupational health services in the forestry sector to regularly carry out medical examinations in relatively short intervals (perhaps 3 years) and to involve medical doctors in ergonomic studies.

9. Presently ongoing work in Sweden on the development of a uniform system for health data collection of forest workers was commended and it was proposed that other countries might join these activities. It was further suggested to

establish medical criteria to be satisfied by workers employed in forestry.

10. The seminar regretted that representatives of machine manufacturers were not present. The continuing need for the consideration of ergonomic requirements during machine design and construction was stressed. It was particularly underlined that this should also include machines used in farm forests. International ergonomic standards such as the ones established by ISO should be respected, preferably on the basis of legal requirements.

11. Vibration induced white finger in chainsaw operators continues to be a serious problem in many countries. Anti-vibration handles have been efficient in reducing the incidence of vibration induced white fingers but did not eradicate this hazard. It is recommended to further reduce the vibration in chainsaws, to keep daily exposure as low as possible, to use gloves in all weather and to prevent the employment of workers susceptible to vibration induced white fingers. Scientists are encouraged to do further research into methods of predicting a worker's susceptibility to vibration induced white finger.

12. Motormanual methods should be further improved or be replaced by ergonomically more acceptable ones. Ergonomic monitoring is required when introducing new equipment, techniques and working methods, in order to ensure that the workload does not exceed the long-term tolerance limit. Change-over from piece work to time work is favourable from the ergonomic point of view.

13. In most countries instruction in ergonomics has been integrated in the training of foresters and forest workers. In spite of this the application of ergonomic principles and guidelines in practical forest operations leaves much to be desired. It is therefore important to develop new approaches to ensure the transfer of ergonomic findings into practice. A crucial role in this respect plays the supervisor (and management level), which requires up-dating training, in order to be adequately knowledgeable and motivated in ergonomics, and to apply ergonomics in work organisation.

14. Future international exchanges in ergonomics are desirable among other things to discuss and exchange research findings and instruction materials. Beyond the seminar on occupational health and rehabilitation of forest workers to be held in Finland in 1985, the organisation of further international seminars are recommended in due course. They should include the discussion of psychological and sociological problems and the establishment of curricula and instruction methods in ergonomics. Furthermore, care should be taken to include machine manufacturers and forest workers and representatives of forest workers' organisations as participants.

15. The seminar strongly recommended that the proceedings of the Austrian/Joint Committee/IUFRO seminar should be issued through the host country for wider circulation.

SUMMARY

Basically the Austrian Conference on Ergonomics was very good. It enabled a massive interchange of lots of very valuable information. To sum up its importance for New Zealand's conditions it showed us that the accident statistics we record are pretty much reflected in what the rest of the world is experiencing. Our development in protective equipment still has a very long way to go. It could be said that we are on a par with countries like Austria and Germany. The overall impression gained was that we were slightly ahead of Belgium, The Netherlands and Switzerland, but behind Great Britain and quite a considerable way behind Scandinavia. With regard to ergonomics in forestry, the Telemetric equipment experiments provided a lot of interest, but I am a little concerned about the direction in which the results are going to be used. It appeared that rather than considering ergonomics in the operations, they were going to be used like target setting devices to determine how long a man can possibly work and how long a break he should have between these work spells. Personally, I feel that the ergonomic studies would be better utilised to find the most demanding parts of the operation in the various systems, and used to investigate ways of reducing the physical work load required. It is quite possible that this was the original intention in the minds of the Austrian researchers when the undertook this project, but the impression gained from the papers suggested that both Austria and Germany were using this information more as a standard for times to be worked than as a guide to improving the conditions of the workers. There may have been some confusion during interpretation at this seminar but that was the impression which was gained.

It is recommended that the further research in ergonomics in the New Zealand Logging Industry should be concerned with the application of existing knowledge once the need has been indentified. Constant monitoring of the progress in overseas research should be carried out but owing to the high cost and advanced technology of the equipment demonstrated the need for local studies using telemetric equipment cannot be justified.

A list of seminar participants is attached in Appendix 1.

SECTION III

SWEDEN

(a) SKOGSARSKOLAN - "ROYAL COLLEGE OF FORESTRY - GARPENBERG"

First contact at Skogsarskolan was Mr B. Ponten, who is a member of the Forest Work Science Group which used to be called the Forest Work Environment Section. The projects of this Work Science Group were as follows :

1. Work Supervision - which was aimed at the foreman or supervisor level and involved research into parts of the psychology of supervision.

2. Energy Ergonomics - a project which proposed to organise work in handling forest energy, in particular the farmer utilisation, e.g. chipping and storing practices. This involved research and development into the various techniques and efficiency of the systems.

3. Problems in Nurseries - a relatively new area where Skogsarskolan were involved in the ergonomic design of nurseries, i.e. aiming to make them a better place to work in.

4. Safety Work - the object of this project was to integrate safety and production. It tried to introduce a system whereby a company was responsible for production and safety, and each part had equal importance.

5. Regional Developments - this was done as a community job. It involved such things as creating policies to find jobs that workers could be redirected to when industries closed down, i.e. the group did feasibility studies on new initiatives in industry.

6. Routine for Health Problem Identification - started by the Occupational Health Organisation to identify the existing problems in the operations by the use of a questionnaire. The outcome of the work was to develop systems to minimise or even eliminate these problems, where possible.

The questionnaire related to the previous 12 months of a worker's career and was kept on a confidential basis. The medical examination when carried out, was done by a doctor. Some of the information included in the questionnaire was personal, i.e. smoking and drinking habits, and it also included the worker's opinions of working conditions, the systems and methods used, the types of equipment available, the training he had received and any recommendations for machine modifications. The third part of the questionnaire involved health complaints where the worker self-diagnosed his problems. An analysis of his sick leave was made and any problems he felt he had, were checked by a nurse. She would evaluate his claim and report accordingly. The workers were asked if they think the health problems were related to the work that they were doing. This particular system worked quite well because independent company health services had considerable control over working conditions, and the health and well being of the workers.

To introduce the questionnaire, the Skogsarskolan researchers worked through the Company Health Service which were, in the bigger companies, divorced from the production costs and therefore had the workers health in their interest. All of the information received was kept confidential and it was stressed to the workers that the benefits were to their advantage. In the majority of company situations in Sweden, the trainers came from the workforce itself and therefore were experienced in logging. In many cases they worked part-time in training and part-time in the workforce.

Originally, to get this project rolling, a conference was held to introduce the idea and there was quite a sceptic response to it, but Skogsarskolan perservered with it and they have now covered something like 3,000 workers. It was planned to extend this number of cover up to 10,000 of the 25,000 workforce and maintain regular checkups during their employment so that comparisons could be made between the checks. This would give a measure of the health and well-being of the workers. The frequency of these check-ups were aimed at being three yearly. When questioned about the worker suitability examinations, it was felt quite strongly that this should be done at school and that it was not really the responsibility of the employer to test whether the worker was suitable for employment or not.

A discussion was held with Mr C. Bredberg, who was the Head of Department for this section. He outlined the main task of the Research Institute, i.e. 50% of its efforts went into agriculture and 40% into forestry. Of the 635 million kroner budget, 310 million went to agriculture and 155 million to forestry. 62% of this was directed to research and 17.5% went on education. A further 10% was spent on publications. The programmes included such things as land use, forest resource valuations, mensuration assessments, yield research and such things as the effects of silvicultural techniques on forest operations. Also considered were methods of conversion and other utilities such as recreation etc. There were something like 170 people at Garpenberg, 65 of whom were in the forestry field section. There were 57 field research scientists in both agriculture and forestry and it was an inter-disciplinary research group. There was also a computer section and an administration section with 35 people. One section was devoted to further education and involved small units or satellite organisations.

The forestry section at Garpenberg was interested in :

1. Ergonomics.

2. Silviculture techniques, establishment of forestry cultivation.

3. Equipment and techniques, particularly for farmers.

4. Forest energy, such things as the I.E.A. project.

5. Planning regimes, research into logging and silviculture practices, and an industrial influence which was handled by an independent section.

6. Rural development, trying to keep both agriculture and forestry demands in perspective.

The financing of Garpenberg was 21% Government (15.5 million Kroner), 41% of the funding came from energy organisations, but this was not reliable and had to be applied for as required. 8% came from applied research in forestry, done for companies and 3% came from a co-operative organisation within Scandinavia. The collective use of research results comprised nearly 10% of the income.

Discussions were held with Uno Brinnen, who was working on ergonomics in nurseries. In this project Skogsarskolan were looking at nursery work environments and trying to project the design requirements on them. They had concentrated mostly on containerised seedlings. There were five to ten different systems used for handling these containers which were bio-degradable, and had to be treated carefully.

A visit was made to Ralph Almquvist, in the Environmental Section, and his particular project area was small scale forestry where he was looking at safety in the organisation of forestry work outside the companies. He was investigating and co-ordinating collective demands of farmers to ensure that the equipment that they could purchase was exactly what they required. The information acquired was then passed on to the manufacturers to ensure that the equipment they were designing was right. These ideas were passed on to improve the work environment of the farmers. Skogsarskolan have to work through the Occupational Health Organisation which appeared to be where there was a communication problem.

To summarise from the day at Skogsarskolan, the only areas of real interest to LIRA were :

1. Work supervision.
2. Safety work.
3. Routine for health problem identification.

In the big companies in Sweden safety was the responsibility of independant health services who could control or change the workers work conditions if it was required. These Health Service people were supposedly unbiased and were therefore a good means of getting contact and eventually information from the employees. Personally I didn't think that this idea would work so well in New Zealand with the state-controlled Labour Department and health organisation in existance. The questionnaire idea appeared to be good, but it would require the assistance of our medical profession, who would have to be prepared to help out with such a survey.

(b) ACCIDENT PREVENTION AND ERGONOMICS IN FORESTRY

Discussions with B. Pettersson. In 1968 Skogsarbeten started collecting information on near accidents and found considerable difficulty in getting reliable information. The reasons were as follows :

1. The workers considered near accidents as part of the job.
2. They were suspicious of reporting such accidents.
3. There was no real means of reporting such incidents.

Skogsarbeten started with a set procedure to overcome this. They developed a routine. Firstly they undertook to explain exactly why they wanted the information and stressed clearly that there was no risk to the operator if he reported accidents. Skogsarbeten undertook in 1969 an intensive effort covering nearly 200 workers, and they found that there was an average of 1 near accident per day per person. The information was analysed. The results showed that for every 1 actual accident involving injury there were 700 near misses. The important spin-off to this was that those involved in the near accident reporting scheme, gradually began to behave in a safe way. It was concluded that the best way for loggers to learn to improve their work environment was to study themselves, hence the value of such a questionnaire. The other important part of the routine was that the results of near accident reporting must be fed back to the workers and this was best done with discussions on the job. In the final analysis when Skogsarbeten did a comparison between the companies that were involved in the near accident reporting and those that were not, the companies in the near accident reporting scheme had fewer accidents (refer Page 53, ref 2).

