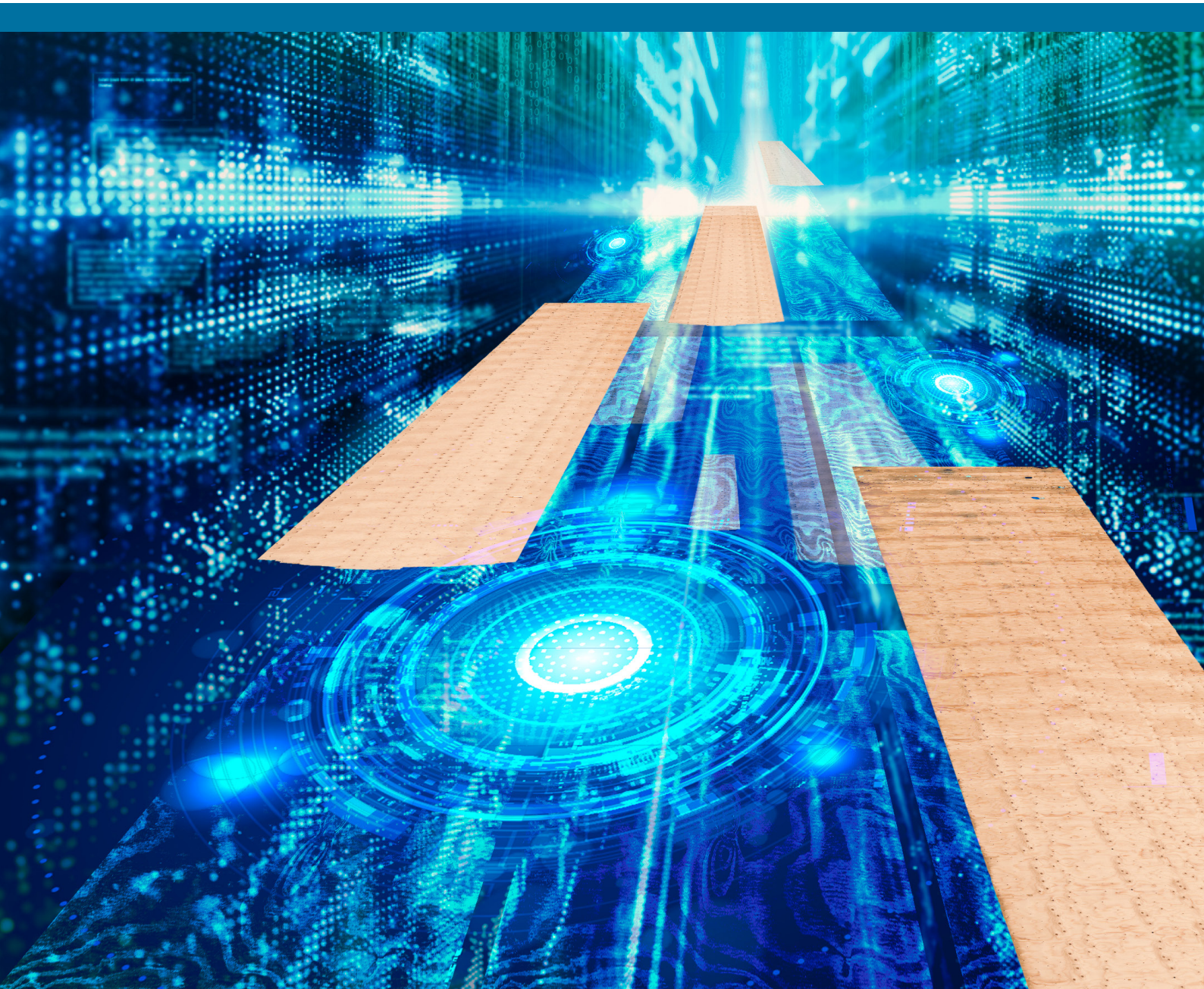
RAUTE

RAUTE WHITEPAPER

DATA-DRIVEN VENEER, PLYWOOD AND LVL PRODUCTION – IMPROVING THE PRODUCTION THROUGH INTELLIGENCE



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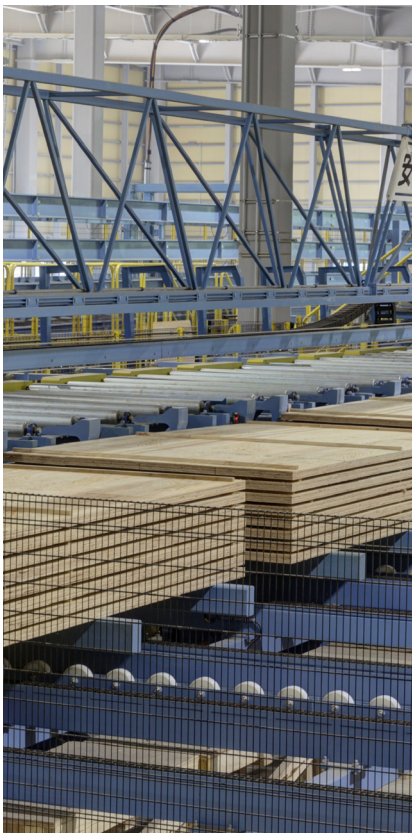
INTRODUCTION

In recent years, a “Smart Mill” or a “Modern Mill” have been concepts that have been looking into the future of the production of different wood-based products. This idea has evolved in veneer, plywood, and LVL manufacturing as experts have discovered using various software-based add-ons to improve profitability.

