Better Utilization of Low-Grade Woods

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The objective of this paper is threefold: to outline briefly some of the avenues of approach so far employed in utilizing low-grade wood, to comment on the economic aspects of the problem, and finally, to speculate about what developments the future might bring to the field of utilization.

It appears to the author that it is worth while to list those attributes which define the general term "low-grade." While the title adjective is applied to wood as such, it needs also to be applied to the standing tree, for it is the low-grade tree that causes our most difficult economic utilization problems.

A list of attributes that cause a tree to be classified as "low-grade" (from a utilization point of view) would include the following:

1. Undesirable species;
2. Small diameter;
3. Short;
4. Crooked;
5. Full of defects such as knots, shake, crooked grain, rot, insect damage, and inclusions of various kinds.

A similar tabulation of properties that cause wood itself to be termed "low-grade" would include the following:

1. Knotty;
2. Available only in small size;
3. Rotten to some degree or containing insect damage;
4. Weak;
5. Not durable;
6. Not straight grained;
7. Difficult to dry;
8. Unstable, i.e., shrinks and swells excessively;
9. Low in resistance to warping;
10. Difficult to machine;
11. Poor in ability to hold nails and screws;
12. Low in split resistance;
13. Poor in ability to hold finish.

As this discouraging list of negative qualities is studied, it appears that it is technically possible to overcome all of them if economic factors can be ignored. The utilization methods employed are almost endless, but a partial list would include the following:

1. Design the finished product to compensate for the inadequacy of the material used in its naturally occurring log-run form. Pallets manufactured from low-grade oak illustrate this idea.

2. Through care in manufacture and good marketing sense, convince the consuming public that a certain portion of these defects are in reality interesting and desirable attributes. Knotty pine (or pecky cypress) paneling is an obvious example of this approach.

3. Upgrade by simply removing that portion of the stock that causes the low-grade classification. Hardwood flooring and industrial cut stock afford two good examples of this method.

4. A refinement of the above-mentioned method involves defect removal followed by reassembly into pieces of the desired size. This reassembly can be accomplished in three different dimensions: i.e., lengthwise, as in the manufacture of finger-jointed long moldings; end- and edge-gluing, as in the manufacture of long, wide, pine panels (also redwood casket stock); or in thickness, as in the manufacture of plywood. In one respect, plywood lamination has a tremendous utilization advantage, as it permits the incorporation of some low-grade material in the interior plies, whereas the end- and edge-glued products can use only high-grade material.

5. Through the addition of other material, alter the properties of the original wood product in such a way that the weakness of the low-grade attribute is neutralized or masked. Examples of this approach are far too numerous to be listed, but some of them might include the following:

a. Overlays.
   (1) Kraft paper overlay on 2 ft. by 8 ft. 4/4 panels manufactured from S2S boards of mixed species. These panels can be used for house sheathing.
   (2) Hardboard overlay on lumber and veneer core for use as a high-performance siding.
   (3) Printed overlays of various kinds to completely mask the natural characteristics of the base material.
   (4) Resin-impregnated fiber overlays to change the surface characteristics and mask the defects in the base material.
   (5) Overlays of nonwood materials. These would include aluminum, porcelain on steel, glass, etc.
   (6) Wood veneers over lumber cores.

b. Chemical bulking or impregnating to increase stability and improve physical properties.

c. Impregnation with toxic agents to increase durability.

d. Impregnation with fire-retardant chemicals.

6. Through mechanical flaking, chipping, defiberizing, or grinding followed by reconstitution (with additives), create a material with entirely different appearance and physical properties. Examples would include particle boards, flakeboards, some fiberboards and hardboards, as well as a multitude of molded products.

7. Through chemical digestion and reconstitution create an endless variety of pulp and paper products, each with special properties.

8. Through chemical utilization produce a variety of products other than pulp and paper. The wood charcoal industry falls into this category and is an important consumer of low-grade wood. Other illustrations would include the manufacture of chemicals from bark and the manufacture of fertilizers and composts from mill residues.

It is the author's opinion that the economic side of

the utilization problem is a great deal further from solution than is the technical side of the problem. To generalize, it is desirable to harvest a low-grade timber resource only if it will advance the economic development of the area. The utilization of a resource of negative conversion value serves to retard economic development. It is evident that the entrepreneur must be meticulous and critical in his evaluation of what constitutes the actual cost of extraction and remanufacture of a low-grade wood resource.

