

TAMPEREEN AMMATTIKORKEAKOULU
Metsätalouden koulutusohjelma

Tutkintotyö

Mikko Heikkilä

ENGLANNINKIELINEN OPINTOMATERIAALI HARVESTERIEN KAATOPÄISTÄ

Työn ohjaaja
Työn teettäjä
Tampere 2004

Pirjo Puustjärvi
Kurun metsäoppilaitos, Markku Heurlin

Heikkilä, Mikko. 2004. Englanninkielinen opintomateriaali kaatopäistä. Tutkintotyö.
Tampereen ammattikorkeakoulu, metsätalouden koulutusohjelma. 10 sivua + 20 liitesivua.

Työn teettäjä Kurun metsäoppilaitos, Markku Heurlin
Työn ohjaaja Pirjo Puustjärvi

Asiasanat metsäkoneet, metsäkoneenkuljettajat

TIIVISTELMÄ

Opintomateriaali on laadittu Kurun metsäoppilaitoksen järjestämille kansainvälisille metsäkoneenkuljettajakursseille. Opintomateriaalin tavoitteena on antaa perustiedot harvesterien kaatopäistä.

Opintomateriaali on pyritty laatimaan niin, että se on sekä luettavissa sekä ymmärrettävissä heikoillakin lähtötiedoilla kuitenkin myös uutta tietoa kokeneemmallekin opiskelijalle tarjoten.

Opiskelijat voivat perehtyä opintomateriaaliin itsenäisesti tai sitä voidaan käyttää lähiopetusmateriaalina sähköisesti tai paperitulosteina.

Opintomateriaalissa perehdytään harvesterien kaatopäiden toimintoihin, rakenteeseen, ohjaukseen sekä niihin liittyviin työskentelymenetelmiin sekä turvallisuusasioihin.

Heikkilä, Mikko. 2004. Harvester head study material in English. Final thesis.
Tampere polytechnical university, faculty of forestry. 10 pages + 20 attachment pages.

Work ordered by: Kuru college of forestry, Markku Heurlin
Instructor: Pirjo Puustjärvi

Keywords forest machine operators, forest machines

ABSTRACT

Harvester heads - study material is made for international forest machine operator courses organised by Kuru college of forestry. The goal of this study material is to provide basic knowledge about single-grip harvester heads.

The study material is supposed to be readable and understandable even for beginners, still providing some further information for students with forestry or machine experience.

This study material can be dealt out as a handout or used as a lecture material as a paper print version as well as in electrical form.

This study material provides information about single-grip harvester heads functions, structure, control, safety instructions and also working methods related to harvester heads.

ALKUSANAT

Päätös tehdä tutkintotyöni metsäkoneisiin liittyvästä aiheesta johtui omasta kiinnostuksestani ja halusta työskennellä tulevaisuudessa niiden parissa. Otin yhteyttä Markku Heurliniin Kurun metsäoppilaitoksesta ja hänellä olikin tarjota aiheeksi englanninkielisen opintomateriaalin teko harvesterien kaatopäistä kansainvälisille metsäkoneenkuljettajakursseille.

Alkuvaiheessa työ eteni hyvin hitaasti, sillä omat tietoni aiheesta olivat kovin vähäiset. Manuaaleja lukemalla ja Kurun metsäoppilaitoksen opettajien avustuksella alkoi työ vihdoin edistyä. Tämän tutkintotyön tekeminen on ollut antoisa oppimisprosessi itselleni. Haluankin kiittää saamastani avusta seuraavia Kurun metsäoppilaitoksen työntekijöitä: Chris Thomson, Pasi Leivo, Pertti Teräväinen, Mika Laakso ja Harri Savonen. Kiitokset myös Markku Heurlinille opastuksesta työn edetessä ja tilaisuudesta tehdä tämä työ.

Mikko Heikkilä

SISÄLLYSLUETTELO

1. JOHDANTO	6
1.1 Kurun metsäoppilaitos	6
1.2 Opintomateriaalin käyttötarkoitus	6
1.3 Kirjallisuus kaatopäistä	6
2. TYÖN TEKEMISEN VAIHEET	7
2.1 Suunnittelu	7
2.2 Aineiston keruu	7
3. OPINTOMATERIAALIN RAKENNE	7
3.1 Introduction - johdanto	7
3.2 Functions - toiminnot	8
3.3 Harvester head structure and control - kaatopään rakenne ja ohjaus	8
3.4 Technical data - tekniset tiedot	8
3.5 Opintomateriaalin luvut 5 - 10	8
3.6 Daily tasks - päivittäiset toimet	9
3.7 Tips about working methods - vihjeitä työskentelymenetelmistä	9
3.8 Safety instructions - turvallisuusohjeita	9
4. JATKOTOIMENPITEET	9
5. LÄHTEET	10
5.1 Opintomateriaalin lähteet	10
LIITTEET	Harvester heads - study material (20 sivua)

1. JOHDANTO

1.1 Kurun metsäoppilaitos

Kurun metsäoppilaitos on osa Tampereen ammattiopistoa, jonka yli 5000 opiskelijasta noin 300 opiskelee Kurussa. Henkilökuntaa Kurun metsäoppilaitoksessa on noin 60.

Kurun metsäoppilaitos kouluttaa metsäkoneen- sekä puutavara-autonkuljettajia työelämän tarpeisiin. Lisäksi tarjolla on mm. eräopaskoulutusta ja kursseja metsänomistajille. Kurussa on paljon kansainvälistä toimintaa, siksi toisena opetuskielenä onkin englanti.

(Kurun metsäoppilaitoksen kotisivut, www.tpu.fi/kmo 11.12.2004)

1.2 Opintomateriaalin käyttötarkoitus

Opintomateriaali on tehty Kurun metsäoppilaitoksen järjestämille kansainvälisille metsäkoneenkuljettajakursseille, joiden opetuskielenä on englanti.

Opintomateriaalin tavoite on antaa opiskelijalle kokonaiskuva harvesterien kaatopäiden rakenteesta, toiminnoista, huollosta, käyttämisestä sekä niihin liittyvistä turvallisuusasioista. Kovin pitkälle teknisiin yksityiskohtiin ei opintomateriaalissa mennä, sillä ne löytyvät helpoiten kaatopäiden omista manuaaleista.

Kursseille valittavilta opiskelijoilta vaaditaan yleensä kokemusta joko metsätaloudesta tai koneiden käyttämisestä, ei välttämättä molemmista. Opintomateriaalin on siis oltava helposti ymmärrettävissä, vaikka opiskelijalla ei olisikaan lähtötietoja metsätaloudesta tai koneista. Tavoitteena on silti tarjota uutta tietoa hieman kokeneemmallekin opiskelijalle.