Discussion centred around whether it would be possible to create a similar type of near accident reporting scheme in New Zealand and it was pointed out that this involved a lot of effort and manpower and it could be too clumsy to use in New Zealand. If we want to do something like this we must accept that it is going to be expensive.

Avenues of getting the safety message across to workers - this was an interesting session. It was mentioned that production must come first and that to really analyse it properly the researcher must put himself in the seat of the company manager, contractor or whoever is being asked to comply with safety regulations. He must consider what he is thinking, and his first thought is that safety is a constraint. To convince someone of the benefits of such things as protective trousers, you must orient yourself to production, i.e. put yourself in the position of a production manager. He must be convinced that the cost outlay to provide protective trousers is going to pay in added production, fewer accidents etc. In an accident prevention programme he must realise how the contractor is thinking. Usually he is unable to perceive the indirect costs. Perhaps it would be easiest to direct research attention into one area - one part of the operation that has been identified as the most serious, i.e. chainsaws. The most improvements that could be made in this area are technical developments, e.g. chain brakes, according to Pettersson.

Training was then mentioned and discussed and a rough over-view of training techniques in New Zealand was given. In a training system it was suggested that you must concentrate on one thing, rather than trying to create a total training package. We may not necessarily agree with this philosophy but apparently it has been applied successfully in Sweden. By directing attention to one key aspect of safety often resulted in other safety factors just falling into place. The use of a chainsaw was cited again as an example and it was suggested that the workers must maintain a high degree of concentration to work safely and efficiently. Reference was made to the high number of old chainsaw workers in Sweden who received serious injuries, and the main reason for this was thought to be a loss of concentration.

Sweden have recorded a considerable reduction in the number of chainsaw accidents. Chainsaws now cause around about 8% of their logging accidents. The main reason for this has been technical, e.g. protective equipment, improved chainsaws etc, and one other reason perhaps can be the fact that companies have now taken over the ownership of chainsaws. This means that most chainsaws on the job are newer and usually have all the latest safety aids. However, company ownership of saws costs a lot of money and it was therefore difficult to get a quantative result. The instructors, in training, say that their most significant results have come from three points.

1. Improving the filing techniques of the operator, and this was probably the most important aspect.

2. Felling practices.

3. Planning of the work site.

Discussion then moved to the New Zealand Logging Industry Accident Reporting Scheme and after a quick look B. Pettersson suggested that there were a few things that should perhaps be clarified on the form, i.e. equipment information - we should ask the type and make of machinery that cause accidents. We should include an indication of the weather conditions, the time of day when the accident happened, the years of experience that the worker had. Pettersson suggested that we could expect a systematic fall off in accident reporting over the next year or so under the present scheme. The importance of reliable information was considered paramount. Examples were cited of chainsaw manufacturers in United States, Germany and Sweden where they were calling for more information on chainsaw accidents. They wanted to know where, how and why they happened. They were all amenable to developing improvements and their main criticism of the logging industry was that not enough information is fed back to them. This is critical because before any moves could be made to encourage manufacturers to change equipment designs the industry needed comprehensive proof that the changes were necessary. Good reliable accident statistics would help to provide that proof. With the New Zealand accident reporting scheme Pettersson felt it would be necessary to make it mandatory to fill out a form in the event of an accident, or an assessment would have to be made to give a percentage accuracy figure. There would have to be a commitment from the companies and supervisors to get this information. To do this a researcher would have to reason like they do and somehow work out a way to get over the great body of inertia which pops us as soon as someone says "accident report". What he would have to look for are measures that effect both production (in a positive way) and safety.

Pettersson described the trip he made to United States where he had discussions with engineers from McCulloch. The engineers mentioned that they examined accident reports back in 1970 and have done a lot of research to find problems. It was found that in the U.S., particularly the northern areas, loggers by tradition did not report accidents. The only source of information was from within the camps, and that was pretty hard to get. Scandinavia and Canada had better data. So all the manufacturers had to go on were published accounts of accidents from victims, e.g. articles in magazines, published doctors reports etc.

In later discussions with Stihl, Pettersson again found reinforcement for the need for accident statistics and identified further work in vibration studies and kick-back testing. The Germans apparently have co-operated with overseas countries and from a cross-section of all these have created their own standards and limits for saw designs.

The ergonomics applied to forestry conference in Austria was reviewed. Some of my reservations were expressed. I questioned Pettersson on how we should apply ergonomics in the field, and I mentioned the successes and failures of the Tarawera pilot scheme (ref 3) asking how we could possibly have avoided the failures. The answer was as follows :

We should not have tried to change an old worker's techniques or habits if he was happy with them. It is best to demonstrate the possible advantages of a system and then leave the worker to make up his own mind about it.

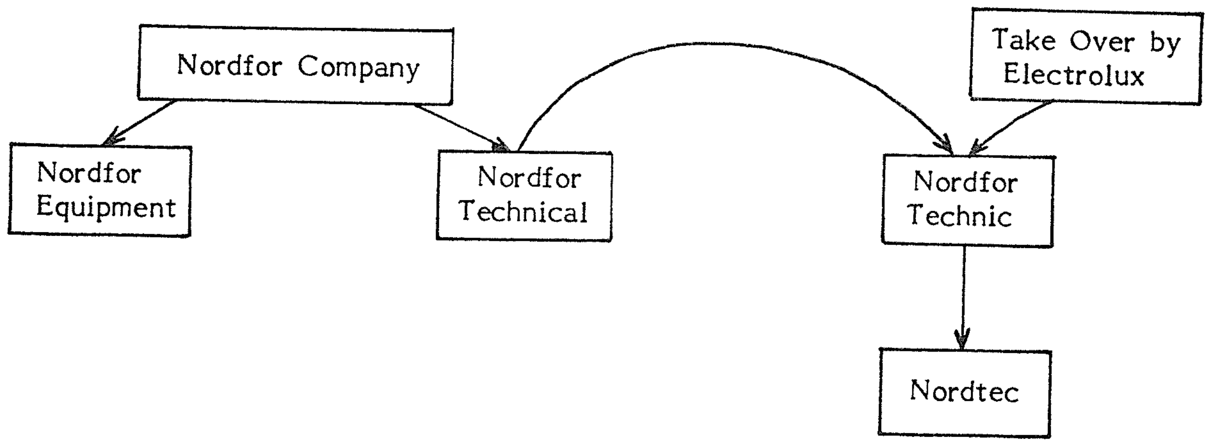
It was pointed out quite clearly that Swedish techniques are not suitable for everyone. There are physical differences between workers etc that make one system better than another and we should not try and change everybody to one system. Attitudes and habits are always hard to change. We can use ergonomic results to compare methods, i.e. one way demands more energy that another, or we can decide which part of the operation has highest energy content, but it was felt that the results seen from the papers in Austria tended to be aimed at finding out how hard a worker can work, i.e. the studies demonstrated the target work effort that could be expected from a worker, and the length and frequency of the breaks he would require to sustain this effort. In other words, setting standards. This was not considered ergonomics. It is best to use ergonomic studies to find the method of doing a job that requires the least energy consumption. This however requires a large sample to be accurate.

Regarding the production of a safety film, Pettersson felt that when making a film it would probably be best to concentrate on work attitude, i.e. things that matter to a worker - e.g. involve the family in the film so when showing the film invite wife and family to see such a movie. Often it was felt that wives and children were ignorant of the dangers of work in which their husbands and fathers were working. We should play on the subconscious mind and look at the effect an accident would have on the social life. We must help the logger to analyse his whole work/life relationship and his approach to it. It is important to remember that a worker will only hear what he wants to hear, therefore to be effective a film should be followed up with something that reminds him, even if it is only of a few small points in the film. Simple things such as stick-on transfers for the chainsaws or the helmets, a logo for the skidder, possibly hand out a leaflet of key points to remind the workers. Pettersson suggested that if we were going to make a film, we should keep training separate from safety. However, if making a training film, safety must be included.

(c) VISIT TO NORDFOREST - FOREST EQUIPMENT SUPPLIERS

Discussions with Mr B. Pettersson and Mr L. Anderberg, Manager of Nordforest. Nordforest began as Nordfor in the 1960's. About 1978 it amalgamated with the Skogston (a farmers organisation) then divided into sections as shown in Fig. 24.

Figure 24

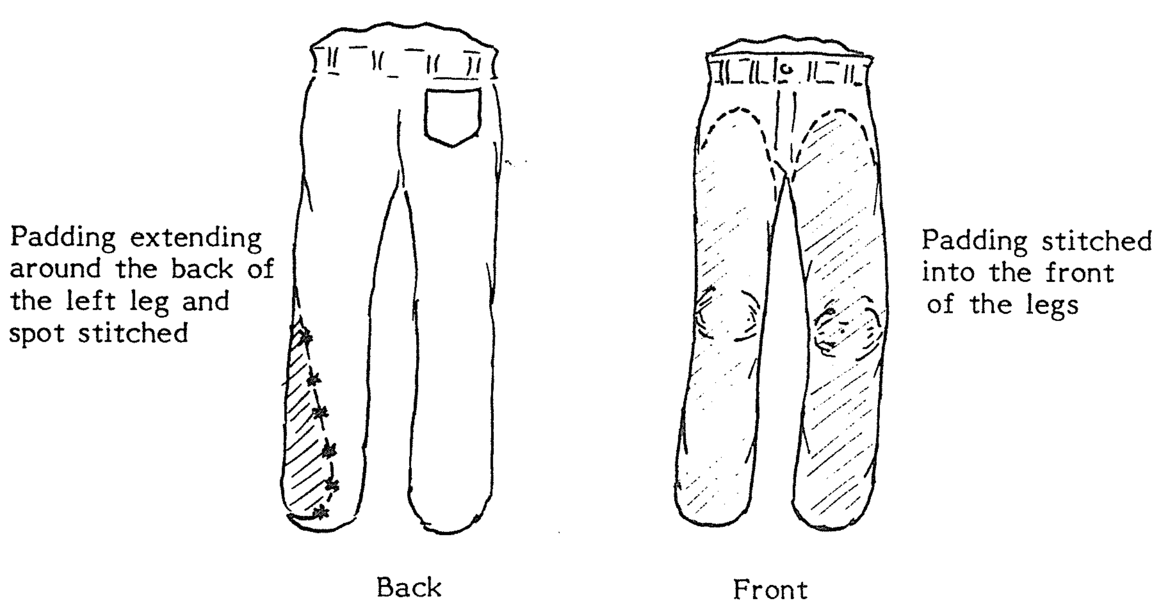


The 50% private ownership involves 135,000 owners, most of whom are farmers. An outfit called Skogsmaterial originally catered for the needs of farmers, but this is now owned by Nordforest, hence they cater for both large and small forest concerns.

Protective trousers - Nordforest have developed a padding configuration which they claimed would resist the cutting action of a saw at full revs. It had the following features :

- full ankle to groin protection
- padding configuration going partially around the back of the leg (refer Fig. 25)
- 7 layers of lightweight polyester cord padding
- a well ventilated polyester outer material.

