Forest Products Utilization and Marketing—a Selected Bibliography of Technical Publications

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Abstract

This paper provides a selected bibliography of forest products utilization and marketing (U&M) publications of interest to Federal, State, and Extension U&M personnel. Renewed interest in U&M technical assistance by the National Association of State Foresters (NASF) and the USDA Forest Service, calls for rebuilding U&M capacity. Consequently, the author initiated a project to determine and ultimately provide this technical information. Topical areas include: forest products utilization and marketing references, log grading and scaling, lumber manufacturing (sawmilling and drying), lumber recovery, veneer, secondary manufacturing, business management, industrial development, marketing, and other resources in addition to basic wood technology references.

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Disclaimers

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Forest Products Utilization and Marketing—a Selected Bibliography of Technical Publications

Introduction

This paper provides a selected bibliography of information of interest to the Forest Products Utilization & Marketing (U&M) specialist. It is intended primarily for Federal, State, and Extension U&M specialists as reference source of important publications for use in their work in providing technical assistance to industry, communities, land managers and the general public. Based on recommendations of several veteran U&M specialists, this selected bibliography provides some of the best sources of technical information pertinent to U&M work. The scope of U&M technical assistance is also explored.

History and Development of Utilization & Marketing Assistance

The wide scope and breadth of today's forest products U&M work can be better understood by reviewing the historical development of U&M assistance (Dramm 2001a). Forest products utilization and marketing (U&M) technical assistance improves quality and efficiencies of wood products manufacure, helps develop stronger wood product markets, and improves the economics of utilizing forest resources by the adoption of advanced technologies in forest harvesting and wood processing. Improved utilization and marketing of forest resources helps sustain rural forest dependent communities and stretches the Nation's available wood and fiber raw material supplies. U&M assistance has been an integral part of economic/rural development as well as pioneered forest products conservation over the past 100 years. From 1900 to 1990, the U.S. industrial roundwood product output per cubic foot of industrial roundwood input increased by 50 percent (Zerbe 1999). This is accounted for by the improved efficiency of converting forest resouces (e.g., logs) into usable primary products (e.g., lumber) made possible by forest products utilization research, technology transfer, and technical assistance.

Wood utilization assistance roots trace back to USDA Forest Service Research with the establishment of the Forest Products Laboratory (FPL) in Madison, Wisconsin in 1910. Initial work (1910–1913) was geared towards the basic understanding of wood, including engineering, mechanical, and chemical properties; wood identification; wood preservation; and plywood technology. Early on, the FPL realized that technical assistance to the forest products industry would be critical role in addition to its research mission.

During World War II the Timber Production War Project (TPWP), created by the Forest Service and the War Production Board, helped stimulate production of lumber, veneer, pulpwood, and other vital forest products. The FPL developed a number of publications for the numerous small mills filling war material needs (Telford 1943). Not only did these FPL publications cover manufacturing basics, but they also included information on how to conserve tires and fuel, how to construct materials-handling devices with limited available materials, and recycling for the war effort. The Forest Service, in cooperation with States, provided direct assistance to improve manufacturing efficiency in the forest products industry. Sawmill operators, loggers, and other forest workers were able to obtain scarce gasoline, tires, trucks, and other equipment needed to keep up production for the war effort.

Technical assistance was expanded after World War II, when Forest Service Research established the Forest Utilization Service (FUS) for improving technical assistance and economic development through the wise use of the nation's forest resources. FUS units throughout the nation provided each of the regions of the country with research-trained wood utilization specialists in expertise. The major focus of the FUS program provided assistance for industrial development particularly where new technologies or new products could be developed (Bergoffen 1976). The FUS met twice each year at the Forest Products Laboratory to help guide utilization research.

The first large-scale U&M technical assistance effort by State & Private Forestry (S&PF) involved in salvaging timber from the great hurricane of 1938 in New England. Recovery efforts salvaged an estimated 2.6 billion board feet of blown down timber. The Forest Service salvaged and purchased usable logs and provided long-term storage in log ponds to be gradually absorbed by the log market. Efforts even included the operation of Forest Service owned sawmills to process salvaged logs (Smith 2000).

Under the Cooperative Forest Management Act, established in 1950, the Forest Service strengthened S&PF Cooperative Programs to give direct technical assistance to private forest landowners and operators and to processors of forest products. The Act expanded authorizations to include harvesting and marketing of forest products. Technology transfer of Forest Service research results and technical assistance responsibilities moved to the newly established Forest Products Utilization program under State and Private Forestry, Cooperative Forestry. The first task for the newly established S&PF Forest Products Utilization (FPU) Program was to develop new recruits from a cadre of State and Federal field foresters. A training plan for S&PF utilization and marketing (U&M) personnel was developed (Page 1966) and followed up with an extensive and intense 6-week U&M training session conducted for the new FPU recruits.

Forest Products U&M Specialists were required to have a broad background in forest products technology, utilization, marketing, economic feasibility, wood and fiber products, resource supply, and forest management. They provided on-the-ground technical assistance, knew the pitfalls of ideas that may not work, and suggested modifications for improved likelihood of project success. Above all, good salesmanship and the ability to build rapport with clients were paramount requirements of the U&M specialist (Page 1966).

One of the most successful accomplishments achieved through cooperative technology transfer was demonstrated by Forest Service utilization research and U&M Federal, Extension, and State programs in response to overcoming the increased demands for improved sawmill conversion efficiency. To this end, the Best Opening Face (BOF) system was developed at the Forest Products Laboratory (FPL) in the 1970s. Successful adoption of BOF technology by industry was made possible by a national technology transfer effort by the Sawmill Improvement Program (SIP). Sawmill assessment tools for increasing lumber recovery and improving sawmill conversion efficiency were developed. Wood Products Extension Specialists (CSREES) provided education and tools for improvement. State U&M specialists conducted SIP mill assessment studies.

Nationally, SIP was responsible for an improvement in lumber recovery of about 4% of the total U.S. softwood production. (Lunstrum 1974). Interest generated by the SIP program lead to commercialization of BOF by industry. Sawmill equipment manufacturers incorporated BOF technology with optical log scanners and computerized sawing systems to maximize recovery of softwood dimension lumber. This National cooperative FS Research, S&PF, Extension, and State effort aided the retooling and automation of the sawmill industry to successfully adapt to the shift from large old growth to small-diameter second-growth timber supplies.

The S&PF U&M program was refocussed in 1992 to expanded opportunities for improving resource conservation and was remnamed the Forest Products Conservation and Recycling (FPC&R) program. FPC&R identified three national priority issues: (1) economic development, (2) forest products conservation, and (3) recycling. FPC&R provides for integrating healthy environmental quality and economic growth through responsible use of forest resources to meet human needs. Its vision includes the continuing role of an active network of professionals capable of quick and reliable delivery of knowledge and expertise relating to the processing and marketing of forest goods and services.

Utilization Research, Technology Transfer, and Extension

Forest Service utilization research support plays a key role in developing solutions to unanswered questions, unsolved problems, and potential opportunities. Primary research institutions include the Forest Products Laboratory and Forest Service Research Stations engaged in utilization, marketing, harvesting, forest management, and economic research. Cooperative research with other Federal and State agencies, universities, and industrial cooperators are also important.

Technology transfer is a critical link between research and implementation of on-the-ground solutions to managing our natural resources and the communities they support. State and Regional assessments help identify research needs. Toward this end, the S&PF Technology Marketing Unit (TMU) stationed at the Forest Products Laboratory, Madison, WI, develops and provides technology transfer tools such as workshops, training programs for the Regional and State Forest Products Professionals, publications, promotional materials, directory of technical assistance professionals, communications and program website development. TMU provides a critical link between Forest Service Research and on-the-ground technology tranfer of research results.

Wood Products Extension personnel (Wood Products Extension Program, USDA CSREES/NRE) play an important role in utilization and marketing training and assistance. The role of Extension specialists follows traditional services provided to industry within State Extension programs. Efforts extend to include regional or national levels depending on U&M

assistance needs. Additionally, professional societies provide forums for exchange of ideas among professionals and technology transfer through technical publications.

Regionally, the USDA Forest Service, State & Private Forestry, Northeastern Area maintains the Wood Education Research Center (WERC), Princeton, West Virginia. WERC provides education, training, and technology transfer opportunities. Forest Service Technology Development Centers as well as several university, state, and private sector institutes also provide additional assistance.

Besides U&M specialists, Forest Service Research and Cooperative Extension support, other technical resources are required. These include technical publications, analysis tools (e.g., economic spreadsheets, databases, and process improvement software, and checklists for improving operations). Forums to exchange ideas regularly and shared learning are critical tools for technology transfer and continuing education for technical assistance staffs. This includes U&M training opportunities, industry tours, and pilot demonstrations, as well as field studies providing on-the-job training. Perhaps the best examples of successful forums are the Northeastern Utilization & Marketing Council (NEU&M) and the Forest Products Society's Technical Interest Groups, as well as the S&PF, Northeastern Area's Wood Education and Research Center (WERC) in Princeton, West Virginia.

Continued Need for Utilization & Marketing Assistance

The ultimate goal of U&M technical assistance is to improve the capacity to manage the Nation's forests through wise use. Such assistance provides tools for accomplishing a number of land management, rural/economic development, and objectives of National importance. The need for improved and expanded forest products U&M technical assistance centers on improved efficiency of processing and marketing of wood and fiber products. Improved processing efficiency and markets are critical for the economical use of low-value trees such as small-diameter softwoods and underutilized hardwoods. Poor market prices and limited utilization options hamper cost-effective forest and land management.

Technical assistance can take several forms for solving problems and capturing opportunities for improved utilization and marketing. Specific technical assistance may take the form of technology assessments, preliminary feasibility of technology options, technology transfer of forests products research, distribution of technical publications, and fielding technical inquiries and referrals for services not covered under the program. Current efforts focus on assistance to manufacturers, communities, and land managers to rebuild and retool processing capacity to economically use small-diameter and underutilized low-value trees in addition to more traditional improved processing efficiency and industrial development.

Since the mid 1980s, there has been a general national decline in Federal, State, and Extension forest products technical assistance program capacity. Currently, there are just a handfull of Federal specialists within the FPC&R program. Several universities maintain Wood Product Extension programs but have also seen declines in U&M capacity. Many State U&M programs west of the Mississippi River have been abandoned altogether. More recently, this also occurred in the South. The last strong hold for U&M assistance is found within the State & Private Forestry's Northeastern Area (NA). Even here, there continues to be a loss of on-the-ground U&M technical expertise. Several veteran State and Federal U&M specialists have retired or had their positions lost to budget cutbacks. Similarly, appropriate publications providing basic U&M technical information are either out-of-print or in limited supplies.

Top 25 Forest Products Utilization Publications Project

Renewed interest in U&M technical assistance by the National Association of State Foresters (NASF) and the USDA Forest Service, calls for rebuilding U&M capacity at the State and Federal levels. In an effort to meet the needs of State U&M programs, the Northeastern Area (NA), State & Private Forestry requested that a basic set of U&M technical publications be supplied to new U&M specialists. In response, the Technology Marketing Unit (TMU) at the Forest Products Laboratory (FPL) provided selected publications to several states.

A number of Federal, State, and Extension U&M specialists also suggested that the USDA Forest Service compile basic forest products utilization information packets. At a minimum, packets containing the top 10 or 20 forest products publications were proposed. Others suggested distributing a CD-ROM containing the top 100 publications. Still others suggested making this information readily available on the Internet.

As a result of these suggestions, the author initiated a project to determine and ultimately provide this technical information to all State, Federal, and Extension U&M specialists. Cooperators in the project included the Northeast Utilization and Marketing (NEU&M) Council and other S&PF Forest Products Conservation & Recycling (FPC&R) staff.

In 1999, veteran Federal, State, and Extension U&M specialists were asked to make recommendations for developing the list of forest products utilization and related publications. Over 350 different U&M publication suggestions were submitted for the *Top 25 Forest Products Utilization Publications* project. These suggestions were compiled into a list that was then reviewed and the number pared down. Each suggestion from the initial compiled list of publications was evaluated for appropriateness. Criteria for selecting the final list of choices were determined. An Ad-Hoc committee, comprised of the NEU&M Council officers and selected Federal, State, and Extension U&M veterans, ranked the publications on the basis of which ones would be the most beneficial to a new U&M specialist.

Availability of each of the top 25 publications was determined and additional copies were aquired by the TMU for limited distribution to U&M Federal, State, and Extension staffs. Abstracts (where available) of the selected top 25 publications were compiled. Hard copy and electronic copy availability, cost per copy, status, and action required were also determined. Out-of-print publications are available at: ***http://www.fpl.fs.fed.us/tmu/publications.htm***. See the "Top 25 Utilization and Marketing Publications," URL: ***http://www.fpl.fs.fed.us/tmu/top_25.htm***.

A project report "Top 25 Forest Products Utilization Publications" was developed and distributed at the 2001 NEU&M Council Annual Meeting in Green Bay, Wisconsin (Dramm 2001b). The TMU also pursued a more extensive list of forest products utilization and marketing publications. These publications were compiled and made available electronically, primarily on the TMU's Website. The TMU proceeded with this option in cooperation with the FPL in order to provide the greatest number of technical publications.

Selected Bibliography of Forest Products Utilization & Marketing Technical Publications

The following provides a more extensive selected annotated bibliography of forest products utilization publications for additional reference. The bibliography provides the publication citation and abstract (where available) or description of the citation's contents where an abstract is not available. Topical areas include: forest products utilization and marketing references, forestry, harvesting, log grading and scaling, sawmilling, lumber drying and storage, lumber recovery and gradeyield, veneer and plywood, secondary manufacturing, business management, industrial development, marketing, wood energy, and other resources in addition to basic wood technology references. The mix of references reflects traditional U&M work throughout the years. Subjects such as sawmilling and lumber drying, marketing, and economic development and feasibility are traditional subjects of most interest. Consequently, those subjects received more attention than others such as special forest products, secondary manufacturing, and wood energy.

This bibliography has been limited to publications of interest within the duties described under the Forest Products Conservation & Recycling (FPC&R) program. Consequently, certain subjects have not been included at the author's choice. These include subjects like timber bridges and rural development publications. Both of these subjects are expansive and deserve individual bibliographic reports. Similarly, small-diameter timber utilization, secondary manufacturing, and value-added publications have been limited to a few general interest reports. So too are the expansive references on forestry and forest management related to U&M work deserving of a separate bibliography. Finally, there are literally hundreds of regionally specific research reports that have not been included. The author leaves these subjects for others to pursue without apologies.

The reader should note that several of the bibliographic references listed are out-of-print or have had limited distribution and may be difficult to find. Every effort should be made to conserve these important U&M publications to pass along to the next generation of U&M specialists. The author would be interested in procuring additional copies of several of the older publications listed in this selected bibliography and to know the status of the availability of more current publications and updates. The author would also greatly appreciate receiving corrections or additions from readers.

Selected Bibliography Listing

FOREST PRODUCTS CONSERVATION & RECYCLING (FPC&R) PROGRAM

Forest Products Conservation and Recycling Personnel Directory. 2000. Technology Marketing Unit. USDA Forest Service, State & Private Forestry, Forest Products Laboratory. 69p.

This directory lists all Forest Service Economic Action Program specialists and coordinators, State U&M specialists, Wood Products Extension specialists, and other sources of utilization & marketing technical assistance and information. Within the State and Private Forestry branch of the USDA Forest Service, the Forest Products Conservation & Recycling (FPC&R) staff is a highly specialized group of technical professionals with particular expertise in processing, converting, and adapting forest resources into goods and services. These professionals are also present in other Federal programs such as USDA's Extension programs and the Department of Interior's Bureau of Indian Affairs (BIA). However, the largest pool of professionals lies within the State governments for utilization and marketing (U&M) of their forest resources. We have assembled the directory as a reference guide in locating those professionals who can provide technical assistance and recommendations for improvement in the areas of timber harvesting, processing, and implementation of forest products as well as economic development, recycling, small-diameter and underutilized species, special forest products, and value-added product processing. The directory includes a state-by-state listing of the following information as well as Federal program listings.

Forest Products Conservation and Recycling (FPC&R) Review. Monthly Newsletter. Technology Marketing Unit. USDA Forest Service, State & Private Forestry, Forest Products Laboratory.

Provides up to date forest products information and news of interest to all U&M specialists.

Top 25 Forest Products Utilization Publications. 2001. Dramm, John "Rusty". USDA Forest Service, S&PF Technology Marketing Unit. Madison, WI. (Unnumbered document – website.)

Appropriate publications providing basic forest products utilization and marketing (U&M) technical information are either out of print or in very limited supply. In an effort to meet the needs of State U&M programs, the author initiated a project to determine and ultimately provide this technical information to all State U&M specialists. Cooperators in the project included the Northeast Utilization and Marketing (NEU&M) Council and State & Private Forestry - Forest Products Conservation & Recycling (FPC&R) staff.

History of Forest Products Utilization & Marketing Assistance. 2001. Dramm, John “Rusty” (editor). USDA Forest Service, State and Private Forestry, Madison, WI. (Unnumbered report.)

The work done by utilization and marketing specialists in improved utilization of Nation’s natural resources through more efficient processing of forest products has brought about substantial benefits. The history of this cadre of resource professionals serves as an integral part of keeping its people alive and alert to their role in the overall effort and what they need to do to accomplish their part. Historical record also helps members keep sight of the original goals of the organization and the sacrifices others have made to reach those goals. The continued need for utilization assistance has been an integral part of economic/rural development as well as pioneering forest products conservation since the early days of forestry in the United States.

S&PF Training in Utilization and Marketing. 1966. Page, Rufus H. USDA Forest Service, State & Private Forestry. Washington, D.C. (Unnumbered document.)

The purpose of this plan is to prescribe training that will provide U&M personnel with the qualifications to do an effective job. This job entails bringing the results of research to the wood industry and assisting the landowner, logger, and wood processor with problems in utilization and marketing wood and wood products. The report describes the job, defines personal and professional qualities needed to do the job, and outlines practicable training plan that will produce men that can do the job satisfactorily. The basis for this training plan consists chiefely of three analyses of the training needs of U&M personnel and the findings of a National conference to explore these needs. A conference to discus training needs and training plan for U&M personnel was held in Washington, D.C., November 1965. Conference findings and recommnedations made by a group of 12 state U&M men who participated in a wood technology course at North Carolina State University the summer of 1965 were also used in preparing the plan.

Techline Series. Forest Products Laboratory and Technology Marketing Unit. USDA Forest Service, Forest Products Laboratory. Madison, WI.

This series of one-page reports summarizes various utilization research projects within the USDA Forest Service, primarily at the Forest Products Laboratory. To date there are approximately 36 Techlines available.

