KEY ATTRIBUTES ASSOCIATED WITH VENEER QUALITY TIMBER THAT MAY BE IMPACTED BY FOREST MANAGEMENT PRACTICES

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ABSTRACT.—Veneer log prices are commonly 4 to 10 times the price of grade 1 sawlogs yet veneer quality trees constitute less than 1 percent of the hardwood timber resource in the northeastern United States. Veneer manufacturers and their customers impose guidelines in specifying wood quality attributes that are very discriminating but poorly defined (e.g., exceptional color, texture, and/or figure characteristics). In order to better understand and begin to define the most important attributes that distinguish veneer logs from sawlogs and high-end from low-end veneer logs, we are conducting a series of studies in which we are collecting veneer log attribute information from veneer log buyers and sellers, veneer manufacturers, and veneer sales personnel. Broad veneer log quality requirements and specific requirements for the most highly demanded veneer log species (cherry, red oak, white oak, white ash, black walnut, sugar maple, and yellow-poplar) are being elucidated. The relative importance of critical, but often subtle, veneer log quality attributes are examined for each of these species. Guidelines for assessing the true veneer value potential of high-quality trees can be based on buyer-cue based log attribute metrics. Important veneer attributes include log form, growth-ring consistency, heartwood/sapwood proportion, and wood color as well as the more obvious defects. Forest managers can consider the relative importance of the different attributes when they initiate silvicultural techniques to produce high-quality hardwood timber.

Introduction

Veneer Log Value and Markets

The pinnacle of log quality for hardwood products manufacturers is the appearance-grade veneer log — logs that are capable of producing veneer that is highly visually appealing (as opposed to veneer that is used in hidden applications). But high-quality trees that contain these top-quality logs are relatively rare, representing less than 1 percent of the hardwood sawlog inventory in the northeastern United States (Hoover and Gann 1999). Because of the high value of the veneer product that comes from appearance-grade veneer-quality trees and their relative scarcity in the forest, these trees command a significantly higher price than do trees that contain only sawlogs. The veneer logs cut from these highest quality trees typically cost from 1.5 to 6 times the price of grade 1 sawlogs. Because of the exceptionally high prices that are paid for veneer-quality trees, a large portion of a quality stand's timber value may be derived from only a small fraction of the trees in the stand. These price differentials can provide significant economic incentive for both the landowner and the logger to manage their resources to optimize the production and recovery of veneer logs.

When managing a timber stand, there are many things that, if done wrong, can damage trees and greatly reduce the price that the landowner receives when he/she decides to sell his/her timber. Timber value is lost if the timber harvest is mistimed; for example, when veneer-quality trees are removed before they are of sufficient size. Also, if potential veneer-quality growing stock is cut or damaged during thinning operations veneer log yield(s) will be reduced. Alternatively, if too much growing stock is removed during thinning, wide growth-ring spacing may ensue, which decreases the value of a veneer log. Other timber management strategies that might be less obvious also affect the value returned to the landowner. By enhancing our knowledge of veneer-quality requirements, we can better understand how these other management practices influence the yield of veneer-quality timber. With lower value products (e.g.,

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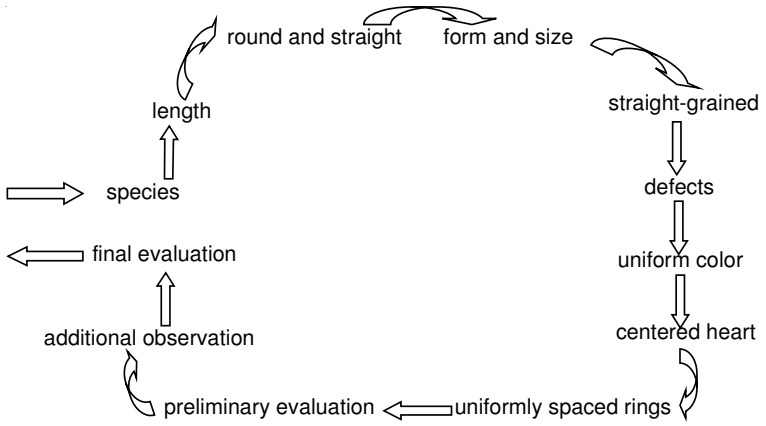

Figure 1.—Veneer log procurement is an iterative process.

rubberwood, medium density fiberboard, plywood) coming into greater use in the construction of furniture, worldwide demand for U.S. hardwood veneer is rapidly increasing. This will lead to continuing price inflation for veneer-quality timber and stronger incentives to manage prime timber stands to promote the yield of the highest-grade sawlogs and veneer logs.