The knowledge gathering in the production environment has changed from a conventional basis to a more advanced process due to the evolution in technology. It has introduced new opportunities to accelerate data collecting, improve data accuracy, and deliver the data in a more appropriate format for production and process development.

In this educational whitepaper, the main topics are data-driven veneer, plywood, and LVL production. This paper discusses how intelligence can improve production, what the transition from manual work to more automated work requires, and what effects it has on production. This paper introduces what the key points in veneer, plywood, and LVL production are, and what to investigate when considering updating the production machinery. In this whitepaper, the whole production process from veneer production to finalized product is covered, with a discussion about data collection in the veneer business.



INTELLIGENT VENEER, PLYWOOD, AND LVL PRODUCTION

Intelligence and data-driven work have become more and more common in the manufacturing industry. Various tools, software, indicators, and sensors have found their way into traditional production facilities, making them appear as modern production facilities. This is a trend that is seen to continue in the future and even faster as it has been till this day.

In the veneer, plywood, and LVL production industry, data-driven manufacturing has also been shown to be an efficient and more profitable way to do business. The more data from the production is available, the more it can be analyzed, and different production variations can be tried in search of the most optimal production conditions, for example. Later, in this whitepaper, the opportunities for data-driven production modernizations will be discussed more in depth.

CONTINUOUS GRADING IN THE CORE OF THE PRODUCTION

In the grading process, veneer sheets are analyzed and graded based on their characteristics. Grading refers to the continuous evaluation of the sheets and raw material throughout the whole veneer production. This can be done by relying on human-based observation (touch, visual, and different measurement tools), or by an automated process with different kinds of intelligent analyzers. The latter is the focus of this paper.

Grading is one of the most crucial phases of veneer, plywood, and LVL production. Grading determines which quality grade sheets can be produced, how many, and, in the end, how much profit can be generated from the raw material.

Later, in this paper, the different grading methods, tools, hardware, and software will be discussed in depth. Various analyzers can be installed and utilized in almost every stage of production.

The equipment and benefits of analyzers that can be installed in the following production lines will be introduced: peeling, drying, patching, composing, scarf-jointing, lay-up, and panel repairing.

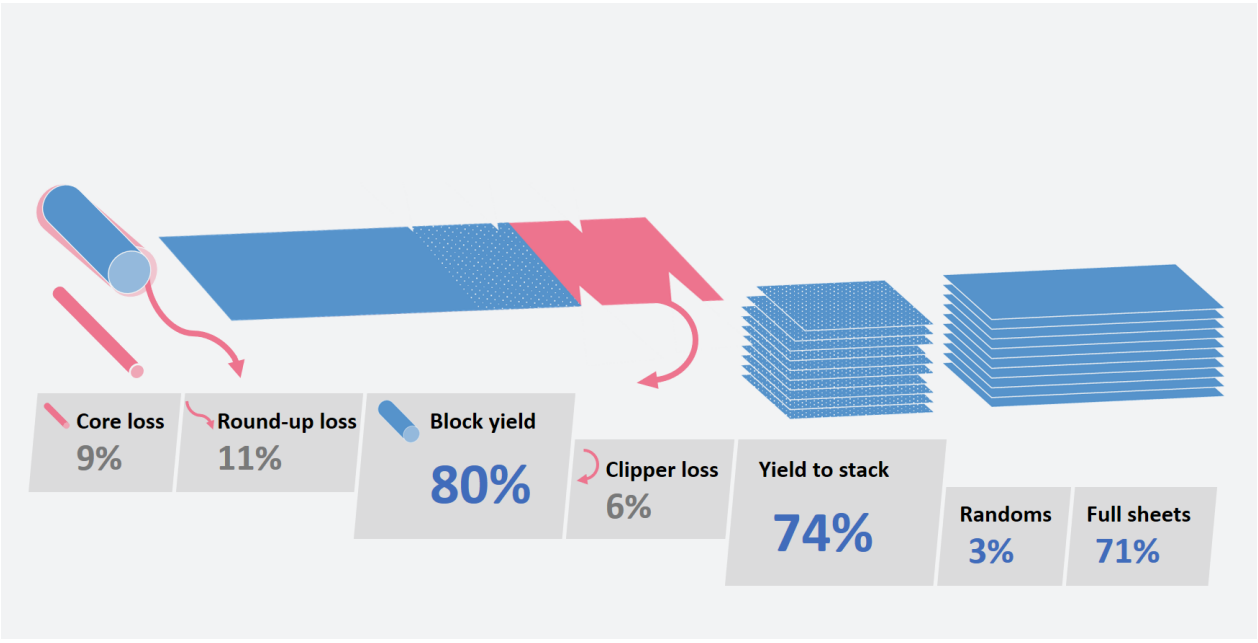
REGULAR MAINTENANCE ENSURES ACCURATE DATA

With automatic grading, the responsibility of correct decisions is handed from humans to automatic analyzers. This brings great improvements in grading accuracy and production efficiency as analyzers are doing constant work with their rule-based grading decisions. As analyzers are dependent on their measuring systems to be able to do their job properly, the maintenance of the systems is as important as with other machines.