UTILIZATION & MARKETING FIELD GUIDES & HANDBOOKS

Wood Handbook: Wood as an Engineering Material. 1999. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-GTR-113.

Summarizes information on wood as an engineering material. Presents properties of wood and wood-based products of particular concern to the architect and engineer. Includes discussion of designing with wood and wood-based products along with some pertinent uses.

Forest Products Utilization Handbook. 1974. Compiled by Julie Morrison and William Wilcox. Colorado State Forest Service. Colorado State University, Fort Collins, Colorado. CSFS Hdbk 3206.1

This pocket-sized Forest Products Utilization Handbook has been complied for use by the Forest Products Utilization Forester. We have attempted the impossible task of putting everything you need to know in one book. The handbook will be revised periodically and your suggestions are welcomed.

Hardwoods of North America. 1995. Harry Alden. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-GTR-83

This report describes 53 taxa of hardwoods of North America, which are organized alphabetically by genus. Descriptions include scientific name, trade name, distribution, tree characteristics, wood characteristics (general, weight, mechanical properties, drying, shrinkage, working properties, durability, preservation, toxicity and uses) and additional sources for information. Data were compiled from existing literature, mostly from research done at the U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, WI.

Softwoods of North America. 1997. Harry Alden. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-GTR-102

This report describes 52 taxa of North American softwoods, which are organized alphabetically by genus. Descriptions include scientific name, trade name, distribution, tree characteristics, wood characteristics (e.g., general, weight, mechanical properties, drying, shrinkage, working properties, durability, preservation, uses, and toxicity), and additional sources of information. Data were compiled from existing literature, mostly from research done at the U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wisconsin.

GENERAL WOOD SCIENCE & TECHNOLOGY

A Discussion of Wood Quality Attributes and Their Practical Implications. 1994. Lez Josa and G.R. Middleton. Forintek Canada Corporation, Vancouver, B.C. Special Publication No. SP-34.

Excellent overview of wood anatomy and properties in easy to understand terms.

Structure of Wood. 1980. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-RN-04

Describes the physical and chemical structure of wood with special emphasis given to the interrelationships of fibers, cellulose, and to how the constituents of wood are used in industrial processes and products.

Inside Wood—A Short Trip into the Interior for the Layman. 1963. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-014

An easy to understand, less technical, simplified version of *Structure of Wood* (see above).

Primary Wood Processing: Principles and Practice. 1993. Walker, J.C.F.; B.G. Butterfield; and T.A.G. Langrish. Chapman Hall. ISBN:0412548402. 595pp.

Forestry and the timber trade are of great economic significance internationally and the importance of appropriate practice in primary wood processing is obvious. This book provides a comprehensive account of the forest products industry. The reasons for processing timber in a particular way are explained and the choice of techniques used is discussed. The authors examine salient features in sawmilling, panel products and pulp and paper, taking into careful consideration both the chemical and physical properties of wood and the enormous variability found in wood quality. The authors have wide experience of teaching the subject areas covered and have produced a book which will be of great use to students studying forestry, wood science and forest products as well as to personnel in the timber trade responsible for production and quality control.

Specific Gravity, Moisture Content, and Density Relationship for Wood. 1993. William T. Simpson. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-GTR-76

This report reviews the basis for determining values for the density of wood as it depends on moisture content and specific gravity. The data are presented in several ways to meet the needs of a variety of users.

Wood—Colors and Kinds. 1981 (reprint). USDA Forest Service, Government Printing Office. Washington, D.C. Ag Hdbk No. 101

Photographic description of various hardwood and softwood species. axis views of lumber samples.

A Guide to Useful Woods of the World. 2001. James H. Flynn, Jr. and Charles D. Holder. Forest Products Society, Madison, Wisconsin. Publication #7255. 640p.

The first edition of *A Guide to Useful Woods of the World* contained information on 201 species of wood that had originally appeared in the monthly issues of the International Wood Collectors Society Journal *World of Wood*. This all new 640-page edition introduces 78 additional species and includes a number of invaluable features not found in the original edition. Each species is described in a two-page Wood Data Sheet that is presented in standard international format and contains information on the scientific name, family, other names, distribution, the tree, the timber, seasoning, durability, workability, uses, and supplies. Specific gravity is included for all species, and shrinkage rates are included where available. In addition, each Wood Data Sheet includes a line drawing of a key botanical feature, a photomicrograph of the end grain of the wood, and a color photograph of a sample of the wood. Also included are a common name index, family name index, and scientific name index. The three appendices include a discussion of biology and taxonomy for woodworkers, insights on wood toxicity, and a list of selected references.

The Nature of Wood and Wood Products CD-ROM. 1998. J.L. Bowyer and R.L. Smith. Forest Products Society, Madison, Wisconsin. Publication #726.

This revolutionary CD-ROM, authored by Dr. Jim L. Bowyer, Department of Wood and Paper Science, University of Minnesota, and Ruth L. Smith, President, WebSmith, Inc., presents a series of 15 modules designed to provide a basic understanding of wood as a material and of the principal products made of wood. Each module includes a review that tests understanding of key concepts. Also included in the series are over 700 photographs and graphics, animations, self-test scroll bars, and many other visually stimulating elements. Designed for use with IBM compatibles (Windows 95 or higher) or MAC PCs (OS 8.0 or higher) and either Internet Explorer 4.04+ or Netscape Navigator 4.5+.

Forest Products and Wood Science, **3rd ed**. 1996. Haygreen, J.G.; Bowyer, J.L. Ames, IA: State University Press.

Abstract not available.

Implications of Changing Wood Quality for Manufacturing of Structural Wood Products. 1995. Galligan, W.L.; Shelley, B.E. 1995. In: Hanley, D.P.; Oliver, C.D.; Maguire, D.A.; [and others] eds. Forest pruning and wood quality of western North American conifers. Institute of Forest Resources. Seattle, WA: University of Washington, College of Forest Resources: 77–88.

Abstract not available.

FORESTRY FIELD GUIDES & HANDBOOKS

Silvics of North America: 1. Conifers; 2. Hardwoods. 1990. Burns, Russell M.; Honkala, Barbara H. (tech. Coords.) Agriculture Handbook 654, U.S. Dept. of Agriculture, Forest Service, Washington, D.C. vol.2, 877 p.

The silvical characteristics of about 200 forest tree species and varieties are described. Most are native to the 50 United States and Puerto Rico, but a few are introduced and naturalized. Information on habitat, life history, and genetics is given for 15 genera, 63 species, and 20 varieties of conifers and for 58 genera, 128 species, and 6 varieties of hardwoods. These represent most of the commercially important trees of the United States and Canada and some of those from Mexico and the Caribbean Islands, making this a reference for virtually all of North America. A special feature of this edition is the inclusion of 19 tropical and subtropical species. These additions are native and introduced trees of the southern border of the United States from Florida to Texas and California, and also from Hawaii and Puerto Rico.

Forestry Handbook, 2nd Edition. 1984. Karl F. Wenger (Editor). John Wiley & Sons Inc. ISBN: 0-471-06227-8. 1355p.

This illustrated classic contains vital on-the-ground forestry information. A revised and reorganized practical reference for the working field forester, incorporating the latest information and new, improved methods in such critical areas as U.S. forest law and policy, forest taxation, cost accounting and accomplishment reporting, pesticide and environmental aspects, safety, and public involvement procedures.

Timber Management Field Book. 1975. USDA Forest Service, Northeastern Area, State & Private Forestry. Radnor, PA. NA-MR-7

This field guide provides practical information for U&M and field foresters on: (1) Surveying and timber cruising, (2) Log scaling, (3) Reforestation, (4) Timber stand improvement (TSI), (5) Silvicultural information, (6) Economic information, and (7) Conversion factors.

Forester's Field Handbook. 1971. U.S. Forest Service, State & Private Forestry, Cooperative Forestry, Rocky Mountain Region. Denver, CO. Unnumbered.

This field guide provides practical information for U&M and field foresters on: (1) Surveying and timber cruising, (2) Log scaling, (3) Reforestation, (4) Timber stand improvement (TSI), (5) Silvicultural information, (6) Economic information, and (7) Conversion factors.

Service Foresters Handbook. 1965. USDA Forest Service, Cooperative Forestry, Southern Region. Atlanta, GA. Unnumbered.

This field guide provides practical information for field foresters on: (1) Surveying and timber cruising, (2) Log scaling, (3) Silvicultural information, (4) Site index curves, (5) Forest soils, and (6) Conversion factors.

FOREST INVENTORY ANALYSIS (FIA) & TIMBER PRODUCT OUTPUT (TPO)

Outlook for sustainable fiber supply through forest management and other developments in the U.S. pulp and paper sector. 2001. Peter Ince. In: Proceedings of TAPPI 20001 International Environmental, Health and Safety Conference.

Continued growth and sustainable development of fiber supply in the U.S. pulp and paper sector appears to be assured for decades to come because of ongoing improvements in forest management, along with projected shifts in product markets, international trade, and production technology. The analysis encompassed economic projections of regional trends in pulpwood supply and demand, process substitution and capacity growth, trends in paper recycling, and potential development of agricultural fiber resources, as well as overall trends in production, consumption, and trade throughout the pulp and paper sector. This paper summarizes the analysis, key assumptions, and key findings related to projected fiber supply and demand in the U.S. pulp and paper sector.

Forest Resources of the United States, 1997. 2001. W. Brad Smith, John S. Vissage, David R. Darr, and Raymond M. Sheffield. USDA Forest Service, North Central Research Station. St. Paul, MN. Gen. Tech. Rpt. NC-219.

Provides a general review of forestlands in the United States including timberland areas and inventories, mortality, growth, and removals.

An Analysis of the Timber Situation in the United States: 1952 to 2050. 2003. Richard W. Haynes. USDA Forest Service, Pacific Northwest Research Station. Portland, OR. PNW-GTR-560.

For more than a century, national assessments of supply and demand trends for timber have helped shape perceptions of future commodity consumption and resource trends. These perceptions have guided forest policy. Since 1952, U.S. timber harvest has risen by nearly 67 percent, accompanied by growing timber inventories on both public and private lands, but there has been a decline in the critical private timberland base. The current assessment envisions forest products consumption rising 42 percent by 2050 and marked shifts in the extent and location of domestic and imported supplies. Prospective shifts include a temporary near-term decline in U.S. roundwood harvest and an increase in the share of consumption from imports. In the longer term, U.S. timber harvest expands by 24 percent. As a result of steady improvement in growth and productivity on U.S. forestlands, this increased harvest is accommodated by continued expansion in inventory despite decreasing area in the private timberland base.

United States Timber Industry – An Assessment of Timber Product Output and Use. 2001. Johnson, Tony G.; [Editor]. U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, NC. Gen. Tech. Rep. SRS-45. 145 p.

This report is a compilation of timber product output for the United States and the five Resources Planning Act regions for 1996 and is a companion report to the Forest Resources of the United States, 1997. Roundwood output from the Nation's forests totaled 16.4 billion cubic feet, 8 percent less than in 1991. Saw logs were the leading roundwood product at 7.1 billion cubic feet; pulpwood ranked second at 5.2 billion cubic feet; and veneer logs were third at 1.3 billion cubic feet. The South supplied 58 percent of the Nation's timber product output and had 7 of the top 10 producing States. Softwood species accounted for 61 percent of output, and nonindustrial private forest owners supplied 60 percent of the Nation's roundwood products. Mill byproducts generated from primary manufacturers totaled 6.1 billion cubic feet. Only 2 percent of the mill residues were not used. Mill residue was used primarily for fuel and fiber products.

TIMBER HARVESTING

Glossary of Terms Used in Timber Harvesting and Forest Engineering. 1989. Stokes, Bryce J.; Ashmore, Colin; Rawlins, Cynthia L.; Sirois, Donald L. USDA Forest Service, Southern Forest Experiment Station, General Technical Report SO-073. GTR-SO-073.

Provides definitions for 1,026 words and terms used in timber harvesting and forest engineering, with an emphasis on terms related to timber harvesting operations. Terminology dealing with basic forestry, harvesting equipment, and economics is stressed.

How to Improve Logging Profits. 1991. Northeastern Loggers' Association, Inc. Old Forge, NY.

This book is a collection of 30 articles originally published in The *Northern Logger & Timber Processor* magazine under the series title *How to Improve Logging Profits.*

Logging and Pulpwood Production. 1985. Stenzel, G.; Walbridge, T.A., Jr.; Pearce, J.K. New York, NY: John Wiley & Sons. 358 p.

Abstract not available.

Handbook for Eastern Timber Harvesting. 1979. Fred Simmons. USDA Forest Service, Northeastern Area, State & Private Forestry. Broomall, PA. 180p.

Provides practical information on timber harvesting including chain saws, hand tools, felling, limbing, bucking, skidding, loading, and hauling.

Logging Practices: Principles of Timber Harvesting Systems. 1982. Steve Conway. Miller Freeman Publications. San Francisco, CA. 432 p.

Logging Practices not only shows what happens during timber harvesting but also how and why it happens. The book gives an overall view of the systems, equipment, and practices used in North America to harvest timber crops. Its thorough coverage includes such essential subjects as forest resources, woods labor, operations planning, ground skidding, cable and aerial logging, safety management, and production control. In addition it gives the small practical details the industry need in order to obtain maximum value from timber and land resources. One of the major contributions of this book is its emphasis on the "systems" approach. To understand timber-harvesting systems it is necessary to see that they are made up of smaller systems called components, and that these in turn are made up of subsystems called elements. It is also necessary to realize that timber harvesting is itself part of the larger, dominant system, which includes manufacturing, marketing, transportation, sales and much else. The book describes the basic components and elements and makes it clear that only by comprehending the various hierarchical relationships among them will it be possible to meet both the short- and long-term goals of the dominant system.

Timber Cutting Practices (3rd Edition). 1978. Steve Conway. Miller Freeman Publications. San Francisco, CA. 192 p.

Conway covers everything from crew organization through cutting patterns, felling, bucking, and safety procedures—with the objective of increasing efficiency and profitability.

Safety and Health Concerns in Forestry Operations. 1997. Rummer, Robert B. APA [American Pulpwood Association, Inc.] Technical Paper 97-P-4. Rockville, MD: American Pulpwood Association: 1-5.

The author discusses several safety models, including the "Three E's": engineering, education, and enforcement; the Heinrich-Lateiner model; the organizational model; and the behavioral safety model. Rummer encourages approaching safety from a broader perspective, enabling the industry to track changes in all aspects and to keep leading the safety target.

The Way Ahead With Harvesting and Transportation Technology. 1995. Kellogg, L.; Milota, G., Eds. 1995. In: Proceedings, International Union of Forestry Research Organizations XX World Congress, IUFRO P3.07 meeting; 1995 August 6–12; Tampere Finland. Corvallis, OR: Oregon State University, Department of Forest Engineering: 318 p.

Abstract not available.

Determining Fixed and Operating Costs of Logging Equipment. 1980. Edwin S. Miyata. USDA Forest Service, North Central Forest Experiment Station. GTR-NC-55. 16p.

This paper analyzes equipment costs and gives a procedure for estimating them. It is intended for those who are in the logging business and need a standardized guide to help them appraise the efficiency and production costs of logging equipment. It can also be used as a basic teaching aid for forestry students.

Understory Biomass Reduction Methods and Equipment Catalog. 2000. Windell, Keith, Bradshaw, and Sunni. USDA Forest Service, Missoula Technology and Development Center. Missoula, MT. Tech. Rep. 0051-2826-MTDC. 156p.

Ladder fuels and dense pockets of young Douglas-fir make it especially difficult, if not impossible, to get desirable results with prescribed fire in ponderosa pine stands without some creative burning techniques or mechanical preburn treatment using equipment and techniques discussed in this report. Although stands of ponderosa pine with Douglas-fir encroachment are the focus for fuel treatments in this report, the equipment and techniques discussed will probably have applications for other species. This report consists of two sections. The first section contains the results of numerous interviews, a field survey, and a literature search. This section discusses fuel reduction equipment and methods that have been tried in the past, those that are currently being used, and those that may warrant consideration in the future. The second section is a catalog of equipment suitable to treat landscape areas before prescribed burns. It is the result of an extensive market search. The catalog is designed to help forest managers make informed decisions. It profiles a variety of small and large pieces of equipment suitable for many different situations and budgets. To keep the size of the catalog manageable, equipment that is commonly available and well known is not included (equipment such as skidders, excavators, loaders, and so forth).

Determining Fixed and Operating Costs of Logging Equipment. 1980. Miyata, Edwin S. General Technical Report NC-55. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station

Describes and analyzes all elements of equipment cost and gives a procedure for estimating them.

Logging System Cost Analysis: Comparison of Methods Used. 1981. Miyata, Edwin S.; Steinhilb, Helmuth M. Research Paper NC-208. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station

Several methods of calculating machine rates, costs, and productivity for both single pieces of logging equipment and for logging systems are discussed.

Logging Damage. 1989. Nyland; Ralph D. In: Clark, F. Bryan, Hutchinson, Jay G., Ed. In: Central Hardwood Notes. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Note 8.02.

The best commercial logging will damage at least some residual trees during all forms of partial cutting, no matter how carefully done. Yet recommendations at the end of this Note show there is much that you can do to limit damage by proper road and trail layout, proper training and supervision of crews, appropriate equipment, and diligence.

Application of Work Sampling Technique to Analyze Logging Operations. 1981. Miyata, Edwin S.; Steinhilb, Helmuth M.; Winsauer, Sharon A. Research Paper NC-213. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station.

Discusses the advantages and disadvantages of various time study methods for determining efficiency and productivity in logging. The work sampling method is compared with the continuous time-study method. Gives the feasibility, capability, and limitation of the work sampling method.

A New Harvest Operation Cost Model to Evaluate Forest Harvest Layout Alternatives. 1997. Clark, Mark M.; Meller, Russell D.; McDonald, Timothy P.; Ting, Chao Chi. In: Forest Operations for Sustainable Forests and Healthy Economies; Proceedings, Council on Forest Engineering, 20th annual meeting; 1997 July 28-31; Rapid City, SD. Rapid City, SD: Council on Forest Engineering: 42-47.

The authors develop a new model for harvest operation costs that can be used to evaluate stands for potential harvest. The model is based on felling, extraction, and access costs, and is unique in its consideration of the interaction between harvest area shapes and access roads. The scientists illustrate the model and evaluate the impact of stand size, volume, and road cost when determining harvest layouts. Since the approach lays the foundation for operational and tactical integration, future research will integrate the two levels for both the single and multi-period problem.