Opintomateriaali voidaan jakaa opiskelijoille itsenäistä opiskelua varten tai käyttää sitä opetusmateriaalina lähiopetuksessa.

1.3 Kirjallisuus kaatopäistä

Ainoastaan kaatopäitä käsittelevää kirjallisuutta on hyvin niukalti, esimerkiksi oppikirjoja aiheesta ei ole olemassa. Parhaiten tietoa kaatopäistä saa valmistajien tekemistä manuaaleista. Manuaaleista saatavissa olevan tiedon määrä tosin vaihtelee suuresti eri valmistajien kesken. Suurimpien valmistajien manuaaleissa on laajalti tietoa kaatopään käyttämisestä, huollosta, säätämisestä ja vianetsinnästä. Pienimpien valmistajien manuaaleissa on lähinnä turvallisuusohjeita, lyhyt kuvaus laitteesta sekä hydraulikka- ja sähkökaaviot.

2. TYÖN TEKEMISEN VAIHEET

2.1 Suunnittelu

Opintomateriaalin lähtökohtana oli, että sen pitää olla ymmärrettävissä heikoillakin lähtötiedoilla. Tämä vaikutti paljon opintomateriaalin rakenteeseen. Aivan ensimmäiseksi ei voi käsitellä teknisiä asioita, vaan aihe on pohjustettava kunnolla. Opintomateriaali etenee vastaten seuraaviin kysymyksiin vastaavassa järjestyksessä:

- 1) Mikä on kaatopää?
- 2) Mitä sillä tehdään ja miksi?
- 3) Mitä osia siinä on?
 - Mitä ne tekevät?
 - Miten niitä ohjataan?
- 4) Miten kaatopäätä käytetään?
- 5) Turvallisuusasiat

Tällä rakenteella työn pitäisi olla ymmärrettävissä helposti vasta-alkajallekin.

Opintomateriaalin muodoksi valittiin Microsoft Word-tiedosto, koska se on helposti tulostettavissa paperille ja käytettävissä myös sähköisessä muodossa. Tarvittaessa aineistoa on helppo muokata ja päivittää. Tein työstä myös Microsoft Powerpoint –esityksen, jonka avulla materiaalin käsitteleminen käy kätevästi lähiopetustilanteissa.

Esimerkkeinä kaatopäistä työssä ovat Ponsse H60, Timberjack 745 sekä Keto 100, koska ne ovat Kurun metsäoppilaitoksen käytössä.

2.2 Aineiston keruu

Aineisto on kerätty suurilta osin kaatopäiden valmistajien manuaaleista. Manuaaleista saatavissa oleva tiedon määrä on kuitenkin hyvin rajallinen ja sitä on täydennetty kyselemällä tarkempia tietoja metsäkoneammattilaisilta, lähinnä Kurun metsäoppilaitoksen opettajilta. Lisäksi opintomateriaalin sisältöön ovat vaikuttaneet omat käytännön kokemukseni ja luennot, joille osallistuin ollessani Kurun metsäoppilaitoksen järjestämällä kansainvälisellä metsäkoneenkuljettajakurssilla.

3. OPINTOMATERIAALIN RAKENNE

3.1 Introduction - johdanto

Opintomateriaalin johdannossa esitellään eri puunkorjuumenetelmiä lyhyesti ja esitetään harvesterit nimenomaan määrämittamenetelmän koneellisen puunkorjuun välineenä. Harvesteri jaetaan eri kokonaisuuksiin, joista yksi on harvesterin kaatopää. Johdannossa mainitaan nimeltä tunnettuja kaatopäiden valmistajia sekä esitellään opintomateriaalissa esimerkkeinä käytetyt kaatopäämallit.

3.2 Functions - toiminnot

Tässä luvussa esitellään kaatopäiden eri toiminnot sekä niiden merkitys eri näkökulmista. Toisin sanoen tässä luvussa pyritään vastaamaan kysymyksiin mitä ja miksi kaatopäillä tehdään.

Luvussa käsitellyt kaatopäiden toiminnot:

- 1) Puun kaato
- 2) Mittaus
- 3) Karsinta
- 4) Katkonta
- 5) Värimerkkaus
- 6) Kantokäsittely

Toimintojen merkitysten selvittäminen katsottiin tarpeelliseksi, sillä osa opiskelijoista tulee maista, joissa metsätalouden lähtökohdat sekä puunkorjuumenetelmät ovat täysin erilaisia Suomeen verrattuna. Esimerkiksi Kanadassa ja Venäjällä puuta korjataan lähinnä valtion omistamista metsistä eikä harvennuksia tai kantokäsittelyä juurikaan tehdä. Myös leimikkojen koko on kyseisissä maissa paljon isompi ja usein korjattava puutavara ei lähde niin monelle eri tehtaalle kuin Suomessa.

3.3 Harvester head structure and control - kaatopään rakenne ja ohjaus

Luvun alussa kerrotaan minkälaisista osista kaatopäät pääasiassa koostuvat ja miten niitä ohjataan, jotta saadaan haluttu liike aikaiseksi. Sen jälkeen tutustutaan ensimmäistä kaatopään tärkeimpiin toiminnallisiin yksiköihin ja niiden perustoimintaperiaatteisiin. Havainnollisuuden parantamiseksi on lisätty kuvia Ponsse H60, Timberjack 745 ja Keto 100 kaatopäistä. Kuvissa on numeroituna kaatopäiden eri osia ja kuvien alla on numeroiden selitykset. Luvun lopussa on esitelty toiminnallisten yksiköiden mahdolliset liikkeet ja havainnollistamiseksi on kuvailtu liikkeiden sarja puuta kaadettaessa ja prosessoitaessa.

Tämä luku siis kertoo mitä osia kaatopäissä on, mitä ne tekevät sekä miten niitä ohjataan.

3.4 Technical data - tekniset tiedot

Kyseisessä osiossa on taulukko, josta näkyy esimerkkinä olevien kaatopäiden fyysinen koko, isoin mahdollinen kaato- ja karsintaläpimitta ja muita teknisiä tietoja. Taulukko antaa perspektiiviä työssä esiintyviin kuviin sekä käsityksen siitä, mihin nämä kaatopäät pystyvät.

3.5 Opintomateriaalin luvut 5 - 10

Näissä luvuissa käydään hieman tarkemmin läpi mitta-, saha-, syöttö-, karsinta-, värimerkkaus- sekä kantokäsittelylaitteistoja sekä niiden merkittävät eroavaisuudet, jos niitä on, esimerkkinä olevien kaatopäiden osalta.

Suurimpia eroavaisuuksia Ponsse H60, Timberjack 745 ja Keto 100 kaatopäiden välillä on mittalaitteissa. Mittalaitteiden teoria on myös hieman monimutkaisempi ja vaikeammin löydettävissä manuaaleista kuin esimerkiksi karsintalaitteiston. Siksi mittalaitteita ja niiden toimintaperiaatteita on esitelty tarkoituksellisesti selvästi yksityiskohtaisemmin ja laajemmin kuin muita osia.

