CHIP QUALITY - A KEY TO PULPING UNIFORMITY AND PRODUCTIVITY

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Abstract

The uniformity of pulp and the productivity of a pulp mill are influenced by many factors, but chip quality can be the most important. The opportunities for improving chip quality start in the forest and continue up to the digester. Understanding the relationships of chip quality to mill operations requires we use problem-solving and quality tools, especially teamwork. This paper will show how the chip quality problems can be solved from the forest to the product.

Introduction

Ask a pulp mill manager what he needs to make high quality and uniform pulp that competes in a highly competitive global market. The response will be very complex. Capturing his list in a cause and effect diagram (Figure 1) will help organize the thoughts. People, machines, materials, measurements, methods and environment must all combine and work together. This isn't an easy task. New process technology, advanced process control and information systems help. But ultimately, people working together in teams is the common ingredient needed to really achieve excellence in pulp and paper manufacture. Teams bring together the knowledge and experience needed to solve complex quality and production problems.

In every mill, chips will appear as one of the factors in producing good pulp. Kappa number is a key measure of pulping performance and reducing Kappa variability is a key goal. If a quality improvement production team worked on the problem of Kappa variability, they would produce a cause-and-effect diagram like Figure 2.[1] In addition to the pulping process variables, chips are a major factor. This paper will discuss recent developments in chip production and quality that have a major impact on pulp mill operation.

Chip Quality

It is not useful for a pulp mill to simply raise the issue of "poor chip quality." There is a strong, well-documented relationship between chip properties and pulp mill operations, but unlike most pulping raw materials, there are numerous natural and controllable chip quality factors.[2,3,4] Figure 3 shows many of the chip quality factors that can be measured and do have an impact on mill operations. But a mill doesn't have enough resources to deal with all of them at once. A Pareto analysis like the one in Figure 4 will help set priorities for quality improvement projects. Based on chip quality data and mill studies, it is obvious from this analysis that chip screening is needed to reduce oversize and fines before any other chip quality programs are pursued.

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The benefits of improved chip quality are found in improved and more consistent pulp mill operation and product quality. To achieve this, a mill must collect facts and data to develop cause/effect relationships. This requires good chip sampling and testing technique.[5] Analysis of this data will determine if the process is consistent and under statistical control. Once the process is under control, economically attractive improvements can be made to continuously improve the system performance.

Quality Measurement Tools

There have been numerous recent developments in tools to provide reliable and accurate chip quality control data. Chip sampling devices are available or can be designed for almost every chip handling situation, but hand sampling can still provide quick, representative samples if technicians are well trained.[5] Chip particle size analysis can be done by a number of manual and automatic systems.[6] Figure 5 shows a convenient manual chip size classifier with trays that sort chips in classes that directly relate to pulping. This relationship is essential, but no standard method has been adopted. There are several similar methods on the market. Similarly, an optical system is being tested in Scandinavia with promising results.[7] Chip moisture sensors are widely used throughout the world to purchase chips on a dry weight basis and more important, to control digester wood and chemical charges.[8] These are only a few examples of the tools that are being used to measure chip variability. Without such facts and data, a chip quality improvement program will not succeed. In a recent and comprehensive survey of pulp mills in the southern U. S., the importance of having good chip quality and production data was demonstrated.[9] Woodyards with well-engineered systems and good maintenance produced good quality chips.

Chip Production Systems

The single most important development in the woodyard in recent years is the development of high capacity, high efficiency chip screen systems with the capability of removing the extremes in chip size, namely fines, over-length and over-thick chips.[10,11] Gyratory and disc screens were initially used in systems that allowed mills to almost completely eliminate pulp knotter rejects, increase yield, reduce chemical costs and decrease pulp dirt. Design of these systems requires more careful attention than given to the woodyard in the past. With the use of statistical analysis of chip variability, pilot plant trials and computer simulation, chip screen systems have been designed with precision and high performance.[11] While these systems may require up to US$10,000,000, the returns on investment are easily justified for almost any mill.

During the last 24 months, completely new technology has been introduced to even further improve chip screen systems. Roll technology has been developed to screen out both fines and oversize.[12,13] A bar screen has been invented for oversize removal. Flexible wave plates are claimed to remove fines as well as the roll screen, especially in frozen chips[14]. While the slicer has been the accepted method of reprocessing oversize chips, a roll-crushing system has been patented.[15] The technology of chip quality improvement continues to develop rapidly.

Chipper Optimization

Before investing in a chip screening system, however, a mill should take a look at the design and condition of the chippers. Although chipping technology is almost 100 years old, there are still developments being made to continuously improve chip size distributions at the best time - while chips are being made. As a general observation, chipper installations need to be audited periodically.(9) Careful inspection shows that they are not always maintained precisely, wood is not being fed so that the wood/knife interface is stable, the chip cut length is not producing the target thickness for each species of wood, and the chipper speed is too fast.(16) Corrections of these problems in woodyards and at the wood product residual sources will provide more uniform chip size distributions and reduce the need for chip screening.(17) Many mills are also taking advantage of disposable chipper knives that not only reduce labor costs, but improve the accuracy of chipping.(18)

To illustrate how chip quality data can be used to optimize chipper performance, Table 1 shows excellent chip quality. Notice the significant decrease in quality that can occur when a chipper is not operated under optimum conditions.(3)

Contaminant Removal

In order to produce clean pulp, bark must be removed from logs before wood products or chips are manufactured. The North American industry attempted to use whole tree chips in the 1970's when wood supply was tight and wood costs very high. However, customer satisfaction and the economics of cleaning the pulp to meet increasing quality specifications, has caused the industry to return to complete debarking. The trend toward smaller diameter trees and tree-length wood handling has forced the improvement in debarking to meet these more stringent bark specifications. Predictive performance equations allow the design and operation of drum debarkers to meet quality and productivity targets.(19) Figure 6 is an example of the precise design equations available to build and operate a drum debarker. For example, in order to account for seasonal differences in bark adhesion, longer debarking time is needed. In addition, this longer time will significantly increase the wood loss to achieve more than 95% bark removal. The ability of drum debarkers to overcome the season variations in bark adhesion has now been achieved through the use of steam treatment in almost totally enclosed drums.(20) There is a strong trend toward tree length debarking in which the wood is not slashed to short (2-4 m) lengths, but is left in up to full tree lengths. The parallel debarking is achieved at high productivity through redesign of the drum infeed chutes and the exit gates. Bark contents below 0.5 percent seem to be achievable year-round with almost any type of wood.