LOG SORT YARDS

Log Sort Yard Economics, Planning, and Feasibility. 2004. John Rusty Dramm, Robert Govett, Ted Bilek, and Gerry Jackson. USDA Forest Service, State & Private Forestry, Madison, WI. FPL-GTR-146.

This publication discusses basic marketing and economic concepts, planning approach, and feasibility methodology for assessing log sort yard operations. Special attention is given to sorting small-diameter and underutilized logs from forest restoration, fuels reduction, and thinning operations. A planned programming approach of objectively determining the feasibility of establishing a log sort yard operation is recommended. This critical thinking will help develop the strategic, marketing, business, and operational plans to guide the development and operation of the log sort yard. Preliminary financial feasibility should begin early in the planning process because it helps focus efforts on potentially viable opportunities and saves time, effort, and money chasing poor investment scenarios. After options have been narrowed, detailed resource assessment, markets, and financial analyses are done. Several critical factors are considered and evaluated for each log sort yard scenario. Although commercial log sort yards have a proven track record throughout North America, small community-based and government-operated log yards have had limited success. Serious consideration must be given to employing an experienced log sort yard contractor to operate and manage the day-to-day operations. Several operational, policy, and judicial issues would need to be resolved for government and community log sort yards to operate successfully in the United States.

Review of Log Sort Yards. 2002. John Rusty Dramm, Gerry Jackson, and Jenny Wong. USDA Forest Service, State & Private Forestry, Madison, WI. FPL-GTR-132. 39p.

This paper provides a general overview of current log-sort yard operations in the United States, including an extensive literature review and information collected during on-site visits to several operations throughout the nation. Log-sort yards provide many services in marketing wood and fiber by concentrating, merchandising, processing, sorting, and adding value to logs. Such operations supply forest products firms with desired raw materials, which helps improve their bottom line by reducing the number of marginal logs processed. Ultimately, sorting logs leads to better use of the avaialble timber resources. Successful log-sort yards are self-sufficient and have well-established markets and a steady supply of wood. Log sort yard concepts and analysis described in this report have broad applications.

A Handbook for Designing, Building, and Operating a Log Sortyard. 1984. Alex W.J. Sinclair and G. Vern Wellburn. Forest Engineering Research Institute of Canada (FERIC). Vancouver, B.C. 285p.

This extensive handbook is a guide for locating, designing and modifying dryland logsort yards. It stresses sortyard systems analysis and design rather than construction details.

Dry Land Log Handling and Sorting: Planning, Construction, and Operation of Log Yards. 1981. Hampton, Charles M. Miller Freeman Publications, Inc. San Francisco, CA. 215p.

Provides an extensive discussion of planning (industrial and civil engineering principles, site selection, materials handling, equipment and processing); system layout and evaluation (layout and flow space considerations and financial evaluation of alternatives); and construction and system operation guidelines for dry land log sort yards.

LOG GRADING & SCALING

A Collection of Log Rules. 1974. Frank Freese. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-1.

This paper discusses a number of log rules in use with tables of board foot estimates. Includes discussion of several diagrammatic and formula log rules and log rule tables. A log rule may be defined as a table or formula showing the estimated net yield for logs of a given diameter and length. Ordinarily the yield is ex-pressed in terms of board feet of finished lumber, though a few rules give the cubic volume of the log or some fraction of it. Built into each log rule are allowances for losses due to such things as slabs, saw kerf, edgings, and shrinkage. At first glance, it would seem to be a relatively simple matter to devise such a rule and having done so that should be the end of the problem. But it would seem so only to those who are unfamiliar with the great variations in the dimensions of lumber which may be produced from a log, with variations in the equipment used in producing this lumber and the skills of various operators, and finally, with the variations in the logs. All of these have an effect on the portion of the total log volume that ends up as usable lumber and the portion that becomes mill residue. Historically, no industrial organization or government agency had control over the measurement of logs, each district or even individual buyers could devise a rule to fit a particular set of operating conditions. The result is that in the United States and Canada there are over 95 recognized rules bearing about 185 names. In addition, there are numerous local variations in the application of any given rule.

A Guide to Hardwood Log Grading. 1973. Everette D. Rast, David L. Sonderman, and Glenn Gammen. USDA Forest Service, Northeastern Forest Experiment Station. Broomall, PA. Tech Rpt. NE-1.

A guide to hardwood log grading (revised) was developed as a teaching aid and field reference in grading hardwood logs. Outlines basic principles and gives detailed practical applications, with illustrations, in grading hardwood logs. Includes standards for various use classes. This publication supercedes "*Hardwood Log Grades for Standard Lumber*," (FPL-63.) and the 1963 report "A Guide to Hardwood Log Grading" by Ostrander and others.

Teaching the Basics of Hardwood Log and Lumber Grading. 1972. Screpetis, George D. U.S. Department of Agriculture, Forest Service, Southeastern Area, State & Private Forestry. Pineville, LA. (Unnumbered report.)

This booklet describes methods of using available material to teach and apply the Forest Service Hardwood Log Grades for Standard Lumber. It is primarily written for use by mill owners and superintendents, college professors, or others involved in group education and training of timber buyers and sellers. It is based primarily on 5 years of experience in teaching Forest Service Hardwood Log Grades at the Annual Hardwood Log and Lumber Grading Course at Louisiana Tech University, Ruston, Louisiana.

National Forest Log Scaling Handbook. 1985. USDA Forest Service, Washington, D.C. FSH 2409.11

Provides standard Forest Service-wide procedures and instructions for scaling National Forest timber. Includes: theory and principles of scaling, defect-deduction methods, log defects and deductions, special scaling requirements, check scaling, and other forms of measurement.

National Forest Cubic Scaling Handbook. 1991. USDA Forest Service, Washington, D.C. FSH 2409.11a

Provides procedural direction for cubic scaling National Forest timber. Includes: general scaling requirements, cubic log scaling rules, measurement methods for other products, utilization assessment, and sample scaling.

Conversion of Board Foot Scaled Logs to Cubic Meters in Washington State. 1970–1998. 2002. Henry Spelter. USDA Forest Service, Forest Products Laboratory. Madison, WI. Gen. Tech. Rep. FPL-GTR-131.

The conversion factor generally used to convert logs measured in (thousand) board feet to cubic meters has traditionally been set at 4.53. Because of diminishing old growth, large-diameter trees, the average conversion factor has risen, as illustrated in this analysis of Washington state sawmill data over the period 1970–1998. Conversion factors for coastal and interior Washington were estimated at 6.76 and 5.93, respectively, up from 4.0 to 4.5 in the 1970s. Average saw-log diameters over the same period were estimated to have declined from 56 to 29 cm for coastal Washington and from 41 to 25 cm for interior Washington.

Official Grading Rules for Northern Hardwood and Softwood Logs and Tie Cuts. 2001. Timber Producers Association of Michigan & Wisconsin. Antigo, WI. 22p.

Provides procedural direction for cubic scaling National Forest timber. Includes: general scaling requirements, cubic log scaling rules, measurement methods for other products, utilization assessment, and sample scaling.

Log Scaling and Timber Cruising. 1993. Bell, John F. and J.R. Dilworth. Oregon State University. Corvallis, OR. 439p.

Concise information, including Variable Plot and 3P Cruising (and a method for combining these surveys); regeneration surveys; taper equations; V-Bar measurements; and $-Bar assessment. Deals primarily with western timber, but has been used throughout the United States and Canada. 124 pages of tables including cubic-foot volume, board foot volume and more. 5" x 6-1/2" x 1", with plastic covers. 439 Pages.

HARDWOOD TIMBER & LOG DEFECTS & TREE GRADING

The Photographic Guide to Selected External Defect Indicators and Associated Internal Defects—Black Cherry. 1985. Rast, Everette D. and John A. Beaton. USDA Forest Service, Northeastern Forest Experiment Station. NE-560.

The Photographic Guide to Selected External Defect Indicators and Associated Internal Defects—Black Walnut. 1988. Rast, Everette D.; John A. Beaton; and David L. Sonderman. USDA Forest Service, Northeastern Forest Experiment Station. NE-617.

The Photographic Guide to Selected External Defect Indicators and Associated Internal Defects—White Oak. 1989. Rast, Everette D.; John A. Beaton; and David L. Sonderman. USDA Forest Service, Northeastern Forest Experiment Station. NE-628.

The Photographic Guide to Selected External Defect Indicators and Associated Internal Defects—Yellow Poplar. 1991. Rast, Everette D.; John A. Beaton; and David L. Sonderman. USDA Forest Service, Northeastern Forest Experiment Station. NE-646.

The Photographic Guide to Selected External Defect Indicators and Associated Internal Defects—Sugar Maple. 1991. Rast, Everette D.; John A. Beaton; and David L. Sonderman. USDA Forest Service, Northeastern Forest Experiment Station. NE-647.

The Photographic Guide to Selected External Defect Indicators and Associated Internal Defects—Northern Red Oak. 1982. Rast, Everette D.; John A. Beaton; and David L. Sonderman. USDA Forest Service, Northeastern Forest Experiment Station. NE-511.

The Photographic Guide to Selected External Defect Indicators and Associated Internal Defects—Yellow Birch. 1991. Rast, Everette D.; John A. Beaton; and David L. Sonderman. USDA Forest Service, Northeastern Forest Experiment Station. NE-648.

> Each publication in this series describes hardwood lumber defects and external indicators of such defects in tress and logs. To properly classify or grade logs or trees, one must be able to correctly identify indicators and assess the effect of the underlying defect on possible end products. This guide assists the individual in identifying the surface defect indicators and shows the progressive stages of the direct throughout its developmnet for the species specified. Several types of external defect indicators and associated defects that are particularly difficult to evaluate are illustrated and described.

Defects in Hardwood Timber. 1989. Carpenter, Roswell; David L. Sonderman; Everette D. Rast; and Martin Jones. USDA Forest Service, Northeast Forest Experiment Station. Washington, D.C. Ag. Hdbk. No. 678. 88p.

> Comprehensive handbook on the causes of wood defects and the effect of these defects on the utilization potential of hardwood timber. Basic information in this handbook was first published in Ag. Hdbk No. 244, Grade Defects in Hardwood Timber and Logs.

Grading Hardwood Trees. 1989. Brisbin, Robert L. In: Clark, F. Bryan, tech. ed.; Hutchinson, Jay G., ed. Central Hardwood Notes. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.: Note 7.03.

> Tree grading provides a way to evaluate the quality characteristics and value of standing hardwood trees. This is important because the differences in price between high-quality and low-quality end products can be very large. Since hardwood timber varies greatly in quality and value among species, within species, and even within specific geographic areas, timber producers and buyers know that an accurate tree grading system is an objective way to account for quality variation and provide a basis for negotiation between buyers and sellers.

Predicting Lumber Grade Yields for Standing Hardwood Trees. 1971. Stayton, Charles L.; Marden, Richard M.; Gammon, Glenn L. Research Paper NC-50. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station.

Presents a method of estimating lumber yields for hardwood trees. The grading system was developed using sugar maple but could apply to similar species.

GENERAL SAWMILLING REFERENCES

Circular Sawmills and Their Efficient Operation. 1993 (reprinted). Stan Lunstrum. USDA Forest Service, State & Private Forestry, Madison, WI. 86p.

Discusses accurate sawing of lumber by circular sawmills, specifically on proper sawing method and mechanical components that affect the primary sawing function for increasing sawing efficiency and economy. This manual was written for circular sawmill operators who recognize the need for producing the maximum yield of well-manufactured lumber in the shortest possible time. It is concerned with primary sawing and all the mechanical components that affect the primary sawing function. Through the use of this manual, many circular sawmill operators can increase the efficiency of their sawing operation. Many operators could realize an increase of 10 percent or more in lumber output by improving the accuracy of their cutting. This means not only substantial savings in timber resources but also a lowering of per-unit cost and consequently higher profits for the operation. Determination to correct deficiencies and insuring that every piece of equipment related to sawing operates properly and functions smoothly together as a unit are keys improvement.

Lumber Manufacturing: The Design and Operation of Sawmills and Planer Mills. 1988. Ed Williston. Miller Freeman Publications. San Francisco, CA. 486p.

This updated edition of the definitive book on lumber manufacturing techniques looks at the modern, efficient mill as a total system -- from the handling of raw materials through the finished product. It also includes coverage of developments in scanner-computer systems, automatic grading, sorting and packaging systems, and automatic data collection. Each unit of the mill is examined and described in detail. Every method, operation, and technique is illustrated and documented with easy-to-read graphs and tables. More than 30 chapters examine five central topics: supplying and preparing the raw material; rough lumber manufacturing; manufacturing dry lumber, chips, and fuel; measuring performance, controlling quality, and maintaining equipment; and principal sawmill types. This practical book is indispensable for management, technical, and operations people who must keep up with the best methods and techniques for producing profitable yield from available raw materials.

Small Sawmill Handbook. 1993. Joseph Denig. Miller Freeman Publications. San Francisco, CA. 182p.

This results-oriented book explains the profitable philosophies behind sawing and describes high-yield equipment, simple and efficient mill layouts, quality lumber drying processes, and value-added techniques. Developed as a hands-on guide for the small mill operator who wants more than the status quo and needs to prepare the mill for the future, this book is also an excellent introduction for novices who need a good understanding of the theory and practical aspects of sawmill operations. With dozens of photos and illustrations showing how sawmilling principles are put into practice, the book's contents cover: the raw material; sawing patterns (the key to yield and productivity); sawmill equipment for primary breakdown; secondary breakdown; edging, trimming, and sorting; mill layouts; lumber drying; and value-added manufacturing. If your sawmill produces 3 to 20 million board feet annually, this book shows you how to survive, prosper, and ensure future profitability.

Modern Sawmill Techniques (Volumes 1, 3, and 5-9). 1973 to 1979. Vernon S. White and Robert D. French. Proceedings of the Sawmill Clinic, Portland OR. Miller Freeman Publications. San Francisco, CA.

These proceedings provide a compilation of papers and discussions presented at the Sawmill Clinics held in Portland, Oregon from 1973 to 1979. The proceedings provide the industry's latest ideas and techniques for its survival and future health. With the high cost of logs, the trend to smaller log processing, and the increasing demand for lumber in face of dwindling log supply, it is essential to optimize production and recovery. Today's sawmill managers must choose between the many products and systems competing to fill the existing technological void. Therefore, the 1973 Sawmill

Clinic was organized to provide a forum for sawmillers and their industry suppliers. Detailing their discussions of common problems and experience, these proceedings include practical, tested ideas on such subjects as log scaling, handling and sorting, log breakdown, best opening face, drying, maintenance and electronic control.

Successive Sawmill Clinics continued focus on innovative methods for achieving maximum utilization of the timber resource including topics such as lumber size quality control, mill residue utilization, co-generation, industrial safety, marketing, exporting wood products, thin-kerf saws, saw filing and mill maintenance, cost reduction, and business management controls in addition to state-of-the-art sawmill and plywood optimization technology.

Modern Sawmill Techniques (Volumes 2 and 4). 1973 and 1974. Edited by Herbert G. Lambert. Proceedings of the Sawmill Clinic, New Orleans, LA. Miller Freeman Publications. San Francisco, CA.

These proceedings provide a compilation of papers and discussions presented at the Sawmill Clinics held in New Orleans, Louisiana. Volume 2 (1973) and Volume 4 (1974) reports the proceedings of the southern Sawmill Clinics. While Volumes 2 and 4 deal mainly with the southern softwood timber resource, the basic principles of engineering and production are applicable in other lumber producing regions. The overall challenge for the industry is the same—to do a better job of handling the increasing volume of small-diameter timber and of converting it into products matching market needs and mill capabilities. The proceedings explain how mill operators and machinery manufacturers are meeting that challenge today.

Modern Sawmill & Panel Techniques (Volumes 1 and 2). 1980 and 1981. Edited by Herbert G. Lambert and Vernon S. White. Proceedings of the Sawmill and Panel Clinic, Portland OR. Miller Freeman Publications. San Francisco, CA.

In 1980, The Portland Sawmill Clinic and Plywood Clinic combined into the Sawmill and Panel Clinic. These proceedings present the Clinic papers. Volumes 1 and 2 continued the theme of improved utilization.

Hardwood Sawmill Techniques. 1976. Vernon S. White. Proceedings of the First Hardwood Sawmill Clinic Program, New Orleans, LA. Miller Freeman Publications. San Francisco, CA.

In followup to successful Sawmill Clinics in Portland and New Orleans, a Hardwood Sawmill Clinic was conducted in 1976. This paper presents the proceedings of this Clinic.

Sawmill Operations Clinic. 1984. Walker, J.C.F. and B.G. Butterfield, et al. Chapman and Hall. London, England. [Book.] ISBN: 0412548402. 612p.

Abstract not available.

Primary Wood Processing: Principles and Practice. 1984. Edited by Forintek Canada Corp. Proceedings of a Sawmills Operations Clinics, Gander and Deer Lake, Newfoundland. Forintek Canada Corp., Ottawa, Ontario, Canada. Special Publication No. SP 22. 52p.

Abstract not available.

Small Sawmill Operator's Manual. 1952. Telford, C.J. United States Department of Agriculture. Washington, DC. Ag. Hdbk. No.27. 121p.

This classic publication is a guidebook for small sawmill operators, especially for those using circular saw headrigs and carriage systems.

Lumber (Second Edition). 1947. Nelson Brown and James Bethel. John Wiley & Sons, Inc. New York. 379p.

Prior to Ed Williston's book, *Lumber Manufacturing: The Design and Operation of Sawmills and Planer Mills*, this book was the best textbook available for dealing with the fundamental prionciples and practices of sawmilling in the United States.

Lumber Manufacture in the Douglas Fir Region. 1920. H.B. Oakleaf. Commercial Journal Co., Inc. Chicago, IL. 182p.

This is a historically important text written by a pioneering sawmill utilization researcher. Oakleaf, then in charge of Research in the Forest Products North Pacific District, U.S. Forest Service, provides information on the methods and costs of constructing and operating plants for the manufacture of lumber in the region west of the Cascade Mountains in Oregon and Washington. The information is intended primarily for National Forest timber appraisers and other National Forest officers, for lumbermen not familiar with the manufacture of Douglas fir and for students of forestry.

SAWMILL AUTOMATION & OPTIMIZATION

Increasing Softwood Dimension Yield from Small Logs—Best Opening Face. 1971. Hallock, Hiram and David W. Lewis. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL 166.