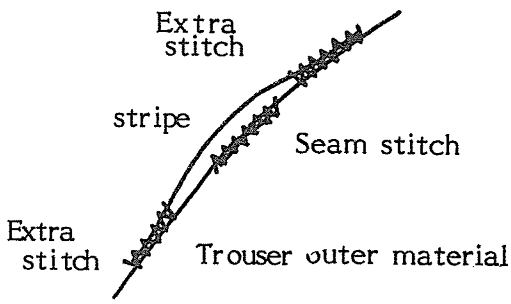
Figure 25 - The Latest Nordfor Trousers



A Jonsered 50cc chainsaw was used to test the pads (demo pads). Firstly the standard grass catcher nylon pad was cut through, then the second new polyester pad was tested. Although it eventually cut through, the resistance of the material was very good, especially as the saw under test was held at full revs into the material. Other features of the trousers included a stripe down the outer edge of each leg. This stripe incorporated a triple stitching of the seam which added strength to the join (Refer Fig. 26).

Another feature was a crimped knee to keep the knee of the trousers partly bent, more like a sort of form fitting to help the trouser leg stay in place. There were two tightening bands at the bottom of the trousers to tighten against the boot. The main purpose of this was to keep the snow out. The outer material of the trousers was polyester. They were called all-weather trousers and appeared to be suitable for New Zealand conditions.

Figure 26 - The Red Stripe Seam



Nordforest were very interested in improving the micro-climate of the user, so have developed vests and capes which draw moisture away from the skin, i.e. double-lined vests etc. They claim that in a sitting position a worker generates 100 watts of energy. When walking it is 300 watts. Skiing is 600 - 800 watts, and using a chainsaw is something like 1600 watts, the same as an element on a stove.

Hydraulically driven pruning saws were shown and pictures and brochures received. The pruning saw had a Jonsered power unit driving a hydraulic pump. The cutting attachment was attached directly to a hydraulic motor which powered a chain around a short, 16cm bar with a narrow tip which resulted in low kick-back, but limited boring ability. There were three pole lengths available with the saw - 2m, 4m and a telescoping 6m boom. The latter two poles were fibreglass. An explantion was given of pruning and topping practices in New Zealand. The quoted price was around $NZ2,000. This type of unit could have good application for :

- shelter belt trimming, i.e. topping.
- power board, trimming around wires etc.
- pruning, only in some situations, (Forest Research Institute).
- tree doctors, trimming around gardens etc.

It was not considered suitable for pruning on a production basis becaue of the lack of control over the flexible poles and the nature of the chainsaw cut. Felling aids available for loggers were also demonstrated along with lightweight wet weather gear, and other assorted safety equipment.

(d) STORAKOPPARBERG - A LARGE FOREST COMPANY

Storakopparberg is the second largest forest company in Sweden and it was originally founded on the copper industry over 100 years ago. Contact was Mr R. Halfvarsson. The company has three sawmills - two large and one small. It has two pulp mills and two paper divisions. It has ownership of Nova Scotia Forest Industries in Canada and also owns its own power plant. The firm used to mine copper only but now zinc is the main product. The original mine has been turned into a tourist attraction. Storakopparberg also has subsidiary companies such as chemist lines and synthetic fibre manufacturing. Of the forest division, a total 805,000 hectares is owned by the company which is divided into eight forest districts. There are 9,100 hectares clear felled annually and 2,000 hectares are thinned. 9,200 hectares annually are cleared, ready for planting, and around about 9,500 hectares are scarified. The planting programme is over 10,000 hectares as is the cleaning process for silvicultural treatment. The company fertilises 19,800 hectares. On the workforce there are 276 supervisors, 741 cutters, 290 machine operators, with 193 doing other jobs. A total of around about 1,500. The main forest transport system is forwarders but the company does have processors and harvesters. The company produces 1,617,000 m3 from its own stands, purchases on the stump 691,000 m3 for other companies, and purchases 969,000 m3 of wood logged by other organisations. It also imports 725,000 m3 for special purposes. On the production side 417,000 tonnes of sulphate pulp are produced every year, 364,000 tonnes of newsprint and 326,000 m3 of sawn timber. The three main species grown, in the Storakopparberg forests, are the Norwegian spruce, the Scots pine and birch, but the pine is the most popular.

On the logging side a chart was shown indicating the trends that have evolved over the last few years. Motor-manual systems have not changed much and are still in common use while the mechanised Logma processor systems have decreased in popularity. The motor-manual plus processor system has shown a slight increase but operations with machine felling and processing have declined in popularity. Multi function harvester systems have increased quite substantially in Storakopparberg. On the safety side the company pays for all safety equipment except underwear. They also provide all the chainsaws.

The company has a positive approach to training and instructors are drawn from the crews to train loggers in the correct techniques. There is one permanent instructor in every forest district. These instructors, when not required to train, work in the workforce. There is a strong emphasis on ergonomic consideration in logging, but the company is finding that 50% of their machine operators have muscle ache problems (i.e. joint and neck complaints). The main steps being taken to remedy this is an intensive education programme. Mention was made of the wage payment systems in Sweden and it appears that south of the Falun area there is a tendency for the loggers to swing back toward piece rate payment systems, whereas in the north they prefer the monthly salary system.

A visit was made to the Medical Centre for the Storakopparberg Forest District of Falun. The doctor in charge was Dr R. Hakaasson.

Hakaasson explained the medical checkups that each forest worker has on a three-yearly basis. He also outlined the intial checks and medical examinations that were undergone before a worker starts work. These checks involve hearing tests, heartrate tests, eye tests, and it gives a worker the opportunity to mention any problems he is having. In particular muscular or joint problems. When an employee is employed the doctors can specify what criteria workers must meet and can influence a workers employment if it is felt that they are not suitable for a particular job. The doctors also encourage sporting activities and body building for strength. The company works on the philosophy that schooling only teaches the workers to learn. When new workers are taken on they are initially paid according to their education qualifications. After approximately six months they are then either offered a full time position or found alternative work. Mostly the Health Service is aimed at work-related illness, but they will handle as many of the normal sickness problems as possible. Every three years is not too bad for medical check ups. Originally it was two years but the economics of this, both as far as time and money goes, were not good so it had to be extended to three years.

The Health Service at Storakopparberg has been running 12 years. It was felt that over that period the hearing degrade among workers has not been a problem, and this is attributed to the fact that most workers wear hearing protection. Every forest district has a safety officer and instructor and their job is to both train and to ensure that workers are following the correct safety measures. There are however no penalties for workers who ignore safety regulations and are injured. The Health Services run their own budget. 50% is paid by the Company and 50% is paid by the Government. This is an accepted policy in Sweden and there is no conflict between production and health services. The small companies, sometimes including farmers, usually form a co-operative health service system. Storakopparberg actually employs five doctors so there is a ratio of about 300 workers per doctor. This is a good situation because most other companies have roughly 500 workers per doctor.

It was felt that Sweden has a big problem with the farmers. Many don't use safety equipment at all and most have no time to be involved in safety health services. It is difficult to get information from them so a lot of what happens out on the farms is unknown. There is a move afoot to try and create a mixed industry health service. Over the recent years Sweden is tending to have more contractors than company employees. The contractors who have been working with the company and purchased their own machines off the company usually have a better approach than those who come from other industries. With regard to machine operators, there is a growing concern about overweight problems and also boredom amongst the workers. In an attempt to overcome this the shifts have been split into three hour periods to try and avoid the constant monotony and mental strain of continuous machine operation. It was found that attitude is of paramount importance. The policy taken by the company health service was to try and steer the attitude rather than try and stop it suddenly. It is very important to make the worker think that he is doing himself good. In winter 98% of the logging is machine logging so accident rates tend to drop. It was found that when loggers are working manually, target setting always makes them work above themselves, so instead of working a consistent 8 hours at a steady pace, they tend to race through the job and sit and wait to go home.

Later in the afternoon a visit was made to one of the instructor/trainers of Storakopparberg. He demonstrated the techniques of felling and delimbing Scots pine in a clear fell situation. He was felling the trees towards an extraction strip where the heads were left for the forwarder to run on. A Kockums 820 forwarder was used for the extraction. During felling, three trees were felled and delimbed and then cross cut and assorted into pulp wood and sawlogs. The pulp wood was manually stacked with pulp hooks into rough grapple sizes and the sawlogs were normally left in the position they lay. The instructor was using a 234 Husquvana saw and apart from the odd drop start, appeared to be quite a skilled logger. He demonstrated the various cuts employed in using the felling lever and also showed his impression of the six-point delimbing technique. He had a very easy working style and he was built like an ox so that he had no problems stacking the pulp wood. During this visit a physiotherapist, Mrs K. Kochschmit from north of Falun, visited to discuss the problem of back injuries in forest workers. She claimed that 80 to 90% of the back problems with manual fellers were caused by bending with the chainsaw. The instructor then demonstrated, using the tree to lean against when felling, and using the stems and the leg to hold the weight of the saw during the delimbing. Mrs Kochschmit suggested that 70-80% of fellers in Sweden did not work in the correct manner, but she and the instructor agreed that cutters were under-utilised in Sweden and that production levels could be higher if correct techniques were used and these work related illnesses reduced.

(e) KOCKUMS INDUSTRIES, MACHINE MANUFACTURERS

A visit was made to Kockums Industries where discussions were held with Mr B. Hedlum who was the Research and Development Manager. Brochures were recieved on the structure of the company and the products that they produce. Kockums have two divisions - forest industry and the logging. Their main outlets for the products are Sweden, Finland, U.S.A. and Canada. Recently they have amalgamated with Hawker Siddley (the manufacturers of Tree Farmer) and now the products produced in Canada are Kockums/Cancar machines. Kockums also have branches in Australia which are fully owned.

Kockums employs 1,900 employees and has an annual turn over of something around 650 million Swedish kroner. During 1979 and 1980 Kockums bought a part of Jonsereds Waco. Their product distribution as at 1980 was 48% sawmill equipment, 37% logging, 5% other products, 10% wood conversion machines. The split now in 1983 is more 45/45 between logging and sawmilling. The other products include outside work for other companies. The turn over in the logging machinery alone is 38 million Swedish Kroner (1982 figures). Kockums experienced a downturn in 1978/79 but the levels had improved again by 1983. Total sales of Kockums equipment is a 40/60 local and export mix, but in the logging machines 55% of the sales were local and 45% export, of which roughly 35% goes to Finland. The Nordic area therefore covers 85% of the sales. Kockums employes 1,200 people in Sweden and 700 overseas people. The first Kockums machine was based on a Garret skidder from the United States but they are now concentrating on designing machines and buy in componentry such as; engines, axles, some parts of the gear box, hydraulic parts, e.g. Clark Transmissions Soma axle parts (from France) and big motors like Scania D8 and small international four cylinder engines in the 81/11 series. These incidentially have hydrostatic transmission. The TP822 thinning processer has a Ford 6 cylinder engine with mechanical transmission. The 82/65, which is based on a skidder with central articulation, has the same Ford 6 cylinder engine with hydrostatic drive.