3.6 Daily tasks - päivittäiset toimet

Tässä osiossa on listattu perustoimet, jotka tulee tehdä päivittäin ja kuuluvat harvesterin kuljettajan rutiiniin. Lista on lyhyt ja helppo muistaa.

3.7 Tips about working methods - vihjeitä työskentelymenetelmistä

Tässä luvussa perehdytään kaatopään käyttämiseen työskennellessä. Koneella ajamiseen ja sen käyttämiseen ei puututa, vaan tekstissä pysytään lähinnä kaatopään käyttämisessä ja siihen liittyvissä asioissa.

Luvun alussa on esitetty näkökohtia siitä, mikä tekee työskentelystä tehokasta ja mitä pitää huomioida ennen puun kaatamista. Sen jälkeen on kuvailtu, kuinka puun kaataminen tapahtuu normaalissa tilanteessa. Lisäksi kuvaillaan toimintaa tietyissä erikoistilanteissa, kuten puun kaataminen pienten yksilöiden seasta, puun kaataminen rinteessä sekä ison puun kaataminen. Kaikkia mahdollisia erikoisia tilanteita ei ole käsitelty, sillä onhan jokainen metsä hieman erilainen ja mahdollisia vaikeuksia lukemattomia. Perimmäinen ajatus on kuitenkin se, että kaatopäällä pystyy tekemään mitä erilaisempia asioita, kunhan käyttää mielikuvitustaan ja tutustuu omaan työvälineeseensä kunnolla.

Seuraavaksi luvussa käydään lävitse puun prosessointi sen kaatamisen jälkeen käyden lävitse myös kaatopään rasiutusta vähentäviä työskentelymenetelmiä.

3.8 Safety instructions - turvallisuusohjeita

Kaatopäissä on valtavia voimia ja nopeasti liikkuvia teräviä osia. On ehdottoman tärkeää antaa opiskelijoille ohjeita turvallisesta koneen käytöstä ja turvallisuuden huomioon ottamisesta konetta huollettaessa. Ohjeet ja kiellot on myös tarpeen mukaan perusteltu, jotta ne jäisivät paremmin mieleen.

4. JATKOTOIMENPITEET

Tämä opintomateriaali tarjoaa perustietoa harvesterien kaatopäistä menemättä syvälle sähkötekniikkaan, hydraulikkaan, tiedonsiirtoon tai harvesterilla työskentelyyn. Jatkossa voisi ajatella tehtävän erillisiä opintomateriaaleja kyseisistä aiheista sekä suomeksi että englanniksi, mikäli niitä ei ole vielä olemassa. Opintomateriaalit voitaisiin jakaa opiskelijoille paperitulosteina tai tarvittaessa tehdä vaikka sähköinen opintomateriaalikonkaisuus linkittämällä sanoja toisiin opintomateriaaleihin.

5. LÄHTEET

Kurun metsäoppilaitoksen kotisivut; www.tpu.fi/kmo; 11.12.2004

5.1 Opintomateriaalin lähteet

1. Ponsse H60 owner's manual
2. Timberjack 745 operator's and maintenance manual
- 3: Keto 100 instructions for installation, use and maintenance
4. www.timberjack.fi (15.6.2004)
5. www.ponsse.fi (13.6.2004)
6. www.kone-ketonen.fi (11.6.2004)
7. Keto 100 spare parts catalogue

Pictures 1, 3, 4, 5, 6, 7 and 9: Mikko Heikkilä

Picture 8: Ponsse H60 owner's manual

Picture 2: Timberjack 745 operator's and maintenance manual

HARVESTER HEADS - Study material

CONTENTS

1. Introduction.....	3
2. Functions.....	4
2.1 Felling.....	4
2.2 Measurement.....	4
2.3 Delimiting.....	4
2.4 Cross cutting.....	4
2.5 Colour marking.....	5
2.6 Stump treatment.....	5
3. Harvester head structure and control.....	5
3.1 Main units of harvester head.....	6
4. Technical data.....	11
5. Measurement equipment.....	12
5.1 Ponsse H60, diameter.....	13
5.2 Timberjack 745, diameter.....	13
5.3 Keto 100, length.....	14
5.4 Keto 100, diameter.....	14
6. Saw equipment.....	14
7. Feeding equipment.....	15
8. Delimiting equipment.....	15
9. Colour marking equipment.....	16
10. Stump treatment equipment.....	16
11. Daily tasks.....	16
12. Tips about working methods.....	17
12.1 Felling stage.....	17
12.2 Delimiting and feeding.....	18
13. Safety instructions.....	18
13.1 Operating.....	18
13.2 Maintenance.....	19
14. Sources.....	20

HARVESTER HEADS

1. Introduction

There is a number of different forest-harvesting methods. The three most common forest-harvesting methods in the world are full tree, tree-length and cut-to-length method.

- 1) The full tree method means that the trees are felled and transported to roadside *without* delimiting, cross cutting and topping.
- 2) The tree-length method means that trees are felled, delimited and topped *before* transport to the roadside.
- 3) The cut-to-length method means that the trees are felled, delimited, cross cut and topped right at the stump area and then transported to the roadside.

In these methods the trees can be processed further at the roadside or transported to the mill as they are. Depending on the harvesting method the roadside processing can include for example delimiting, topping, debarking, chipping and cross cutting.

The felling can be done

- 1) manually, for example man with an axe or saw
- 2) motor-manually, man with a motorised hand tool
- 3) mechanised, for example harvester/feller-buncher etc. and a machine operator

Mechanised felling is a fast, safe and effective way to harvest wood. The machinery varies a lot throughout the world from small, self made and modified tractors to gigantic machines made for large timber. Some machines can do only the felling and some can do also the delimiting, measurement, cross cutting and a number of other functions. In cut-to-length method the mechanised felling is usually done with a single-grip harvester. The base machine can be on wheels or tracks and it is equipped with a crane. On the tip of the crane is a harvester head, which process the trees. This work provides information about single-grip harvester heads structure, safety issues and operating methods.

There is a lot of different single-grip harvester head manufacturers, for example Timberjack, Ponsse, Kone-Ketonen, LogSet, Lako and Valmet are quite well-known. They all have a large variety of different sized harvester head models. The smallest ones are suitable for early thinning and the biggest ones for regeneration harvesting.

Harvester head models presented in this study material are *Ponsse H60*, *Timberjack 745* and *Keto 100*. These are very common sized heads and they can be used for both thinning and regeneration harvesting in Finland. The Kuru college of Forestry has all these three models in use (year 2004).