While rock and metal can be removed by magnets or aerodynamic separators, plastic contamination cannot be economically removed once it enters the chip system. education of everyone in the chip production, transportation and storage system is the only effective means of preventing plastic contamination through inappropriate waste disposal.(21)

Chip Storage and Handling

Once chip quality has been achieved, it must be preserved in storage and handling. The mechanisms of chip pile deterioration are understood. Further, equipment is available that will minimize deterioration from compaction and heat.[22] The most popular equipment utilizes automated outstocking conveyors that build linear or round piles without the use of chip dozers and limited to about 50 ft in height. An additional benefit to this type of system is the blending that occurs as a transverse conveyor reclaims across the layers of the pile. This blending reduces the impact of variations in chip moisture, chip source and chip species and has been shown to reduce the Kappa variability by as much as 50 percent.[23] Figure 7 shows how this blending occurs as the layers are reclaimed from under the pile.

Satellite Woodyards

Localized wood shortages and trends toward harvesting smaller stem sizes have made the use of satellite woodyards attractive. A satellite woodyard has the necessary equipment to produce chips (debark and chip), but a smaller and sometimes portable size.[24] Figure 8 shows a portable system that incorporates a chain flail for bark removal and a portable while log chipper.[25] Bark contents of 0.5-1.0% are possible on most conifers at high productivity. Such units are usually located at collection yards in the woods where small logs and trees are transported a few miles, but the chips can be transported hundreds of miles economically.[26]

Chip Quality Improvement

A mill may only work on a limited number of chip quality factors, but the economic and product quality benefits are substantial. We have just looked at several that have been most productive in recent years. Even with the highly variable nature of wood and chips, the quality of the fiber raw material used in pulp mills can be made consistent and controllable. For example (see Figure 9), the oversize has been reduced in a series of improvements. The progress is plotted on a control chart. The highly variable amount of oversize was reduced by improving stability of logs in the chipper infeed. This is still not enough improvement. A chip screen system reduced not only the variability, but also the amount of oversize chips. This lower level is sustained and monitored by the quality monitoring program.

The cost of chips can be 30-50 percent of the total cost of producing a fiber product. Use of quality improvement tools and new technology will optimize the use of this valuable raw material. The vital role education of all those involved in producing and handling chips cannot be overemphasized. This education in the fundamentals will gain understanding and commitment from the forest to the product.

Assessment of process capability of woodyard and chip production equipment will result in chip quality targets. Part of the education must include what can be done by each chip supplier to achieve such targets. Some can be achieved through good maintenance practices and adjustment back to original equipment tolerances and settings. Others may require capital spending over time. Supplier ranking and reporting can help a supplier see where his quality is with respect to other suppliers and against the targets that are set. But all of this takes communication - two-way, routine, consistent and cooperative communication - from supplier to customer and customer to supplier.