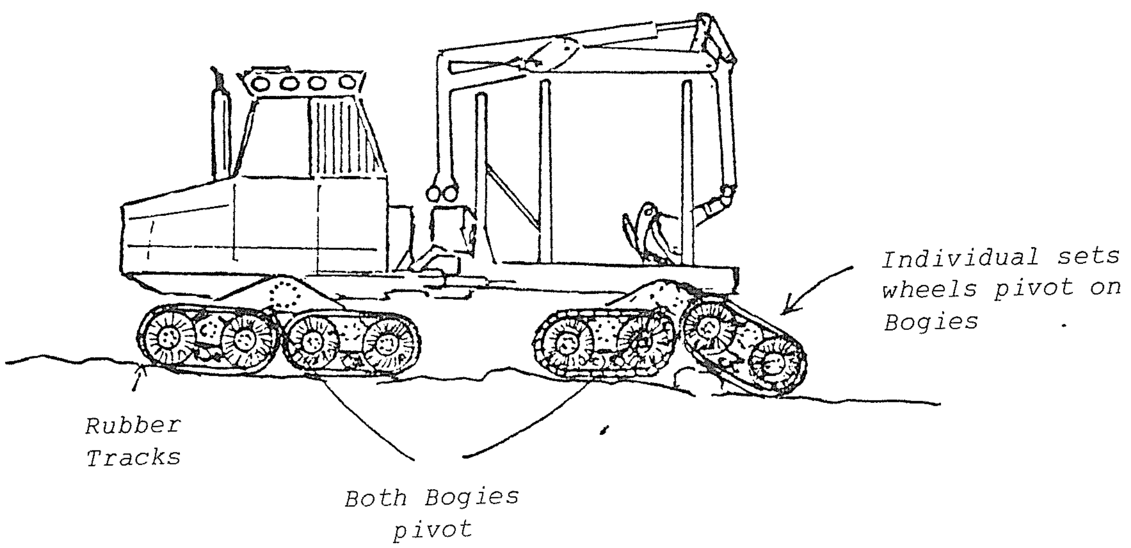
As far as ergonomics go, Kockums have been concentrating a lot of their development on improving ergonomic design of cabs, and this was no more apparent than when they went to Australia where they had to modify quite a few things to satisfy the Australian demands. The 85/41 Logma system required some minor design changes and one or two structural alterations to the boom, according to Hedlum. During the early part of 1983 there had been an upsurge in the demand for processors, particularly the bigger models, hence the development of the 88/65 unit. Originally it was an 875 forwarder which had been sent to Australia. Although this machine is still manufactured, there were not many sales of it. The 85/35 machine incorporated some of these designed developments, but the idea in Kockums is to standardise as much as possible the component replacement parts for all machines so parts inventories can be kept low and also so that people will continue to buy more Kockums machines.

Most of the trees grown in Sweden can be harvested mechanically. Hedlum reckoned that their machines could handle 90% of all trees. Forwarders all have similar shapes except for the smallest one which has eight wheels. All the others have six. Most of the transport machines don't have blades, except the 85 series and this is an extra. The ergonomic environment of Kockums equipment is considered the best in the world, according to Kockums, and because of the recent devaluation of the Swedish kroner their machines are now 30-50% cheaper than competitive makes.

Ergonomic designs of cabs has changed through the years with closer association between doctors and operators, but it has been found that the most significant way to improve the occupational health of the operators is in the undercarriage.

Hence, Kockums have developed a 16 wheeled, rubber track mounted, forwarder based on the 83/35 machine. This unit was in the prototype stage and I could only view the tracks and the undercarriage (refer Fig. 27).

Figure 27 - New Kockums 83/35 Forwarder Undercarriage



The 83/35 design allows the oscillating effect of the bogey and the complete rotation of a track to smooth out the terrain over which the forwarder is travelling. It has been designed with air suspension for extra comfort, and the controls have been made so that they are completely adjustable according to the desires of the operator. As mentioned at Skogsaskolan there has been a high incidence of shoulder and neck complaints from forwarder operators. It was believed that these have been derived from having shoulders and arms in an unnatural position, hence the effort to try and increase the number of positions that a seat can be adjusted to.

SECTION IV

FINLAND

(a) VISIT TO VAKOLA - THE FINNISH RESEARCH INSTITUTE IN AGRICULTURE AND FORESTRY

Background

The purpose of this visit was to test New Zealand made protective equipment against the Scandinavian testing procedures. Contact was Mr K. Turtiainen who gave a brief history of Vakola and explained that it has been in existence since 1700. The Institute owns 500 hectares of forest land and 150-200 hectares of farmland. It employes 11 scientists, but has a total staff of over 50 people. There were six researchers in forestry. Vakola is a state institute and is required to test everything that is sold in Finland, for either agriculture or forestry, so most of the equipment that is on the market in Finland has been tested by Vakola. Apparently very few garments or pieces of equipment are rejected but often design changes are recommended to improve certain aspects or pieces of equipment.

Protective Equipment Standards

Turtiainen explained that there was a meeting to review the Nordic standards laid down for protective leg shields on 16/1/83 in Stockholm. At this meeting the Danes and the Swedes wanted to increase the chain speed of test rigs from 13.2m/second up to 20m/second. The accepted Standards at that time; SF4700, "the safety shields of the chainsaw workers requirements", and SFS4701, "the safety shield of the chainsaw worker test methods" were considered to be quite sufficient by the Finns (copies attached, Appendix 11). It appeared that the Swedes and the Danes had developed a superior padding material which could resist higher cutting speeds, and they wanted to create a standard which would give them the market edge. Apparently the outcome of the meeting was inconclusive and the standard remained the same.

Discussion moved to cut resistance and chain force resistance. In the standard the minimum cut through time must be above .15 sec, but the standard also states that the resistance to chain cutting and chain movement must reach a minimum of 275 Newtons. This is measured by a load cell mounted at the pivot point of the pad support. The rotational force that the chain exerts on this support is measured and gives the resistance that the material has to chain force. When discussing this in more detail it was queried whether too much resistance to chain force was a good thing, because it could cause a rotational effect of the protective device around the leg and consequently expose parts of the leg that were not covered. Recent developments from Nordforest in their trousers with wrap around padding was cited as an example of this and it was suggested that New Zealand made protective garments were saving a large number of injuries and that the value of this chain force resistance measurement may be questionable. No conclusive answer to this query was received.

Testing New Zealand Made Garments

It was stressed that any testing of protective devices done by Vakola required a sample of 6 of each item before they could be considered to satisfy the standard. As only 1 of each New Zealand made garment was available, the test results can only be considered indicative. The garments tested were as follows :

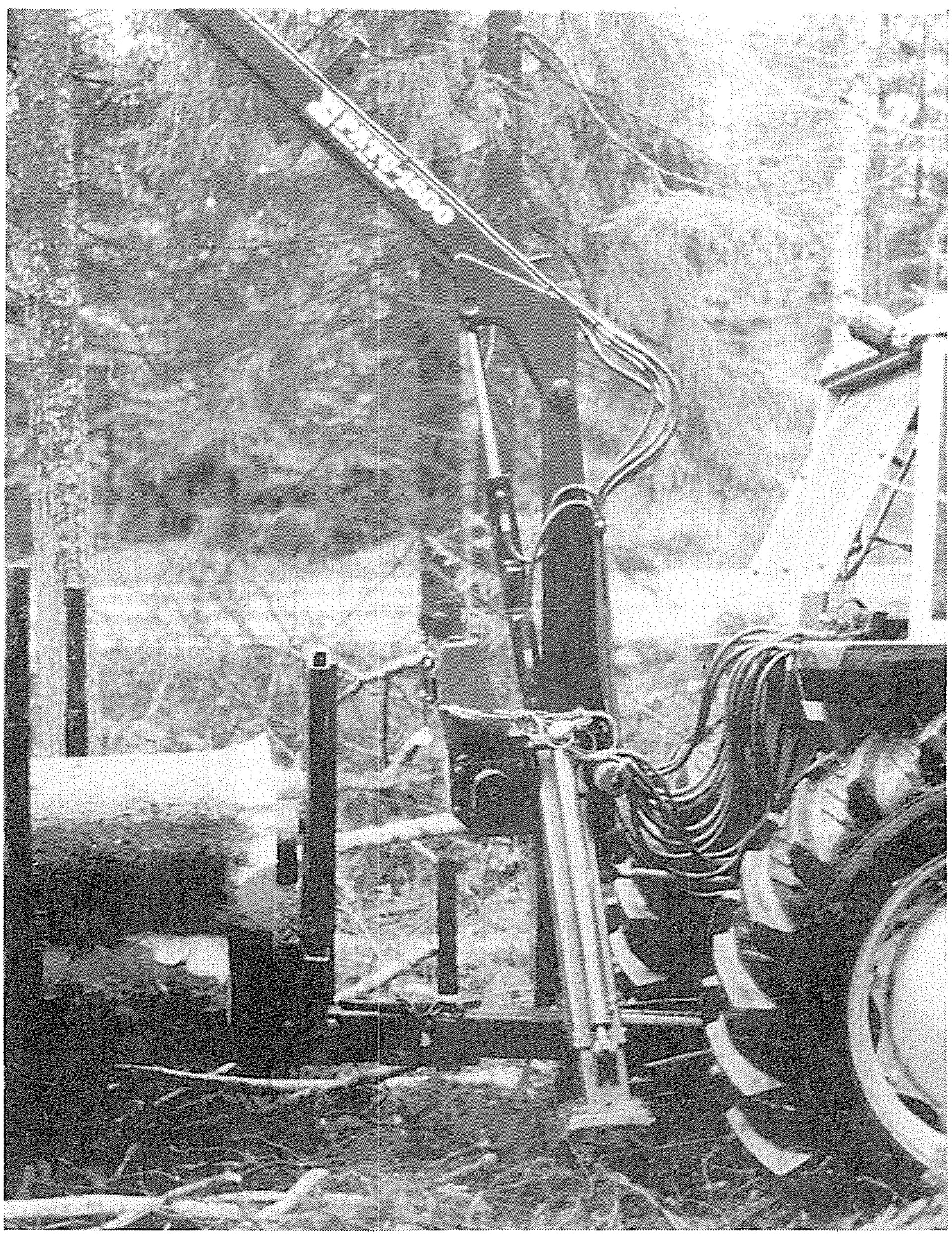
	Type	Pad Configuration
1.	Spacetime trousers	22 layers of Nylon Charmeuse
2.	Wormald chaps	2 layers of Woven Kevlar, 1 layer of Kevlar felt
3.	Cairnwood chaps	2 layers of Woven Kevlar, 2 layers of Kevlar felt

The test results for cut resistance and chain force impediment are shown in Appendix III. Contrary to the usual practice when testing for the standard, the cuts were performed at 45° and 90° to the vertical alignment of the leg. Normally just the 90° cut is made. The results showed that the Spacetime trousers satisfied the cut resistance standard for both directions of cut, but did not meet the requirements of the chain force impediment. The Wormald chaps showed good cut resistance in both directions and easily met the standard for chain force impediment. The Cairnwood chap readily exceeded the cut resistance test in both directions, but did not satisfy the chain force impediment tests. As stressed before, these tests were only indicative and there is a serious doubt about the validity of the chain force impediment measurement.