2. Functions

Harvester head has several functions; harvester head does the felling, cross cutting, delimiting, measurement of diameter and length, colour marking and stump treatment. Using the crane it is also easy to cut logs into stacks and place branches and tops for example on the strip road to prevent machine sink on wet sites. All this can be done by processing a tree once. Stump treatment is done during the felling cut and after the felling cut the tree is fed to cross cutting lengths and cut to logs. Delimiting and measurement are done simultaneously during the feeding.

2.1 Felling

Felling is a very basic function of harvesters. Harvester head takes a grip of a tree and a saw cuts it. Felling can be aimed: tree falls to that direction where the head opens.

2.2 Measurement

Measurement is very important tool in modern tree harvesting. The computer calculates the volumes of the logs using diameter and length information collected with the sensors in the harvester head and stores the information. Storing the information is important for reasons listed below.

- 1) The forest owner and the harvester contractors can be paid according the harvester measurement.
- 2) Forest companies can get real time information about their forest storage levels and plan their future operations more accurately.
- 3) The computer can predict tree's shape using information from previous trees. This combined with accurate measurement makes it possible to get high level utilisation of stem and provide optimal dimensions of raw material for mills.
- 4) Measurement information makes it also possible to follow operators production levels.

2.3 Delimiting

There is many reasons why the branches are removed already in the forest. Branches take a lot of space on forwarders load space as well as in the landing area and log truck. Logs are ready for saw mills and pulp mills and no other delimiting machines or labour is needed.

2.4 Cross cutting

Trees are cut to pieces at the stump area. The computer suggests the lengths where the stem should be cut so that the saw-log portion as well as the pulp portion will be accurately utilised. Also raw material dimension needs of mills are taken into account in computers decisions. The operator can change the length if for example quality issues demand it. Pieces are easier to transport to the landing area on thinning sites

than whole stems because long stems have a big turning radius. The terrain and the shape of the site don't always allow to make straight strip roads.

2.5 Colour marking

In-cut-to length method it is possible that for example different dimension spruce logs are transported to several different saw mills, so they have to be in separate piles at the landing area. Also different assortments can look quite similar, for example small saw logs can look like pulp logs. Colour marking makes the sorting a lot easier for the forwarder operator and so decreases sorting errors significantly.

2.6 Stump treatment

In southern Finland there is some problems with a root rot fungus (*Heterobasidion parviporum*) in the Norway spruce. The fungus spreads to new spruce individuals via root connections, damaged branches, roots and trunk. Fresh Norway spruce stump is an ideal environment for this fungus. The fungus can live in a big stump for decades and contaminate the next spruce generation or spread to spruce near the stump. That is why thinning in spruce stands is usually made in a winter time when the soil is frozen. Frozen soil decreases damages in the root and because of this the risk in having a root rot decreases. Stumps can be treated with urea spray or Rotstop stump treatment liquid when doing felling in spruce stands in summertime. Urea spray prevents the root rot coming to the stump via fresh cutting surface. Rotstop has another fungus (*Phlebiopsis gigantea*) in it, which takes over the whole stump preventing also the root rot coming via roots. This another fungus is not dangerous to living trees, it can survive only in a dead tree. Once the root rot gets into a stump, nothing can make it go away; only fire can make the fungus weaker. Harvester heads can be equipped with stump treatment devices or it can also be done manually.

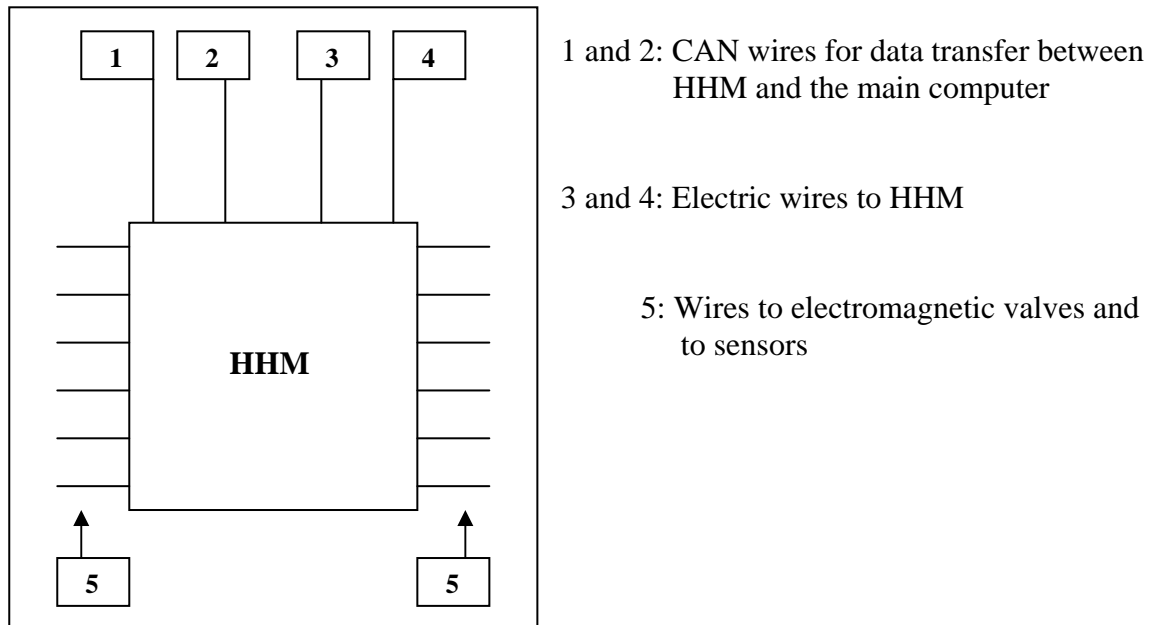
3. Harvester head structure and control

Harvester heads work with hydraulic pressure, which is created with hydraulic pump. Pumps again are powered by diesel engine. Hydraulic oil is led to the harvester head with hoses. Hydraulic cylinders, pumps, motors and valves as well as different sensors are the basic components of harvester heads.

The functions of modern harvester heads are controlled with computer units. When the machine operator uses the harvester head controls, the main computer sends data to another computer unit located in the head. Different manufacturers have different names for this unit, for example Timberjack uses name HHM (harvester head module). HHM analyses the received data and gives electricity to electromagnetic valve in the valve block. Valve block is the place where the valves are, it is under a cover in the back of the harvester head. Valve lets the hydraulic oil flow to wanted cylinder or motor.

HHM also sends data, for example from the sensors, to the main computer. The data transfer between HHM and the main computer is done with two CAN-wires

(Controller Area Network). So altogether there has to be only four wires between the base machine and HHM: plus and minus, usually 24 volts, for giving electricity to the valves and two CAN-wires. The CAN-system has decreased the amount of wires coming from the base machine to the harvester head; in the past there was coming electric wires for each valve in the head from the base machine.