FIGURE 1

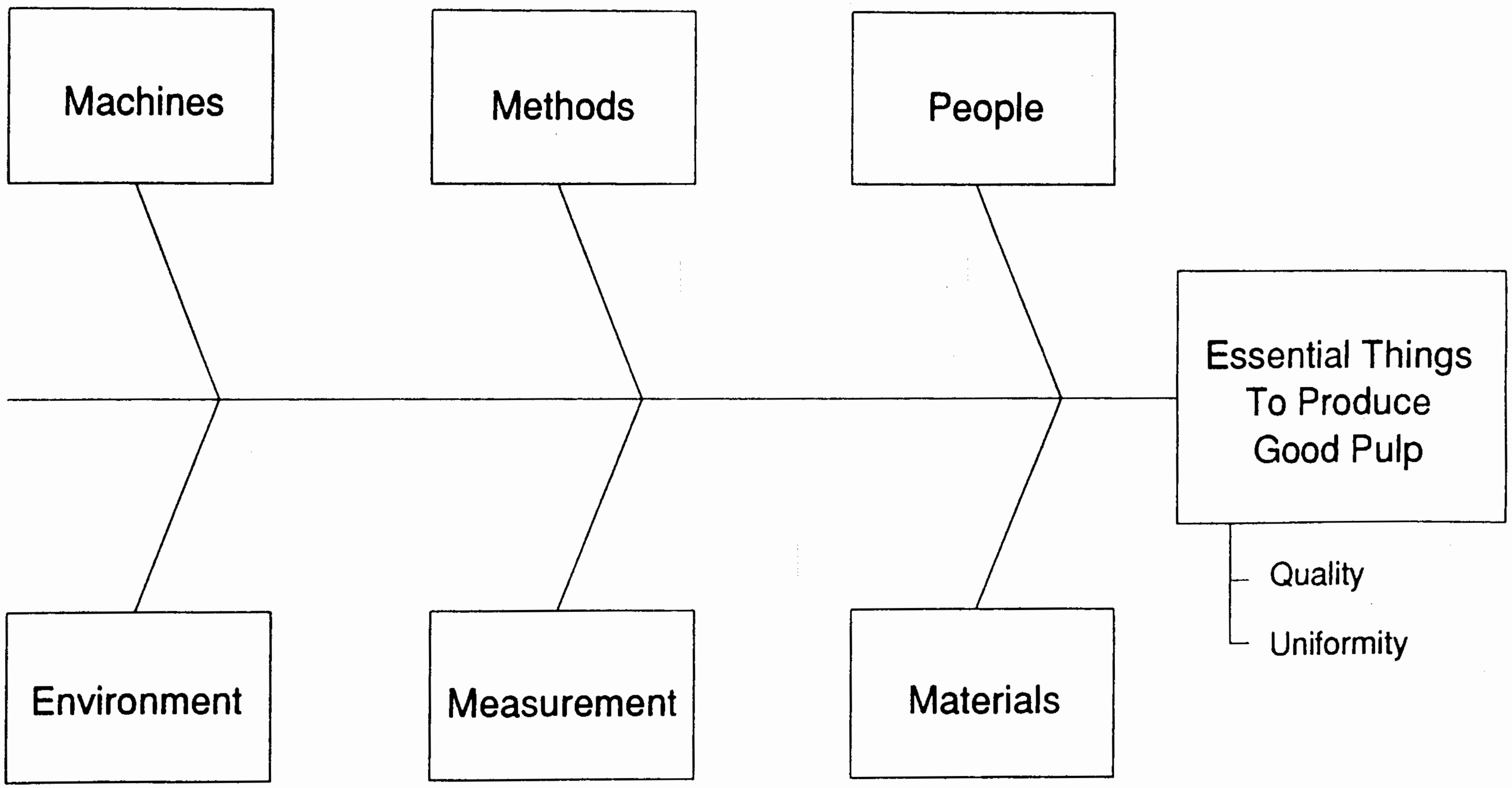

Machines
Methods
People
Essential Things To Produce Good Pulp
Quality
Uniformity
Environment
Measurement
Materials