Veneer Procurement Judgment Tasks

In our previous research, wide variations in the decisions made and values assigned in veneer log procurement have been observed. For example, the definition of acceptable ring count (e.g., fine, medium, or loose texture) varies widely among individual buyers. Ring count also is an attribute on which secondary manufacturers place great importance. This attribute is important for forest management as well. Forest management decisions such as choosing between clear-cutting, single-tree selection, or crop-tree release treatments can be directly affected by the weight buyers place on ring count. The most familiar judgments made by buyers during log procurement have to do with species and several log quality attributes: 1) butt or upper logs (log form and size); 2) freshness of cut; 3) roundness and straightness; 4) straight-grained; 5) free of knots, bark distortions, decay, seams, and bird peck on each of the four log faces; 6) heart (pith) centeredness; 7) color uniformity; and 8) uniformity of ring spacing.

The diagnostic evaluation of logs can be considered an iterative process (fig. 1) that begins with the species and moves through an evaluation cycle until a final decision is arrived at (e.g., Prime plus, prime, select, No. 1, No. 2, etc.).

Social Judgment Theory

SJT is a systems-oriented viewpoint for analyzing human judgment in discrete ecological (i.e., environmental) situations. According to SJT, an individual does not have direct access to information about objects in the environment. Instead, one's perception of those objects influences judgment(s). Perception is an indirect process, mediated by the set of proximal cues one receives. It is assumed that judgments result from the integration of "*cues*" or sources of perceptual information arising in the "*ecology*" (environment). SJT includes representative design, cues (i.e., information), multiple correlation, and regression, and the Lens model (fig. 2).

Brunswik's SJT focuses on achievement and the degree to which a subject successfully attains his/her goal is *achievement*. One of the primary benefits of SJT is the derivation of criterion values (correct values) or achievement that arises from analysis and permits the researcher to compare judgment processes to the environmental processes and also judgments between the subjects. Processes and judgments have a common interface that includes the proximal cues in perception and the *task system* and the *cognitive* (judgmental) system. The task system is defined in terms of the relations between the cues (X_i), the distal variable (Y_e), and relations among the cues (X_i). The cognitive system is defined in

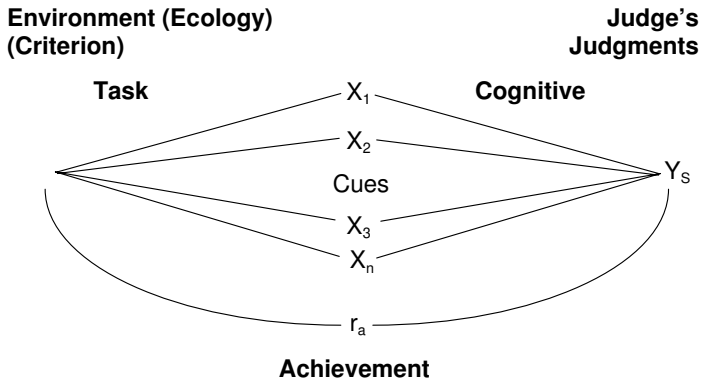

Figure 2.—Brunswik's Lens Model.

terms of the relations between the cues (X_i) and the judgment (Y_s). R_a is achievement, which simply is how good the judge's judgments are when compared to other judges, criterion, or other distal variable(s) of interest. Comparison results in cognitive feedback as a tool to facilitate discovery and learning (Cooksey 1996).

SJT allows for the decomposition of the judgment process after the judgments have been rendered (*a posteriori*) and is accomplished by multiple regression analysis to recover both cue weights and prediction equations. "Brunswik's Lens Model" is employed next, it allows for comparisons between judgments, subjects, and ecological systems. Brunswik's representative design emphasizes sampling subjects in their environment.

SJT is appropriate for researching veneer log procurement. The tasks for log buyers involve making decisions under uncertainty that require the evaluation of visual cues (e.g., species, diameter, length, attributes, and defects). For example, log buyers must decide whether to purchase logs based on the aforementioned cues, which also include color, grain pattern, and blemishes as well. Other, but not all, uncertainties include: is the color consistent throughout the log, is the grain pattern consistent throughout the log, are blemishes extensive or are they confined, and market uncertainties. There are no heuristics for predicting buyer judgments or success. Buyers must make many such judgments daily, but little is known about how buyer judgments are made or how accurate the judgments are.