Picture 1: Harvester head module connections

Picture 1 shows the basic connections of HHM, the number of wires to valves and sensors varies depending on the equipment and model of the head. Quite often there is also spare wires coming to HHM from the base machine in case one of them brakes.

3.1 Main units of harvester head

Rotator Between the crane and the harvester head is a rotator. It is used for rotating the harvester head to get a grip of the trees easily.

Tilt The tilt is the part in a harvester head which makes it possible to get the harvester head both vertical and horizontal position. The head is moved by hydraulic cylinders. This makes it possible to process standing trees as well as felled or fallen trees.

Feed rollers/feeding tracks

Feed rollers/feeding tracks have a rough surface and the stem moves in the head when they are rotating. Hydraulic motors are rotating

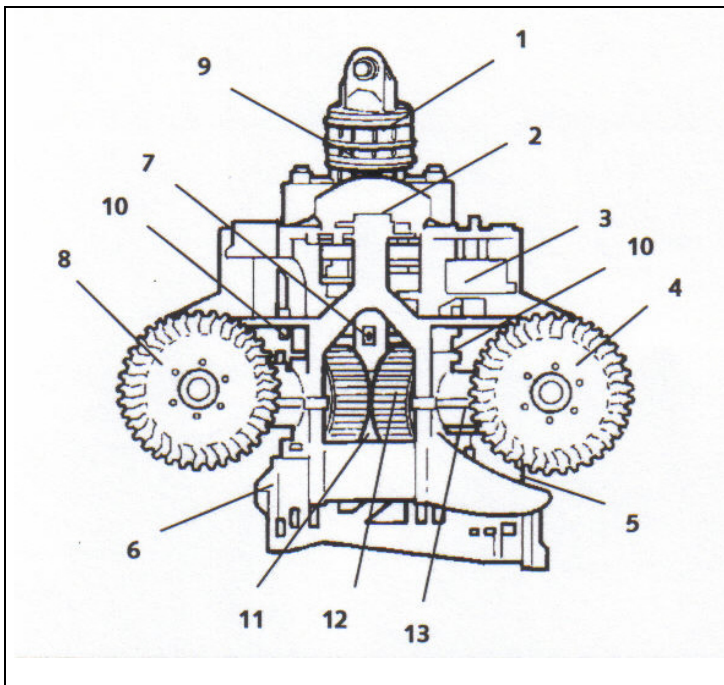
rollers/tracks. The arms of tracks/rollers are closed and opened with hydraulic cylinders. Stems can be fed to both directions.

Delimiting knives

Harvester heads have both fixed and moving delimiting knives. Fixed knife means that the blade can't be moved, it is attached to the harvester head frame. Moving knives are closed and opened with hydraulic cylinders. Knives slide on the surface of the tree when it is fed and lop off the branches.

Saw Saw chain is rotated with a hydraulic motor and the saw bar is moved by a hydraulic cylinder.

TIMBERJACK 745



Picture 2: Timberjack 745

- 1: Rotator
- 2: Fixed delimiting knife
- 3: Moving delimiting knife, left
- 4: Motor for left feeding roller
- 5: Saw guide bar and motor
- 6: Moving delimiting knife, lower (optional equipment)
- 7: Equipment for measuring of length
- 8: Motor for right feeding roller
- 9: Serial number
- 10: Two diameter sensors (on upper delimiting knives)
- 11: Valve block for harvester head control (not shown)
- 12: Upper feeding roller
- 13: Motor for left upper feeding roller

PONSSE H60

- 1: Rotator
- 2: Feeding rollers
- 3: Saw bar
- 4: Hydraulic motor for the saw
- 5: Moving delimiting knives
- 6: Delimiting knife cylinder
- 7: Fixed delimiting knife
- 8: Length measurement roller



Picture 3: Ponsse H60

Ponsse H60

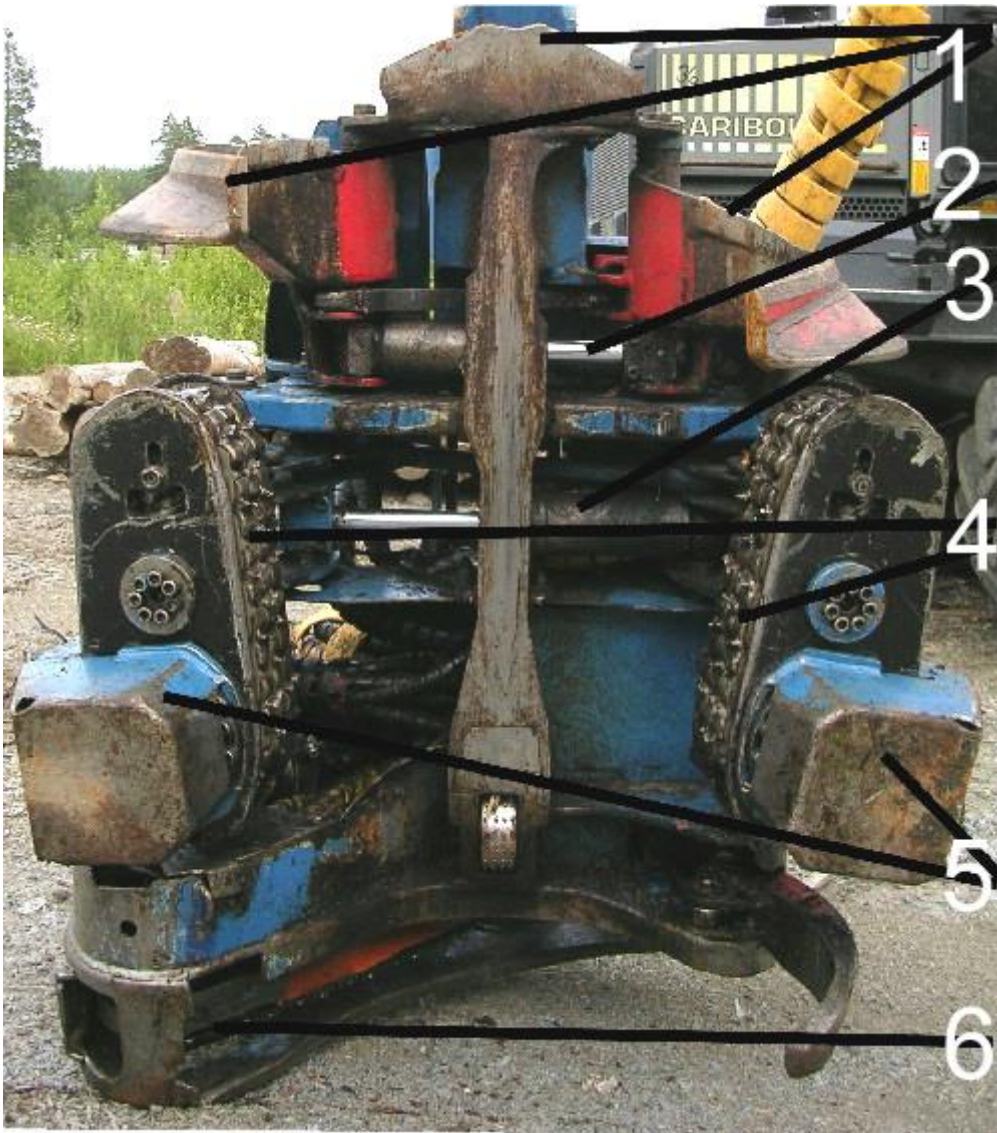
- 1: Filling hole for colour marking paint
- 2: Tilt cylinder
- 3: Hydraulic motor for feeding roller pair
- 4: Chain traction for upper feeding roller