FIGURE 2

EXAMPLE ISHIKAWA DIAGRAM FOR KAPPA NUMBER VARIABILITY

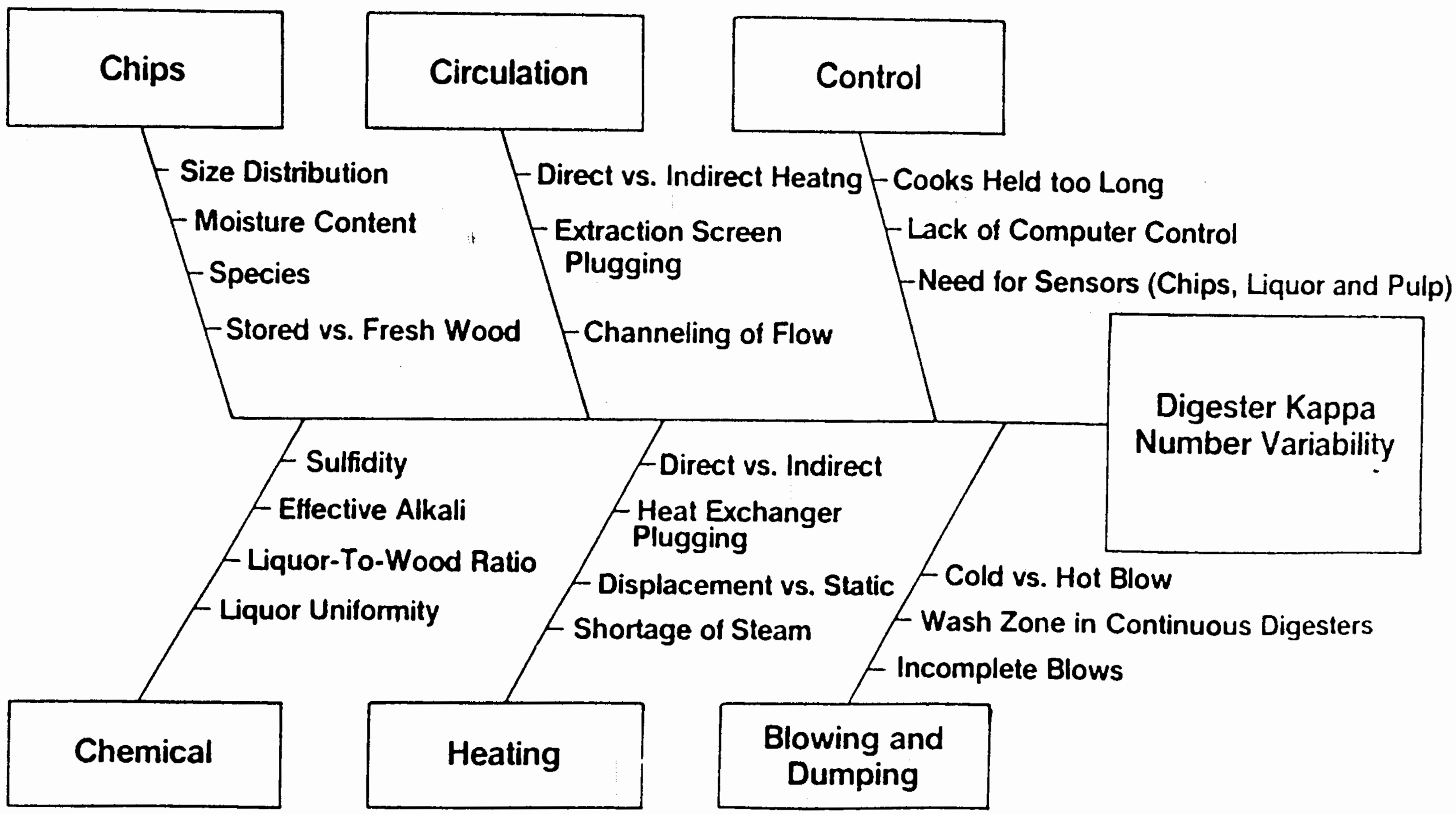
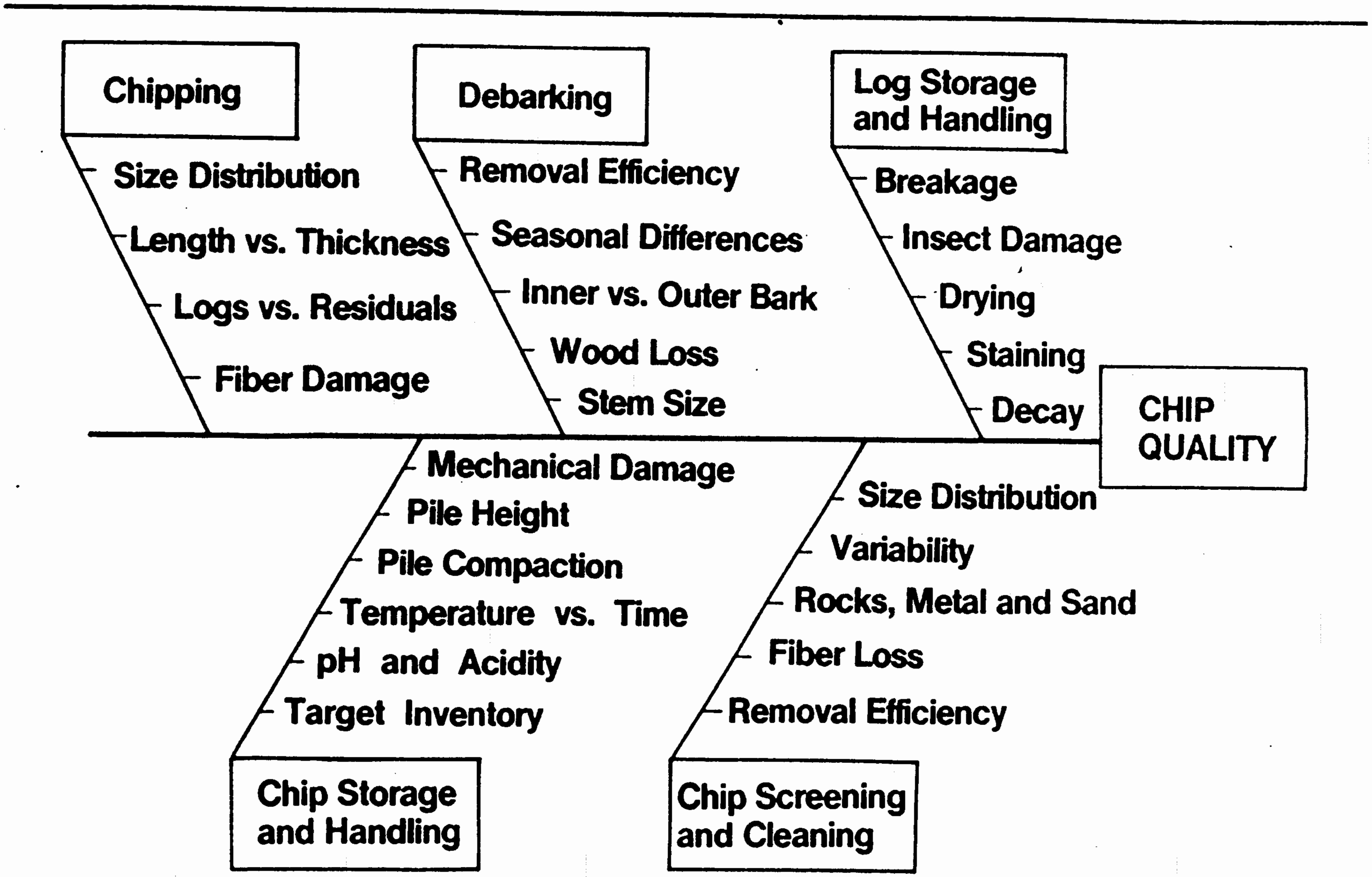


FIGURE 3

CHIP QUALITY FACTORS



From top to bottom, CHIP CLASS™ delivers the features that set the industry standard.