Analyzers very rarely require maintenance because of component breakdowns. Normally, they do not limit the production material flow in any way and thus it may be difficult to see if the system requires cleaning or other maintenance. Decreased performance is normally seen in the following process phases after days or even weeks of delay. In the case of minor performance changes, real-time data collection is essential to detect the change.

By following regular maintenance practices and inspecting the system performance at regular intervals, the highest possible performance level can be maintained from day one to years to come. These maintenance and inspection tasks can be done during the regular maintenance breaks by the mill´s maintenance personnel or the equipment supplier's specialist. New technologies and remote connections allow some tasks to be done remotely.

In data-driven production, every decision is based on the data available. Accuracy of the data is the key factor in optimal production efficiency. To keep your data as accurate as possible and production as efficient as possible, regular inspections for the analyzers is a requirement.

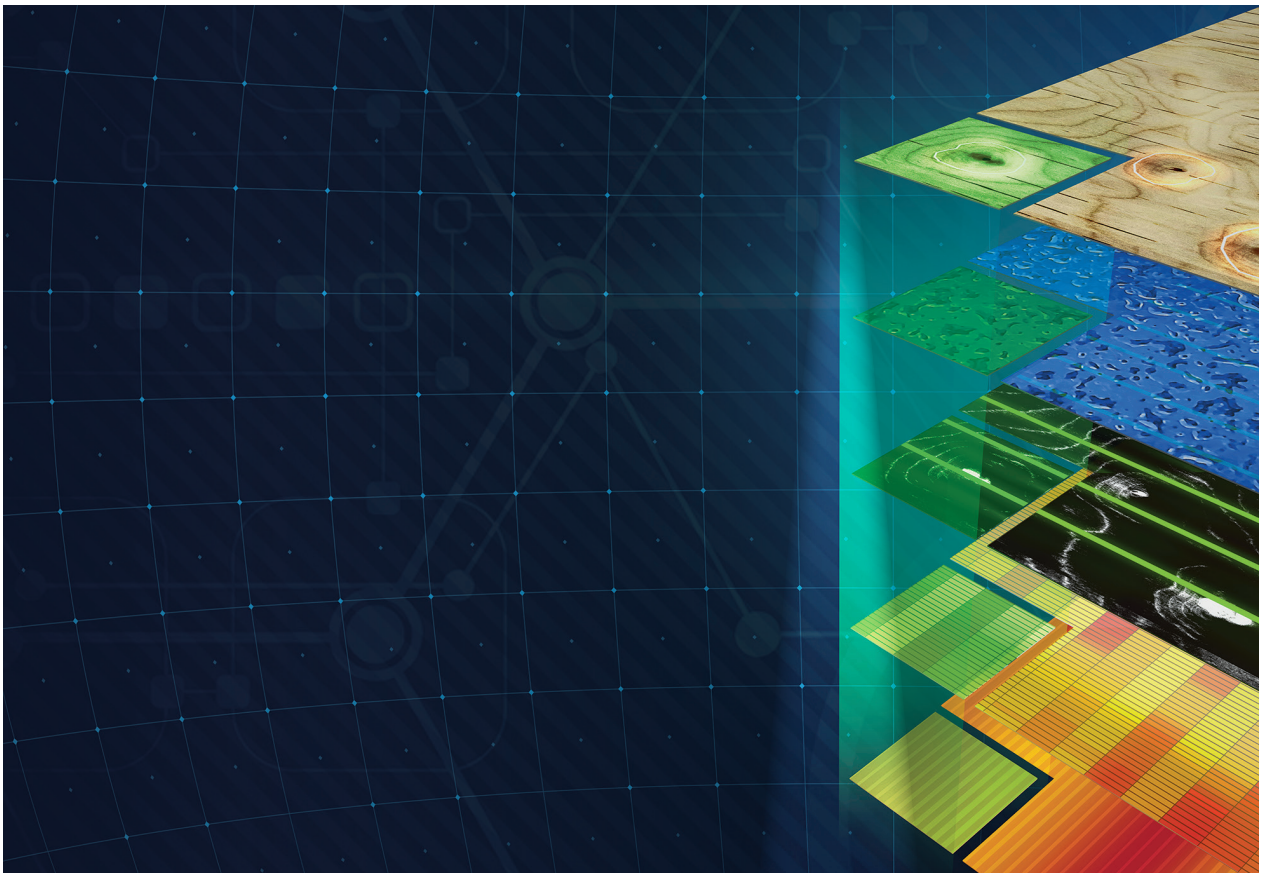


GRADING IN THE CORE OF INTELLIGENT PRODUCTION

The veneer production and grading process aims to maximize the added value of the raw material. This can be achieved by aiming for the most valuable product mix with high production efficiency.