General

Vakola has approximately 500 hectares of forest area in the Olkkala area. The annual cut from this area is low, approximately 2000 m^3/year. This is achieved in two operations. The first visited was a Massey Ferguson agricultural tractor 675 with a trailer made by Patu and a Patu 1800 knuckle boom grapple,(refer fig. 28). The grapple has a 300 kg lift when extended to 4 m. It is mounted on

Figure 28 - The 675 Massey Ferguson Tractor and Patu Trailer



a three point linkage and has a small winch with 10 mm wire rope cable to enable it to get logs that were outside the reach of the boom. The stand that the machine was working in was 60 year old Norwegian spruce mixed with birch. It was originally established at 1,800 stems/hectare and was being thinnned down to 1,300. The crew was a three man gang working on an hourly rate. They were employees of Vakola.

The tractor and trailer worked to 30 mm strip roads, approximately 4 m wide. The tree cutters fell and delimb stems for pulp wood and sawlog material. The pulp wood is manually stacked close to the road in easily grapple sized stacks, while the sawlogs are normally left in their felled position. The trailer could carry approximately 5,000 kg but the daily production of the gang was around 25 m^3. The cutting specifications in this stand were - for pulp wood down to 6 cm minimum diamater, and for sawlogs down to 7 cm at random 3, 4 and 5 m lengths.

Later a visit was made to a clear fell operation where an Osa 250 forwarder (refer fig 29) was supposed to be logging an area which was being felled by six cutters. However, the gang, for some unknown reason, was not on site. The forwarder has a pay load capacity of approximately 15 m^3 and was capable of producing around about 120 m^3/day. The maximum haul distance worked by the forwarder was up to 500 m, but the average was around 250-300 m. Apparently the Massey Ferguson tractor and trailer works similar distances. As mentioned, the forwarder had a seven man crew, six chainsaw workers and one machine operator. A possible reason suggested for why the crew had knocked off was that the felling was ideally suited for processor operation and they could have been waiting for the processor.

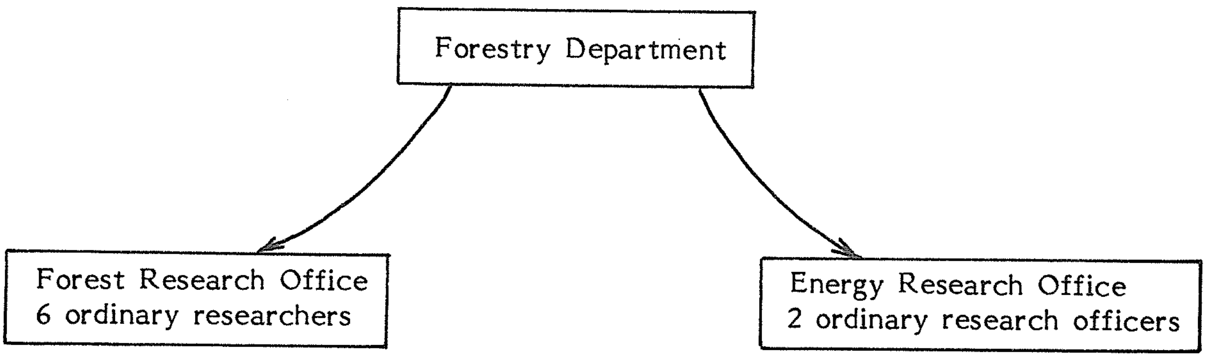
In Finland the maximum area that can be clear felled is determined by the total area of the forest. In the case of Olkkala the limit on the size of a clear fell was 6 hectares. Naturally, the bigger the forest area, the larger the area that can be clear felled. This is to ensure that the stands are managed on a rotational basis. The stand where the forwarder was supposed to be working was approximately 80 years old and the expected yield was around 300 m^3/hectare. The stand was mostly Norwegian Spruce but had some scattered patches of pinus silvestrus and birch.

Figure 29 - The Osa 250 Forwarder

(b) TYOTEHOSEURA, THE WORK EFFICIENCY ASSOCIATION OF FINLAND

Mr J. Makela, a researcher, described the structure and the purpose of the Tyotehoseura and the new Manager/Director, Mr E. Oksaueu was briefly introduced. Tyotehoseura is a forestry experimental section which designs and makes forestry equipment on a small scale, usually based on research findings. They have in the past manufactured and marketed some equipment including the Brown Scarifier. They work in close association with the training institutes etc. The main purpose of their work is to study the efficiency of operations and feed this information on to training institutes or interested parties. They have, for instance, contributed information to the Rojamaki Training Centre, which rents 100 hectare of forest for research and development work. The number of staff at Tyotehoseura was 160 people, half of whom worked in the training aspects and the rest in the general aspects. the economics section had 30 of the remainder, and there were 15 in the forestry department, 15 in the experiment station and the rest were in administration. Forest foremen undergo a one-year course in Finland at the various training institutes scattered throughout the country. The structure of forestry department is shown in Fig. 30.

Figure 30 Structure of Tyotehoseuras Forestry Department

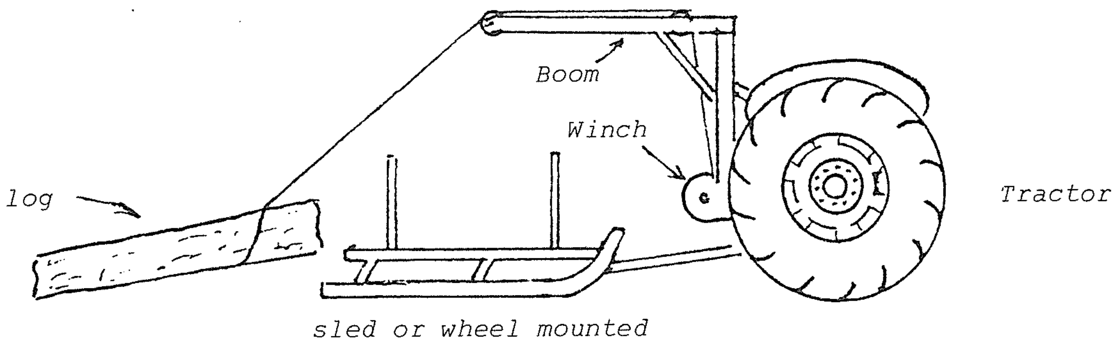


Only two people worked in the ergonomics field as less emphasis was being placed on it than before. Makela mentioned that Professor Hakalla from the Forest Research Institute had done a lot of work in the ergonomic area but it was not possible to visit him. The Forests Experimental Station planning office had designed harvesting and silviculture equipment but concentrated on the silvicultural aspects. Any products developed by the station were marketed under the name of TTS. The Finnish firm of Normet, for example, manufactured suitable attachments for farmers in the form of winches designed by TTS.

The forestry section of TTS had two research staff in ergonomics, two in energy harvesting and four in the farm forestry aspects, which seemed to involve a lot of their time. The objectives were mostly orientated towards research to try and improve the efficiency of logging on a small scale. In consequence they studied machines from the various manufacturers and tried as wide a sample of operators as possible to determine the variables in both training and performance. Then they publish the results for the rest of the forest industry. There are appoximately 200,000 farms in Finland with forest resources, and most of the landowners do their own forest work. A large proportion of Tyotehoseura's work was concentrated on in forest transport, i.e. forwarders and agricultural tractors. There were many alternatives for diversification into other areas such as research into energy use with the farmers etc. The organisation was evaluating the efficiency of home and farm heating units as well. This was done by engineers looking at the use of wood, peat and straw as fuel.

The forestry sector of Tyotehoseura was established in 1942, and a lot of its effort recently has concentrated on farm forestry logging. Farmers were inclined to thin their stand five times in attempts to increase their yields, whereas the larger forest firms only thinned three times. The general principle applied when thinning was to space skid roads at 30 m intervals. Approximately 50 m3/hectare was taken out with each thinning and 150 m3/hectare in the final clear felling. Many of the farmers developed their own machines. Often these developments were simple ideas like a winch mounted on the back of a three point linkage to haul logs up on to a sledge drawn by the drawbar of the tractor. This concept was capable of pulling approximately 2 m3/load and had a very low cost (refer fig. 31).

Fig 31 - A Winch and Sled Arrangement for Logging Farm Woodlots

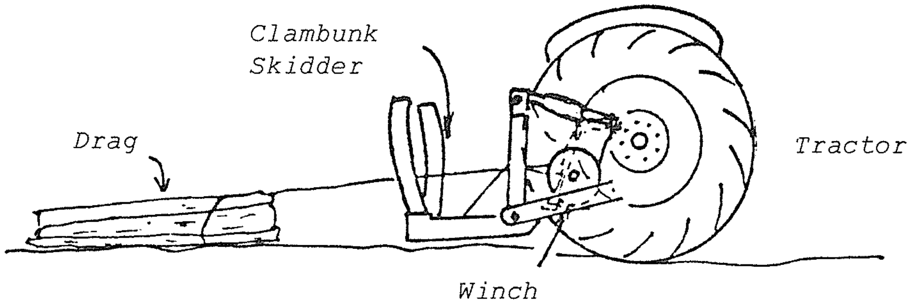


The cost of the unit all up, excluding the agricultural tractor, was 5,000 Finnish marks ($NZ1,400 approx.) for the winch, and approximately 3,000 Finnish marks ($NZ850 approx.) for the sledge.

The law in Finland stated that farm tractors manufactured after 1968 had to have safety cabs. In reality only about 30% of them actually had cabs. The knuckle boom concept for loaders was becoming a lot more popular in Finland and many farmers used home made bogeys for transporting the wood. A good knuckle boom could cost up to 25,000 Finnish marks ($NZ7,000 approx.) and perhaps a cheaper one 15,000 ($NZ4,000 approx.)

Forwarders were the most common extraction machine used by the companies in Finland. The farmers were included to use old winches on tractors mounted on the three point linkage. One example was a clambunk mounted on a three point linkage of an agricultural tractor (refer fig. 32).

Fig 32 - A Winch and Clambunk Setup for Log Extraction



More recently, one of Tyotehosuera's main concerns was soil cultivation for regeneration and re-establishment. Farms reafforestated in the 80's had an average of around 2,000 stems/hectare planted in Northern Spruce and Scots Pine and about 1,600 planted in birch.

A Miss K. Turkkila explained what Tyotehoseura have done in ergonomics. Firstly they had studied the various heart rates of particular parts of the operations and tried to relate the physical effort involved to the type of operation. They had also done studies on the operation of various machines to try and standardise the controls of these machines. More recently they have been studying back problems and measuring noise levels and dust levels in conjunction with vibration.