Decisions about the end-user market are equally important and judgments are typically made during the evaluation process and before log evaluation is complete. From an SJT perspective, buyers generally do not have access to information about cue weighting and the degree of uncertainty in their judgments. From a researcher perspective, minimal attention has been paid to the utility of these evaluation cues in distinguishing one attribute or defect from another. This has occurred because necessary information was either unknown, or unavailable, and varies from setting to setting (i.e., regional differences in veneer log attribute requirements).

Objectives

Our overall project goal is to identify and learn how to influence those tree growth attributes that have the greatest effect on the quality and value of high-grade hardwood logs. The objectives of this study are to:

1. identify critical factors in the selection of logs for veneer,
2. identify relationships between those attributes/defects that may assist veneer buyers in assessing the quality of logs,
3. discern the allowable variability along those factors, and
4. produce metrics that can be used to evaluate the veneer potential of trees grown under different forest management systems.

Methods

To determine the most important attributes that distinguish veneer logs from sawlogs and high-end veneer logs from low-end veneer logs, we conducted informal surveys with 3 veneer log graders (buyers for a veneer producer), 4 veneer log brokers, 15 veneer producers, and 1 veneer broker (table 1).

Table 1.—Initial participants in survey to determine the most important veneer attributes.

Business type	Location	Number
Veneer producers	IN	6
	KY	1
	OH	2
	PA	2
	VT	2
	WV	2
Veneer brokers	PA	1
Veneer log brokers	PA	3
	WV	1
Log buyers	NH	2
	WV	1

Subsequent to our initial survey, Social Judgment Theory (SJT) will be utilized to conduct a more rigorous assessment of veneer log characteristics. SJT has been used to evaluate decision-making in several disciplines (e.g., physician decision-making, weather and climate forecasting, managerial decision-making, workplace judgments, etc.). By investigating the decision-making process, we will be able to ascertain salient veneer log attributes and/or defects via analysis of cues and the weights of log buyers, and then develop evaluation metrics. SJT will be employed in evaluating decision-making among log graders and buyers as they appraise the quality of veneer logs. If graders and buyers utilize different criteria to evaluate veneer log quality, then inefficiencies are created in log procurement. For example, suppose log buyers place substantial weight on the quantity or discrete types of defects (character marks) in the log, while others do not and thus reduce the value of a log as a result of these marks. Greater efficiency and cost savings can occur given a higher level of coordination among the criteria used to evaluate veneer logs.

Applications of SJT to Procurement Judgments

In this research project, we will incorporate a strategy-capturing policy at the idiographic level. Strategy capturing refers to research that analyzes how buyers weight cues in making judgments (i.e., the right hand side of the lens model). A single system design (fig. 3) will be utilized where buyer judgments are measured in the absence of final criterion (Y_e). Strategy capturing does not provide a method to measure the accuracy of buyer judgments because the final criterion have not been established (e.g., research on final clipping decisions, consumer preferences). Essentially, we are researching the value systems or establishing which cues are important to judgments and how they are utilized (Ullman and Doherty 1984). However, it should be noted that ongoing and future research includes both double and triple system designs where buyers, clipping technicians, and consumers' judgments will be evaluated simultaneously. This will allow for the opportunity to discern inefficiencies in the procurement, manufacture, and marketing chain.

This research is addressing several pertinent issues (adapted from Wigton 1996):

1. Do buyers use cues that are generally recognized as important?
2. Do they use previously unrecognized or irrelevant cues?
3. Do buyers use cues similarly?
4. Do buying strategies become more similar as experience increases?
5. Do buyers utilize all of the information available in making judgments or just a few cues?
6. How do weights elicited in this manner compare with self-described strategies?
7. Can strategies be characterized or clustered in meaningful ways?
8. Can we identify clusters of buyers with similar strategies?