Picture 4: Ponsse H60

Keto 100

- 1: Delimiting knives
- 2: Hydraulic cylinder for delimiting knives
- 3: Hydraulic cylinder for feeding tracks
- 4: Feeding tracks
- 5: Hydraulic motors for feeding tracks
- 6: Saw unit



Picture 5: Keto 100

The basic moves of a harvester head are:

- 1: Rotator: head rotation to left /right
- 2: Tilt: head up /head down
- 3: Knives: open /closed
- 4: Feed roller/track arms: open /closed
- 5: Feed rollers/tracks: feed backwards /forward
- 6: Saw: cut (running chain, saw bar out)

The normal chain of harvester head moves when processing a tree would be following:

Moving the head to the tree: tilt is up, knives and feed roller/track arms are open. The head is rotated to wanted position.

Grasping the tree, the tree is in the head opening: knives and feed roller/track arms are closed around the tree.

Felling the tree: saw cut, tilt down automatically after the cut. Changing the angle of felling while the tree is falling is possible by rotating the head (small trees).

Processing the tree: Feed forward and backwards to cutting lengths, saw cut. Rotator is used to get the logs fall nicely on stacks. When there is only the top left in the head the knives and arms are opened and the head tilted up back to the position in the beginning.

4. Technical data

Chart 1: Technical data

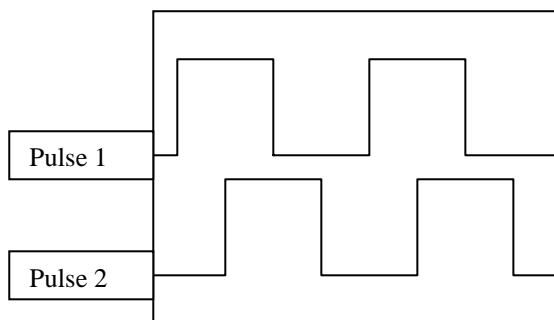
	PONSSE H60	TIMBERJACK 745	KETO 100
Weight (kg)	720	815	600
Width (mm)	1220	1280	1120
Height (mm)	1780	1400	1400
Power consumption (kW)	70-90	90-114	70
Operating pressure (Mpa)	20-24	24	21
Oil flow requirement (l/min)	200-300	250	190
Max. felling diameter (mm)	520	550	450
SAW UNIT			
Bar length (cm)	64 / 75, optional	64	46 (Keto 100LD: 56)
Cutting diameter (cm)	52 / 65	55	45
FEEDING UNIT			
Feed	4 spiked rollers or two tracks	Rollers, 2 moving and 2 fixed	Two tracks
Feed force (kN)	24	20	18
Feed speed (m/s)	0 - 4,5	0-5	0-3,8
DELIMBING UNIT			
Delimiting diameter, max (mm)	520 / 650	400 (maximum opening 560)	400

5. Measurement equipment

The diameter sensors are connected to the feeding track/roller arms or the delimiting knife arms. Sensors are usually resistors, which voltage resistance depends on how wide open the feeding tracks/ delimiting knives are. This kind of resistor is called potentiometer. Computer calculates the diameter from voltage; certain voltage equals certain diameter, if the calibration is done properly.

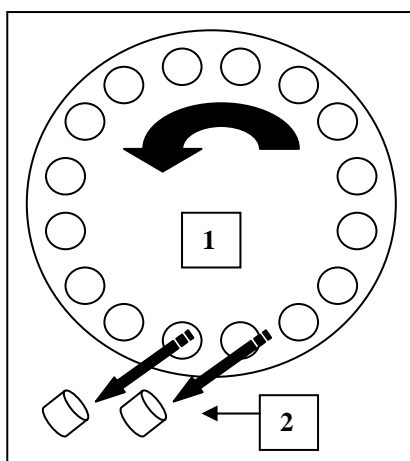
The length of the tree is measured usually with a pulse sensor. There is a measurement roller, which touches the tree. When the tree is moving in the harvester head, it makes the measurement roller roll. Every time the roller has moved for example one centimetre on the surface of the tree, it makes the pulse sensor to send an electrical pulse. In this case hundred pulses equals one metre. It is important to have firm grip of the stem so that the stem touches the measurement roller all the time.

The length measurement roller makes a disc go around in the measurement device. There are two sensors, which are measuring how much the disc moves. Sensors are positioned so that they send pulses in different phases. The computer knows feeding direction from which order the sensors are sending pulses.



Picture 6: Pulses are in different phases

Pulse sensors in Keto 100 and Timberjack 745 are optical sensors. On the other side of the disc is light emitting diodes (LED's) and on the other side are sensors. There is holes in the disc and that way the sensors can read the movement of the disc.

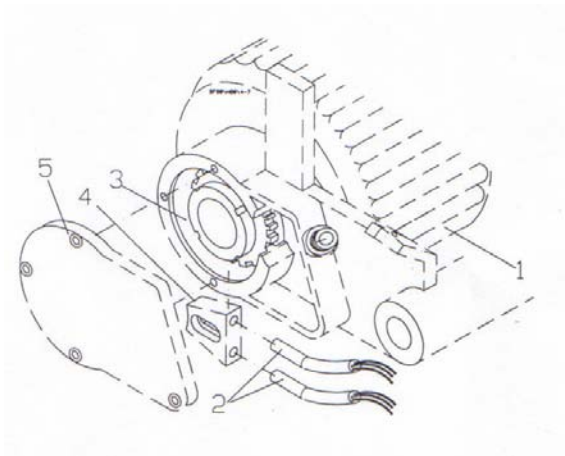


- 1: A disc with holes on the side
- 2: Optical sensors receiving light sent by light emitting diodes located on the other side of the disc

Picture 7: Optical pulse sensor

Ponsse H60 and Timberjack 745 heads have the measurement roller in the middle of the head opening. When processing big, heavy trees the stem can sometimes fall off from the measurement roller. If that would happen, the stem has to be fed back to the butt end reset the length measurement. Sometimes pieces of bark might get wrapped around the roller causing errors in measurement.

