Sawmilling and Sawing Process in the Future

A. Usenius[1], P. Holmila[2], A. Heikkilä[3] & T. Usenius[4]

Abstract

Major part of present sawmills are volume, high speed and bulk product oriented. Normally the focus is minimisation of costs – not maximising profit. Production typically yields also so called "falling" products which are not desired and may cause big economical losses. At present sawmills it is not possible to manufacture products with specific properties according to the customers specific needs. Profitability of conventional sawmill business is very sensitive to economic fluctuations.

New business concepts and processes for sawmill industry are needed in order to improve radically value yield through increased customer orientation and satisfaction. Only very few small mills can manufacture special wooden components according to the actual needs of customers. Future sawmill business has to support also sustainable development.

VTT Technical Research Centre of Finland is realising several projects mapping future production and business concepts for sawmills. This paper presents results and ideas in the field COST Action 53 from the research point of view and from industrial point of view. The focus is how the future scanning, sorting and grading of wood raw materials, semi finished and finished products supports optimisation of conversion chains from the forest to the final products in order to

- convert non-homogenous wood raw material to the products with defined properties with maximum yield and minimum waste
- shift from bulk products towards value added products
- improve flexibility of manufacturing systems
- make business and processing adaptive

The investigations clearly show that it is possible to increase considerably sales value and profit of the conversion by implementing new concepts and technologies in the production.

---

[1]Professor, VTT Technical Research Centre of Finland, Arto.Usenius@vtt.fi
[2]Manager, UPM Kymmene Finland, Pertti.Holmila@upm.fi
[3]Research Scientist, VTT Technical Research Centre of Finland, Antti.Heikkila@vtt.fi
[4]System Designer, VTT Technical Research Centre of Finland, Timo.Usenius@vtt.fi

1 Introduction

Sawmill industries are very important in many countries. Sawmills are utilising forest recourses by producing sawn timber to be used in construction, manufacturing of furniture, windows and doors industry etc. Sawmills are also supplying pulp mills chips. Typical production and business features of sawmills are following.

1. Conversion from the forest to the customer is not considered as an unbroken chain. Delivery and processing time may require weeks or months.
2. Volumes and cost minimisation is emphasized in production.
3. Production is not flexible allowing only marginal freedom. Production and business are not adaptive. Feed back information is not generated and cannot be utilised.
4. Limited volume of reliable and less reliable data is measured, however only locally used.
5. Product properties vary considerably due to the inhomogeneous wood raw material. It is not possible to produce special products with desired, specified properties. Products which are not desired fall in the manufacturing processes.

In the present sawmills it is not easy to produce products with specific properties. Big problem is also so called "falling" products which may cause considerable economical losses. Modern and future scanning technologies provide efficient tools to handle and reduce radically these problems. They are very important for improving value yield and developing customer orientated sawmilling business.

Essential elements of the new business and production system concepts are:

1. Sawmills are moving forward in value chain by manufacturing more value added components.
2. Control and optimisation of information and material flows in planning and production systems.
3. Integrated information systems covering entire conversion and supply chains.
4. Intelligent, flexible and self learning scanning, production and logistic systems.
5. Creation and utilization of the feed back information in order to make manufacturing adaptive.
6. Optimised mechanics and conveyer systems for production concepts and cells.

2 Global view instead of local view

The utilization of wood raw material resources starts with the supply of raw material, including the bucking of sawlog stems, and proceeds via the manufacture of sawn timber and its further conversion into final products and their end uses. Traditionally different stages of the wood conversion chain have operated too much independently. In the conversion chain the product of the former phase provides raw material for the latter one. Raw material and semi-finished products are not optimal or even good in respect to the final product. The incompatibility between wood raw material, conversion products and the final product causes a lot of waste and considerable economic losses.