In many forest areas, low-grade trees grow in conjunction with good stands of excellent timber. It is, therefore, relatively easy to let the good portion of the stand bear the full burden of access and development costs and place a minimum or even negative stumpage value on the low-grade trees and assign to them only the incremental or additional portion of costs involved in their removal. Unfortunately, some important forest areas of the world have virtually no high-quality timber, and the forest cover is composed almost completely of low-grade trees which, in turn, produce low-grade wood. It is in this situation—where the low-grade timber must bear the full cost of access, extraction, and manufacture—that economic utilization is most difficult.

While it is relatively easy to find an economic use for clear trim ends that are a zero-cost byproduct of a high-quality ponderosa pine log, it is quite a different problem to start out with a forest of low-quality trees, against which the full charge of forestry, logging, sawing, and remanufacturing must be charged. To use a different example, it is one problem to design an economic hardboard production unit utilizing the bark-free slabs and edgings from high-quality Douglas-fir logs and quite another (and more difficult) problem to harvest a mixed-species, low-quality scrub forest for the sole purpose of converting it first to chips and then to hardboard. In the latter case, the end product is not only technically more difficult to achieve, but it must also bear the full cost of the harvest, without any high-grade material being removed en route to pay the major part of the expenses.

In many regions of the United States we are confronted with exactly this situation, and no good solution seems to present itself. The retardation of economic development in some of these areas is frequently traceable to operations that are attempting to extract and remanufacture a raw material that has a negative economic value.

From the foregoing discussion one might conclude that the sensible thing to do is manage the forest lands of the world in such a manner that, in the future, only high-quality trees will be grown. While this is an admirable goal, we unfortunately are faced in the here-and-now with the presence of huge volumes of low-grade wood that must be used as it stands or not at all.

As the years have passed we have seen better and better wood utilization, and the product of the tree has been transformed into an ever-wider range of products. It is probable that all residual materials from high-quality logs can be economically utilized, if we assume a minimum raw material cost for these residues. The waste product that is discarded in the largest quantity by otherwise integrated mills is bark. For those mills that are financially able, it is probable that within a relatively few years a wider range of economic possibilities will present itself for the utilization of this important fraction of the tree's total volume.

One might, therefore, conclude that if we could find an economic use for the low-grade lumber itself, we might then economically utilize all of every log. The almost unsurmountable obstacle to such complete utilization of the whole log remains the fact that if we are to assign zero or nominal values to the residual materials, then we must assign realistic values to the low-grade lumber itself that is sawn from the low-grade logs.

In some instances this dilemma may be sidestepped by chipping the entire log. It appears that in some areas where stumpage price is at a minimum, stands pure, volumes high, and logging costs low it is economic to base a flakeboard, hardboard, or pulp plant on a raw material source which would be entirely uneconomic for conversion into lumber.

Repeatedly, however, we are confronted by the problem of forests comprised of low-density stands of low-grade trees of mixed, undesirable species. As of this date, it is difficult to find a solution that is economic even in a marginal sense. What one hopes to find is a solution that is sufficiently profitable to permit the allocation of enough money to treat each acre harvested in such a manner that a more usable future crop of trees may be produced on the same ground. It is probable that a general solution to fit all areas will not be found. It may be more fruitful to seek a special solution applicable only to the area under study.

Suppose the problem is attacked by asking the question —What is the end use of most of the wood harvested in the United States (exclusive of pulp and paper)? Statistics are available to show that home construction is, by far, the most important single market for wood products in the United States today.

Consider the northeastern section of the United States. This area is amply endowed with forest cover, some of which is high-grade but most of which must be classified as mixed-species stands of low quality. The outstanding feature of this forest cover (other than its low quality) is its proximity to one of the biggest housing markets in the world today. By way of illustration, the New England States plus New York, New Jersey, and Pennsylvania had, in 1950, a population of approximately 40,000,000, which is twenty-six percent of the total population of continental United States. While the region is not expanding as fast as some regions in the United States, it is still growing at a fairly impressive rate.

It is conceivable that it may be an economic possibility to carry on a vertically integrated operation that harvests the trees in this forest cover and, after manufacture, markets finished houses to ultimate consumers. In essence, the operation would consist of the manufacture of lumber from these stands, with that portion of the cut that is in demand by retail yards and industrial accounts being so marketed, and with the unmarketable portion being converted into house components.