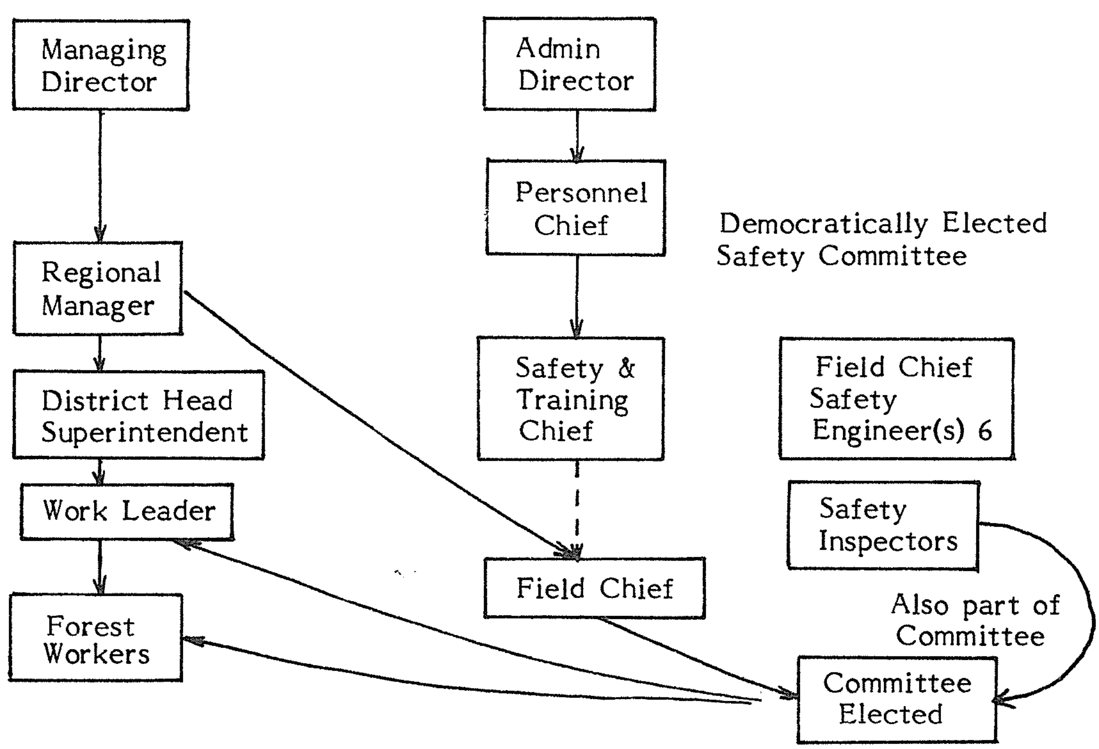
(c) VISIT TO TEHDASPUU OY - ONE OF THE LARGER FOREST COMPAINES IN FINLAND

Introduction

Tehdaspuu Oy organises logging for approximately 30 mills which are wholly or partly owned by the company. There were 36 forest districts and 2,500 workers employed, 700 of whom were salaried. Roughly 200 employees were forwarder operators, 200 truck drivers and 1,800 actual loggers. 10% of the wood supply came from outside Tehdaspuu Oy, 15% was imported from Russia and 75% local. The company controlled the wood supply for 30 mills. It controlled its own logging operations and it co-ordinated any imports. The transport side of Tehdaspuu Oy operations were 50% water based, 30% by road and 20% by rail. The company had shareholder areas covering about 500,000 hectares.

80% of the logging operations were manual and the machines mostly owned by the contractors. The company used to own them but have now sold them off to the contractors. The fallers worked all year round and about 90% of them were permanent employees. There were six regions of 6 to 8 forest districts. The 36 districts had something like 40 instructors who were normally loggers and work in the logging crews, but were called away to instruct for between five and fifty days per year. Most of the chainsaw operators owned their own equipment but the companies subsidised this on a 70/30 basis. Tehdaspuu Oy is based on a line organisation system with its staff in head and regional offices (refer fig. 33).

Figure 33 The Line Structure of Tehdaspuu Oy

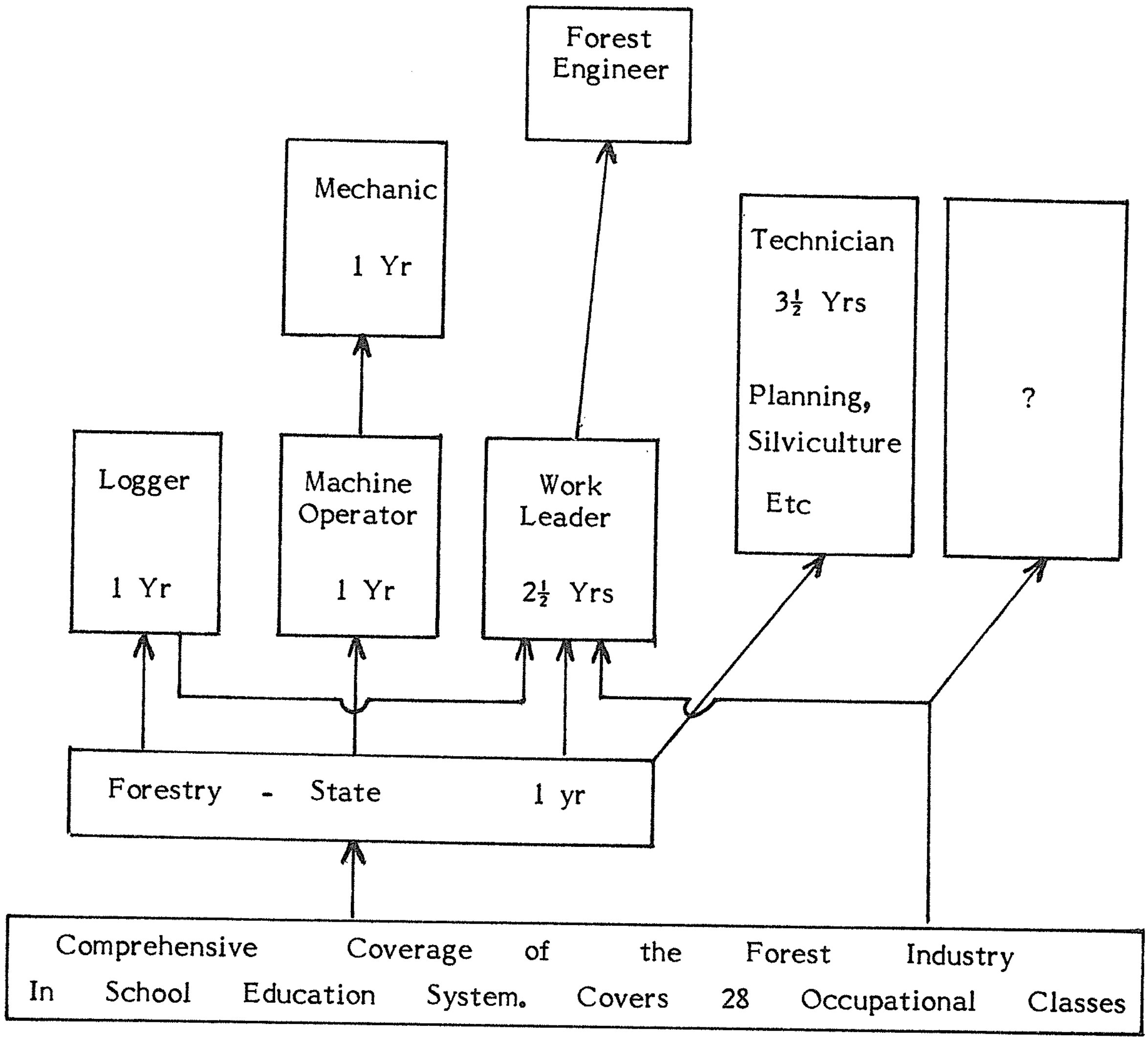


Apparently any company with more than 400 workers in Finland must have a Safety Committee which is entitled to 11 man-days during a month to investigate safety conditions. Tehdaspuu Oy had six commissioned safety inspectors for each area and in each operation was a work leader who inspected the safety of the operation daily. Some of the commissioned safety inspectors were full time. They had a committee structure which was set up to investigate accidents and inspect logging conditions.

Education of Forest Workers

Forestry is an integrated part of the education system in Finland and students study forest practices as part of their cirriculum. They then have the choice of pursuing education in forestry through to the tertiary stage. Fig 34. shows the structure of the Finnish Forestry Education system.

Figure 34 The Structure of Finnish Forestry Education



Loggers have to go through periodic courses over the first four years of their employment. There are chainsaw and logging general courses and then after one year they are able to specialise in courses according to their desires. These courses are approximately one week and held at the State Forest Training Schools. The first basic logging course is a maintenance and safety course which has the emphasis on the maintenance of chainsaws and involves three days of instruction on the repair and maintenance of saws, and two days of first aid. The logging technique course involves more actual training in felling, delimbing and bunching, and also planning of the work. It includes one day first aid and a half day on the payment system, which is very critical in Finland. The first aid section, incidentially, includes ergonomic considerations.

The logging methods course is more detailed and that is conducted in year two. It covers the application of safety equipment and ergonomics in practical logging, and offers solutions to the day to day problems met on the job. It involves the introduction of improved techniques from the latest research and development. For example, the recent move to long pulp dimensions to reduce the amount of manual handling, and the introduction of long reach cranes. The training also includes systems and their effect on ergonomics.

Stand Management Practices

After a logging operation the soil was cultivated and left to regenerate. Because of its poor regeneration ability, Scots Pine was planted on most sites. Stands were usually stocked initially at about 2,000 stems/hectare and an inventory done after the first two years. The stands were then cleaned, which is usually done twice, and most stands received four thinnings. The first after 35 to 40 years, when the stands are thinned from about 1,800 down to 1,200. This yields approximately 50 m^3/hectare. The second thinning is after about 40 to 50 years and reduces the stocking of the stand to about 1,000 trees/hectare. 60 to 80 m^3/hectare is normally produced in this operation. The third thinning takes place 15 years later and it reduces the stand down to under 500 stems/hectare. Again this yields 60 to 80 m^3/hectare. The fourth and final thinning is again 15 years later and takes the stand down to 200 stems/hectare with a yield of 80 - 100 m^3/hectare. In clear felling Tehdaspuu Oy expected to yield between 400-500 m^3/hectare.

The average rotation in Finland is 70-100 years but Tehdaspuu Oy worked on 100 years. In Northern Finland they have no choice - it is always 100 years. Where they expected a stand to regenerate naturally approximately 10 trees/hectare were left for seeding. The company forests tended to regenerate their areas more than the private sector, mainly because the companies were considered more efficient. All of the cutting was done by employees of the company who were on a piece rate payment system. They worked an average of 6.5 hours per day and preferred the piece rate system because they earned more money and liked the freedom it allowed, e.g. they could go home in the adverse conditions knowing that they had to work harder when the conditions were good. The logging machines were not worked below -25°, but the manual systems could go on working in even colder climates. In actual fact the loggers preferred the colder conditions because they were drier. When loggers attend courses they are paid an average of their earnings over the previous two weeks.

The Role of Instructors and Safety Inspectors

Instructors normally underwent an 8 week course when they began, and then every year they went back for a one week refresher. Instructors also held the position of a safety engineer, normally as elected by the workers. These safety instructors, or engineers, have check lists which they use when visiting crews. They can turn up when they like and evaluate an operator. Normally this was planned with the District Safety Commissioner and scheduled on a yearly basis. Sometimes the programme outlined for the year had to be altered to cater for new employees, or the retraining of loggers who changed jobs. Often instructors went to check on how much workers had learnt from a course.