The stages involved in converting wood raw material to final products influence on each other as well as the result. To obtain a good economic result the chain must be seen in its entirety. Wood raw material have to be chosen taking into account the requirements of the final products. This is the only way for optimal utilization of wood raw material. The material flow proceeds from the forest to the customers. The information flows in the same direction but should also take the reverse course (Figure 1).

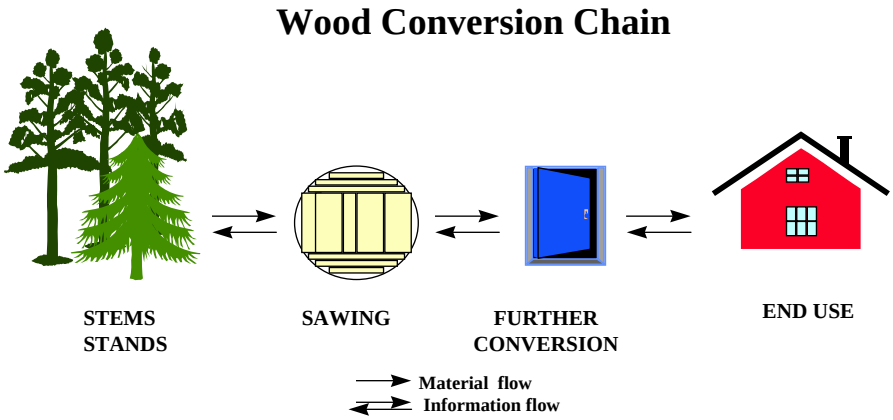

Figure 1: The phases in wood conversion chain are interacting to achieve maximum profitability

3 Value added components and upgrading of sawn timber into components with flexible and adaptive manufacturing systems for sawmills.

Present production systems are effective, however bulk product orientated. They are not flexible and production of components with specified quality features and properties is not possible.

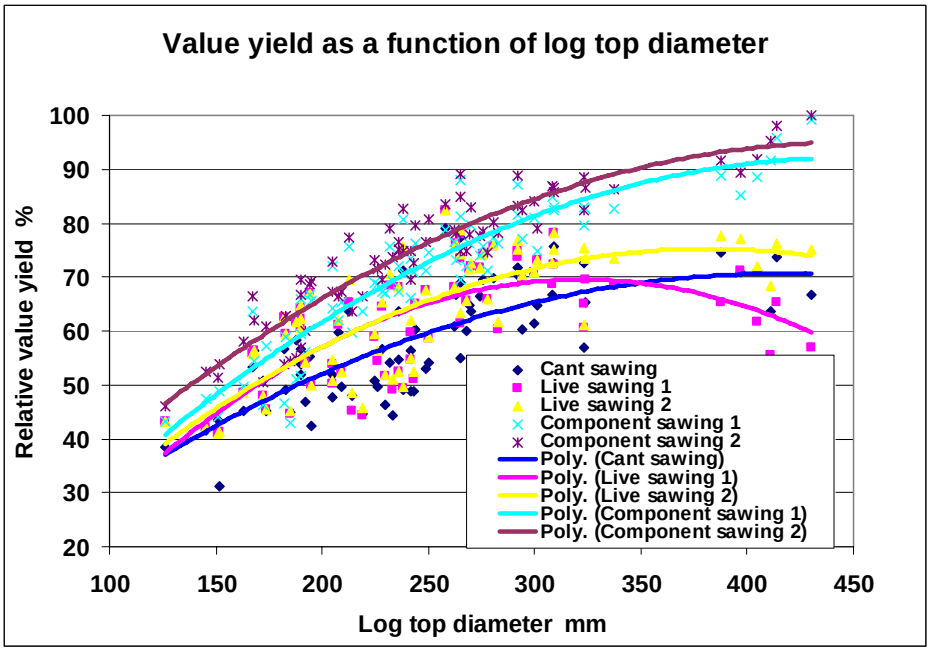

Figure 2: Comparison of cant sawing, live sawing. and component sawing methods. Best value yield is achieved by using component sawing method.