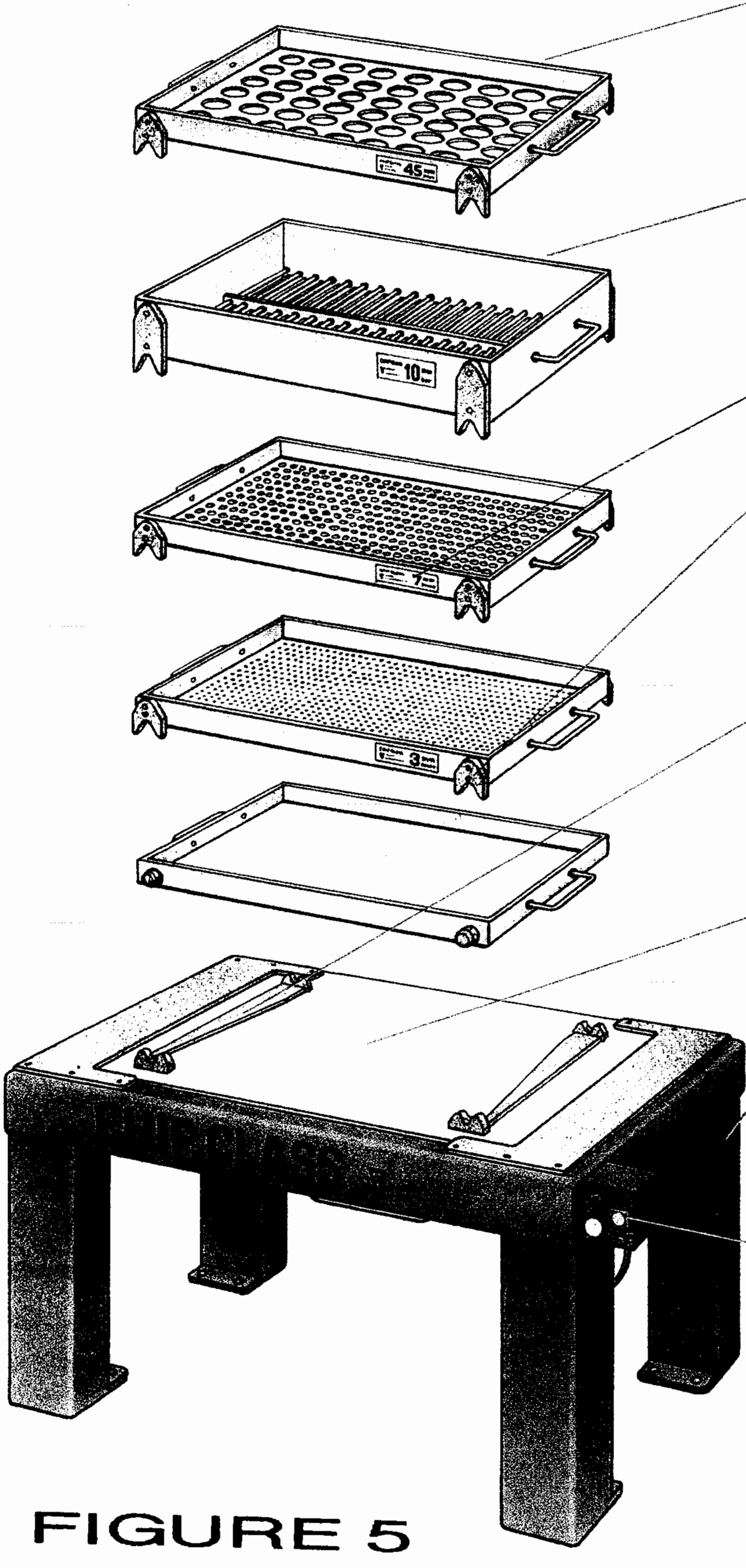


FIGURE 5

1. Rugged, Lightweight Trays
Lightweight CHIP CLASS™ trays leave your testers with the energy to focus on getting you accurate results throughout the entire shift. And you can be confident that the trays will stand up year after year.

2. Interchangeable Trays
You can meet the need for special test results with CHIP CLASS™. Because the trays are interchangeable, you quickly produce new test information by simply adding or substituting different trays.

3. Easy-To-Read Labels
Large, easy-to-read labels get your test results reported accurately.

4. Easily Aligned Tray Interlocks
You don't have to struggle with cumbersome metal clamps when using CHIP CLASS™. The tray locks allow you to easily and accurately align and secure the entire stack of trays. Made of highly durable Delrin™, the tray locks ensure you of a safe and quiet operation.

5. Fast Tray Alignment Guides
The tray alignment guides allow you to set an entire stack of trays on the CHIP CLASS™ base in one quick, easy motion. This feature, combined with an extra set of trays, makes it possible for you to test more than 40 samples per shift.

6. Low-Maintenance Shaker Platform
Extensive durability tests ensure you that CHIP CLASS™ is the most reliable chip classifier on the market today.

7. Strong, Compact Base
The rugged and heavy CHIP CLASS™ base provides you with a stable platform for repeatable tests even if the unit must be mounted on a wood floor. And installation is simple. Each leg comes equipped with a leveling jack and a floor bolt hole.

8. Convenient Controls
You set the timer once and then forget it. To start, you just push the green button and the timer automatically stops the shaking motion.