Production of lumber, especially from small logs, is in essence the fitting of rectangles into a circle. For any given set of conditions the sizes of the lumber and the size of the log are fixed. Maximization of yield becomes a geometrical problem with the key being width of the opening face. This paper presents a system called BOF for Best Opening Face width which makes it possible to precisely locate the opening face. An example is presented for the five common log breakdown methods with logs of a diameter range of 4.6 to 20.5 inches, by 0.l-inch-incre-ments. Three of these methods have the possibility of varying opening face width. The average difference in yield for the best and poorest opening for these three methods are 27, 21, and 8 percent. If it is assumed industry practices are midway between the best and poorest points, substantial industry increases may be possible. This research makes possible an automated mill system through the use of presently available precise diameter- measuring equipment, numerically controlled log positioning equipment, a mini-computer, and the opening face data available from the BOF program. The BOF program also makes possible precise comparison of the potential yields of each of the five sawing methods. Of these, the variable-opening-face live sawing method is shown to be consistently the best.

Scanning Technology & Process Optimization: Advances in the Wood Industry. 1999. Ryszard Szymani. Forest Products Society, Madison, Wisconsin. Publication #MF-4180. 251p.

Scanning technology and process optimization are indispensable in today’s competitive forest products industry, particularly considering the high cost of logs which accounts for almost 80% of the cost of lumber. To operate profitably, mills must utilize logs to their maximum potential. Optimization of any operation requires machine vision technology that can accurately determine log geometry and external and internal features considered as defects, as well as computer technology that provides a solution at production speed. Electronic scanning is one of the most rapidly changing technologies in the wood industry mostly due to tremendous advances in data processing. This book provides an overview of various scanning methods and their application to the wood industry in order to maximize processing efficiency and value recovery. Topics include: enterprise optimization using scanning and process control as management tools; optimizing log bucking and sorting; three dimensional log scanning for automation of log breakdown; lumber scanning for optimized edging, ripping, and cross-cutting; and automated defect detection for lumber grading. This book contains a selection of papers which were presented at International Conferences on Scanning Technology in the Wood Products Industry and provides mill managers with practical guidance on the selection of scanning and process optimization systems for primary and secondary wood processing.

Computer Control Systems for Log Processing and Lumber Manufacturing. 1985. Ed M. Williston. Forest Products Society, Madison, Wisconsin. Publication #MF-4660. 416p.

A computerized lumber mill with a series of automated subsystems can save 25%, or more, on raw material costs. Since raw material can be as much as 90% of the total cost of sales, the savings potential is enormous. This hands-on guide shows you how to evaluate your needs and implement process controls which measure and control raw material and machine variables. The three main sections are: process control equipment; applications in the yard and mill; and process management and quality control. In addition there are detailed tables of performance standards, log yields, and conversion factors; a glossary of terms; and a check list of programmable logic controller capabilities. This book is an essential reference for anyone who plans, designs, operates, and maintains facilities for processing logs, lumber, and other wood products.

A Segmental Analysis of Current and Future Scanning and Optimizing Technology in the Hardwood Sawmill Industry. 2002. Bowe, S.A.; Smith, R.L.; Kline, D.E.; Araman, P.A. Forest Products Journal. 52(3): 68-76.

A nationwide survey of advanced scanning and optimizing technology in the hardwood sawmill industry was conducted in the fall of 1999. Three specific hardwood sawmill technologies were examined that included current edger-optimizer systems, future edger-optimizer systems, and future automated grading systems. The objectives of the research were to determine differences between user groups for advanced scanning and optimizing technologies and to identify company expectations of these technologies. Three comparison groupings were used including company size, sawmill technology, and National Hardwood Lumber Association affiliation. These objectives were chosen because timely information for this technology was not available. The survey consisted of a mail questionnaire sent to over 2,000 hardwood sawmills. Adoption decision factors for scanning and optimizing technologies were rated on a 7-point Likert-type scale. Improved raw material recovery and increased lumber revenues were the two most highly rated factors for both current edger-optimizer and future edger-optimizer systems. Accuracy of grading and system lifespan were the most highly rated factors for automated grading systems. Responding companies expressed concern over the high initial cost of such technology; however, a short return on investment outweighed the high initial cost issue in many cases. For those that have adopted advanced scanning and optimizing technology, production-related issues were the driving factors.

Use of Advanced Hardwood Sawmill Equipment, and Desired Features for Next-Generation Systems. 2000. Bowe, Scott; Smith, Robert; Araman, Philip A.; Kline, D. Earl. Proceedings, 28th Annual Hardwood Symposium. 131-140.

Many segments of the forest products industry have seen significant technological leaps in manufacturing. These new technologies and new products are instrumental in meeting the increasing demand for wood products. The hardwood lumber industry has not followed this trend, however. The hardwood sawmill industry, as a whole, has not readily adopted advancements in sawmill technology. This leaves a great deal of room for improvement in the hardwood sawmill industry. The demographics of the hardwood sawmill industry may in part drive this reluctance to adopt new technology. Despite the recent trend toward consolidation in the industry, a significant number of hardwood sawmills are small. Companies of this nature may not have the capital or the supporting market share to justify purchasing advanced technology equipment. However, a significant number of large- and medium-sized mills do exist, and are a potential market for hardwood sawmill technology. In addition, the existence of several manufacturers of commercial scanning and optimizing technology suggests that there is a market for this equipment; however, this market is not well developed. A small segment of hardwood sawmills have adopted advanced scanning and optimizing technology such as edger-optimizers and trimmer-optimizers. As the names suggest, these technologies are designed to optimize (or partially optimize) production. Slow adoption of this technology may also stem from the lack of quality market information supporting scanning and optimizing technology.

PRIMARY LOG BREAKDOWN

Is there a "Best" Sawing Method? 1978. Hallock, Hiram; Abigail R. Strern; and David W. Lewis. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-280

The Best Opening Face (BOF) computer sawing program has been used to investigate the relationship, in terms of lumber yield, of log diameter (5 to 20 in.), log length (8 to 24 ft.), and taper (1 to 5 in.) to eight of the most commonly used sawing methods. Results generally show that logs 16 feet or shorter and with 3 inches or less of taper, yield best when sawn by one sawing method, and those longer and with more taper by another method. Results of this research can form the basis for making rational selection of sawing systems in new mills when the log mix to be processed is known. As examples of the potential of this information in management decisions, three actual sawmill log mixes were analyzed in terms of expected yields by each of the sawing methods.

Individual Log Yields by Eight Sawing Systems. 1978. Hallock, Hiram; Abigail R. Strern; and David W. Lewis. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Supplement to FPL-280.

Provides supplemental information and tables for FPL-280 (*see above*).

A Look at Centered vs. Offset Sawing. 1979. Hiram Hallock, Abigail R. Strern, and David W. Lewis. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-321.

Best Opening Face (BOF) was used to compare centered and three offset sawing patterns and there effect on lumber recovery.

Individual Log Yields by Four Centered Sawing Systems. 1979. Hiram Hallock, Abigail R. Strern, and David W. Lewis. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Supplement to FPL-321.

Provides supplemental information and tables for FPL-321 (*see above*).

Small Log Sawmills: Profitable Product Selection, Process Design and Operation. 1981. Ed Williston. Miller Freeman Publications. San Francisco, CA. 368p.

Coniferous forests composed mostly of small-diameter trees now predominate in North American, Northern Europe, Scandinavia, and Siberia. Smaller more uniform trees lend themselves to automation from harvesting, transportation, and conversion into lumber. This book discusses, sawmill automation, computerization, scanning, and high production aspects of small log processing.

Manufacturing Lumber from Small Logs. 1982. Williston, E., Ed. Proceedings; 1982 April 19–21; Portland, OR. Seattle, WA: University of Washington, College of Forest Resources.

Abstract not availablee.

Small Log Processing. 1998. Mason, H.C. Proceedings from Wood Technology Clinic and Show Conference, Portland, OR. Miller Freeman Publications, San Francisco, CA.

Abstract not available.

Some Thoughts on Marginal Sawlogs. 1964. Hallock, Hiram. USDA Forest Service, Forest Products Laboratory. Madison, WI.

Much of the economic difficulty experienced by operating sawmills stems from milling substantial quantities of logs whose costs exceed the value of the products derived from them. Existing technology, if applied, could result in lowering the costs and increasing the value of the primary product, lumber. Both of these aspects, either independently or in association, greatly reduce the volume of nonprofitable logs which a mill must process.

Technical Changes that Solved the Southern Pine Lumber Industry's Small-Log Problem. 1987. Anderson, W.C. Forest Products Journal. 37(6): 41–45.

Abstract not available.

A Simplified Procedure for Developing Grade Lumber from Hardwood Logs. 2000. Fred Malcolm. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-098. 13p.

This paper describes grade sawing procedures for improving lumber grade yield recovery from hardwood factory logs. Basic principles of hardwood lumber grades are applied to simplified sawing procedures to accomplish improved grade recovery. Discussion includes positioning surface defects in relation to opening faces. Special consideration is given to defects such as seams, end splits, and rot as well as sawing sweepy logs. While the head sawyer duties are the primary focus of this paper, edging and trimming considerations are also covered.

The Sawyers Handbook. Undated. Michael G. Long. Ohio Department of Natural Resources, Columbus, OH. 20p.

Expands on "A Simplified Procedure for Developing Grade Lumber from Hardwood Logs."

Sawing Frozen Timber with Circular Headrigs. 1972. Stanford J. Lunstrum. USDA Forest Service, State and Private Forestry, Forest Products Utilization. Madison, WI. FPU Tech. RPT No. 4. 2p.

For many sawmillers a freezing temperature is the signal to shut down operations and wait for more favorable conditions. Sawing frozen logs is probably the severest test a mill can face, yet many mills operate successfully in the winter. What makes the difference? The following suggestions may help your operation in cold-weather sawing.

Procedure for Quartersawing Logs 16-19 Inches in Diameter and Procedure for Quartersawing Logs 20 Inches in Diameter and Over. 1980. Stanford J. Lunstrum. USDA Forest Service, State and Private Forestry, Forest Products Utilization. Madison, WI. FPU Tech. RPT No. 9. 2p.

Procedures for quartersawing hardwood factory lumber logs are discussed.

SECONDARY BREAKDOWN—EDGING & TRIMMING

How to Edge and Trim Lumber. 1982. Petro, F.J. Forintek Canada Corporation, Eastern Laboratory. Ottawa, Ontario. 135p.

Many technical terms used in the Rules of the National Hardwood Lumber Association and in hardwood lumber industry are defined and explained. The Rules themselves are explained and their implication is described and illustrated in the group of many typical boards.

Guidelines are provided for edging and trimming hardwood lumber to maximize its value within the constraint of market acceptability. Separate explainations are provided for each grade, and special board types such as boards from sweepy logs, miscut boards, tapered boards, etc. Another chapter is devoted to mill equipment, operator aids, and mill design, as they affect lumber value yield.

Rules and Guidelines for Edger and Trimsaw Operators. Undated. Michael G. Long. Michael G. Long, Hardwood Consultant, Powell, OH. 8p.

This publication outlines edging and trimming instructions for machine operators.

Proper Edging and Trimming Will Help Improve Lumber Value. 1991. Araman, Philip A. Hardwood Manufacturers Association. HMA Link. 3(5): 6-7

Decisions on where to edge and trim waning edged boards, or to trim other boards, can have a major effect on the performance of a sawmill. Optimum decisions are difficult for a number of reasons, including: complexity of grading rules; operator skills; operator fatigue or lack of interest at times; and, the inability of operators to include lumber prices in decisions. This article discusses the results from a study of three medium-sized hardwood sawmills and indicates that edging and trimming can be improved significantly.

Optimum Edging and Trimming of Hardwood Lumber. 1992. Regalado, Carmen; Kline, D. Earl; Araman, Philip A. Forest Products Journal. 42(2): 8-14.

Before the adoption of an automated system for optimizing edging and trimming in hardwood mills, the performance of present manual systems must be evaluated to provide a basis for comparison. a study was made in which lumber values recovered in actual hardwood operations were compared to the output of a computer-based procedure for edging and trimming optimization. The optimization procedure was based on National Hardwood Lumber Association grading rules and market prices for green lumber. Using a sample of 120 red oak boards obtained from three sawmills in southwest Virginia, it was found that the respective mills recovered only 78, 65, and 62 percent of the value yielded by the optimization procedure. Given the level of value recovery actually attained by sawmills, it was concluded that substantial increases in value can be expected from optimizing edging and trimming. Other aspects of interest were investigated, such as the quality (grade) of lumber that benefited most from optimization, the effect of volume loss on value recovery, and the relative impact on lumber value if each operation were optimized independently of each other.

SAWMILL PERFORMANCE & CONVERSION EFFICIENCY

Eleven Million Trees Wasted. 1972. E.W. Al Thrasher. Thrasher Publications. Ukiah, CA. 47p.

This booklet has been prepared to alert persons interested in conservation of our nation's timber resources to the huge waste that has occurred in the manufacture of lumber in this country. A further objective is to depict and explain to leaders in the lumber industry the true nature of this huge unnecessary waste that continues only slightly diminished even though the technology to eliminate it has been available to the entire industry for over five years. Improved conversion methods and technology have not only been proven under actual conditions as to the great increase in recovery possible, they have also demonstrated that substantial improvements in profits can be realized. Not withstanding the foregoing, only a relatively small portion of the industry has adopted these more advanced methods. [Ed note: This landmark paper brought attention to and motivated the sawmill industry to begin to improve lumber recovery through such efforts as the Sawmill Improvement Program (SIP).]

Softwood Sawmill Improvement Program: Selected Study Results (1973-1979). 1981. Lunstrum , Stanford. State and Private Forestry, Forest Service, U.S. Department of Agriculture. Cooperative Extension Programs, University of Wisconsin – Extension. Madison, WI. 107p.

Approximately 900 mill studies were conducted between May 1973 when the Softwood Sawmill Improvement Program (SSIP) was officially inaugurated and September 1979. About 160 of these have been a second or a followup study to determine if improvements made in the mill actually resulted in additional recovery. Together these data represent the most comprehensive information ever assembled on U.S. softwood dimension sawmills. The intent of this document is to utilize the extensive SSIP data to help extend our Nation's timber resources by further improving the lumber recovery efficiency in sawmills. This report summarizes some of the major findings in the SSIP program.

Regional Softwood Sawmill Processing Variables as Influenced by Productive Capacity. 1991. Philip H. Steele, Francis G. Wagner, and Kenneth E. Skog. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-RP-504.

The relationship between annual softwood sawmill production and lumber processing variables was examined using data from Sawmill Improvement Program (SIP) studies of 650 softwood mills. The variables were lumber recovery factor (LRF); headrig and resaw kerf width; total sawing variation, rough green size, and oversizing-undersizing for 4/4 and 8/4 lumber; planer allowance; and average log diameter and length. All variables except planer allowance and average log diameter were significantly influenced by annual sawmill production. The conversion efficiency of the mills in terms of most of these variables increased as sawmill size increased but decreased at annual production levels approaching or exceeding 100 million board feet. Study sawmills were grouped by geographic region and annual production class. Weighted values of LRF, sawing, and resource variables were calculated for each region by weighting by the percentage of mills of that production class in each category. Weighted and mean values are presented for each annual production class by region.

Band vs. Circular Sawmills: Relative Labor & Maintenance Costs. 1997. Steel, Philip H.; Araman, Philip A. Southern Lumberman. June: 22-25.

Substantial sawmill lumber yield increases from kerf and sawing variation reductions can be realized by employing band rather than circular headrigs. Softwood sawmills rapidly adopted bandsaw headrig technology to the extent that it is currently unusual to find circular saw headrigs in a softwood sawmill. Hardwood sawmills, faced with a different economic situation, have been relatively slow to adopt bandsaw headrigs. Hardwood sawmills utilizing circular headrigs to process low-value products or making relatively few headrig saw cuts on each log may find that headrig kerf reduction is not a significant factor in profit maximization. For them, circular headrigs are usually the most economical primary processing option. Cost is another reason that hardwood sawmills have been slow to convert to band headrigs. Hardwood sawmill managers may not feel that increased profits from higher yields would offset increased costs. The capital cost of a band headrig can be expected to be three to six times that of a circular headrig. Installation costs and income lost during installation may be considerable. These costs can be determined from band headrig manufacturers and engineering consultants. Unlike headrig and installation costs, operational costs relative to circular headrigs are currently difficult to determine. No published information describing the relative operating costs of band versus circular headrigs exists. This information, if available, would be valuable in helping hardwood sawmill managers determine the feasibility of converting to band headrigs. Our study quantifies and compares the more difficult-to-estimate relative labor and maintenance costs of band versus circular headrigs.

Relative Performance of Hardwood Sawing Machines. 1991. Steele, Philip H.; Wade, Michael W.; Bullard, Steven H.; Araman, Philip A. In: Proceedings, 19th Annual Hardwood Symposium of the Hardwood Research Council: Facing Uncertain Futures and Changing Rules in the 1990s. pp. 119-133.

Only limited information has been available to hardwood sawmillers on the performance of their sawing machines. This study analyzes a large database of individual machine studies to provide detailed information on 6 machine types. These machine types were band headrig, circular headrig, band linebar resaw, vertical band splitter resaw, single arbor gang resaw and double arbor gang resaw. Kerf width and within-board, between-board and total sawing variation values are given with an analysis of their origin in individual machine characteristics. Feedworks and setworks type and sawblade thickness and type generally determined machine type performance.

Estimating Hardwood Sawmill Conversion Efficiency Based on Sawing Machine and Log. 1992. Wade, Michael W.; Bullard, Steven H.; Steele, Philip H.; Araman, Philip A. Forest Products Journal. 42(11): 21-26.

Increased problems of hardwood timber availability have caused many sawmillers, industry analysts, and planners to recognize the importance of sawmill conversion efficiency. Conversion efficiency not only affects sawmill profits, but is also important on a much broader level. Timber supply issues have caused resource planners and policy makers to consider the effects of conversion efficiency on the utilization and depletion of the timber resource. Improvements in sawmill conversion efficiency would favorably impact sawmill profits, and would be equivalent in effect to extending existing supplies of standing timber. An equation was developed to estimate lumber recovery factor for hardwood sawmills based on the characteristics of sawing machines and log resources. Variables included in the model were headrig type, headrig kerf, average log diameter and length, and the influence of total sawing variation. The estimated coefficients significantly influenced lumber recovery factor. The model should be helpful in assessing conversion efficiency trends and potential benefits from gains in sawmill efficiency.