Producing value added components – smaller pieces with specific dimensions and quality features – instead of standard products offers sawmills big potential to improve profitability of sawn timber business. Production of components can be started directly from the logs. The option is also that sawmill process is provided with machine vision system and smart decision making system for grading and selecting sawn timber pieces into different classes. One class is converted in traditional way into normal sawn timber. This situation concerns high quality sawn timber. Low quality sawn timber pieces are converted into smaller pieces – value added components with high price. Further processing may consist of cross-cutting, ribbing and edging phases.

Figure 2 shows that sawing of components may yield 20…30 more value compared to the sawing of standard sawn timber products. It is also necessary to saw several sawn timber bars to be cross cut from individual flitches.

4 Cross cutting of stems and sawing methods

Cross cutting of stems is very important part of wood raw material processing. The maximum value and volume yield is determined in bucking of stems. In later phases in conversion it is not possible to compensate the faults made in cross cutting of stems. Modern harvesters are very sophisticated and effective. However they are operating in circumstances where precise measurements of stem properties are impossible.

Best bucking and cross cutting result can be achieved when the stems or part of stems are transported to cross cutting station. In the station stems can be measured very accurately using different scanning methods i.e. x-ray scanning. Scanning and information processing provides the model of the stem. Sophisticated software can calculate optimised bucking result for the stem based on sawn timber order file. This method is very interesting especially for high quality raw material.

Sawing method is also affecting considerable on the yield in sawmilling. Figure 2 shows that live sawing method produces more value than conventional cant sawing method. This is because of increased flexibility. The economical impact is increased by decreased top diameter of the log.

5 Information systems and intelligent material flow control

Figure 3 presents in principle the amount of information in different stages of the forest - wood chain. Measurements and observations throughout the chain produce data and information. In individual stages information is growing rapidly. This information is, however, used only locally. After the wood material has left the processing phase, almost all specific information has been lost. This happens all the way throughout the supply chain. It is not possible to link final products, raw materials and processing parameters together. The picture also shows an accumulated curve assuming that all the information from previous phases would be available in the later phases. If the lost information could be regained, much more effective business could be realised. Information "recovery" can be achieved through marking pieces, reading of the markings and storing the corresponding data in a database.

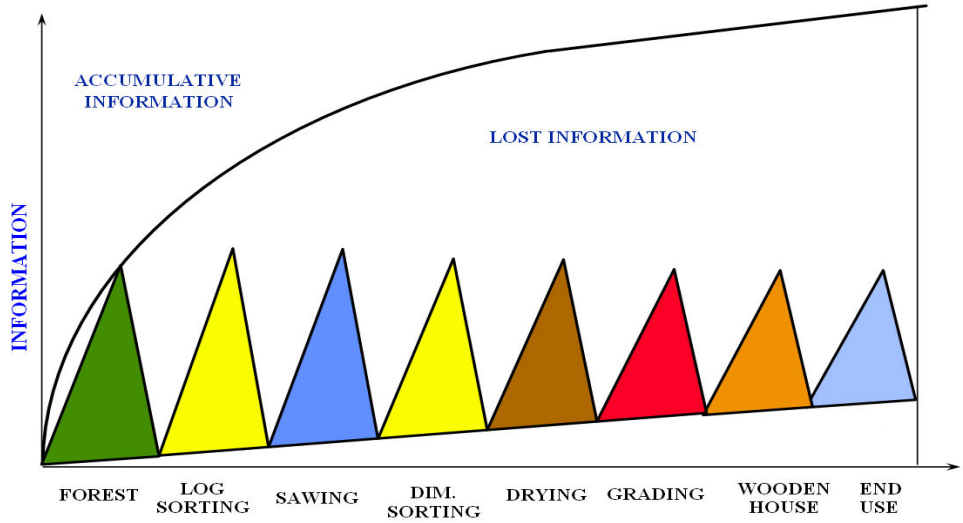

Figure 3: Recorded and lost information can be recovered through marking / reading pieces and advanced data processing.