These questions relate to a buyer judgment model. This research design also has a non-ubiquitous aspect in that all buyers respond to the same set of cues: species, logs, and their respective attributes

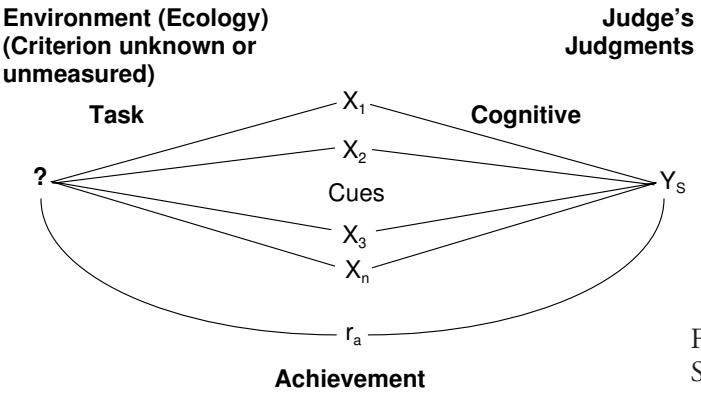

Figure 3.—Brunswik's Lens Model – Single System Design.

and defects. Wigton (1996) references Ullman and Doherty (1984) and states this will allow for the opportunity to examine additional questions regarding the variation among buyers:

9. Do buyers have similar means and variances?
10. What is the correlation among judges (buyers)?

Population and Sample Frame

The sample frame consists of members of the Hardwood Plywood and Veneer Association (HPVA), which includes approximately 30 firms. The subjects will include veneer graders and buyers, or both. A census (i.e., 100% sample of graders and buyers) will be attempted for each species.

Cue Development and Testing

In pretesting, multiple photographs of cherry logs (as a stimulus) have been created for use during the interviews with the log buyers. These photographs vary from extremely high quality logs, to those that have various character marks. After pretest interviews, revisions will be undertaken, if necessary. The stimuli (i.e., photographs of the log and veneer slices) and a questionnaire instrument will be administered to assess perceptions of the log attributes in the sample.

Data Analysis

Data analysis will take two basic forms: multidimensional scaling (MDS) of the attributes associated with the veneer product, and a regression approach for the policy-capturing component of the research. MDS will allow for a perceptual map to be produced and regression will yield the relative weights buyers place on the veneer log characteristics. The goal of a strategy policy capturing approach using multiple regression is to produce a linear equation that optimally weights each cue in terms of the discrete cue's predictive contribution to the judgments (Cooksey 1996). The judgment model is presented below:

$$Y_s = \underbrace{[b_0 + b_1X_1 + b_2X_2 + b_2X_2 + b_3X_3 + \ldots + b_kX_k]}_{\ddot{Y}_s} + \varepsilon$$

where;

b_0 = regression constant,
b_i = cue regression coefficient,
X_i = cue,
Y_s = judgment,
ε = error.

Upon judgment model capture, judgment predictor values can be produced for each case in the judgment task. Correlation between authentic judgments and corresponding predicted judgments across *m* profiles results in a goodness-of-fit measure for the regression model, which R_s is the term for a discrete captured judgment policy. R_s^2 is the squared multiple correlation and yields the proportion of judgment variance that has been captured.

Cue Weights

Cue weights are critical in assessing the salience or degree of importance as the researcher is developing metrics from these weights. One method for assessing the cue sensitivity is to standardize the raw regression weights and convert cue scores to standard *Z*-scores. The modified judgment model would take the form of:

$$\underbrace{Z_{Y_s} = \bullet_1 Zx_1 + \bullet_1 Zx_1 + \bullet_1 Zx_1 + \ldots + \bullet_1 Zx_1 + \varepsilon}_{ZY_s}$$

Prediction now concerns the standard score for each judgment; each β_i provides a less ambiguous indicator of cue importance (Cooksey 1996).

Results

Initial Survey Results

The hardest-to-see veneer log defects, according to the veneer log buyers we spoke with, are bird peck, T-shaped scars, pin knots, ingrown bark (especially in cherry), and insect-induced localized defects such as glass worm in ash and sugar streaks in maple. Most log buyers surveyed indicated that sugar maple is the most difficult species in which to predict veneer log quality. White oak also was cited by multiple sources as being particularly difficult to evaluate. Red oak, ash, and walnut are considered easy species in which to judge quality. Cherry, in some regards, is simpler to evaluate. However, pin knots and gum pockets are important defects in cherry that can be difficult to detect from an external examination. Also, some cherry logs have extremely flaky bark, which is much more difficult to read.

These generalized quality standards for veneer logs may be more or less important depending on the veneer market segment, species, and manufacturing system. For instance, logs above the butt log are acceptable when large trees with high crowns produce second logs of large diameter that do not have any branches. However, due to pin knots, the closeness to the surface of overgrown knots and smaller bole diameter, the majority of high quality veneer logs are butt logs – from 60 to 98 percent depending on species. Species that grow straighter with less taper, such as cherry and yellow-poplar, will yield more veneer logs from upper portions of the tree than will white oak, walnut, and hard maple.