LUMBER MANUFACTURING QUALITY CONTROL

Lumber Manufacturing Quality Improvement Workshop. 1994. Dramm, John R., Stanford J. Lunstrum, and Adele Olstad. Presented at Portsmouth, New Hampshire, April 1994. USDA Forest Service, Forest Products Laboratory, Technology Marketing Unit. Madison, WI. (Workshop Materials)

Quality improvement is an effective way to reduce costs and improve manufactuing productivity and marketablity of forest products by objectively evaluate process performance and product quality. This workshop provided a general introduction to the Deming management method for the improvement of quality and productivity. Topics include management philosophy and commitment, basics of quality improvement tools including statiastical process control (SPC), and applications to sawmills and other wood using primary manufacturers. SPC helps identify and locate problems which occur in breakdown systems. This is especially effective in setting maintenance priorities and evaluating machine replacement and capital improvement projects. SPC also helps determine when adjustments to a breakdown system become necessary and when to leave the process alone.

The Memory Jogger—a Pocket Guide of Tools for Continuous Improvement. 1988, 2nd Edition. Brassard, Michael, ed. GOAL/QPC. Methuen, MA. ISBN 1-879364-03-4.

This pocket handbook is designed to help you and every person in your company to improve daily the procedures, systems, quality, cost, and yields related to your job. This continuous improvement process is the focus of today's quality revolution.

Results-Driven Approach to Improving Quality and Productivity. 1998. Dramm, Rusty. USDA Forest Service, State & Private Forestry, Madison, WI. Published in proceedings from Wood Technology Clinic & Show, Portland, OR.

Presents a proven results drive approach to improving bottomline business performance though quality and productivity improvement.

Statistical Process Control and Other Tools for Continuous Improvement. 1997. Dramm, Rusty. USDA Forest Service, State & Private Forestry, Madison, WI. Published in proceedings from Wood Technology Clinic & Show, Portland, OR.

Discusses various quality and organizational tools to control and improve quality in the forest products industry including control charts and process capability studies with current quality improvement philosophy based on Deming and Juran.

Statistical Process Control Technologies: State of the Art for the Forest Products Industry. 1994. Forest Products Society, Madison, Wisconsin. 290p.

Provides a general text on forest products industrial marketing including definitions and descriptions of wood products marketing, industrial customers, commodity and specialty markets, product differentiation, distribution, promotion, pricing, marketing research, and market feasibility study.

Successful Change Programs Begin with Results. 1991. Schaffer, Robert H. and Harvey A. Thomson. Harvard Business Review, January-February 1992. Harvard Business School. Boston, MA. pp80-89.

The performance improvement efforts of many companies have as much impact on operational and financial results as a ceremonial rain dance has on the weather. While some companies constantly improve measurable performance, in many others, managers continue to dance round and round the campfire—exuding faith and dissipating energy. Many of these activities parade under the banner of "total quality" or "continuous improvement." Companies introduce these programs under the false assumption that if they carry out enough of the "right" improvements, actual performance improvements will "some how—someday" improve. At the heart of these "activities centered" programs is flawed logic that confuses means with ends, processes with outcome. The momentum for activity-centered programs continue to accelerate even though there is virtually no evidence of improvement. In stark contrast to activity-centered programs, results-driven improvements bypass lengthy preparations and aim for quick, measurable gains within a few months. The results-driven path stakes out specific targets and matches resources, tools, and action plans to requirements of reaching those targets. As a consequence, managers know what they are trying to achieve, how and when it should be done, and know when improved performance has been achieved.

Quality Control in Lumber Manufacturing. 1982. Terry Brown, Editor. Miller Freeman Publications. San Francisco, CA. 288p.

Along with 15 other industry experts responsible for successful quality control programs in North America, lumber authority Terry Brown has compiled the first how-to guide for starting and improving lumber quality control programs. With an emphasis on maximizing your company's value and profits, this book takes you through the entire manufacturing process step by step. You'll learn about efficient, standardized procedures and useful tools for controlling lumber size, monitoring machinery, and evaluating personnel. In addition, this guide fully explains how to: establish the best quality control program for your mill; improve your existing quality control program; sell the importance of quality control to management; and keep your quality control program simple.

Are You Looking at Reasons for Mill Losses But Not Seeing Them? 1980. Terence D. Brown. Forest Industries, Miller Freeman Publications, San Francisco, CA.

This article describes common every day quality problems that go unnoticed but may drastically impact a forest industries firms's bottomline and suggests ways to help boost mill profits. Most sawmills waste hundreds, if not thousands, of dollars each day. Most of this waste is either lumber degrade created in the manufacturing operation, or lumber that could have been recovered but wasn't. Frequently the circumstances creating this waste are very obvious yet overlooked by the mill management or employees.

Lumber Process Control Checklists. 1979. Terry Brown. Oregon State University Extension Service. Corvallis, OR.

Packet includes 16 quality control checklists covering log bucking and scaling to sawmill machine centers to dry kiln and planer mill operations. Written for softwood sawmills, but adaptable to hardwood operations as well.

Quality Control Troubleshooting Tools for the Mill Floor. 2000. John "Rusty" Dramm. USDA Forest Service, State & Private Forestry, Madison, WI. Published in proceedings from Wood Technology Clinic & Show, Portland, OR.

Discusses control charts as troubleshooting tools in sawmill and other forest products operations to track down problems. Includes a case history of improvement tools including control charts and process capability studies.

Statistical Process Control—Lumber Size Analysis. 1994. Dramm, John R. USDA Forest Service, Forest Products Laboratory, Technology Marketing Unit. Madison, WI. Version 1.0(07/01/92)

This guide describes the general procedures necessary to successfully collect, analyze, and interpret lumber size varaition. It is designed to be used in conjunction with the ***Statistical Process Control—Lumber Size Analysis (SPC-LSA)*** computer routine developed by the USDA Forest Service. The reporets produced by SPC-LSA help evaluate the sawing performance of breakdown systems by anlyzing size variation in lumber.

IMPROVE Systems Lumber Manufacturing Program: Statistical Process Control in Lumber Manufacturing—Training Manual. 1991. Dramm, John R., Stanford J. Lunstrum, and Adele Olstad. USDA Forest Service, Forest Products Laboratory, Technology Marketing Unit. Madison, WI. (Workshop Materials)

Statistical process control (SPC) methods have been developed as tools to meet the demand for higher sawmill conversion efficiency and improve lumber quality. Quality improvement is an effective way to reduce costs and improve productivity and marketablity. SPC methods are designed to objectively evaluate process performance and product quality. This helps the sawmill operator manufacture lumber within specified tolerances and indicates when specifications cannot be met.

Lumber size analysis is the application of SPC to the problem of lumber size variaiton. It helps identify and locate problems which occur in breakdown systems. This is especially effective in setting maintenance priorities and establishing specifications for new breakdown systems in capital improvement projects. Lumber size analysis can also be used as a maintenance tool to determine when adjustments to a breakdown system become necessary and when to leave the process alone.

Lumber Size Control Analysis. 1986. Terry Brown. Oregon State University Extension Service. Corvallis, OR.

This paper provides the necessary background and procedures on setting up a lumber size control program in a sawmill. Lumber size control is a systematic procedure that properly caried out, identifiies and locates problems occurring in sawing-machine centers, sawing systems, or setworks systems. It is a key component of all good lumber quality-control programs. In both the large-log sawmill, where board feet may sometimes be sacrificed to recover grade, and in the small-log sawmill, where baords must be sawn to the smallest green target size possible without losing grade from planer skip or undersizing, a size-control program can optimize decisions on breakdown, edging, and trimming, and is essential for maximizing baord-foort recovery.

Improving Sawing Accuracy Does Help. 1979. Strern, Abigail R.; Hiram Hallock, and David W. Lewis. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-RP-320.

The relation of sawing accuracy to lumber recovery was studied using the Best Opening Face computer sawing program to mathematically simulate log breakdown as practiced by a major segment of the North American lumber industry. Sawing accuracy is a combination of sawing variation and lumber oversizing. An analysis was made for 16 sawkerf combinations and the cant sawing method. The results show that exponentially larger in-creases in lumber yield can be expected as sawing accuracy increases. This increase in yield, with no additional raw material consumed, tends to compensate for the exponentially increasing costs of improving sawing accuracy.

Evaluation of Alternative Statistical Techniques in Use for Monitoring Sawmill Machine Centers. 1981. Theodore A. Peterson and Donald S. Ermer. University of Wisconsin, Department of Forestry. Madison, WI. Staff Series Paper No. 12.

This paper provides the background methodology for estimating lumber size analysis statistics: average measured size, total lumber size variation, and within- and between-board variation in lumber thickness or width. The methodology presented is the basis of the Statistical Process Control – Lumber Size Analysis (SPC-LSA) IMPROVE software routine.

How to Calculate Target Thickness for Green Lumber. 1973. Warren, W.G. Department of the Environment, Canadian Forest Service, Western Forest Products Laboratory. Vancouver, British Columbia. Information Report VP-X-112.

Following is an illustration of the effects of within- and between-board variation in lumber thickness, a method for determining target thickness is detailed whereby the proportion of undersized material may be kept below a prescribed minimum (here taken as 5%). The estimation of the separate components of variation will indicate what part of the production process is in need of control.

Relative Kerf and Sawing Variation Values for Some Hardwood Sawing Machines. 1992. Steele, Philip H.; Wade, Michael W.; Bullard, Steven H.; Araman, Philip A. Forest Products Journal. 42(2): 33-39.

Only limited information has been available to hardwood sawmillers on the performance of their sawing machines. This study analyzes a large database of individual machine studies to provide detailed information on 6 machine types. These machine types were band headrig, circular headrig, band linebar resaw, vertical band splitter resaw, single arbor gang resaw and double arbor gang resaw. Kerf width and within-board, between-board and total sawing variation values are given with an analysis of their origin in individual machine characteristics. Feedworks and setworks type and sawblade thickness and type generally determined machine type performance.

LUMBER RECOVERY & GRADEYIELD

Know Your Sawmill Performance. Undated. Dan Bousquet. University Extension Service, University of Vermont. Burlington, VT. 5C-QPC-587 25p.

Discusses lumber recovery, mill productivity, production costs, and financial indicators of good and poor sawmill performance.

Guidelines for the Study of Sawmill Performance. 1972. James Dobie. Western Forest Products Laboratory, Forintek Canada Corporation. Vancouver, B.C. Information Report VP-X-93.

Describes procedures for conducting sawmill analysis studies.

Procedures for Analyzing Sawmill Performance. Undated. Marshal White. Virginia Polytechnic Institute. Blacksburg, VA.

Describes procedures for conducting sawmill analysis studies.

Increasing Your Lumber Recovery. 1973. Sawmill Improvement Program. U.S. Department of Agriculture, Forest Service, Washington, D.C. 25p.

This booklet was used to introduce the Sawmill Improvement Program (SIP) to industry and describes study procedures for sawmill owners to encourage them to participate in the SIP studies.

Estimating Opportunities in Lumber Yield Improvement. 1978. John White. USDA Forest Service, State & Private Forestry. Published in proceedings of the 8th Sawmill Clinic, Portland, OR. Miller Freeman. San Francisco, CA. 88-92pp.

This paper describes procedures for estimating improvement of lumber recovery such as by the reduction of saw kerf. Estimating lumber yield improvement is directly correlated to target set (i.e., saw kerf plus target size) reduction.

Comparing Lumber Yields from Board Foot and Cubically Scaled Logs. 1979. Hallock, Hiram; Phil Steele; and Richard Selin. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Res. Paper FPL-324

Historically, sawtimber has been bought and sold by the board foot, but now cubic scaling of logs and timber has begun and is scheduled to entirely replace board foot scaling by 1985 in sales from National Forests. In board foot scaling of sawlogs, the contents are estimated by measurement of small-end diameter and log length, and reference to log rule. The actual lumber recovered usually exceeds the estimate by a factor known as “overrun.” Increasing taper has been shown to increase overrun when logs have been board foot scaled. The exact opposite occurs when the logs are cubically scaled.

Through the medium of mathematical modeling, this study defines the degree of change to be expected from either scaling method as taper is increased. Several examples are developed to explain the use of the tabular and graphic data presented.

The Effect of Log Taper on Lumber Recovery. 1979. Hiram Hallock. In: Proceedings of the 9th Sawmill Clinic, Portland, OR. Miller Freeman. San Francisco, CA. 72-78pp.

Log rules (over 100 of them) are not so good at helping the sawmill manager determine sawmill performance. Many log rules (e.g., Scribner Decimal C) do not account for taper in scaling logs, while other log rules (e.g., International) do. The paper describes the effect of log taper in terms of sawmill performance using cubic measurement as a better way to evaluate mill performance.

There is More Lumber in that Log! 1978. Hiram Hallock. USDA Forest Service, State & Private Forestry. Published in proceedings of the 8th Sawmill Clinic, Portland, OR. Miller Freeman. San Francisco, CA. 93-108pp.

This paper describes opportunities to increase lumber recovery using the Best Opening Face program, sawing patterns, as well as through kerf and oversize reduction, sawing patterns, and tightening up on lumber size variation.

Managing the Stands of the Future Based on the Lessons of the Past: Estimating Western Timber Species Product Recovery by Using Historical Data. 2000. James A. Stevens and R. James Barbour. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. PNW-RN-528. 33p.

Researchers at the Pacific Northwest Research Station have completed over 100 forest product recovery studies over the past 40 years. Tree, log, and product data from these studies have been entered into a database, which will allow further analysis within, between, and across studies. Opportunities for analysis include stand-to-log-to-final product estimates of volume, quality, and value. Examples of possible database queries include determining the variation in recovery volume and product yield from different age or diameter classes, the relation between percentage of sound log volume and product yield, and the relation between product quality and age.

Hardwood Log Grades and Lumber Grade Yields for Factory Lumber Logs. 1980. Leland F. Hanks, Glenn L. Gammon, Robert Brisbin, and Everette D. Rast. USDA Forest Service, Northeastern Forest Experiment Station, Broomall, PA. Res. Paper NE-468. 92p.

The USDA Forest Service Standard Grades for Hardwood Factory Lumber Logs are described and lumber grade yields for 16 species and 2 species groups are presented by log grade and log diameter. The grades enable foresters, log buyers, and log sellers to select and grade those logs suitable for conversion into standard factory grade lumber. By using the appropriate lumber grade yields, log buyers and sellers can appraise the logs in terms of expected lumber grade volume and value. This report supersedes an earlier report on hardwood log grading, Forest Service Research Paper FPL 63.

Changes in Mill Run Hardwood Sawlog Lumber Grade Yields When Veneer Logs are Withdrawn. 1964. USDA Forest Service, Forest Products Laboratory.

USDA Forest Service Standard Grades for Hardwood Factory Lumber Logs are described when veneer logs by species groups are presented by log grade and log diameter.

Hardwood Tree Grades for Factory Lumber. 1976. Lee Hanks. USDA Forest Service, Northeastern Forest Experiment Station, Broomall, PA. Res. Paper NE-333. 81p.

The Forest Service hardwood tree grades for factory lumber are described, and lumber grade yields for 11 species are presented. The yields, expressed in board feet, are based on equations in which dbh^2 and merchantable height were used as independent variables. Actual board-foot volumes by lumber grade serve as dependent variables. Species included are yellow and paper birch, red and sugar (hard) maple, yellow-poplar, black cherry, basswood, and northern red, black, white, and chestnut oak.

Effect on Defect Placement and Taper Setout on Lumber Grade Yields when Sawing Hardwood Logs. Undated. F.B. Malcolm. USDA Forest Service, Forest Products Laboratory. Madison, WI. Old Report No. 2221

The study here reported was made to evaluate some of the principles used by skilled sawyers as well as some of the principles developed at the Forest Products Laboratory for getting the optimum grade from all logs. The study, which was statistically designed, evaluates six sawing methods for which the sawing faces were positioned relative to gross external defects and the amount of setout for log taper. Lumber-grade yield tallies were summarized, and a quality index was computed for individual logs, each grade, and each method. This index was calculated from the value of the lumber sawn, based on prevailing market quotations. It was concluded from the study that sawmill operators lose considerable money in producing their lumber by ignoring the position of defects on sawing faces and taper setout.

Influence of Lumber Volume Maximization in Sawing Hardwood Sawlogs. 1993. Steele, Philip H.; Wagner, Francis G.; Kumar, Lalit; Araman, Philip A. In: Proceedings of the Forest Industries 21st Wood Technology Clinic and Show. Portland, OR. Miller Freeman Publishing. San Francisco, CA. . pp. 1-26.

The Best Opening Face (BOF) technology for volume maximization during sawing has been rapidly adopted by softwood sawmills. Application of this technology in hardwood sawmills has been limited because of their emphasis on sawing for the highest possible grade of lumber. The reason for this emphasis is that there is a relatively large difference in price between the respective grades of hardwood lumber compared to the difference between the softwood lumber grades. Hardwood sawmillers have judged that an attempt to maximize volume would result in value loss to the degree that total value yield would be significantly reduced. While hardwood sawmillers may be correct there has been no data available supporting their expectation that maximizing for volume yield will reduce value yield. The potential volume yield improvement from BOF decisions for sawing hardwood sawlogs is 6.3 percent which is only slightly less than for sawing softwood sawlogs. The BOF technology employs an iterative procedure that tests numerous initial opening face distances from log center for each given sawing pattern. These solutions begin at an opening face position at which the first board face sawn will be of the minimum acceptable dimension. The complete simulated sawing of the log is performed at this minimum opening face position. Subsequent opening face positions are tested by reducing the opening face distance from log center by arbitrarily selected increments. The distance over which opening-face position is tested has been the thickness of one piece of lumber plus kerf width. Maximum-volume yield is attained at the initial minimum opening face position for only a small percentage of BOF solutions. For this reason maximum-volume yield is generally obtained for some opening face position somewhat closer to log center than that of the minimum opening face. In fact, Steele et al. showed that the highest yielding BOF position is generally obtained by centering the sawing pattern in the sawlog. The most frequent of the defect types in sawlogs are knots. Knots are most numerous near log center. Therefore, the movement of sawlines slightly towards log center from a minimum opening face, required for BOF volume maximization, should increase the frequency of sawline intersection with knots. Increased frequency of sawline intersection should result in the yield of lower grade lumber that is of lower value. Past research has examined hardwood log orientation to determine the influence of defect placement on total lumber value with the most recent study showing a significant 10 percent increase in lumber value for best log orientation. The objective of this study was to determine the influence of lumber volume maximization on value yield in sawing hardwood sawlogs.

The Value Versus Volume Yield Problem for Live-Sawn Hardwood Sawlogs. 1993. Steele, Philip H.; Wagner, Francis G.; Kumar, Lalit; Araman, Philip A. Forest Products Journal. 43(9): 35-40.