9. Quiet Operation
Your lab will remain quiet because CHIP CLASS™ has no metal-to-metal contact of any moving parts.

FIGURE 4

PARETO CHART OF PULP QUALITY DEFECTS SHOWING HOW FREQUENTLY CHIP QUALITY IS A FACTOR

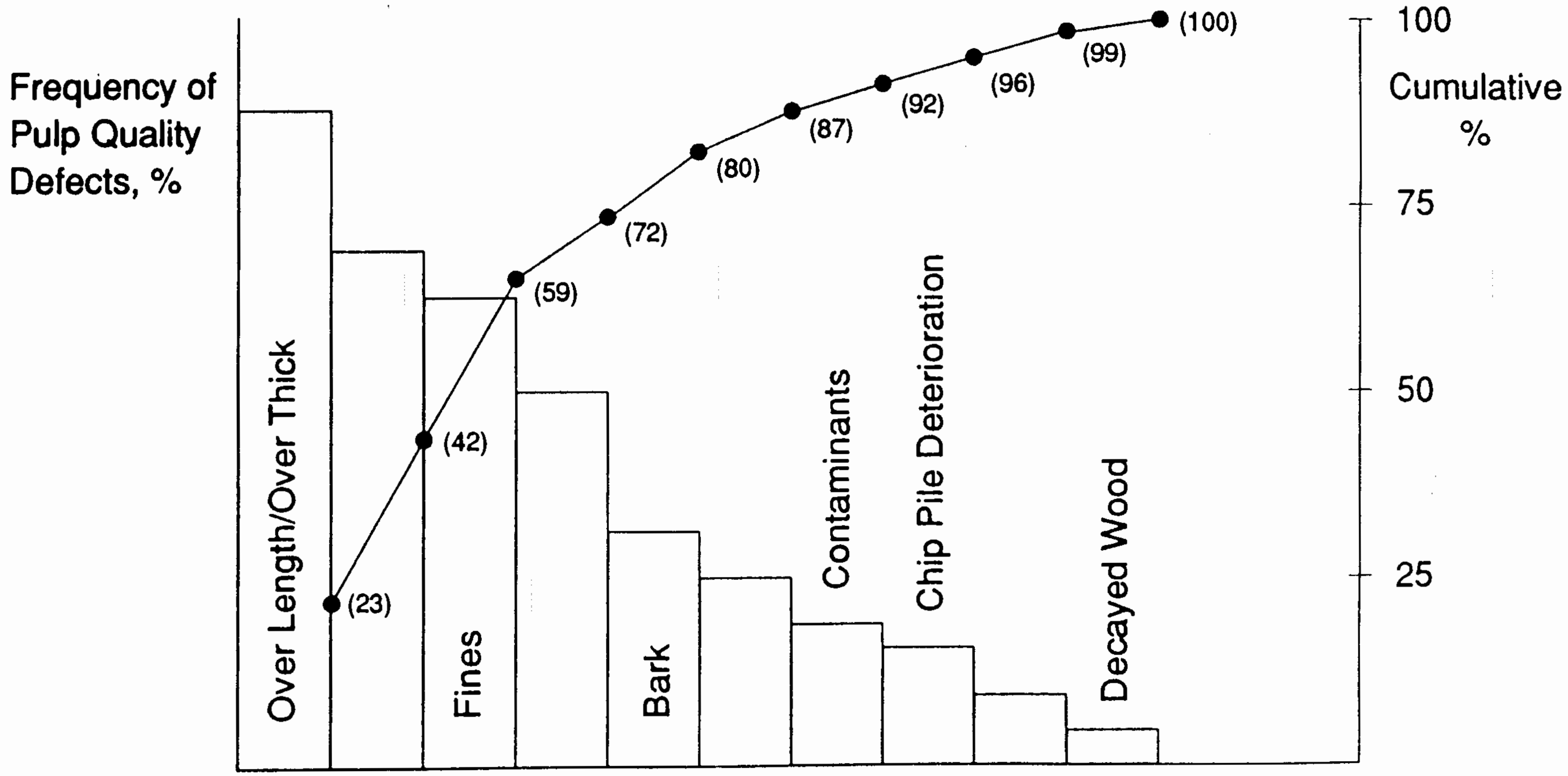


FIGURE 6

Seasonality Comparison

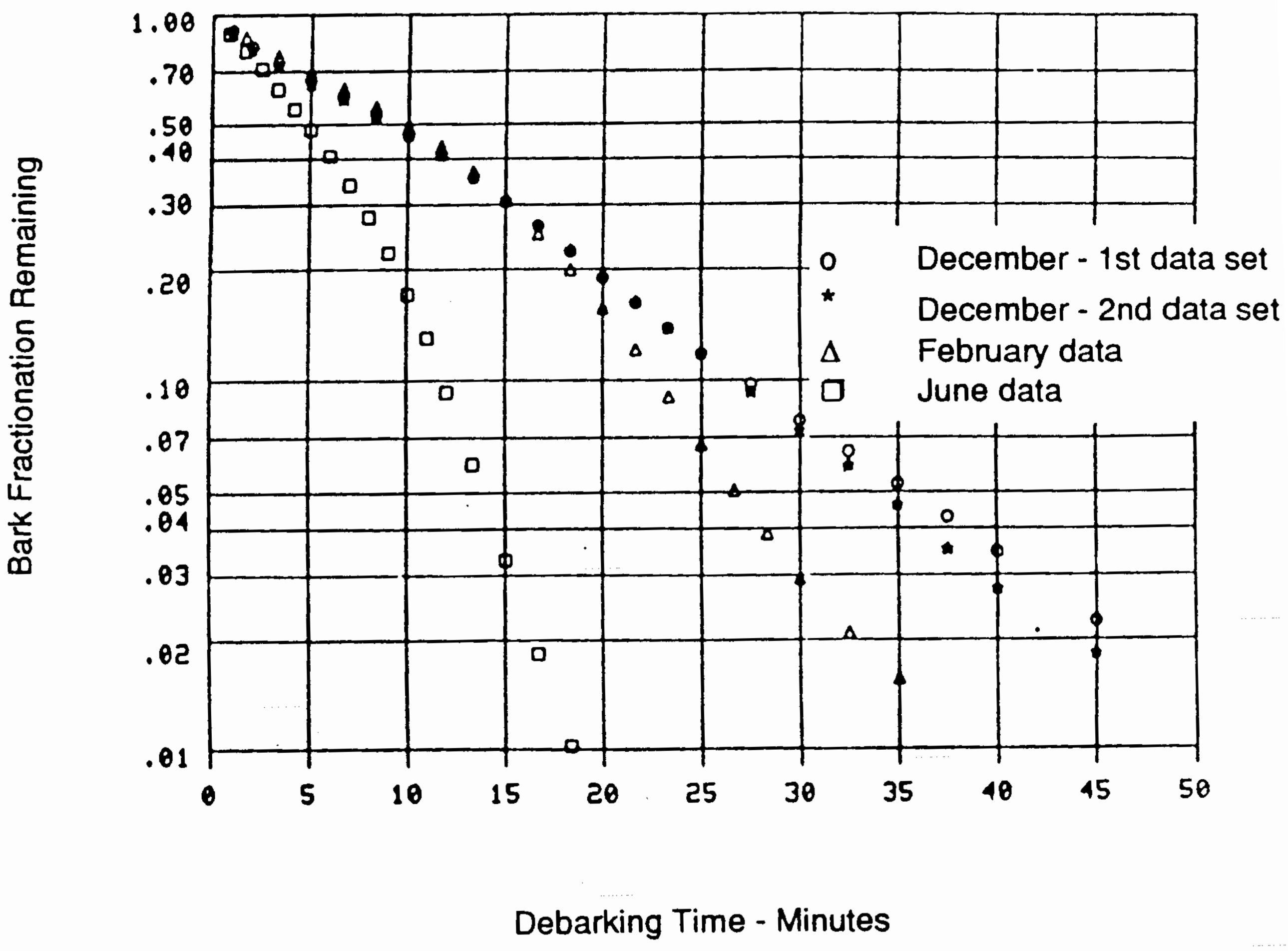


FIGURE 7

Chip Blending Using a Chip Reclaim System[24]

(Pile-blending action. The top layer of chips is gradually blended through the system.)