This process is normally driven by the standards and norms for the end products. Conventionally, different production phases have been optimized as individual units instead of taking the whole manufacturing process into account. A human operator has played a key role in decision making and thus a single person's experience and knowledge have had a great effect on the performance and efficiency of each process phase.

To make the process less dependent on human decisions, different kinds of analyzers have been developed for various process phases during the last three decades. The benefits of the analyzers in improving production efficiency, quality, and consistency are evident. Still, many mills rely on human operators and manual work, even though there are various ways to automate decision making and make it accurate.



DATA-DRIVEN VENEER GRADING

One of the most common habits is to walk from machine to machine to gather production data after each shift from different production phases and then utilize this information in production control. This develops many error points and a wide interpretation variation, which may lead to variable decision making with enlightened guesses about the effects on production, quality, or profit.

The intelligent veneer grading tools (e.g., software and hardware) have developed considerably during recent years. With increasingly accurate tools, veneer grading has developed into precise business intelligence. This helps production facilities to understand the real dependencies and effects of decision making on each production step and to optimize their production in terms of costs, quality, and efficiency with real-time access to the data from one's workstation.

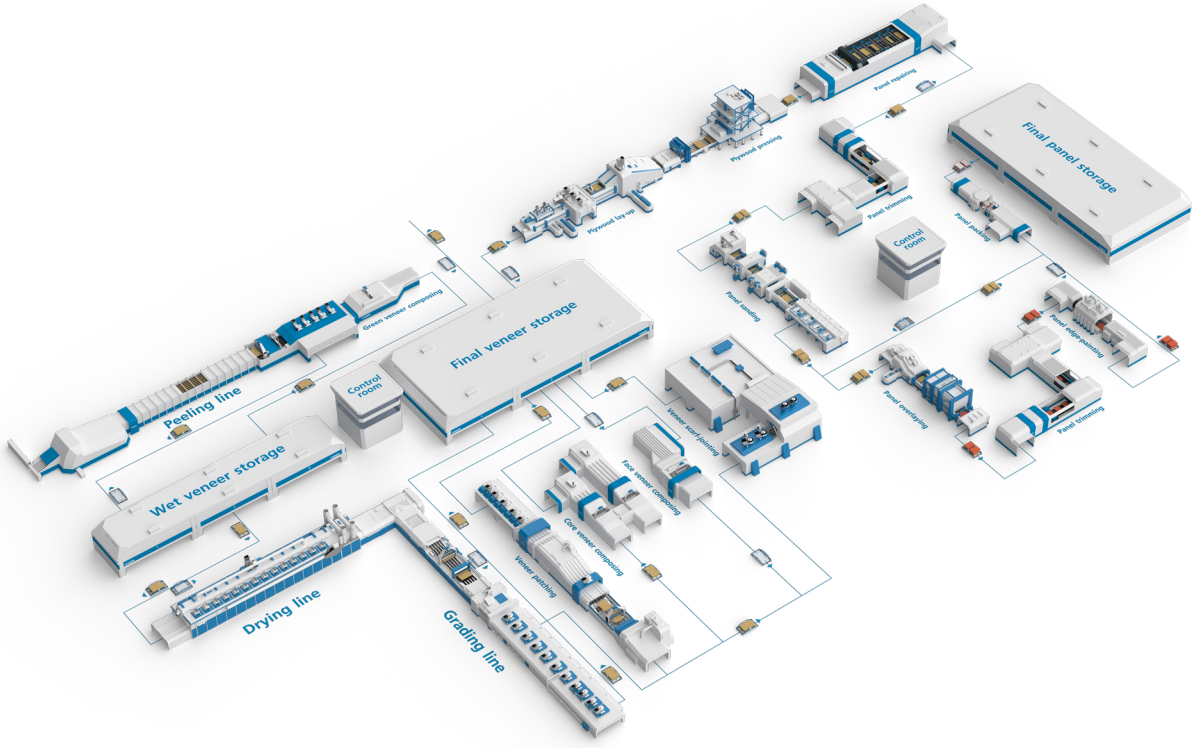
In the core of data-driven veneer grading are analyzers and the production data. Making production and quality decisions based on extremely accurate information ensures that producers achieve operational efficiency, quality, and profitability based on their requirements.

One good example is automatic dryer speed control along with accurate moisture grading on the peeling line, which reduces both re-drying and over-drying and can add up to 15% more drying capacity while improving veneer quality. Grading maximizes the high-quality veneer yield and ensures efficient material flow throughout production. Manual work and recovery loss in dry veneer processing are minimized.