The potential conflict between value and volume maximization in sawing hardwood sawlogs by the live sawing method was analyzed. Twenty-four digitally described red oak sawlogs were sawn at the log orientation of highest value yield. Five opening face sawlines were iteratively placed in the sawlog a 1/4-inch intervals and lumber grades, volumes, and values from completely sawing the log at each opening face position were determined. Volumes were computed for several sawing positions of interest: maximum and minimum volume, minimum opening position, mean volume, and centered solution. Dollar values and distances from minimum opening position were also determined for these sawing positions of interest. Statistical comparisons of these variables showed that the conflict between value and volume yield was significant. A potential average loss of $2 per sawlog was indicated if volume yield was maximized at the expense of value yield. Results also indicated that a precise knowledge of internal defect location is apparently required to obtain maximum value yield. An internal scanning system will be required to obtain the needed defect location information.

TIGHTENING UP SAWMILL PERFORMANCE

Troubleshooting Circular Sawmills. 1984. Edited by Jack Zollner. Michigan Department of Natural Resources. 45p.

This booklet provides basic troubleshooting tips for circular sawmills.

Sawmiller's Guide to Troubleshooting. 1995. Casey Creamer. Northeastern Loggers' Association, Inc. Old Forge, NY. 182 pages.

Provides basic troubleshooting procedures for circular sawmills. Publication builds on Stan Lunstrum's Circular Sawmills and Their Efficient Operation.

Trouble-Shooting in the Circular Sawmill: Operating and Maintenance Manual. Undated. Pacific/Hoe Saw & Knife Company. Portland, OR.

This booklet provides basic troubleshooting tips for circular sawmills.

Tightening-Up Sawmill Improvement Procedures for Bandmill and Circular Sawmills. 1978. Ted Peterson and Stan Lunstrum. USDA Extension Service, University of Wisconsin Extension in cooperation with USDA Forest Service, State & Private Forestry, Madison, WI.

Overview of tightening-up procedures for sawmills with a slide tape presentation.

Tightening-Up Sawmill Improvement Procedures for Bandmill and Circular Sawmills: How to Check Your Setworks Accuracy. 1978. Ted Peterson and Stan Lunstrum. USDA Extension Service, University of Wisconsin Extension in cooperation with USDA Forest Service, State & Private Forestry, Madison, WI.

Describes procedures on how to evaluate setworks setting accuracy and repeatability.

Tightening Up the Mill for Increased Recovery—A Dialogue 1979. Dean Huber and Fred Eagan. USDA Forest Service, State & Private Forestry. Published in proceedings of the 9th Sawmill Clinic, Portland, OR. Miller Freeman. San Francisco, CA. 61-71pp.

A case history of a sawmill's experience in developing a statistical based QC program. Benefits include tightening up sawmill performance, increasing lumber recovery and reduced target sizes.

Tighten Up Your Sawmill for Better Profit. Undated. Dan Bousquet. University Extension Service , University of Vermont. Burlington, VT. 5C-980-VP 22p.

Discusses impacts of lumber sizing and kerf thickness on lumber recovery and sawmill profitability.

Managing Mill Maintenance: The Emerging Realities. 1990. Richard F. Baldwin. Forest Products Society, Madison, Wisconsin. Publication #MF-4710. 302p.

Mill maintenance today is no longer a simple series of "break it/fix it" tasks. Instead, it's a complex system of procedures and techniques aimed at capturing the competitive edge in productivity, quality, yield, and profits. But how do you use it? This book is a guide to maintenance management techniques for winning the competitive edge. Supervisors, machine operators, owners, and senior managers alike can put the system described to use immediately. Emphasizing increased mill efficiency in the forest products industry, the book cites examples of competitive mills throughout North America, Europe, and Japan. Key topics include: creating and sustaining an effective maintenance program; managing for results; predictive maintenance: tools and techniques; budgets and cost controls; maintenance support systems; obtaining more from the mill; innovation, involvement, and quality circles; and designing away from maintenance. This book is a hands-on guide to devising a new system for mill maintenance that is based on lower costs, optimum equipment performance, maximum effectiveness of each function, less downtime, and simpler maintenance efforts.

SAWS & SAW FILING

Saws: Design, Selection, Operation, Maintenance. 1989. Ed Williston. Miller Freeman Publications. San Francisco, CA. 450p.

This second edition book includes more than 150 pages of new material covering the latest technology in saws but retains the basic information and practical approach that made the first edition such a valuable training and reference work. This second edition responds to business concerns, such as maximizing lumber value recovery to get the most out of costly raw materials. The new technologies and improved methods that have changed sawmilling are explained in detail: computerized analysis of saw design, setout, v-belt hookup and lumber recovery; improved tooth wear resistance, including new developments in Stellite tipping; thin kerf saws; and increased automation in the sawmill and filing room.

Saw Filer's Handbook (Second Revised Edition). 1970. Phil Quelch. Armstrong Manufacturing Company. Portland, OR. 104p.

Authoritative guide on bandsaw and circle saw filing and benching and sawmill alignment.

Sawmill Feed and Speeds: Band and Circle Rip Saws (Revised Edition). 1972. Phil Quelch. Armstrong Manufacturing Company. Portland, OR. 57p.

Reference book of speed and feed rates for various types of band and circular saws.

How to Calculate Required Horsepower for Circular Saws. 1980. Stanford J. Lunstrum. USDA Forest Service, State and Private Forestry, Forest Products Utilization. Madison, WI. FPU Tech. RPT No. 10. 2p.

The horsepower required for a circular saw is determined by several interrelated factors: tooth style; number of teeth; saw speed; kerf width; bite; wood hard-ness; and cant face width. A formula developed by Hiram Hallock, retired, U.S. Forest Service, can be used to determine horsepower requirements.

Balanced Saw Performance. 1985. Stanford J. Lunstrum. USDA Forest Service, State and Private Forestry, Forest Products Utilization. Madison, WI. FPU Tech. RPT No. 12. 17p.

Correctly selecting a saw for a job is one of the most critical decisions a sawmiller has to make. Even after the selection is made, the saw must be set up and operated within certain specifications for balanced performance. An understanding of the interrelationship of raw materials, end products, machinery, and the sawing process itself is essential. Often sawmillers operate their saws with less than adequate knowledge about correct bite, feed speeds, tooth speeds, side clearances, depths of cut, and power requirements. Every saw is limited to a rather narrow operating range. Experience has taught most sawmillers which saws to choose for specific applications. However, for correct saw selection and saw operation, it is possible to mathematically calculate the variables involved. Program "SAW" has been developed to integrate these variables quickly and accurately. Operators who use Program "SAW" will be able to (1) maximize production from their saws, (2) reduce saw operating problems, (3) maximize saw life, and (4) increase recovery efficiency by producing more accurately sized lumber.

How to Increase Profit in Bandsawing: Practical Models for Increasing Lumber Recovery. Undated. Ed Williston and Others. Uddeholm Strip Steel AB. Munkfos, Sweden. 41p.

This manual is concerned with the vital interplay between bandsaw blade and machine. The booklet covers areas for improving saw blade stability, dollar value of certain improvements, a system for quality control on the mill floor, and comparative studies concerning saw design and operation.

Thin Kerf Sawing: A Technology Worth Adopting. Undated. Bratkovich, Stephen M. Misc. Pub. [Newtown Square, PA:] U.S. Dept. of Agriculture, Forest Service, Northern Area State & Private Forestry

The saw kerf has a significant impact on conversion efficiency (referred to as lumber recovery). A crude but effective way of calculating the amount of sawdust that develops during sawing is to determine the total wood usage per "pass" (logs being processed as a sawmill generally move or "pass" back and forth through the saw blade). Wood usage per pass includes the average thickness of the piece being sawn plus the saw kerf. For example, in cutting a board that is 1.125 inches thick with a saw kerf of 0.300, the total wood usage per pass is 1.425 inches. Calculating the saw kerf as a percentage of the total wood usage per pass results in 21% of the wood removed as sawdust or about one-fifth of the log resource. A band saw with a kerf of 0.140 inch would result in an increase in lumber recovery of about 10%.

PORTABLE SAWMILLS

Handbook on Portable Bandsaw-Type Sawmills. 1992. Michael Folkema. Forest Engineering Research Institute of Canada (FERIC). Pointe Claire, Que. FERIC Hdbk No.10. 65p.

This handbook is a guide for entrepreneurs considering using paortable bandsaw-type sawmills. The handbook is based on a series of case studies of successful operators located in eastern Canada. FERIC studied a variety of equipment and operating methods to make recommendations on how to improve sawing effiiciency and reduce costs.

Portable Sawmill Encyclopedia. Undated. Sawmill Exchange. Sawmill Exchange, Birmingham, AL.

Abstract not available.

Portable Sawmill Manufacturers. 2003. Terry Mace and Adele Olstad. USDA Forest Service, Technology Marketing Unit. Madison, WI. (Unpublished list of portable sawmill manufacturers.)

Abstract not available.

LUMBER DRYING, STORAGE & HANDLING

Dry Kiln Operator's Manual. 1991. Edited by Bill Simpson. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Ag Hdbk 188. 274p.

A well-designed and properly operated dry kiln can in a few days or weeks turn green lumber fresh from the forest into a dry, stable material necessary for successful industrial enterprises in today's highly competitive markets. The more critical the drying requirements, the more firmly the dry kiln becomes established as an integral part of the lumber mill, the furniture factory, or the millwork plant. For many wood products, kiln-dried lumber is essential.

The full benefits of modern kiln-drying technology can be gained only when certain prerequisites are observed. Mill management must recognize the importance of efficient operation to quality of product, and operators must be well trained and encouraged to apply the best techniques. Quality should not be sacrificed for quantity in the production of kiln-dried lumber. The high value of our timber resource makes it uneconomical to do so.

The purpose of this manual is to describe both the basic and practical aspects of kiln drying lumber. The manual is intended for several types of audiences. First and foremost, it is a practical guide for the kiln operator-a reference manual to turn to when questions arise. It is also intended for mill managers, so that they can see the importance and complexity of lumber drying and thus be able to offer kiln operators the support they need to do their job well. Finally, the manual is intended as a classroom text-either for a short course on lumber drying or for the wood technology curriculum in universities or technical colleges. This manual is a revision of the 1961 edition by Edmund F. Rasmussen.

Dry Kiln Schedules for Commercial Woods: Temperate and Tropical. 1988. Sid Boone, Charles J. Kozlik, Paul J. Bois, and Eugene M. Wengert. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-GTR-57. 158p.

This report contains suggested dry kiln schedules for over 500 commercial woods, both temperate and tropical. Kiln schedules are completely assembled and written out for easy use. Schedules for several thicknesses and specialty products (e.g., squares, handle stock, gunstock blanks) are given for many species. The majority of the schedules are from the world literature, with emphasis on U.S., Canadian, and British publications. Revised schedules have been suggested for western U.S. and Canadian softwoods and for the U.S. southern pines. Current thinking on high-temperature drying (temperatures exceeding 212 ^{o}F) schedules for both softwoods and hardwoods is reflected in suggested high-temperature schedules for selected species.

Air Drying of Lumber. 1999. William Simpson, John Tschernitz, and James Fuller. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Ag Hdbk 402. 62p.

This report describes how lumber can be air-dried most effectively under outdoor conditions and illustrates the principles and procedures of air-drying lumber that were developed through field investigations and observations of industrial practices. Particular emphasis is placed on the yarding of lumber in unit packages. Included are topics such as why lumber is dried, advantages and limitations of the drying process, properties of wood in relation to drying, layout of the drying yard, piling methods, causes and remedies of air-drying defects, and protection of air-dried lumber. This manual is a revision of the 1971 edition of *Air Drying of Lumber: A Guide to Industry Practice* by Raymond C. Rietz and Rufus H. Page. A major contributor to the 1971 edition was Edward C. Peck, formerly a wood drying specialist at the Forest Products Laboratory. The major reason for this revision is the continued interest in and requests for the manual, even almost 30 years after initial publication. Because of this continued interest, we maintained.

Drying Hardwood Lumber. 2000. Joe Denig, Gene Wengert, and William Simpson. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. GTR-117. 138p.

Drying Hardwood Lumber focuses on common methods for drying lumber of different thickness, with minimal drying defects, for high quality applications. This manual also includes predrying treatments that, when part of an overall quality-oriented drying system, reduce defects and improve drying quality, especially of oak lumber. Special attention is given to drying white wood, such as hard maple and ash, without sticker shadow or other discoloration. Several special drying methods, such as solar drying, are described, and proper techniques for storing dried lumber are discussed. Suggestions are provided for ways to economize on drying costs by reducing drying time and energy demands when feasible. Each chapter is accompanied by a list of references. Some references are cited in the chapter; others are listed as additional sources of information. In this manual, measurements are expressed in both English (inch–pound) and SI units. The following provides SI equivalents for lumber thickness sizes, dimension lumber, board foot volume, and other units. This publication supercedes *Drying Eastern Hardwoods* (see above).

Storage of Lumber. 1978. Ray Rietz. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Ag Hdbk 531. 63p.

Surveys the most effective current techniques for protecting the quality of stored lumber. Physical properties of wood which are basic to the storing of lumber in commerce are explained. Causes of storage losses in lumber are discussed. Individual chapters deal with protection of wood in specific storage environments, such as in yards, at manufacturing plants, or in transit.

Quality Drying of Softwood Lumber: Guidebook—Checklist. 1991. Michael R. Milota, R. Sidney Boone, Jeanne D. Danielson, and Dean W. Huber. USDA Forest Service, Forest Products Laboratory, State & Private Forestry. General Technical Report FPL-IMP-GTR-1

The IMPROVE Lumber Drying Program is intended to increase awareness of the lumber drying system as a critical component in the manufacture of quality lumber. One objective of the program is to provide easy-to-use tools that a kiln operator can use to maintain an efficient kiln operation and therefore contributes to lumber drying quality. This report is one component of the IMPROVE Program. It contains a guidebook–checklist for drying quality softwood that kiln operators or management can use to readily evaluate how well their operations rate on those factors that most strongly affect drying quality, with particular emphasis on kiln operation and maintenance and lumber handling. Appendix 1 contains a summary checklist for easy duplication and filing. Appendix 2 contains the same checklist items; however, the information is arranged by drying system components for convenience in checking individual components.

Quality Drying of Hardwood Lumber: Guidebook—Checklist. 1992. R. Sidney Boone, Michael R. Milota, Jeanne D. Danielson, and Dean W. Huber. USDA Forest Service, Forest Products Laboratory, State & Private Forestry. General Technical Report FPL-IMP-GTR-2

The IMPROVE Lumber Drying Program is intended to increase awareness of the lumber drying system as a critical component in the manufacture of quality lumber. One objective of the program is to provide easy-to-use tools that a kiln operator can use to maintain an efficient kiln operation and therefore improve lumber drying quality. This report is one component of the IMPROVE Program. It contains a Guidebook-Checklist for Quality Drying of Hardwood Lumber that kiln operators or owners can use to readily evaluate how well their operations rate on those factors that most strongly affect drying quality, with particular emphasis on kiln operation and maintenance and lumber handling. Appendix 1 contains a shortened version of the checklist for easy duplication and filing. Appendix 2 contains the same checklist items; however, the information is arranged by drying system components for convenience in checking individual components.

Quality Drying in a Hardwood Predryer: Guidebook—Checklist. 1993. Eugene M. Wengert, and R. Sidney Boone. USDA Forest Service, Forest Products Laboratory, State & Private Forestry. General Technical Report FPL-IMP-GTR-3

The IMPROVE Lumber Drying Program is intended to increase awareness of the lumber drying system as a critical component in the manufacture of quality lumber. One objective of the program is to provide easy-to-use tools that a kiln/predryer operator can use to maintain an efficient drying operation and therefore improve lumber drying quality. This report is one component of the IMPROVE Program. It is a guidebook–checklist for quality drying in a hardwood lumber predryer that kiln/ predryer operators or owners can use to readily evaluate how well their operations rate on those factors that most strongly affect drying quality, with particular emphasis on predryer operation and maintenance and lumber handling. Appendix 1 contains a shortened version of the checklist for easy duplication and filing. Appendix 2 contains the same checklist items; how-ever, the information is arranged by drying system components for convenience in checking individual components.

Drying Wood. Undated. Dan Bousquet. University Extension Service , University of Vermont. Burlington, VT. 5C-1181-VP 33p.

Discusses why dry wood, how wood dries, factors in drying control, quality control in drying and drying economics.

Guide to Drying Defects: A Supplement to the Drying Quality Assessment. 1984. Ed Sprague and Dave Schumann. USDA Forest Service, State & Private Forestry, Northeastern Area. NA-TP-10. 14p.

This publication describes common lumber drying defects including warp, checks, splits, honeycomb (internal checking), collapse, and stress.

Moisture Content and Shrinkage of Wood. 1989. Dave W. Green. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-RP-489

Discusses the relationship of wood moisture content and lumber shrinkage with implications to lumber drying.

Kiln Drying Lumber in the United States—A Survey of Volume, Species, Kiln Capacity, Equipment, and Procedures, 1992-1993. 1994. Robert W. Rice; Jeffrey L. Howe, R. Sidney Boone, R. Sidney; and John L. Tschernitz. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL-GTR-81. 25p.

A survey was conducted of primary and secondary manufacturing firms that have at least one dry kiln and process approximately 2 million board feet or more of lumber annually. More than 1,500 surveys were completed, representing manufacturers in 43 states. According to survey respondents, approximately 5 billion board feet of hardwood lumber and 24 billion board feet of softwood lumber were kiln dried annually. Drying data were collected for 48 commercial species or species groups and volume information was reported by state and region. The 13-state southern region dried more than twice as much wood as any other area. There were more than 7,000 dry kilns in the United States with a holding capacity of 447 million board feet. This capacity varied by species and region. The majority of kilns were steam heated. The most common maximum operating temperature was between 160°F and 180°F. The decision to use time-based or moisture-content-based kiln schedules depended on the species being dried. Generally, softwood producers used time-based schedules and hardwood producers used moisture-content-based schedules. This is the first national survey of its type to be conducted in the United States. It provides information that may be used to further examine drying practices in the United States.

Checklist for Drying Small Amounts of Lumber. 1982 (revised). P.J. Bois, E.M. Wengert, and R.S. Boone. USDA Forest Service, State and Private Forestry, Forest Products Utilization. Madison, WI. FPU Tech. RPT No. 6. 4p.

For many small woodworking companies and hobbyists, questions frequently arise as to proper procedures in processing the wood from the log to the ready-to-use dry lumber. This report suggests a list of procedures developed from the experience of personnel from the U.S. Forest Products Laboratory and State and Private Forestry. If these procedures are followed, there will be little, if any, loss from drying degrade.

How to Determine Seasoning Degrade Losses in Sawmill Lumberyards.. 1965. USDA-Forest Service, Northeast Forest Experiment Station. Research Note NE-32. 7p.