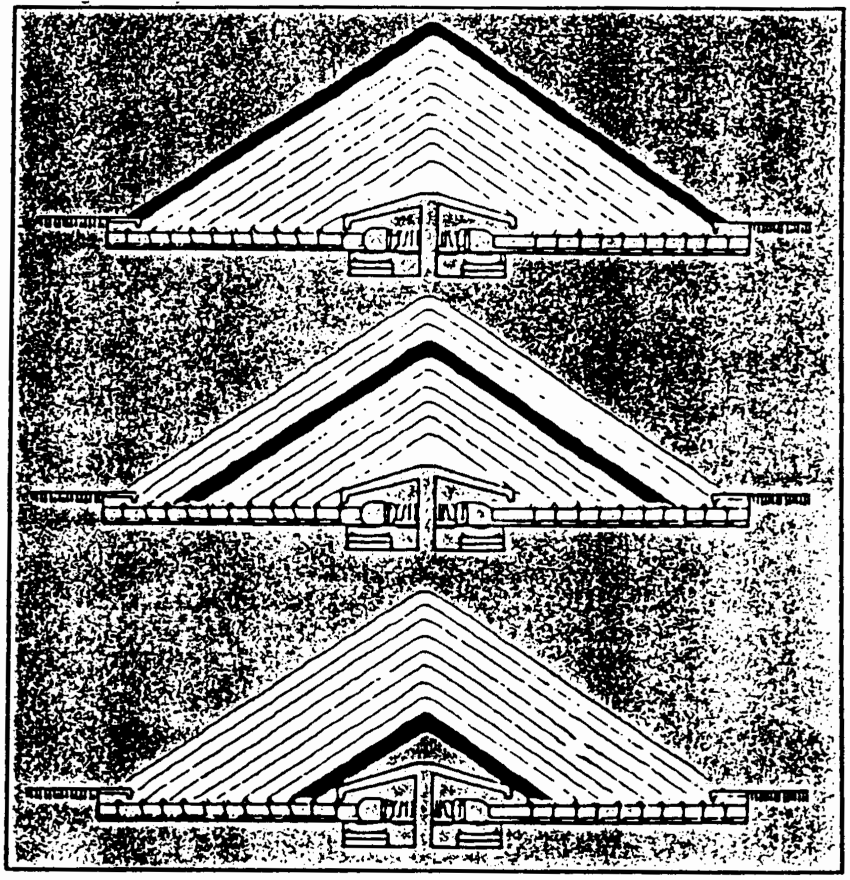


FIGURE 8

Satellite Chip System Using Double Chain Flail and Woods Chipper

(Southern U.S. Pine - 15-yr-old Plantation Thinnings(26)