THE GRADING ANALYZERS

Nowadays, the analyzers evaluate and grade the raw material, make process optimizations, and gather valuable information from basically every phase of the production. These production phases are:

- Peeling
- Green Composing
- Drying
- Patching
- Face Composing
- Core Composing
- Scarf-jointing
- Lay-up
- Panel Repairing



PURPOSE OF THE ANALYZERS

The ultimate purpose of an analyzer is to ensure that the product is usable in the following process phase. A simple application analyzer measures some physical features of a product and pass the information forward for use in another system, or make an analysis and decision based on the information.

An easy example is the measurement of veneer moisture after the dryer, where the moisture is measured at one or more points, and a decision is made based on the result – whether the veneer is dry enough for the next process phase or if it needs to be re-dried.

Over the years, analyzers have evolved from devices measuring only a single physical property to devices capable of making complex optimization decisions. More and more often, the measurement data produced by different analyzers are combined to make more accurate decisions.

Combined analyzers can better consider the requirements of the next process step and optimize decisions so that efficiency is maximized.

Analyzers can be divided at a high level into three categories: visual, moisture, and strength analyzers. These different analyzers can be applied to different production lines as required.

VISUAL ANALYSIS

Visual analysis is the most common form of analysis and is applied at almost every stage of production. Its purpose is to optimize the handling of the product or to determine the product's quality category according to the visual characteristics of the product.

Grading rules are usually based on requirements set by the end product, guided by standards and norms. In the latest and most advanced visual analyzers, grading can also be based on simulations of the following process phases to ensure that the product is suitable for the next production step and that its processing is efficient.

One example of this is the simulation of composing when optimizing the peeling line cutting decisions and when sorting dry veneer. This means that the veneer sheets are analyzed already on the peeling line when cutting the sheets to make sure that the composable sheets are usable also after drying. This method prevents drying veneer that will end up in the waste and enhances production both at the drying and composing lines.

MOISTURE ANALYSIS

Moisture analysis plays an important role in improving drying efficiency and ensuring that there are no problems during hot pressing due to excessive moisture in the sheet. Sorting veneers on a peeling line is one of the most effective ways to improve production efficiency, reduce energy consumption, and improve quality.

Depending on the raw-material type, veneers are usually divided into two or three grades according to their green moisture. Each of these moisture grades is usually dried at a different speed and temperature to achieve the best drying capacity and to avoid over-drying the veneers while minimizing the requirement for re-drying. Green moisture sorting has a huge impact on the veneer quality after drying: the sheets are less wavy, have fewer cracks and open defects, and the sheets are more often unbroken, for example.

The moisture measurement after the dryer, in turn, checks if the sheets require to be re-dried or if they are ready for the next process phase. Based on the moisture measurement data, the speed of the dryer is usually automatically controlled so that the dryer operates continuously as efficiently as possible. The result of moisture measurement can also be combined with visual quality in more advanced systems and allow, for example, significantly higher moisture for surface veneers, thus further increasing the capacity of the dryer and improving the quality of the veneer. These advanced devices also have a variety of

ways to optimize moisture sorting instead of measuring only the average moisture or peak moisture.

STRENGTH ANALYSIS

The purpose of strength analysis is to sort the veneers into different strength grades after drying so that products requiring structural strength, such as LVL, can be glued from them. Selecting veneers that meet a certain strength for use in the product ensures that the end product meets the requirements set by standards.

Various measurement methods can be used for strength analysis, of which sound velocity measurement and density measurement are the most common. The use of the same methods in plywood manufacturing would also make it possible to produce various special products for the requirements of, for example, the transport equipment industry or the furniture industry.

Methods of strength analysis have also been introduced in the latest applications on the peeling line to evaluate the drying shrinkage of the wet veneer.

PROOF OF IMPROVEMENT

This section discusses in detail the proofs of improvement that affect the quality of plywood production. In this section, the article introduces the production equipment step by step to demonstrate their positive effects on production. For all the improvement actions, one common point is that analyzers are fully compatible with data collecting. By utilizing analyzers with intelligent data collecting software it is possible to maximize efficiency and quality through the whole production process instead of optimizing single processes.

DATA USAGE IN VENEER, PLYWOOD, AND LVL PRODUCTION

The Management Information System collects, combines, and analyzes a comprehensive amount of data from all essential elements of production.