Tapered or elliptically shaped logs can be a problem for some veneer products, but can be an asset if veneer with cathedral pattern is desired. Even severe butt taper is usually not a serious problem because it is removed with “butt reducers” during log preparation prior to peeling or slicing. A butt reducer grinds off buttresses and swollen bases and is usually accompanied by debarking. However, grain deviations associated with taper may be a problem if the veneer will be bent for furniture parts or woven into baskets.

Sweep is a defect that reduces the usable volume of a veneer log and affects the grain pattern of the veneer. The altered grain pattern can decrease the grade and value of the veneer. In addition, sometimes the change in grain direction characteristic of sweep causes buckling in certain types of high-end veneers. Crook is similar to sweep but usually is caused by deflection of the main stem caused by a major branch. Thus, in sectioning logs with crook prior to slicing, the position of the branch knot also must be considered.

External evaluation of logs includes not only log form, bark, and outer-wood evaluation, but also evaluation of log ends. Some log defects, such as gum in cherry, sugar streak in maple, and worm holes in

several species are seen only on the freshly cut ends of logs. Log buyers will spray log ends with water to enhance the visibility of the hardest to see defects (e.g., sugar streak and mineral stains/streaks). Growth ring consistency (or texture), density, and wood color also are judged by viewing log ends. The location of the pith (centered or off-centered) and evidence of tension wood (which can buckle and tear in the manufacturing process) are evaluated here too. Finally, the heartwood and sapwood content of logs is assessed by looking at the two log-end cross-sections.

Although centered heart and uniformly spaced rings are important for production of sliced veneer with symmetrical appearance, some cutting methods can bypass this requirement. Veneer manufacturers report a tendency for logs with off-centered piths to be more prone to splitting. Off-centered heart is addressed when the log is flitched (cut into sections) in the sawmill — the log is flitched so that the edge of the log sections goes through the pith. By doing this, the pith is contained in the part of the flitch that is not recoverable as veneer (called the backing board).

Non-uniform rings (or double texture) are less of a problem in the furniture-grade veneer market since this veneer is generally cut into smaller face sections than is door and panel veneer.

Sapwood is desirable in maple, ash, yellow-poplar, hackberry, sycamore, and sometimes in birch and hickory, whereas heartwood is desired in walnut and cherry. Sapwood color may be critical, such as in architectural panels and high-value furniture, or it may be less important when used in strips that will be dyed or given clear but darkening stains, such as basket-weaving strips. In white oak, red oak, hickory, and sometimes yellow-poplar, the heartwood-sapwood distinction is less important due to the color consistency between the two wood regions and less intense product color requirements.

Based on knowledge we gained from this series of visits with veneer log procurement and production personnel, it is evident that subtle appearance factors are critically important determinants of veneer value in both domestic and foreign high-end veneer markets (architectural, door, and panel). Therefore, these subtle factors are of keen importance to log buyers/graders when purchasing and sorting/selecting logs for processing to supply these high-end markets. The basic color (shade) of the wood is important for all species, but especially so for maple, walnut, ash, and white oak in today's veneer markets. Minor color variations and blemishes are considered defects in these three high-end veneer market sectors since these sectors require large veneer sections of consistent appearance. Thus the color variations caused by insect pests are a concern. These include gum pockets and rings in cherry, sugar flecks in maple, and glass worm in ash. Mineral streaks in oak and maple also are important since they too cause color variations that are defects in high-grade veneer. Next to color consistency, grain pattern consistency is almost as important. The texture of the growth-ring pattern must be uniform (i.e., consistent rate of growth) and the grain must be relatively straight.

Expected Results from SJT

Social judgment theory's statistical and conceptual approach provides a most informative method for assessing and analyzing several factors of the veneer log procurement process. As veneer procurement and production becomes more competitive, SJT allows for valuable insights. These insights include categorization and metrics for attributes and defects, ring count metrics for procurement and forest management, and useful information on the weights buyers place on other elements of the procurement process.

Expected Impact

Foresters will have better information on critical attributes affecting stand quality and value which will allow them to make forest management decisions that will promote optimal financial return to the forest landowner. In addition, timber sales consultants will be more aware of those criteria being used by buyers of high-quality timber when they make their pricing decisions; this will remove some of the ambiguity from the timber sales process so that the highest possible return to landowner is realized. Finally, the attribute importance ratings and metrics derived in this study can be used by individual companies to

produce a judgment system that will lead to more consistent procurement among company timber and log buyers.

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