Information system for an advanced control of forest - wood chain through marking pieces, reading the markings and data processing establishes a strong opportunity to make better business (Figure 4). Marking of pieces can be done using different techniques i.e. RF-tags and ink jet markings. Reading of marking can be done using antennas or cameras.

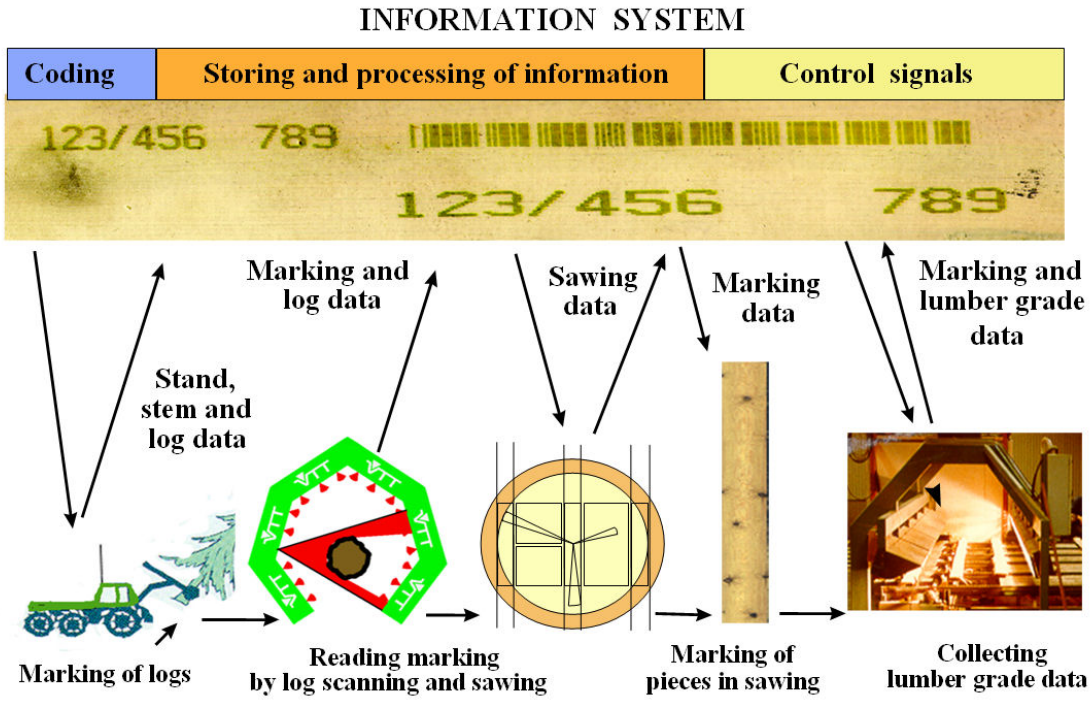

Figure 4: Marking of logs and sawn timber pieces in different production phases

.

Marking - reading – information (MRI) system applications concern quality control, process control, planning procedures and customer service. Marking of pieces is also a way to show the origin of pieces and can be for instance used to ensure that the material originates from a certified source. MRI provides a quite new approach for the management of material and information flows from forest to the end products supporting customer oriented business and added value production.

Information system is covering whole chain –from the forest to the end products. Integration of data throughout whole conversion chain can be done by marking wood raw material, logs, in the forest and storing data into information system. Marking can be i.e. electronic tag which provides address in the information system. When a piece is passing a process phase the tag is read and the measured data stored into the information system. The linked data and information is available for planning systems and process control ensuring precise management of business processes.

6 Scanning of internal properties of stems and logs for characterisation wood raw material and for optimisation of sawing operations.