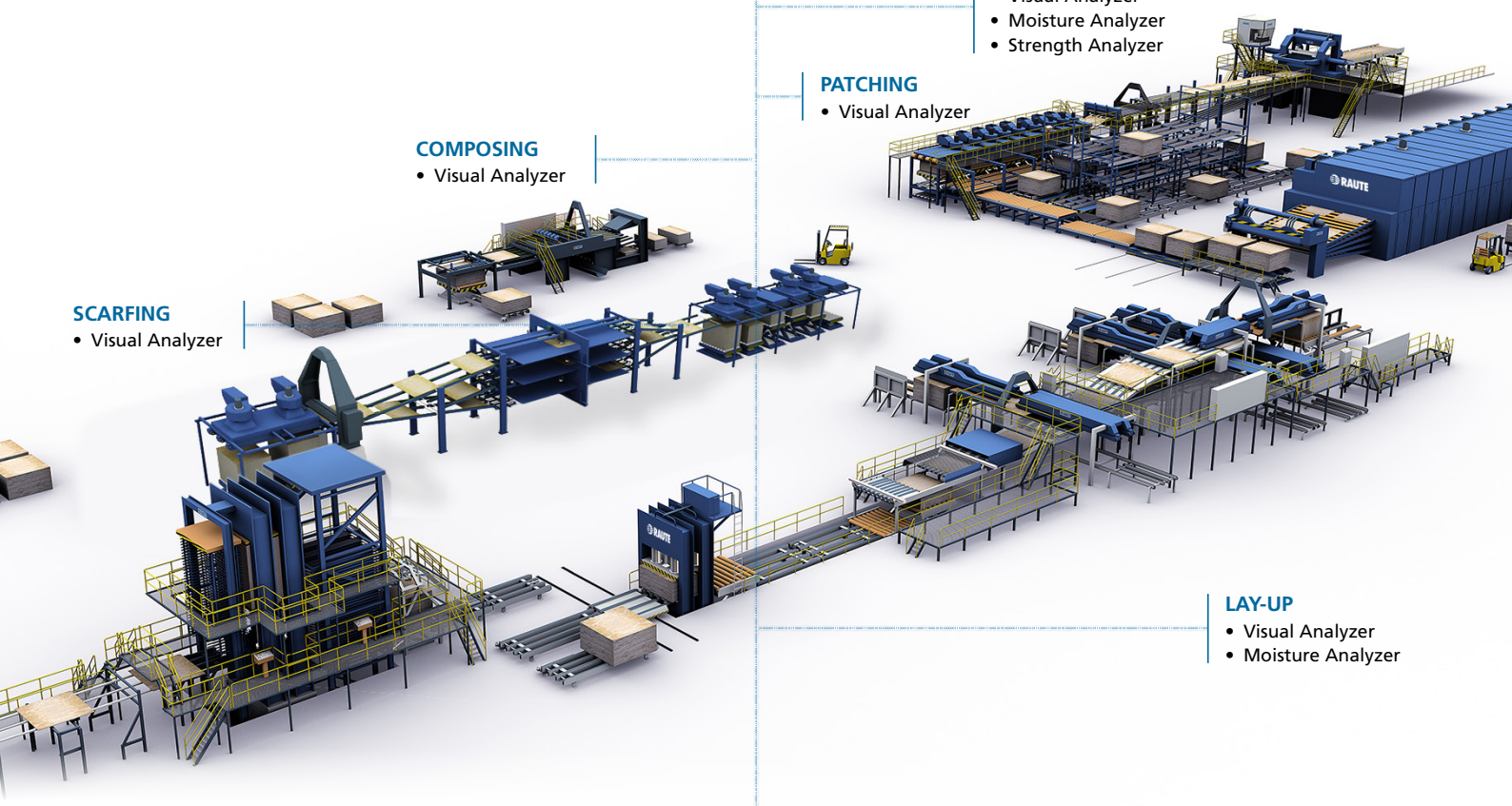
DRYING
- Visual Analyzer
- Moisture Analyzer
- Strength Analyzer

PEELING
- Visual Analyzer
- Moisture Analyzer
- Strength Analyzer

PATCHING
- Visual Analyzer

COMPOSING
- Visual Analyzer

SCARFING
- Visual Analyzer



LAY-UP
- Visual Analyzer
- Moisture Analyzer

PANEL REPAIRING
- Visual Analyzer

PEELING

The Starting point: Basic visual defect detection camera for clipping decisions and basic moisture meter for moisture sorting.

The Upgrade: The peeling line is equipped with an advanced color camera-based visual analyzer with optimizing capabilities together with accurate moisture and strength analyzers.

The Improvements: Clear improvements in drying efficiency and capacity because of accurate moisture sorting. Increased raw material savings as clipping widths of veneer sheets are minimized by estimating their drying shrinkage. This also produces additional full veneer sheets in production and real improvements in drying process operations as veneer material quality is optimized for drying to eliminate dryer jams and other issues.

> ***A CUSTOMER CASE:***
> *Customer A had a basic defect detection camera that was replaced with an advanced color camera-based visual analyzer with optimizing capabilities. The customer utilized visual clipping optimization to achieve clear improvements in the amount of face quality veneers. An accurate color camera with accurate defect detection analyzes veneer quality and avoids the downgrade of face veneers after drying. Optimizing material for the subsequent process steps has increased drying efficiency as drying material that is not suitable for further processes after drying is avoided. The customer started to think about the total production efficiency instead of optimizing only the yield of one process phase.*

GREEN COMPOSING

The Starting point: Not utilizing the green veneer composing. Random sheets and sheets with big defects are dried and composed after drying.