In Ponsse H60 harvester head the disc is like a toothed wheel. Sensors are inductive sensors, which sense the movement of the teeth. Inductive sensor means that it detects metal when it is near enough.



- 1: Measurement roller
- 2: Sensors
- 3: Measurement roller housing
- 4: Sensor fastener
- 5: Cover

Picture 7: Ponsse H60, length measurement device

5.1 Ponsse H60, diameter

The diameter sensor is mounted on the side of the reaction bar. There is a chain attached to the sensor, the other end of the chain is attached to the harvester head frame. When feeding track arms open, the chain pulls the sensor and the voltage resistance changes.

Weather conditions can influence the accuracy; feed roller spikes go deeper to unfrozen wood than frozen wood. So the measurement has to be corrected upwards if the temperature rises in the winter and the wood melts and again downwards when it gets frozen.

Also worn feed rollers spikes may cause errors in the diameter measurement. Worn feed rollers should be replaced when the diameter is less than 157 mm measured at the middle of the roller.

5.2 Timberjack 745, diameter

The diameter sensors of Timberjack 745 are mounted on the upper delimiting knives. Weather conditions are not such an issue as regards to accuracy, but the knives has to be sharp so they will stay firmly at the surface of the trunk when delimiting. Wrong angle in knives blades can cause debarking and so decrease the diameter measurement accuracy.

5.3 Keto 100, length

Length measurement is done with pulse sensor located in feeding track. Some heads have sensors in both tracks (sensor A and sensor B), some just in another feeding track. In Keto 100 heads with two sensors it is possible to switch the B sensor off and use only A sensor in case the B sensor would brake down. If the stem for some reason doesn't move through the head when the tracks are moving, there will be errors in measurement. It is good thing to help the feeding by moving the harvester head to the feeding direction if the tree is big and branches thick. If the tracks would slip, the stem has be fed backwards to butt end and reset the measurement.

Kone-Ketonen Oy has made before also Keto 100 equipped with similar measurement roller systems than Ponsse and Timberjack. Nowadays they make only models which measure the length from feeding tracks.

5.4 Keto 100, diameter

Keto 100 measures the diameter according the opening of the feeding tracks. The difference to Ponsse H60 is that Keto 100 uses pulse sensor instead of potentiometers. That is why the computer may tell you to close the grab after you have started the machine. This way the computer calibrates the minimum pulse level. There is possibility that the computer tells you to both close and open the grab to calibrate both minimum and maximum opening pulse levels, it depends on what kind of program the computer is using. Keto 100 has a pulse sensor mounted only in the other feeding track arm.

6. Saw equipment

The saw chain is powered by hydraulic motor. The chain speed is about 40 m/s (140km/h). Because of saw chains high speed the chain and the tip sprocket of the saw guide bar needs constant lubrication. The lubrication system consists of the chain oil tank and pump, the tank is located in the frame. The pump pushes oil out when the saw bar comes out of the casing. The oil goes to the saw bar and lubricates the chain and the tip sprocket. One should always check that the lubrication system works properly in the beginning of a new shift, without oil the tip sprocket will brake down. If you are changing a new chain to the saw, remember to retighten the chain after a while, unless the saw unit is equipped with automatic chain tensioner.

There is an inductive sensor in saw casing to make sure that the saw bar is in the casing. When the saw bar is out the feeding forward doesn't work because the saw bar would brake if a stem would be fed against it.



Picture 8: Saw cylinder on the right side of the orange saw bar

7. Feeding equipment

There are some differences between feed rollers and feeding tracks: feeding tracks are more gentle for the surface of the wood, so they are better if the surface wood is really valuable. Feed rollers again are more long-lasting and cheaper to maintain.

Ponsse H60 has two double feed rollers, but they can be replaced with feeding tracks. Timberjack 745 has four feed rollers, two moving rollers and two at the bottom of the head opening. Rollers are all in separate places, so there are no possibilities for feeding tracks. Keto 100 has two feeding tracks in it, no options for feed rollers.

8. Delimiting equipment

Delimiting is done with sharp knives, which slide on the surface of the stem and cut off the branches. The amount of the knives varies; there is one or two fixed knives and 2-5 hydraulically controlled knives. These 2-5 moving knives are pressed against the trunk by hydraulic cylinders.

The Keto 100 and Ponsse H60 harvester heads both have one fixed and two moving knives. Timberjack 745 has two fixed knives and three moving knives. The number of knives is not necessarily always the same in the same model; there might be variations for example in different countries they are sold to. Also certain tree species are easier to process with only having the upper knives in the harvester head, that way curved and bent stems go easier through the head.

9. Colour marking equipment

The paint tanks are placed in harvester heads tilt frame. Depending on the manufacturer and manufacturing year the tanks can be pressurised by the base machines own pressured air system or hydraulic pumps. The paint is led to nozzles, which are located in the bottom of the harvester head, often in lower delimiting knives or saw casing. Nozzles spray paint stripes to the logs when they fall down after cross cutting. There is usually at least two different colours so it is possible to have different colour combinations for different logs. For example red and blue colour combinations could be red, red-blue and blue. There is also possibility to do colour marking through saw bar, this method is used seldom and it requires a special saw bar made for spraying stump treatment liquid.

The direction of the nozzles and the spray timing can be adjusted. It is important that the spray hits also the smaller logs. One of the most common faults in the colour marking system is that the nozzles are too dirty. It is very important to make sure that no litter or anything else extra goes to the paint tank.

10. Stump treatment equipment

Stump treatment tank is placed in the base machine. The tank is pressurised by pumps and the stump treatment liquid is led to the saw bar. The saw bar has to be specially made for stump treatment; there is holes at side of the stump treatment saw bar where the liquid comes out during the felling cut. In minimum 85 per cent of the trees cutting surface should be covered with the liquid to make sure the root rot can't get to the stump. Use only clean water when making the liquid to keep the equipment clean and in working condition.

11. Daily tasks

Greasing should be done every day. It is easier to do when the machine is still warm. Store the grease somewhere warm in the winter, it will come easier out from the grease gun. Force grease in until you see grease coming out. Almost every moving part and joint has a grease nipple.

Fill up the colour, diesel and chain oil tanks after every shift, so the machine is always ready for the next operator.

Make a visual check for example oil leaks and cracks in the crane and harvester head.

Before starting your shift check the saw bar and chain for sharpness, tightness, damages and fastening. Check that the saw lubrication works before starting to work. Check also the motor oil, hydraulic oil and coolant levels.

Make control measurements every day to ensure the measurement accuracy.