A visit was then made to a private forest area where Mr H. Kilkki, the world champion logger, gave a brief summary of the procedure involved as an instructor and safety inspector. During the work day, (6-7 hours), cutters usually have approximately a one hour break.

The company normally provided a helmet for the worker and could make him use it, but this was not a law in Finland. The company would replace the helmet on a three yearly basis, they cost approximately 100 marks which included a visor and earmuffs. Most of them were Swedish made. The popular type of jacket worn by the loggers in Finland was a light shower-proof nylon type vest which had a bright coloured area around the shoulders and chest. The important thing was that the garment be able to breathe, i.e. allow air to circulate to allow the dispersal of moisture. In more adverse conditions raincoats were used. Boots, gloves and underwear were all standard equipment for loggers, but a lot of personal choice came into the selection of which equipment was used. As mentioned before, 30% of this cost was paid for by the worker and 70% by the company. The company provided two pair of protective gloves a year for the worker, but he could get extra pairs if he cut a glove. The same principle applied with the boots, but with the underwear they only received one pair every five years. The trousers used were Swedish made with eight layers of nylon cord padding material. The outer material appeared relatively light but it was difficult to assess how well it would breathe. The trousers cost approximately 200 marks, the jacket 150 marks and the boots over 350 marks.

The use of the chain brake in Finland was not law, but most companies were enforcing its use. Cutters in Finland used to produce about 12 m^3/day, but with improved safety and training the average was up to 15-20 m^3/day. The reason for this increase was partly due to new techniques, partly due to the bigger wood being logged and also the fact that the loggers could cut logs to longer lengths with the long reach cranes that were being used. Pulp wood dimensions were 6 cm s.e.d. in softwood and 7 cm s.e.d in hardwood, and the sawlogs were 13-14 cm in softwood and 15 cm in hardwood.

<u>State Training School</u>

A visit was made to the Mikkala forest area to Pieskamaki, a state owned and operated forestry training school. The school was set up to train loggers in 1960 although it had been established a long time before that. It began with one to two week courses to train in the basics of logging, but in the new system, after the school year, forestry students have had a vacational training year and by 1988 everybody working in the logging operations will have been exposed to this year.

At the training centres, people lived in the school in barracks. There were approximately 40 people per course, most of them 16 to 22 years old. 13 of those 40 people were graduates. Usually refresher courses were run for individual companies so only Tehdaspuu Oy employees would go to one course, then employees from a different company would go to the next one. The Pieskamaki training school at Mikkala had 2 forest technicians and 2 instructors in logging. In mensuration courses there were 2 instructors and 1 technician, and 3 other instructors and 1 technician were available for short courses. The training courses were a mixture of students fresh out of school and high school students preparing to go on to University.

The school began in 1910 but the Institute of Logging did not begin until the 1960s. The school alone had approximately 100 hectares of forest for training and instruction, but during courses students also went out to independent company areas to broaden their experience. The average annual course involved 1,460 hours, 10-15% of this being practical and as well students were expected to work during their summer vacation. All students borrowed equipment from the schools.

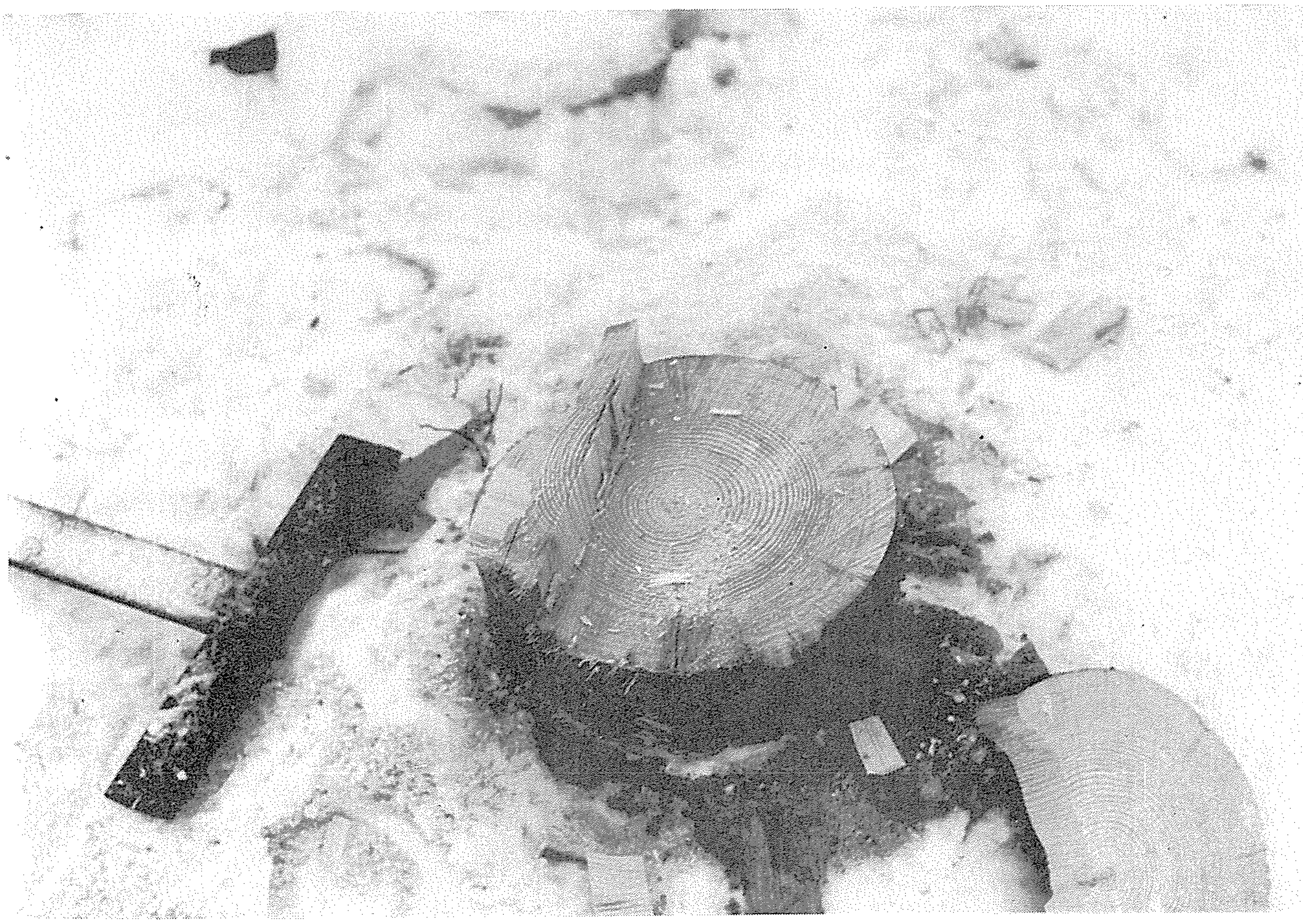
In the first year basic logging training was included in the general course and this included a strong emphasis on thinnings with an introduction to thinning models. Seven different systems were taught. The idea of marking boundaries was outlined, as well as where to locate strip rows in thinning, the minimum economic area that could be logged (approximately 1.5 hectares), and also the planning and location of landing areas.

A practical demonstration was given of a simple delimbing bench used to instruct trainees or students on the techniques of delimbing (refer Fig. 35). The bench was just a spruce log with holes drilled around the circumference at various intervals along its length. The log was supported on other logs at each end, and rested at about knee height. Small 3 cm x 3 cm wooden stakes about 50 - 60 cm long were then poked into the holes and the students shown how to delimb the stem but cutting the stakes off. The stakes were then reinserted in the holes and each student given the opportunity to practice delimbing. The instructor stood by and corrected any mistakes being made.

Figure 35 - The Simple Delimbing Training Bench at the Forestry School at Mikkala

This was followed by a quick run through felling techniques and students were again asked to demonstrate their skills. The models were small billets 1 - 2 m long and about 25 cm in diameter. Each student had a model to himself which he placed (in the vertical position) on a spiked base. The student then put a scarf in, aiming it for a stake in the ground where the model tree was expected to fall. The accuracy of this scarf was then checked with a simple T square which indicated to the student how far off his scarf was. The back-cut was then done to a stage when the model tree would have fallen. The instructor then cut the whole model off about 7 - 8 cm above the backcut and chipped the cut wood away with an axe to reveal the holding wood left. (Refer fig. 36.)

Figure 36 - The Method of Assessing Scarf Accuracy for Tree Felling



In the operations, the contractors only owned the forwarders and did not control the felling crews. Normally there were about 10 cutters per forwarder and 70-90 cutters per area. About 10 to 12 work leaders in these areas organised the men and controlled the felling and delimbing. Each district had a feller processer, one 4 m long reach crane, 6-7 forwarders and about 5 trucks. Altogether the district employed approximately 100 people. Contractors were paid extra if they couldn't reach their targets. In thinnings the pieces from the cutters were marked for identification prior to extraction, but in clear fell payment was by area felled. All workers were paid per cubic metre produced.

As per agreement, sawlogs on stumpage reached between 12 and 20 marks per cubic metre in spruce and this ranges up to 60 marks per cubic metre for pine. Forwarder operators were paid between 10 and 30 marks per cubic metre for extracted wood, depending on the piece size, and truck operators paid between 10 and 20 marks per cubic metre over an average haul distance of 70 to 80 kilometres. For water transport, the average floating distance was 200 kilometres. Rail distances usually had to be more than 100 kilometres to be economical. Snow did create problems with operations being worked out of phase, particularly when trying to find wood after heavy snow. Logging managers often found it difficult to balance supply with demand.

Tehdaspuu Oy did not register near miss accidents. It relied on information from the work health centre about accidents without injury, but the work health centre only took random samples of near misses. Contact at the work health centre was P. Samaki. Ergonomics in forest work was covered in a separate course prepared by Tyotehoseura. They had published a book on man and machine, and used that as a basis for the course content.

(d) METSATEHO - THE LOGGING RESEARCH INSTITUTE, FINLAND

A visit was made to Metsateho where discussions were held with Mr E. Mikkonen. His main area of work was clear felling - looking at machine and technique development. He mentioned that Metsateho had only done limited work in ergonomics and then they really only became involved in it if it was related to a particular project area they were working in. For example, they would publish results from Vakola tests or Tyotehoseura tests where they were relevant to a particular machine being evaluated or a technique that was being developed. Also if they wanted a particular aspect of the job being done to be investigated, they will employ the other organisations to do it.

Every worker employed in forest and farming in Finland has to be insured by his employer. Usually the company had a work history of each employer and Mikkonen believed that about 80% of all loggers were insured with the insurance companies. These companies get reports on accidents, but not all near misses are recorded. There was also a Board of Occupation Protection which had inspectors who visited the work sites to ensure that they were safe and that the workers were working in a safe manner. The inspectors of the Board could have employers penalised if they found workers not using the correct safety procedures or equipment. It was very difficult to enforce however, particularly the use of protective equipment and safe working habits, because workers simply refuse to use them. The centre for this Board of Occupational Protection was located in Tampere.