The Upgrade: Installing green veneer composing with an accurate color camera system.

The Improvements: The dryer capacity increases by up to 5% as only the full veneer sheets and not the trash is dried. Automatic feeding and stacking systems can be used for all veneers in the drying line, and fewer operators are required as there is no need for manual handling of the randoms in drying. This also enables less cleaning for the dryer as less trash is fed to the dryer.

DRYING

The Starting point: Customer operating the dryer without camera grading. The visual grading is done manually after drying. Moisture is measured only occasionally, and veneers are mainly dried over-dried.

The Upgrade: Grading line with accurate visual and moisture analyzers installed after the dryer. Additionally, the refeeder option is installed for refeeding veneers to the grading line.

The Improvements: The required accuracy and consistency of visual and moisture grading are heavily increased after the installation of the visual and moisture analyzers. At the same time, the amount of required labor decreases, and the drying capacity is optimized.

> ***KNOWLEDGE***
> *Visual grading accuracy is much better with a visual analyzer than with the human eye. Based on real-life tests, the maximum accuracy of a human eye has been analyzed to be 70% and the visual analyzer accuracy is at least 95%. This is when grading is done on the grading line. The situation may differ if the inspection is done offline from stacks veneer by veneer, but then the need for operators is heavily increased.*

Visual grading of the dried veneer is an extremely important production phase, especially for face grade veneers, as grading a sheet to a lower quality grade may decrease the value of the sheet by 50%.

Utilizing the possibility to refeed veneers to the grading line together with accurate moisture and visual grading allows the separation of those veneers with high moisture peaks to be stacked for even out moisture spots and regrading after a period of storing. This method can increase drying capacity by up to 5%

when up to 10% of veneers are run through the refeeding system.

Using the optimization possibilities on the grading system allows the mill to maximize the benefits for the subsequent process steps by choosing the optimal process for each veneer sheet.

Utilizing accurate moisture measuring combined with visual quality allows the use of high moistures for face veneers. This increases the dryer capacity as the average moisture content of veneers increases. This also improves the quality of dry veneer.

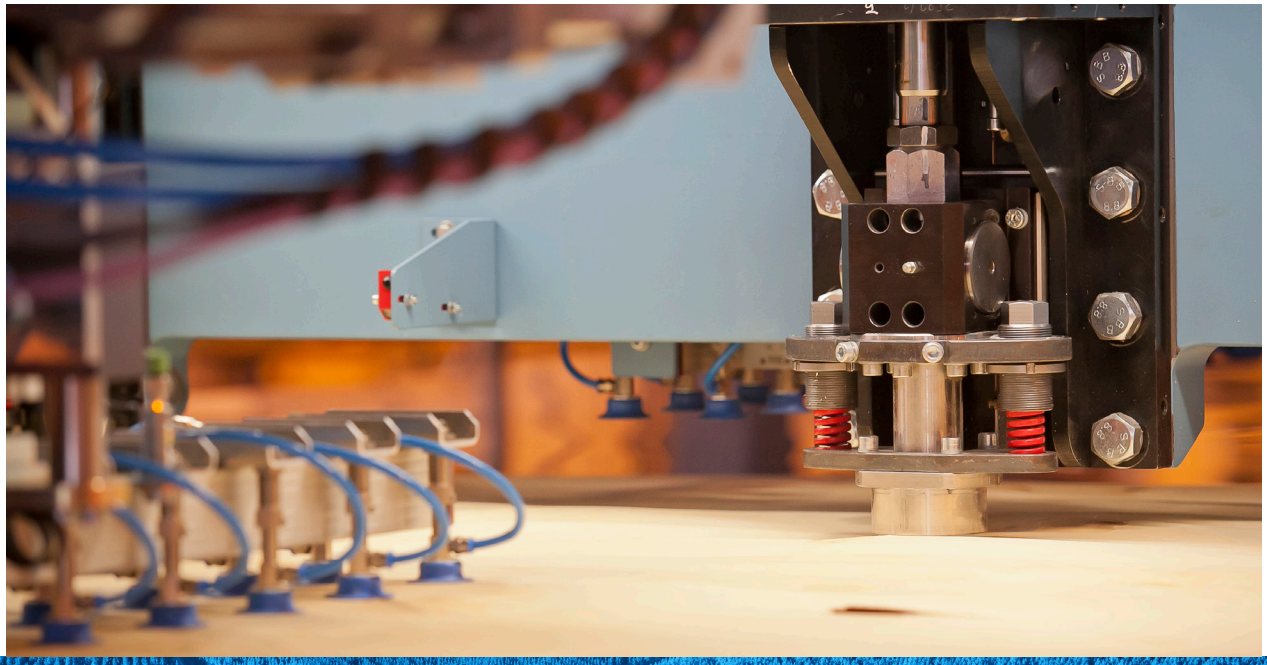
PATCHING

The Starting point: Utilizing manual patchers for veneer patching.