Abstract not available.

Stresses in Wood During Drying. 1958 (revised). J. M. McMillen. USDA Forest Service, Forest Products Laboratory. Madison,, Wisconsin. No. 1652 (revised).

During drying, wood is subjected to highly complicated internal stresses. They come about because the outside of a piece of green wood dries below the fiber saturation point and tries to shrink before the interior is ready for shrinkage. They are greatly influenced by the temperature and relative humidity of the air in which the wood is dried. An understanding of these stresses is essential to kiln operators and others who set out to develop drying procedures, because the stresses can be used to advantage and un-favorable effects avoided. Initial drying conditions can be set up that will avoid surface and end checks, retain maximum dimension, and minimize warping. Intermediate and final kiln conditions can be modified to speed drying without fear of internal defects. Final conditioning treatments can be used when necessary to relieve residual stresses at the end of kiln drying, thus avoiding distortion when material is resawed or machined to a nonsymmetrical pattern.

Electric Moisture Meters for Wood. 1988 (revised). William L. James. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL-GTR-6

Electric moisture meters for wood measure electric conductance (resistance) or dielectric properties, which vary fairly consistently with moisture content when it is less than 30 percent. The two major classes of electric moisture meters are the conductance (resistance) type and the dielectric type. Conductance-t type meters use penetrating electrodes that measure in a small volume, so moisture gradients may be deduced by repeated measurements at increasing depths. Dielectric-type meters use surface electrodes that do not puncture the wood surface, and can measure the moisture content of relatively dry wood. This paper describes these major types of meter and includes detailed information on the kinds of electrodes used with each type. Readings of moisture meters are affected by such factors as wood species and temperature, chemical treatments, moisture distribution, and operator skill. This paper contains information for correcting for these factors and for minimizing potential errors.

Save Money with Good Air-Drying Practices for Hardwood Lumber. 1981. William W. von Segen. USDA Forest Service, Southeastern Area. Atlanta, GA. Forestry Bulletin SA-FB/U 1.

This report is based on a preliminary study by the Utilization Department of the Arkansas Forestry Commission on air-drying operations at several hardwood lumber processing plants in Arkansas. This study was implemented by the Commission with assistance from Resource Use Unit, Southeastern Area, USDA Forest Service. DIP is designed to help mill owners and managers improve their practices of drying green lumber. Its objective is to recover greater volumes of usable wood products through increased processing efficiency. Improvements in drying practices should help reduce needles volume and value losses of lumber and thus moderate industrial demands on the standing resource.

Accelerating Oak Air Drying by Presurfacing. 1972. William T. Simpson and R.C. Bales. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL-RP-0223.

Previous research has shown the benefits of presurfacing oak lumber before kiln drying. Leney (1964) showed that the tendency of red oak to surface check during kiln drying was reduced by surfacing the lumber before drying. McMillen (1969) took advantage of this reduced checking tendency to accelerate kiln drying. Wengert and Baltes (1971) showed both the separate and combined effects of presurfacing, accelerated schedules, kiln automation, and smooth vs. step changes in kiln conditions. Their finding on the effect of presurfacing alone was that it reduced kiln drying time from green to 8 percent moisture content by 7-10 percent. They attributed this time reduction to the reduction in board thickness by presurfacing. The above-mentioned drying research was all conducted on material kiln dried from the green condition. While kiln drying green from the saw has definite advantages, most oak drying operations air dry before kiln drying. The question then arises does presurfacing offer similar advantages in air drying as it does in kiln drying?

Effect of Drying Methods on Warp and Grade of 2 by 4's from Small-Diameter Ponderosa Pine. 2001. William T. Simpson and David W. Green. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL-RP-601. 17 p.

Two studies were performed to characterize and control warp in nominal 2- by 4-in. (standard 38- by 89-mm) dimension lumber sawn from small-diameter ponderosa pine trees. One study was conducted at a commercial sawmill with trees harvested in central Arizona. The other study was conducted at the USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin, in small experimental kilns with lumber from trees harvested in central Idaho. The three main variables in the studies were top loading, presteaming, and a high-temperature kiln schedule. A limited study of hot press drying was also included. The high-temperature kiln schedule in the experimental kilns reduced drying time to about half that of the conventional temperature schedule. Press drying time was slightly more than 3 h. Crook and bow caused most of the warp and the grade loss from warp. There was no evidence that presteaming affected warp or grade loss from warp. Top loading had a modest effect in reducing warp and grade loss from warp. High-temperature drying did not affect measured warp compared with the conventional temperature schedule. Grade loss from warp was less in high-temperature than in conventional temperature dried lumber. This might be explained by differences in moisture content change during storage. Press drying did not reduce warp or grade loss from warp.

Quality Drying: The Key to Profitable Manufacturing . 2003. FPS. Forest Products Society, Madison, Wisconsin. Publication #7248. 197p.

This proceedings contains over 30 presentations from a fall 2002 conference on quality drying sponsored by the Forest Products Society. The presentations provide the latest practical information on innovative technologies, markets, and management practices designed to improve product quality of kiln-dried softwoods and hardwoods for manufactured (non-structural) wood products. Topics covered include: an overview of current drying technologies; market trends, needs, and opportunities; advances in kiln controls and other new drying technologies; managing the drying process; and improving the profitability of drying operations.

Softwood Drying: Enhancing Kiln Operations. 2000. Larry Culpepper. Forest Products Society, Madison, Wisconsin. Publication #MF-4190. 350p.

In this book Larry Culpepper explains why and how the entire manufacturing and drying process affects the final quality of lumber from any dry kiln. From log cutting to kiln maintenance, discover how the proper equipment and practices can increase quality and profitability (by producing narrowed moisture distribution, improved grade recovery, reduced drying time, easier operation, and lower costs). Use this comprehensive resource to: understand the latest kiln technologies and techniques; identify potential problem areas in your operations; learn more efficient use of natural resources; stimulate new ideas for kiln improvement; and contribute to your operation's overall success. Chapters include: lumber manufacture and its impact on drying; sorting and green lumber handling; lumber stacking and stick laying; kiln setups and loading practices; final loading considerations; dry lumber handling; fan systems and air flow; humidity control; steam-heated kilns; direct-fired dry kilns; computerized lumber drying control; the drying process; quality control; and kiln maintenance and design. Exploring the full scope of processes and challenges involved, this book helps you develop outstanding kiln operations for drying softwood of all kinds.

Lumber Drying Sourcebook: 40 Years of Practical Experience. 1998. FPS. Forest Products Society, Madison, Wisconsin. Publication #7274. 372p.

This 372-page publication contains a wealth of information for today's dry kiln operator and drying supervisor--young or old, experienced or inexperienced. The more than 130 articles contained in the *Sourcebook* resulted from a careful selection of the most practical and pertinent articles on lumber drying that were published in the Forest Products Society's *Wood Drying News Digest* over the past 40-plus years. The *Sourcebook* is filled with down-to-earth practical information from understanding the basics of shrinkage, stresses, and moisture movement in wood to troubleshooting and maintaining drying equipment. The articles are brief and were clearly written by the world's leading authorities on lumber drying. Articles are grouped by subject matter for easy access, and a comprehensive index is also provided.

Effective Predryer Operations. 1999. by Kenneth Eckert and Robert Little. Forest Products Society, Madison, Wisconsin. Publication #7264. 58p.

This manual presents a common sense approach to predrying. The manual reviews common problems experienced by predryer operators in an easy-to-understand manner. Simple, practical solutions to the problems of mixed species, varying lumber thickness, and stain development are presented. Solutions to the problems of slow drying rates and moisture variation are also discussed. Chapters include: introduction to predryers; stacking, loading, and start-up; air flow; temperature and humidity control; management decisions; sample boards; special problems; considerations when building a predryer; troubleshooting; and references. Applying the ideas and methods presented in this 58-page manual can improve predryer performance and drying quality.

LUMBER GRADING

An Illustrated Guide to Hardwood Lumber Grades. 1992. National Hardwood Lumber Association, Memphis, TN. 17p.

This guide helps the reader become familiar with the grading rules foe hardwood lumber established by the National Hardwood Lumber Association. Photographs are included for demonstrating the range in appearance that the buyer may expect to receive when purchasing each grade. This is an excellent resource book for mill employees, sales personnel, lumber buyers, and U&M specialists.

An Introduction to Grading Hardwood Lumber. 1994. National Hardwood Lumber Association, Memphis, TN. 16p.

This trade publication acquaints the reader with the basics of grading hardwood lumber. It is an introductory framework for understanding lumber grading rules.

Simplified Guidelines to Hardwood Lumber Grading. 1967. Walt Smith. USDA Forest Service, Southeastern Forest Experiment Station. Asheville, NC. 25p.

All native hardwood lumber is graded according to the rules established by the National Hardwood Lumber Association. The rules are complete and detailed so that they permit accurate lumber grading with a minimum of personal judgment. To the student lumber grader, the many fine points and exceptions by species are often confusing and hide the basic rules of standard lumber grades . This short course emphasizes the basic requirements for grading hardwood lumber on the proportion of clear pieces that can be cut from a board. Once these requirements are mastered, practice grading and continued study of the Rule Book will give the novice an appreciation of hardwood lumber grading. For information on construction grading, special grading, etc., see the Rule Book. Many people who work with lumber every day do not know specifically how to grade it. Sawyers, edgermen, trim saw operators, cut-up men in furniture plants, lumber purchasing agents, and many others in similar positions, need to have a good knowledge of basic lumber grades , even though they may never grade a car or truck of lumber. This course is designed to simplify lumber grading to the point where many people can acquire an understanding of the grades and be able to apply standard grades to individual boards. The course is not intended to be used in training lumber inspectors or to serve as a substitute for the official rules.

Graders Handbook. Undated. Timber Products Inspection and Testing Service, Inc. Portland, OR. 55p.

This handbook offers simplified terms, sketches, and illustrations, the measurement and limitations of major defect characteristics in 2” dimension softwood lumber under the national grading rules as adopted by the Department of Commerce as Voluntary Products Standard PS20-70. The handbook should make the grading of 2” dimension much simpler.

NHLA Inspection Training Manual: Guide to General Instructions & Standard Grades for Measurement and Inspection of Hardwood Lumber, Revised Edition. 1989. National Hardwood Lumber Association. Memphis, TN. 103p.

Abstract not available.

Rules for the Measurement and Inspection of Hardwood & Cypress Plus NHLA Sales Code & Inspection Regulations. 1998. National Hardwood Lumber Association. Memphis, TN. 136p.

Abstract not available.

Standard Grading Rules 98 for Northeastern Lumber. 1998. Northeastern Lumber Manufacturers Association. Cumberland Center, ME.

Abstract not available.

Western Lumber Grading Rules 98. 1998. Western Wood Products Association. Portland, OR. 248p.

Abstract not available.

1997 Standard Grading Rules for Southern Pine Lumber. 1997. Southern Pine Inspection Bureau. Pensacola, FL. 248p.

Abstract not available.

Graders Manual for Boards and 2" Dimension. 1977. Southern Pine Inspection Bureau. Pensacola, FL. 111p.

Abstract not available.

Short Course in Grading Based Upon Standard Grading Rules for Southern Pine Lumber. 1968. Southern Pine Inspection Bureau. New Orleans, LA. 44p.

Abstract not available.

SECONDARY MANUFACTURING

Machining Characteristics of United States Hardwoods. 1962. E.M. Davis. USDA Forest Service, Forest Products Laboratory, Madison, WI. Government Printing Office, Washington, D.C. Tech Bul No. 1267.

Provides general information on hardwood machining properties (planing, turning, shaping) and related properties such as bending, nail holding and splitting, shrinkage, warp, and variation in specific gravity.

Simulation for Rough Mill Options. 1992. Wiedenbeck, Janice K. Wood and Wood Products. November: 67-71.

How is rough mill production affected by lumber length? Lumber grade? Cutting quality? Cutting sizes? How would equipment purchase plans be prioritized? How do personnel shifts affect system productivity? What effect would a reduction in machine set-up time have on material flow? Simulation modeling is being widely used in many industries to provide valuable insight into questions such as these.

Sawmill Production of Hardwood Dimension Parts—A Guide for Potential Manufacturers and Users. 1996. Stephen M. Bratkovich. USDA Forest Service, State & Private Forestry, Northeastern Area, St. Paul, MN. 24p.

Provides a guide for manufacturing furniture blanks and other dimension parts directly from hardwood logs at the sawmill.

Kiln Drying Hardwood Dimension Parts. 1980. William T. Simpson. USDA Forest Service, Forest Products Laboratory. General Technical Report FPL-RP-388

Discusses drying furniture blanks and other hardwood dimension parts. This publication compliments Steve Bratkovich's publication Sawmill Production of Hardwood Dimension Parts (see above).

The Value Versus Volume Yield Problem for Live-Sawn Hardwood Sawlogs. 1988. Steele, Philip H.; Wagner, Francis G.; Kumar, Lalit; Araman, Philip A. Forest Products Journal. 43(9): 35-40.

Competitiveness, imports, exports, and technological improvements—these are issues facing secondary wood-product manufacturers. The major problems focus on increasing foreign imports and the inability of U.S. industries to repel the imports. How and where should we, as researchers, allocate our efforts to enhance the competitiveness of secondary forest industries in the United States? Is our purpose to help ensure that current and planned utilization research is properly focused on making the United States more competitive not only in the U.S. market but also in the world marketplace? This paper discusses several types of secondary products but focuses on furniture products, including cabinets. Furniture products are the most important secondary hardwood products in the United States. Also discussed is the hardwood sawtimber resource situation for the Eastern United States, technological improvements, and potential research. Other hardwood products such as millwork, mouldings, dimension, flooring and pallets are reviewed.

Trends in the use of Materials for Pallets and other Factors Affecting the Demand for Hardwood Products. 2002. Robert J.; Bejune, Jeffery J.; Hansen, Bruce G.; Araman, Philip A. 2002. Proceedings of the 30th Annual Hardwood Symposium: Current Topics in the Processing and Utilization of Hardwood Lumber. 76-81pp.

The pallet and container industry plays a critical role in the forest products industry and the U.S. economy. The industry provides a large market for low-grade wood, employs more than 50,000 in the U.S., and its products facilitate the shipment of goods within and outside the country. Due to the importance of this industry, the Center for Forest Products Marketing and Management, Department of Wood Science and Forest Products, at Virginia Tech and the U.S. Forest Service collaborated on a series of studies during the 1990s designed to track and report industry trends. These studies focused on the use of wood materials by the industry during the years 1992, 1993, 1995, and 1999, as well as the level of pallet recovery and reuse. This paper describes some of the trends suggested by the study results and identifies factors that will affect future hardwood use by the industry.

Options for Small-Diameter Hardwood Utilization: Past and Present. 2000. Bumgardner, Matthew S.; Hansen, Bruce G.; Schuler, Albert T.; Araman, Philip A. Proceedings, Annual Meeting of the Southern Forest Economics Workers (SOFEW) -- Hardwoods - An Underdeveloped Resource. 1-7.

Effective and maximum value use of small-diameter hardwood timber has long been of interest to forest managers and researchers. In addition to being a significant component of the standing forest base, small-diameter hardwoods often are available after thinning or other tending operations. Although the use of this material is important to achieving healthy and sustainable forests and other ecosystem management objectives, finding economical uses is sometimes difficult. Much prior research has addressed small-diameter hardwood utilization. After discussing some forest statistics concerning the small-diameter hardwood resource, this paper reviews past small-diameter research and provides an overview of one small-diameter strategy, called System 6. It concludes by looking at evolving markets and utilization opportunities for small-diameter hardwoods

Value-Added Wood Products: Manufacturing and Marketing Strategies. 1991. Ed M. Williston. Forest Products Society, Madison, Wisconsin. Publication #MF-4760. 216p.

Drawing on his 40-plus years of experience in developing, manufacturing, and marketing wood products, Williston demonstrates how to uncover opportunities for increased return in every phase of the business. Value-added manufacturing requires a shift away from standardized, high-volume commodity products such as framing lumber and sheathing plywood toward the development of new products tailored to the needs of specific market segments. This book shows you how to boost product value to appeal directly to those niche markets—where there's less competition and more profit opportunity. In addition, the book demonstrates how to remain profitable in the face of rising threats from foreign and domestic competitors by adding direct value to the product line. Topics include: analyzing the market for new products; tailoring product specifications to use requirements; low, medium, and high-capital cost business opportunities for value-added products; readily available, low cost products; and training and motivating employees for value-added manufacturing. This book explains how to enhance the value of your product line and remain profitable.

Building An Industrial Wood Finish. 2003. by Robert M. Cox, Jr. Forest Products Society, Madison, Wisconsin. Publication #7247. 72p.

The information contained in this manual has been gleaned from the experiences of the author collected during more than 30 years as a supplier of wood finishes to manufacturers of finished wood products and as a consultant to the industry. The purpose of the manual is to help manufacturers gain a full understanding of all of the factors that impact the quality, durability, cost, and environmental impact of finished wood products. Four chapters cover: Finishing Products -- multiple-step wood furniture finishes, kitchen cabinet and office furniture finishes, specialty wood finishes, and waterborne/ water-based finishes; Executing the Wood Finish -- wood finish application hardware options, examples of wood finishing manufacturing lines, and transfer efficiency and calculation of wood finish costs; Wood Finishes and the Environment -- legal and regulatory issues and pollution prevention opportunities through hardware and finish product improvements; and Quality Control -- white room wood preparation, wood finish variables and recommendations, finish inconsistencies/troubleshooting, the importance of lighting, and analyzing rejected pieces

Interior Wood Finishing—Industrial Use Guide. 1997. by Robert J. Tichy. Forest Products Society, Madison, Wisconsin. Publication #7288. 124p.

Abstract not available.

VENEER, PLYWOOD, PANELS & OTHER ENGINEERED WOOD PRODUCTS

Plywood & Veneer-Based Products: Manufacturing Practices. 1995. Richard F. Baldwin. Forest Products Society, Madison, Wisconsin. Publication #MF-4170. 388p.

This book clearly explains every phase of the manufacturing process and covers the most recent developments in LVL and other new veneer-based products, as well as changes in plywood manufacturing methods, standards, and market demands by focusing on the efficient manufacture of softwood plywood while highlighting the new opportunities and challenges created by today's growing, diverse veneer-based industry. Fully illustrated, the information is divided into eight major sections. Section I provides a summary and profile of the veneer-based industry; defines the manufacturing task; and describes how industry activities relate to current environmental thinking. Section II provides an historical perspective of the business, with an emphasis on understanding the past and applying its lessons to the future. Section III refines the guidelines for raw material selection and processing of the peeler. Section IV introduces the various peeling and green end systems in chronological order and discusses the latest innovations and trends that will extend into the immediate future. Section V describes the various veneer drying and product assembly machinery and methods, including the latest adhesive use. Section VI illustrates the secondary manufacturing of the basic glued assembly and gives ideas for selling the resulting products. Sections VII and VIII provide tools for managing the business and insights for the future, as the softwood plywood industry moves into its next 100 years.