Log scanner systems for measuring shape and internal properties of logs can be used in the following processes:

- Log sorting station - optimisation of borders of log classes based on order files
- Bucking and cross cutting terminal - optimisation of cross-cutting of stems and sorting of logs
- Just before sawing - optimisation of log rotation angle and sawing set up for individual logs
- Harvesting machines - optimisation of cross-cutting of stems

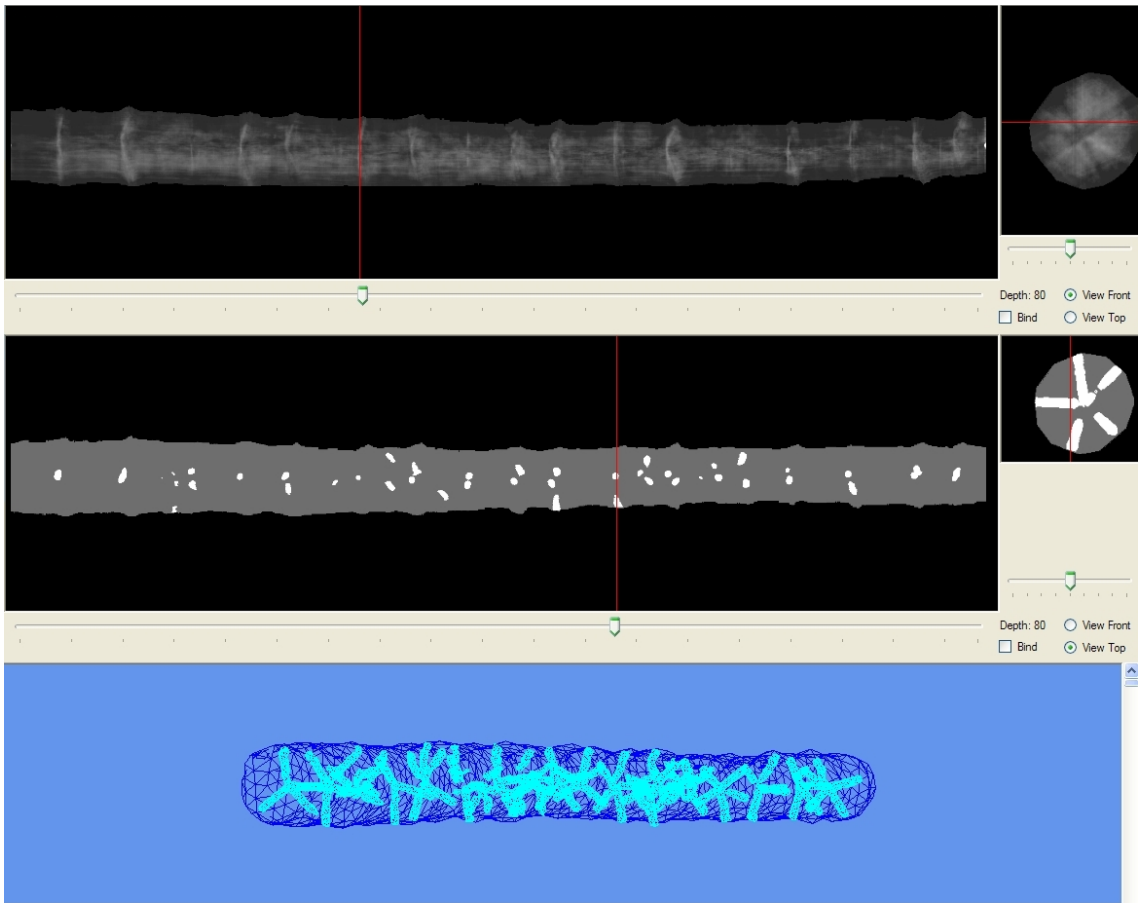

Figure 5: 2D X-ray picture of a log

The purpose of X-ray inspection system (Figure 5) is to show the accurate position of internal wood properties and defects, knots and heartwood / sapwood areas. It can also detect defects, which are not visible on any surfaces of wood. X-ray system can be used at inspecting boards, planks and logs depending on the configuration of the system. The analysis software is tailored

to meet application requirements. Typical functions can include measuring of dimensions/volume, moisture content, detection of knots, rot and other defects and heartwood/sapwood ratio. Big variations in moisture content and density profiles may difficult the detection accuracy and has to be taken account for when suitable X-ray systems is to be chosen. It is not necessary easy to detect the border between living and dead parts of the knots. This needs also to be taken account when designing optimization software which uses the inside log information.