Metsateho is funded primarily by the forest industry companies, although the State does support a small share, roughly 5-7%. Of the 60 industry companies in Finland, 50 were members. The big companies helped direct research policies. Their system of levying was similar to LIRA's, i.e. on a production basis, but their actual work output was different - 40% of their expenditure was used in wage base studies so they investigated problems affecting wages in most forestry activities. A secondary function of theirs was to research and develop systems for machine companies. There were 36 people on the Metsateho staff, 15 research workers with degrees, five field technicians and the rest in administration. The organisation was founded in 1945, mainly for the wage base studies. Their latest work was involved with building up planning models for the major companies and that involved about 20% of the research effort.

A query was put forward on the use of polyester roundslings in logging but Mikkonen said that they were not commonly used by professional loggers in Finland (that was about 80% of the logging). Apparently some of the farmers who wished to get away with cheaper operations would use the slings, but the farmers only totalled 20% of the logging. The main incentive for them was to keep their production levels fairly low because they had to pay high tax if they produced over 150 m^3 per year. In the swampy areas with unstable ground conditions, the land was left until frozen in winter and then operations began. Sometimes the freezing extended down to over a metre deep. With the ground hard they could use conventional logging machinery on soils that would have otherwise been too soft to traverse.

(e) VISIT TO THE INSTITUTE FOR WORK SAFETY - TYOTURVALLISUUSKESKOS

Discussions were held with Mr Esko Kolehmainen. This organisation was like the Department of Labour but had the support of the unions etc. Its main function was informing and educating in forestry. It had a close association with State bodies and was involved in making rules and regulations for bush work, controlling working conditions, etc. There were three main organisations concerned with ensuring the work place was safe and that the employers fulfilled their responsibilities. They were; The labour protection organisation, (which was involved in working conditions); The Institute for Occupational Safety, (whose main work was in techniques and equipment); and the Centre for Industrial Safety.

Approximately 1,500 people were involved in safety and training of workers in Finland. They ran five day courses, directed towards specific parts of the logging operation. Attendance of these courses were covered by the employers. They also had special areas of concern such as back injuries, where a survey using questionnaires was used to get information. Research then concentrates on reducing or eliminating these injuries and a course compiled to instruct and train workers to avoid the type of dangers that cause these injuries. In Finland employers have responsibility for the worker's safety. They must supply the equipment for the worker to use or wear and ensure that the working conditions are safe. The fact that these provisions were often not used was a matter of contention, but the legislation was introduced in 1958 and it was totally worker oriented. Any attempts to change the law met with resistance because it would not benefit the workers. Almost 2% of the premiums collected by the Insurance Organisations was redirected to the Institute for Work Safety. On the scale of premiums paid by various industries, the forest industry was above the average, but not the highest. Forestry work was considered the seventh most dangerous occupation in Finland.

The Work Safety Institute was involved in making and selling films on training and safety and could organise translations into other languages, if required. For example, quite a few of their films were sold to Sweden with Swedish translations. They would also translate films into English to secure a sale.

When questioned about the contact that the organisations had with farmers, it was obviously a point that needed investigation. Kolehmainen said that they had tried many ways of getting across to the farmers the need for safety and accident prevention. The diverse nature of the operations, the scattered locations in which they are working in, and the often negative approach of the people, meant that they didn't have a lot of success.

LIST OF APPENDICES

Appendix I

LIST OF PARTICIPANTS AT THE ERGONOMICS APPLIED TO FORESTRY SEMINAR IN AUSTRIA

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Appendix II

Translation

STANDARD SFS 4700

FINNISH STANDARDS ASSOCIATION

THE SAFETY SHIELDS OF THE CHAINSAW WORKERS : REQUIREMENTS

1 INTRODUCTION

1.1 General

This standard specifies the requirements on the dimensions of the safety shields used in the safety boots, safety suits and protective gloves of chainsaw workers.

Protective gloves, safety suits and safety boots with their safety shields shall be tested by using the test apparatus and test method (6000 rpm) specified in standard SFS 4701.

This standard applies to safety shields, the objective of which is to prevent or to relieve injuries to the hands, legs and feet caused by a saw chain.

2 DEFINITION

2.1 Safety Shield

The safety shield is a shield fastened securely to protective gloves, safety suit or safety boots used by forest workers or the outfit itself that mitigates or prevents injuries caused by a saw chain.

3 REQUIREMENTS

3.1 Safety Shields of Protective Gloves

In testing, the penetration time of the safety shield of a protective glove shall be at least 0,15 seconds.

The safety shield shall be dimensioned so that it protects the back of the gloved hand that holds the front handle of the chainsaw.

3.2 Safety Shields of Safety Suits

In testing, the penetration time of the safety shield of a safety suit shall be at least 0,15 seconds.

The safety shield shall be dimensioned so that it provides protection for the checked area shown in picture 1.

The length of the shield shall be measured from the mid point of the diagonally cut upper part.

Picture 1

e.g. in size 52 the length is about 70 cm, the width of the upper part at least 30 cm and that of the lower part at least 22 cm. The shield shall extend down to the lower edge of the trouser leg. A corresponding protection shall be provided in other sizes. The safety shield shall be sewn firmly to the trousers or trouser leg from the upper edge and along the sides.

3.3
Safety shield of safety boots

The penetration time of each safety shield of the safety boots shall be at least 0,20 seconds and the average of the sawings at least 0,40 seconds.

The safety shield shall be dimensioned so that the requirements imposed on the penetration time are complied with. The upper edge of the shield shall be at a height that is not less than 22 cm from the frontal lower edge of the heel.

SFS 4700 The Technical Board of Finnish Standards Association 1981-08-31

GUIDING INFORMATION

The requirements imposed on the strength of the steel-reinforced toe-cap have been specified in standard SFS 3301.

The clog-proof feature usually adds to the protective effect of the safety shield. However, no unambiguous measuring method has been developed to date to determine the value of clog-proofness.

The safety clothing furnished with safety shields should be as comfortable as possible in use, easy to clean, stand up to rough wear and tear, and they must not cause new jeopardies to the user by e.g. increasing the clumsiness.

The National Board of Labour Protection issues upon request statements on the appropriateness of the safety shields of lumbermen's safety equipment. In order to obtain the statement the applicant has to provide the National Board of Labour Protection with test results and samples.

Translation

STANDARD SFS 4701

FINNISH STANDARDS ASSOCIATION

THE NATIONAL BOARD OF LABOUR PROTECTION

THE SAFETY SHIELDS OF THE CHAINSAW WORKER : TEST METHODS

1 INTRODUCTION

This standard presents the test methods for the safety shields of chainsaw workers and gives description of the equipment and methods used.

The requirements imposed on safety shields have been specified in Standard SFS 4700.

2 DETERMINATION OF THE PROTECTIVE EFFECT

2.1 Test Apparatus

The safety shield of a chainsaw worker shall be tested on an apparatus onto the body of which a 2,2 kW electric motor and the bar and chain assembly of a chainsaw are mounted. The power is transmitted from the electric motor to the bar and chain assembly of the chainsaw. The bar and chain assembly shall be provided with an 8-tooth sprocket, hard tipping guide bar and a chain furnished with a tooth that restricts the kickback (a half-round tooth, depth gauge setting 0,65 mm, worn $\frac{1}{2}$ of the length of the cutter at the most), pitch 8,25 mm (0.325"). The effective length of the bar and chain assembly shall be 39 cm. The chain has to be kept sharp so that the side plate angle is 90°, the filing angle 30° and the top plate angle is angle 60°. The apparatus has a transmission weight by means of which the burden of the bar and chain assembly against the safety shield is set to the value desired as well as a hydraulic damper that regulates the dropping speed of the bar and chain assembly onto the safety shield. The force by which the shield strives to impede the movement of the chain is measured by means of a sensor mounted onto the anchor points of the log onto which the shield is attached.

2.2 Test Objects

For a set of tests are needed :

12 pairs protective gloves
6 pairs safety trousers or overalls size 52.
The test is carried out on both trouser legs.
8 pairs safety boots size 42.
The test is conducted on each boot.

If the institute conducting the test regards it as necessary more samples than mentioned above shall be tested.

2.3 Pre-conditioning

The coating of the safety shields of protective gloves and safety clothing is of the same material as used in the outfit itself. The safety boots shall be filled with gypsum that is cast into a boot-shaped waterproof plastic or rubber sock.

The test objects shall be pre-conditioned for at least 48 hours at a temperature of 20 ± 2°C and a relative humidity of 65 ± 5%.

2.4 Test procedure

The safety shield of the safety clothing and protective gloves shall be fastened onto a log half that is 10 cm in diameter and covered with 20 mm thick foam plastic (mass 50 kg/cubic metre).

The safety clothing and protective gloves shall be fastened so that the tightness is 10 N at the sawing point.

The safety shields of the safety trousers (trouser leg) shall be fastened at a 90° angle to the bar and chain assembly and the cut is made at the mid centre point of the shield.

The safety boots filled with gypsum shall be fastened onto the test apparatus so that a cut can be made at all the points shown in picture 1. Each boot is sawn only once. Of each of the sawing points (points 1 ... 5) shown in picture 1 three parallel determinations shall be made either of the right or left boot.

Testing points

1 Lower part of the boot leg, mid-centre point in the front.

2 Middle part of the boot leg, in the front.

3 Foot part of the boot, mid-centre point on the top

4 Foot part of the boot, inside

5 Foot part of the boot, outside

Picture 1

While testing, the speed of the sprocket shall be 6000 ± 100 rpm and that of the chain $13,2 \pm 0,2$ m/s.

The burden of the chain against the shield shall be 15 N and the chain shall be dropped at a speed of $0,2 \pm 0,02$ m/s.

The size of impact energy against the shield at the sprocket speed of 6000 rpm shall be 0,141 Nm. When testing the time spent on the penetration of the safety shield shall be measured. For this purpose a thin lead shall be fastened on the top and underside of the safety shield. Whilst sawing the shield the breaking moments of the leads shall be registered on the tape of a printer from which the cut-through time can be read.

In addition, the force by which the shield strives to impede the movement of the chain shall be meaured.

Before the actual testing 5 test sawings shall be made by means of the test apparatus on a comparison sample made of 22 ply nylon fabric.

The characteristic values of the comparison sample (weft and warp) :

Raw material : 100% PA 66, yarn density : 170/10 cm

Bond : 1/1, tearing resistance (Elmendorf): over 32 N

Break load (SFS 2983) : 1000 N/5 cm

Break elongation (SFS 2983) : 25%, mass 85 g/square metre

3 REPORTING OF THE RESULTS

As the test result shall be reported the cut-through times (accuracy ± 0,01 s), average of the cut-through times and deviation as well as the number of cases in which no cutting through occurred, obtained in the test sawing and the actual testing. In addition shall be reported the forces restricting the movement of the chain in each sawing as well as their average in order to assess the clog-proof characteristic of the safety shield.

SFS 4701 The Technical Board of Finnish Standards Association 1981-08-31

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