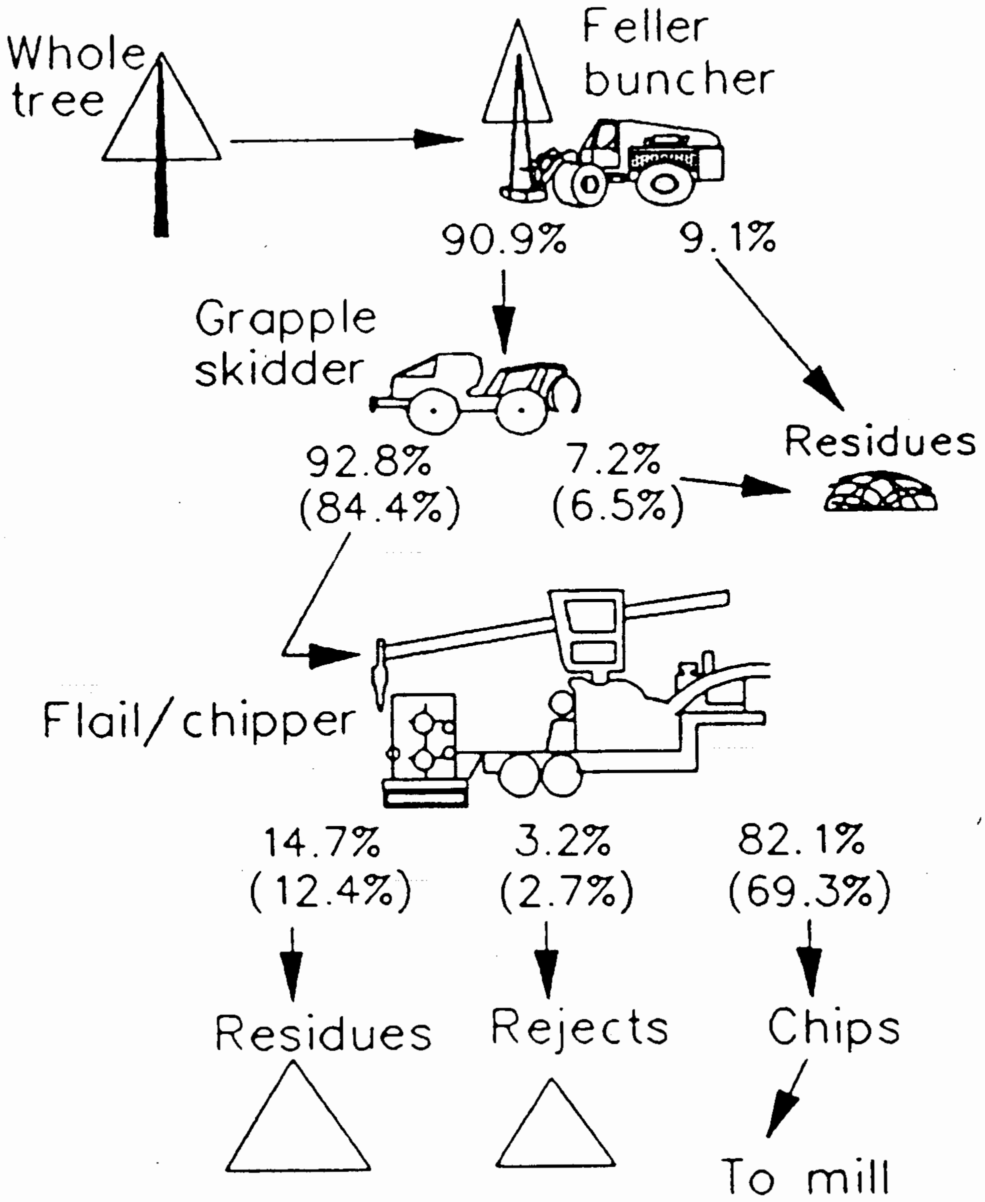


FIGURE 9

Example Control Chart for Oversize

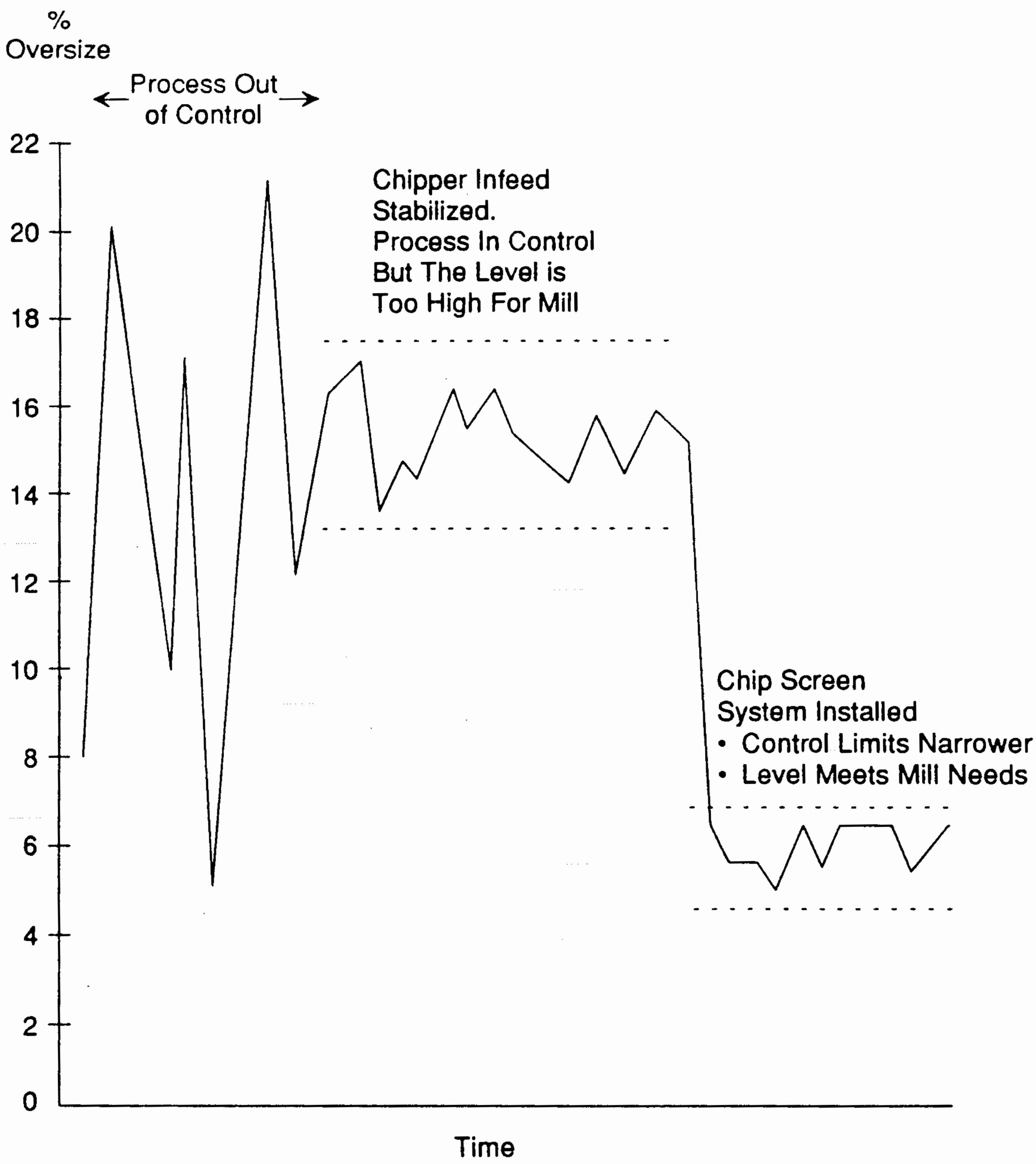


TABLE 1

Impact of Poor Maintenance/Operating Practices on Chip Quality

Size Fraction	Best* SOA	Excessive Anvil Gap	Worn Blower System	Hardwood in Softwood Chipper
Overlength, +4 -5 mm	2	2	1	3
Overthick, +10 mm	4	4	3	10
Accepts, -10 +7 mm	85	80	73	82
Pins, -7 +3 mm	7	10	17	4
Pan, -3 mm	2	4	6	1

*For Softwood Long Logs Through a Disc Chipper

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