The Upgrade and the Improvements: Installing a modern automatic patching line with an accurate color camera-based visual analyzer increases the number of usable face veneers and decreases the need for manual labor. The automatic patching line can replace up to 20 manual patching units.

The visual analyzer optimizes and minimizes the required number of patches. In some veneer qualities, too many patches on a sheet drop the veneer to the lower grade which decreases the veneer value heavily. The grading system allows the determination of allowed patch counts, for example, pcs/m^2, which is a limiting factor in some quality grades. Setting and following up that kind of rule is difficult in the manual patching process.

The patching line visual analyzer can be also used for grading of face veneer sheets in cases when there are not enough bins for different grades in the dry veneer grading line.



FACE COMPOSING

The Starting point: Not utilizing face veneer composing. The only way to get good face veneers is to use the natural face veneer grades or patch veneers to meet the grades.

The Upgrade: Utilizing the face veneer composer with an accurate visual analyzer for defect cutting increases the number of face veneers by up to 25%. Face veneer amount is increased by composing face veneers from smaller face veneer quality veneer pieces and by utilizing veneers that would normally be graded to core veneers because of some small defects but can be upgraded to face veneers by cutting those defects out on the face veneer composing line.

CORE COMPOSING

The Starting point: Core veneer composing line where trash cutting is based on thickness measurement and simple defect marking and detection system.

The Upgrade and the Improvements: After installing a color camera-based visual analyzer for defect detection, line capacity, and recovery both increased by up to 20%. The line is also easier to work with, as the operative person can concentrate on feeding the new veneers to the composer and let the camera system make the decisions about defect clipping. This ensures better quality sheets for the following phase without quality variation.

SCARF-JOINTING

The Starting point: Scarf-jointing line without a visual analyzer and the operators are manually downgrading broken sheets and sheets with a major shape error. The veneer sizing saw is set to cut some extra from every veneer to ensure that the scarf quality is valid. This causes raw material losses because of extra sawing.

The Upgrade and Improvements: After installing the visual analyzer, up to 10% of veneers have been downgraded for composing because of their size, shape error, or defects. This improves the quality of joint veneer sheets, and problems with too narrow sheets in the panel can be minimized.

Additionally, the scarf saw can be adjusted to the optimal position as no extra sawing is required. This produces thousands of veneer sheets more per year as saved raw material. The visual analyzer also provides accurate data to be used as feedback to the dry veneer grading where grading parameters can be corrected if the downgrade on the scarf-jointing line is too high. The feedback data is transferred to the peeling line if the veneer cutting dimensions are wrong.

LAY-UP

The Starting point: No visual or moisture analyzers on the lay-up line. An operator needs to monitor and replace any broken veneer sheets. There are some rejected panels because of the wrong veneer sizes as it is difficult for a human to visually check veneer dimensions in a really short time. Occasional high moisture sheets cause delamination on hot pressing and thus reject panels.

The Upgrade and the Improvements: The lay-up line is equipped with the visual and moisture analyzer. The visual analyzer monitors the veneer sheet dimensions and automatically rejects any broken or otherwise disqualified sheets. The moisture analyzer monitors that all sheets are dry enough for hot pressing. These improvements release the operator time for other tasks and panel rejects because delamination and the amount of undersized veneer sheets are minimized. Analyzers provide accurate data to be used as feedback to dry veneer grading where grading parameters can be optimized when required. Minimizing panel rejects increases factory profitability.

PANEL REPAIRING

The Starting point: Manual panel repairing where operators are visually checking panels and manually fixing the defects.

The Upgrade and the Improvements: Installing an automatic panel repairing line with an accurate visual analyzer reduces the number of required operators and minimizes the required number of repairs on each panel.

Up to 50% less repairing material is required as accurate defect detection minimizes over repairing. With an automatic grading system, it is possible to adjust the defect detection parameters and adjust the line for different panel qualities, and still keep the high-quality output consistent. The visual analyzer provides accurate data to be used as feedback to the lay-up and dry veneer grading processes where grading parameters can be fine-tuned for the best possible full process efficiency and profitability.

CONCLUSION:
KNOWLEDGE IS THE KEY FOR SUCCESS

In modern veneer, plywood, and LVL production, data collection and usage are increasingly becoming one of the key elements of efficiency. In grading, manual work and human sense-based knowledge move to the background, and the real, data-based knowledge rises to the top of decision making.

Knowledge is the key to success, and many innovations are usable in already existing production machinery with just a few add-ons – hardware, and software.

In this whitepaper, this concept of knowledge-based decision making was covered from several perspectives and the findings underline that data collection and its smart usage are the most accurate and efficient way to grade veneer-based products and develop production.

This brings many advantages to the production phases in terms of continuity, measurability, reproducibility, and usability. While the grading process is one of the most crucial elements in the veneer, plywood, and LVL production, the data enables the most accurate knowledge, leading to maximized savings and efficiency.

Some visualized examples of collected process data.