At first glance, this must be greeted with considerable skepticism. However, the idea picks up considerable appeal when one reflects on the reluctance of retail lumbermen to stock some species and narrow or short lumber of any species, in spite of the usability of such lumber in

home fabrication. It is now becoming evident that an increasing percentage of the houses of the future are going to be constructed from components. When one observes that the most popular module for house-wall components is 4 feet and that ceiling heights are on the order of 7 or 8 feet, it becomes apparent that short lumber has a definite place in the construction of these components for both dimension and sheathing. The same observation can be made about floor systems that employ full-span floor girders on 4-foot centers, with 4-foot-wide component floor panels assembled over a grid of short 2x4's. The roof system of a house may be designed to use short structural members fabricated into trusses for use in conjunction with low-grade 4/4 roof sheathing, or it can be designed to use beams on 4-foot centers with a roof sheathing system similar to the previously discussed floor system.

Consider for a moment the type of product mix that can be designed into a house fabricated from lumber components. Out of a total of perhaps 10,000 board feet of lumber per house, one-fourth might be short dimension lumber cut from low-grade spruce, hemlock or even mixed hardwoods (consider how effectively the pallet manufacturers utilize short hardwood), one-half might be low-grade hemlock, spruce, or pine used as sheathing, subfloor, and roofers, with the remaining one-fourth being interior and exterior pine finish, finish flooring, exterior siding, and interior paneling.

It is to be kept in mind that such an operation contemplates good manufacturing control, including well-operated kiln and planing facilities. It might also be observed that it requires perhaps 10,000,000 board feet of lumber production a year distributed through normal wholesale channels to bring in $1,000,000 gross volume, whereas only 75 houses, consuming perhaps 750,000 board feet of lumber, will also bring in a gross revenue of $1,000,000.

One other aspect of utilization in the northeastern section of the United States (and in many other areas of the world as well) is worth considering. As the population grows, the demand for undeveloped land is certain to increase. In considerable areas of the region, this demand for land may preclude the possibility of holding forest land for the long rotation periods necessary to convert the presently existing scrub to something more usable. Thus, we can predict the situation where some areas of low-grade woodlands will be harvested, and within a relatively few years the ground may be converted from forest land to industrial site, superhighway, residential site, or perhaps recreation area. To reinforce this prediction, one has only to observe the real estate divisions of the State of Washington.

In the first part of this paper there have been listed some of those attributes which define the term "low-grade," when applied to trees and wood. Also tabulated are some utilization processes whereby low-grade wood can be converted into useful products. The economic aspect of the problem of low-grade wood utilization appears to be much more difficult to solve than the technical aspects of the problem. As briefly illustrated, there may be special solutions for each forest area that do not apply to all areas generally, and it is for these special solutions that the entrepreneur, the technologist, and the economist must look.

RESUMES

Vers une meilleure utilisation des bois de qualité inférieure

Le présent document définit l'expression "qualité inférieure" comme étant applicable à la fois aux arbres sur pied et au bois, et énumère les caractéristiques qui contribuent à faire entrer un bois dans cette catégorie. On trouvera également une liste des méthodes d'utilisation représentatives actuellement appliquées pour convertir les bois de qualité inférieure en produits pouvant être utilisés. Nous avons souligné que l'aspect économique du problème de l'utilisation des bois de qualité inférieure semble être beaucoup plus difficile à résoudre que son aspect technique. Nous estimons en conclusion qu'il n'existe pas de solution d'ordre général à ce problème et que chaque cas particulier doit recevoir une solution spéciale.

Mejor Aprovechamiento de Maderas de Baja Calidad

En el presente trabajo se define que el término "baja calidad" es aplicable tanto al árbol en pie, como a la madera. Se especifican algunas de las condiciones que contribuyen a la clasificación de árboles o maderas "de baja calidad." Asimismo se enumeran algunos ejemplos de métodos de utilización que se emplean en la actualidad para convertir maderas de baja calidad en productos útiles. Se observa que el aspecto económico del problema de la utilización de maderas de baja calidad parece ser mucho más difícil para resolver que el aspecto técnico. El autor arriba a la conclusión de que no será posible encontrar una solución general y de que será menester buscar una solución especial para cada caso en particular.