Scanners can be implemented at log sorting station, cross cutting terminals for stems and also just before sawing machines.

7 Measuring systems for characterisation and grading of sawn timber as well as supporting secondary conversion

Multisensor scanning systems are provided with several sensors like RGB-camera, IR-camera, microwave detector, ultrasound detector, x-ray camera etc. in order to detect all wood properties of interest (Figure 6). Data fusion – combining information from different sensors together ensures high resolution detection and identification result. System configuration is depending on the type of wood raw material and products and the size of the mill.

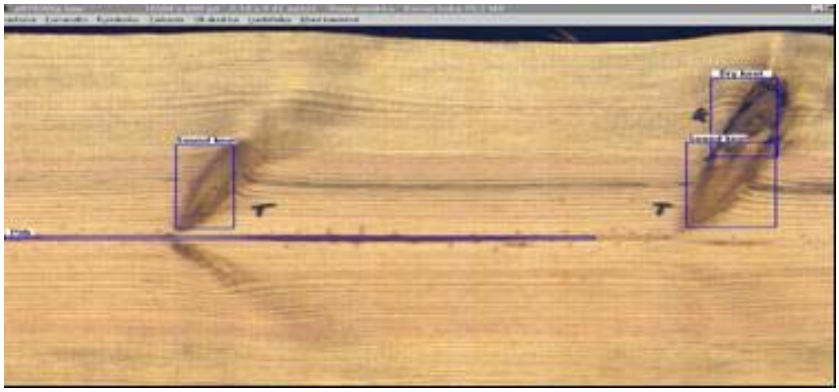

Figure 6: Image analyses provides 2D or 3D map of wood properties for grading and optimisation of secondary conversion options.

Scanner based grading provides precise map of wood properties on four faces of entire piece. Grading can be based on precisely defined customers specifications. However conventional grading can be realised with high accuracy. Map of wood defects provides possibility to convert original sawn timber piece efficiency into smaller components in secondary conversion phase. Information produced by the scanners can be stored into companies database and used in management of business processes and process control systems.

8 Development trends in the sawmilling industry

Pertti Holmila who has been in leading positions in Finnish sawmill industry has presented some trends in the sawmilling in the Table 1. His perspective is starting from seventies and looking forward to 2020.

Table 1. Recent and future trends in the sawmilling.

Process	1970	2000	2020
Log Sorting	Shadow measuring 20 sorting bins	Speed 13 000 pcs/8 h 3D-scanning 40 or more sorting bins	Speed 15 000 pcs/8 h 3D + X-ray scanning Better measuring of logs –> better control of final products Increased number of bins Bucking also at cross cutting terminals
Sawing	Frame sawing Cant sawing Manually controlled edging of sideboards	Circular and band sawing Cant sawing Automatic edging	Circular and band sawing Cant and live sawing Sophisticated edging Better guide systems for blades Higher sawing speed
Green sorting	Automatic dimension sorting into bins	Automatic dimension and grade sorting, more bins	More precise grade sorting, more bins and higher speed Real time measure control
Drying	Compartment and progressive kilns	Increased number of progressive kilns	Intensifying of present drying methods
Final sorting	Manual sorting Limited number of grades, no customer grades, length sorting at separate plant	Automatic sorting	Self learning sorting automats. Knots could be scanned at green sorting and knot information could be used at final sorting by using marking of sawn timber pieces. Final sorting can also be carried out at green sorting