12. Tips about working methods

There is a lot of different factors that makes operating a harvester effective:

- The more you do felling, delimiting and crosscutting instead of moving the crane or machine unnecessarily, the more efficient your work is.
- Using different crane and harvester head functions simultaneously and smoothly saves a lot of time.
- Keep your machine in good condition. Repair faults right away before they cause more damage to other parts.

12.1 Felling stage

There is several things to take notice during the felling stage. The stump height should be as small as possible; high stumps are a waste of wood and can make forwarding a lot more difficult, especially on soft ground if forwarders wheels sink (less space under the machine). Other trees should stay undamaged (thinning, cutting site border) as well as the harvester head, too. One should also think about the following steps as delimiting and stacking.

First the felling direction has to be decided so that it is easy to delimit the tree and stack the pulpwood and logs separately. In windy conditions take notice of the wind direction and also the lean of the tree. If the tree is big, first drive the machine as close as possible. Then move the harvester head firmly at the tree. Lower the head on right cutting height and close the harvester head. The cutting height can still be adjusted when the head is closed by using the feeding up or down. If the tree is big, the inner boom can be raised a bit to make sure the tree is going to fall at the right direction; otherwise do not move the harvester crane during felling. Then saw a felling cut through the tree; if the cut is not done all the way, the lower part of the tree is going to break off and split. Do not saw so long that the saw bar would come all the way out to the other side of the tree, otherwise the saw bar can get stuck behind the stump and get damaged. Wait until the saw is back in the cover and then remove the tree from the stump.

If there is a lot of brush growing next to the tree you are about to fell, you can keep the head open and use the saw for cutting the brush down. If there is two trees growing side by side it is hard to get the head closed around either one. In this case you can close only the knives around the tree and cut it, knives will surely fit between the trees. If the tree is small you can also keep the tilt up - button down during the felling cut, the head will stay up and you can bring the tree in the head near your stack and tilt the head down to chosen direction. That is handy especially on thinning sites.

Keeping the stump height low can be tricky on slopes; If the harvester head is on lower ground side of the tree there is a risk to hit the ground with the saw bar. If the head is on the higher ground side, the stump would stay very high but the saw bar surely doesn't hit the ground. There is a big advantage in felling the tree uphill; feeding and delimiting are easier and less stressing for the harvester head especially if

the tree is heavy, because the gravity helps the tree come downhill. So trees are better to fell uphill if possible, the felling cut just has to be done carefully.

Big trees tend to have large buttresses, which makes it harder to leave low stumps because the saw bar does not reach through the whole tree. To avoid high stumps the felling can be done in two stages; first a directional cut and then the final felling cut. The directional cut is made on that side of the tree where you want it to fall. Directional cut should be about 1/3 of the diameter. Then rotate the head to the other side of the tree so that the saw bar will meet the whole directional cut line when doing the felling cut. Make the felling cut slightly above the directional cut.

12.2 Delimiting and feeding

You can start to feed the tree when it is still falling, the stem goes easily through the head using its own weight. Try to keep the harvester head quite close to the ground while processing a stem. If the stem is very big and the branches are thick, you can help the feeding and delimiting process by moving the head to the feeding direction. It is possible also program an overshoot to the computer, which means that the computer feeds the stem first over the cutting length and then backs it up; it is easier to start feeding again because the first part of next log is already partially delimited.

If the stem is curved, bent or growing thick branches, it might not go easily through the head. Then it is good to feed first slightly backwards, then again forward and just before the problem area open the knives a little. Usually it goes nicely over the problem area. If those thick branches are still in place, feed backwards again and they should fall down.

13. Safety instructions

Harvester heads have several features which can cause severe injuries: chemicals, oils, high hydraulic pressure, powerful movements of sharp objects and possibility of flying wood or metal pieces. It is very important to work with caution. Do not operate any machines under influence of drugs or alcohol. Never let untrained persons operate the machine.

13.1 Operating

Always check the harvester for faults before starting to work and make sure there is no-one near the machine. Check especially the saw chain and the guide bar. Don't operate the machine if you notice any parts broken or other faults.

Make sure when sawing that the saw line is not pointing to the cabin or other people; in case of it breaks and flies off it can cause lethal injuries. If there is anyone at sight make sure that the saw line is not pointing at that direction either. Minimum safety distance from harvester is 70 meters and from forwarder 50 meters. It is possible to have a chain reaction if a tree is felled on other tree, this other tree can fall again on

standing tree etc. If someone comes inside the safety area the machine has to be stopped right away.

Don't use feeding if the bottom of the trunk is pointing straight to the cabin. Feeding speed is usually about 5 m/s (20 km/h), so the trunk can make damage to the cabin or even come in from the window.

Use common sense when felling. Don't try to fell trees too big or do any manoeuvres not familiar to you. If you haven't used the machine before, start with smaller trees at first. Check the maximum felling diameter of the harvester head you are using. Make sure that you make the felling cut right through the tree. Never leave a tree standing, which has been partially sawed through; it could fall later on to someone. If the machine should break down during the felling cut and the tree stays standing, make the repair work at least two tree lengths away from the partially cut tree.

Keep a proper working distance from the electric lines. Leave at least 5 metres safety distance to electric lines, operate with extreme caution. If an accident occurs, move the crane and the harvester away. If that is not possible, do not leave the cabin. If you must leave the harvester, do not touch the harvester and the ground at the same time. Hop away from the area with your feet together.

When you are going to leave the harvester you should leave the harvester head to the ground. Always stop the engine and switch the main power off.

13.2 Maintenance

Always use proper gloves and safety goggles when you are doing maintenance work.

One should never do any harvester head maintenance while the engine is running. Machine can have different malfunctions and do unexpected moves. If you have a working partner you should either inform him that you are doing harvester head maintenance or you can keep the machine keys in your pocket so that your partner will not start the engine for example to move the machine. When the engine is started the harvester head can close or move and grasp with fatal force. Don't stand near the harvester head when the engine is running.

Don't do any maintenance work that you don't have the skill, proper tools or spare parts for.

Do not open any of the hydraulic components if they contain pressure. If any oil or other chemicals get on your skin, wash it off as soon as possible. Remember that hot oils and liquids can cause severe burn injuries.

The oils and the chemicals are considered as problem waste; store them for disposal, do not let them to the ground.

14. Sources

1. Ponsse H60 owner's manual
2. Timberjack 745 operator's and maintenance manual
- 3: Keto 100 instructions for installation, use and maintenance
4. www.timberjack.fi (15.6.2004)
5. www.ponsse.fi (13.6.2004)
6. www.kone-ketonen.fi (11.6.2004)
7. Keto 100 spare parts catalogue

Pictures 1, 3, 4, 5, 6, 7 and 9: Mikko Heikkilä

Picture 8: Ponsse H60 owner's manual

Picture 2: Timberjack 745 operator's and maintenance manual