Veneer Species that Grow in the United States. 1972. J.F. Lutz. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-167

Describes properties of 156 U.S. tree species that affect their manufacture and use as veneer or products made from veneer and covers categories of construction plywood, decorative face veneer, inner plies, container veneer and plywood.

Techniques for Peeling, Slicing, and Drying Veneer. 1974. John Lutz. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Res. Paper FPL-228. 64p.

Procedures used to manufacture wood veneer are reviewed in detail.

Wood and Log Characteristics Affecting Veneer Production. John Lutz. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-150. 31p.

Discusses the suitability of wood species for use as veneer including physical and mechanical properties, and specific characteristics of veneer logs, that are related too veneer production and use.

Lathe Operator's Manual Part 1: Operating a Veneer Lathe. 1975. W.V. Hancock and J.R.T. Hailey. Forintek Canada Corporation. Department of the Environment, Canadian Forest Service, Western Forest Products Laboratory. Vancouver, BC. VP-X-130.

Abstract not available.

Lathe Operator's Manual Part 2: Operating a Veneer Lathe. 1976. W.V. Hancock and O. Feihl. Forintek Canada Corporation. Department of the Environment, Canadian Forest Service, Western Forest Products Laboratory. Vancouver, BC. VP-X-158.

Abstract not available.

Plywood Products Standard Handbook: U.S. Products Standard PS 1-83 for Construction and Industrial Plywood. Revised 1990. Pittsburgh Testing Laboratory. Eugene, OR. 111p.

Abstract not available.

Modern Particleboard & Dry-Process Fiberboard Manufacturing. 1993. Thomas M. Maloney. Forest Products Society, Madison, Wisconsin. Publication #MF-4560. 688p.

This updated edition presents comprehensive, practical information on particleboard and a wide array of other composite wood products. It is designed to provide accessible information to the novice and valuable insight to the manufacturing professional. The 688-page book covers manufacturing practices, processing systems, product standards and material properties, and presents material ranging from an overview of the industry and definitions of terms to technical factors governing production. This updated edition also includes an all-new chapter which focuses on the enormous range of composite panels and lumber products, including plywood, MDF, fiberboard, OSB/waferboard, and lumber or timber composites. Chapters include: introduction; production and markets; modern processing systems; composition board materials: properties and testing; parameters affecting board properties; raw materials and particle geometry: effects on board properties; particle generation, conveying, and storage; drying principles and practices; moisture measurement and control; particle separation: principles and equipments; fire and explosions: prevention and detection; resins and other additives; resin/wax applications and blenders; caul and caulless systems; mat forming and formers; prepressing; hot pressing and presses; finishing board; and new developments.

Wood Particleboard and Flakeboard: Types, Grades, and Uses. 1986. Charles Carll. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-GTR-53. 9p.

This report is for those who use or may want to use wood particleboard. The term "particleboard" is used as defined in the American Society for Testing and Materials (ASTM) Standard D 1554, which includes flakeboards as a subclass of particleboards, and not as used in the lumber trade where the term is usually reserved for panels made of fine wood particles such as sawdust and planer shavings. Types and grades of particleboard are described and discussed in relation to end uses as nonstructural underlayment, stair tread, shelving, furniture, core material, cabinetry, structural sheathing, subflooring and combination subfloor/underlayment, and siding. The structural panels used in light-frame construction are primarily flakeboards.

The Family of Wood Composite Materials. 1996. Maloney, T.M. Forest Products Journal. 46(2): 19–26.

Abstract not available.

McMillian, E. 1989. Trends for particleboard and medium density fiberboard. In: Hamel, M.P.; Robertson, D., eds. Composite board products for furniture and cabinets: Innovations in manufacture and utilization; Proceedings 47357; 1986 November 11–13; Greensboro, NC. Madison, WI: Forest Products Research Society: 101–105.

Abstract not available.

Expanded Markets for Engineered Wood Products: The Forest Products Laboratory's View. 1993. Peterson, K.R.; Falk, R.H.; Wolfe, R. [and others]. In: Bender, D., ed. Wood products for engineered structures: Issues affecting growth and acceptance of engineered wood products. Proceedings 47329; 1992 November 11–13; Las Vegas, NV. Madison, WI: Forest Products Society: 164–166.

Abstract not available.

Laminated Veneer Lumber and the Resource. 1988. Pierson, D.; Glenn, P. In: Hamel, M.P., ed. Structural wood composites: New technologies for expanding markets. Proceedings, international conference. Proceedings 47359; 1987 November 18–20; Memphis, TN. Madison, WI: Forest Products Society: 85–87.

Abstract not available.

Capacity, Production, and Manufacturing of Wood-Based Panels in North America. 1996. Spelter, Henry. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL–GTR–90.

Structural and nonstructural panel products have constituted the fastest growing segment of the wood products industries over the past two decades. Based on announced plans, growth will accelerate in the next 2 years. The cost of wood fiber used in these processes has been rising. To keep wood costs as low as possible, a growing share of the new production is being channeled into regions where panel manufacturing has been low or nonexistent and where underutilized timber supplies are still available. There is also increasing interest in using agricultural fibers for panels, either to complement or to replace wood. The projected increases in production over the next 2 years are likely to exceed projected growth in demand, leading to an oversupply, at least temporarily. This paper summarizes capacity growth in various wood-based panels: Southern Pine plywood, oriented strandboard, medium density fiberboard, and particleboard. It also examines changes in the manufacturing costs and the emerging supply–demand balance through 1997.

Wood-Based Panels—Supply, Trade and Consumption. 2001. Jorge Najera and Henry Spelter. In: UN-ECE/FAO Forest Products Annual Market Review, 2000-2001. Geneva, Switzerland.

Panel markets in the UNECE region out-performed all other forest products market sectors in 2000. A price collapse hit the structural panel markets in North America and Europe in 2000. In the EU/EFTA countries, total consumption of wood-based panels increased 6.7% to a record high of 45.2 million m3, confirming the recovery of the sector.

Role of Wood in Advanced Composites. 1992. Wilson, J.B. In: Wood product demand and the environment. Proceedings of an international conference; 1991 November 13–15; Vancouver, British Columbia. Madison, WI: Forest Products Research Society: 97–100.

Abstract not available.

TREATING WOOD & WOOD PRESERVATION

American Wood Preservers' Association Standards 1999. 1999. American Wood Preservers' Association, Granbury TX. 466p.

The American Wood-Preservers' Association is the principal standards writing body for the wood preserving industry in the United States. AWPA standards help ensure that treated wood products perform satisfactorily for their intended use. They are recognized and used by most, if not all, specifiers of treated wood including electrical utility, marine, road and building construction as well as by local, state and federal governments. This *Book Standards* is intended for use by the wood preserving industry as well as for guidance of the purchaser in specifying and obtaining adequately treated wood products. Generally, all wood products may at some time in their life history be subjected to wood destroying organisms such as decay fungi, insects and marine borers. The purpose of these Standards is to ensure that wood products are treated with suitable preservatives for reasons of safety, service and savings resulting from unnecessary expensive replacements. In the AWPA Book of Standards, pertinent phases of adequate treatment requirements for preservatives, quality control and inspection are described.

RTA Tie Guide (vols I & II). Undated. David A. Webb, edited by James C. Gauntt. The Railway Tie Association, Fayetteville, GA. 78p.

The wood crosstie has served the American railroad industry since its earliest days. The dependability and service life of this wood component has been exemplary. With the use of wood preservatives, the durability and service life of wood is significantly enhanced. The information provided in this booklet provides a description of the identification, treatment and ultimate use of wood in the engineered crosstie system. The Tie Guide provides a common thread illustrating the development and ultimate performance of the treated wood crosstie. Presented are some practical applications given along with certain technical details outlined in the wood crosstie engineering section. The Railway Tie Association Performance Standard found in the engineered wood crosstie section of this manual describes specific strength property characteristics and load traffic environment applications for the various types of wood tie material. This booklet is intended for use in the classroom as well as a practical guide.

Pest Management Principles for the Commercial Applicator (Second Edition). 1991. Ted Peterson, David Kammel, Roger, Flashinski, and Daniel Wixted. Pesticide Applicator Training (PAT) program, University of Wisconsin-Extension. Cooperative Extension. Madison, WI. 143p.

Manual and Study Guide for commercial wood pesticide (wood preservative) applicators. This publication prepares the reader for taking the wood preservative pesticide licensing examinations for application of restricted use pesticides, specifically wood preservatives. Subjects covered include wood and its structure, pests and pest control, laws and regulations, pesticides and wood preservatives), labeling, toxicity, protecting human health and the environment, and pesticide waste disposal.

Wood Preservation and Wood Products Treatment Training Manual. 1989. G. Thomasson, J. Capizzi, F. Dost, J. Morrell, and D. Miller. Oregon State University Extension Service. Corvallis, OR. 16p. [Reprinted May 2002.]

Federal and State regulations establish standards that you must meet before you can legally use certain pesticides. Effective November 1986, Federal regulations administered by the Environmental Protection Agency (EPA) restrict the sale and use of certain preservatives to ensure that only properly trained applicators, or people under their direct supervision, will have access to them. Wood preservatives affected by these regulations include creosote, pentachlorophenol (penta), and inorganic arsenicals. This publication will help those preparing for the wood preservative pesticide licensing examinations. Wood pesticides (preservatives) extend the life of wood products by protecting them from damage by insects, fungi, marine borers, and weather. Preservatives are applied on the basis of how and where the products will be used, the expected conditions of exposure to wood-destroying agents, and the cost per year of service life. Crossties, poles, posts, and other wood products that contact the ground or are exposed to the weather must be protected with preservatives to ensure a reasonable service life. Other wood products not in contact with the ground may be treated as a precautionary measure even though they are not exposed to moisture and weather. This publication was revised from a University of Georgia Cooperative Extension Service publication "Wood Preservation and Wood Products Treatment."

Wood Preservation and Wood Products Treatment. 1986. M. Applefield, V. Coleman, R. Mostinger, and J Beckwirth. University of Georgia, Cooperative Extension Service, Athens, GA. Bull No. 823. 26p.

This guide for applicators and handlers of wood preservatives and wood treated products contains information you must know to meet categorical national standards. Because this guide was written to encompass the entire nation, some information important to your individual state may not be included. The guide discusses the prevention of wood deterioration and degradation. It includes (1) recognition of pests and the damage they can cause, (2) methods of control, and (3) environmental and safety precautions.

Management Practices for Used Treated Wood. 1995. Tetra Tech, Inc. Electric Power Research Institute, Pleasant Hill, CA. EPRI TR-104966

Pentachlorophenol, creosote, and other chemicals are used to preserve poles, crossarms, and railroad ties for the electric, telecommunications, and railroad industries. Each year, millions of pieces of treated wood are retired. This report provides information on current and potential options for management of used treated wood.

Enhancing the Durability of Lumber and Engineered Wood Products. 2002. FPS. Forest Products Society, Madison, Wisconsin. Publication #7249. 320p.

Changes in environmental concerns, increasing regulatory pressures, and public perceptions concerning the use of treated wood have placed increasing emphasis on the need for safe, economical treating systems that can produce durable wood products. The nearly 60 papers in this proceedings were prepared from presentations given at a 2002 conference sponsored by the Forest Products Society. Subjects covered include: emerging issues in wood protection; an overview of current research on wood protection and durability; durable engineered wood products; environmental issues; new protection technologies; and whole-house protection against termites and decay.

Biology and Prevention of Sapstain. 1998. FPS. Forest Products Society, Madison, Wisconsin. Publication #7273. 110p.

The development of sapstain on the surface of freshly sawn lumber poses major challenges for those interested in marketing wood on the basis of its bright, clear appearance. For decades, sapstain was controlled by dipping freshly sawn lumber into solutions of sodium pentachlorophenate. This situation changed dramatically in the early 1980s as environmental restrictions encouraged the development of alternative sapstain control chemicals and increased the use of kiln drying. The industry remains in a state of flux and lacks a single, broadly toxic and widely used chemical such as sodium penta. The lack of a magic bullet type of chemical that controls stain on all materials has encouraged a wealth of new research to explore the fundamental mechanisms of fungal discoloration, identify new chemicals, and develop alternative non-chemical protection systems. Sapstain and its control was the subject of a conference sponsored by the Department of Forest Products, Oregon State University, held in 1997. This 110-page proceedings represents the written papers from that meeting.

Prevention of Discolorations in Hardwood and Softwood Logs and Lumber. 1996. FPS. Forest Products Society, Madison, Wisconsin. Publication #7283. 90p.

Staining and discoloration of logs and lumber due to the activity of various fungi and bacteria can have a significant economic impact on market value. Although the presence of stain-producing microbial or non-microbial organisms normally does not affect the mechanical properties of the wood, the downgrade in quality due to appearance can have an enormous impact in value-added products such as high-quality hardwood products, veneer, and millwork. This 90-page publication contains technical reports and reviews originally published in the *Forest Products Journal* that cover in detail the causes and possible methods for preventing and controlling various microbial and non-microbial discolorations in both hardwoods and softwoods.

Selection and Use of Preservatively-Treated Wood. 1995. Daniel L. Cassens, William C. Feist, Bruce R. Johnson, and Rodney C. De Groot. Forest Products Society, Madison, Wisconsin. Publication #7299. 104p.

Wood is subject to decay, insect, and marine borer attack. These agents are nature's way of recycling wood in the natural ecosystem. Without nature's recycling systems, we would literally be burried by wood and other cellusose-based materials such as grass, leaves, and agricultural field residues. However, when wood is used in a more or less permanent application, it must be protected from biologiacl degradation. Destruction can be prevented by any number of methods or combination of methods. This book was written for homeowners, contractors, building supply clerks, architects, and others who use or recommned wood products. This summary briefly reviews the major causes of biological deterioration of wood and how it can be prevented.

Treatability of Native Softwood Species of Northeastern United States. 1992. Lee Gjovik and Dave Schumann. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-RP-508

Reports results from research on treating Northeastern softwood species.

RESIDUES FROM FOREST & MILL

Uses for Sawdust, Shavings, and Waste Chips. 1969. John Harkin. 1963. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-0208

Although many outlets are available for the utilization of wood fines, economical disposal of sawdust, shavings, and waste chips remains a problem of growing concern to the wood industry. This report summarizes current uses for wood residues and pro-vides sources of further information on available outlets, processing methods, and economic considerations.

Uses for Slabs, Edgings, and Trims. 1964. Forest Products Laboratory. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-038. 12p.

Summary of possible uses an markets for sawmill residues (i.e., slabs, edging strips, and trim).

Bark and Its Possible Uses. 1969. John Harkin and John Rowe. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-091. 42p.

What to do with bark is a major question facing the wood conversion industries. Optimum utilization of bark residues demands appreciation of the complexity of bark and the extreme variation in chemical and physical properties between barks of different wood species. This report discusses bark structure, past and present utilization, and methods of upgrading bark both physically and chemically for increased utilization. Pertinent literature citations and continuing bibliographic sources of information on bark are included. Appended directories indicate sources of technical assistance and utilization equipment.

A Mathematical Model to Calculate Volumes of Lumber and Residue Produced in Sawmilling. 1979. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-RP-336.

The need to measure the volumes of all materials produced in the sawmilling process is becoming more important as the value of these materials increases. This paper introduces a geometric model with which to calculate the volumes of these materials with a minimum of data gathering. Methods to calculate the volumes of green lumber, dry lumber, green chips, green sawdust, and dry planer shavings are given. The mathematical and geometric theory making up the model is illustrated by equations and drawings.

Uses for Forest Residues. 1965. L.H. Reineke. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. FPL-092. 14p.

Many uses exist for forest residues, and the Forest Products Laboratory receives numerous requests for information on the subject. This report is designed to furnish that information to people in the forest and wood-using industries, those who contemplate entering these industries, and others interested in conserving timber supplies. Consideration of the problems involved necessitates the discussion of some aspects of residue utilization that are quite obvious to the experienced operator but less apparent to others. The existence of forest "residue" is proverbial. Much of this residue is uncontrollable, yet a large portion of it may be reduced. Because wood lacks the plastic flow qualities necessary for such major reshaping as is done with metals, the irregularly round shape and varying dimensions of the tree must be reduced to the required shape and size by removal of extraneous material. Parts of the trees, or entire trees, are rejected for a specific use because of size, shape, quality, or species. Such residue is often increased by poor operating practice or by mismanufacture, and some woods mismanufacture is the direct cause of residue in later stages of processing. Forest residues wasted through nonuse can be reduced by preventive measures. The portion of the residue due to the nature of the raw material is unavoidable, of course, but improvements in operating practices and processing equipment Although many outlets are available for the utilization of wood fines, economical disposal of sawdust, shavings, and waste chips remains a problem of growing concern to the wood industry. This report summarizes current uses for wood residues and pro-vides sources of further information on available outlets, processing methods, and economic considerations.

ECONOMIC FEASIBILITY, BUSINESS MANAGEMENT & INDUSTRIAL DEVELOPMENT

Economic Feasibility of Products from Inland West Small-Diameter Timber. 1996. Henry Spelter, Rong Wang, and Peter Ince. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-GTR-92.

A large part of the forests located in the Rocky Mountain region of the U.S. (inland West) is characterized by densely packed, small-diameter stands. The purpose of this study was to determine the economic feasibility of using small-diameter material from this resource to manufacture various wood products: oriented strandboard (OSB), stud lumber, random-length dimension lumber, machine stress rated random length lumber, laminated veneer lumber (LVL), and market pulp. The analysis indicated that LVL promises the best ratio of revenue to wood input, followed by market pulp and OSB. Among the lumber alternatives, machine-stress-rated lumber yields the greatest return. In terms of investment risk, the lower-cost lumber alternatives are favored over the capital-intensive OSB, market pulp, and LVL options. The manufacture of OSB would require the most fiber, almost four times the amount required for market pulp.

Profile 2001: Softwood Sawmills in the United States and Canada. 2001. Henry Spelter and Tim McKeever. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-PR-594.

More than 1,200 sawmills produce the bulk of U.S. and Canadian softwood lumber. The maps and tables in this report show the location and size of these mills by State and Province. Analysis of timber inventories in relation to use shows a close correspondence between pricing and use intensity. In some Southern States, the intensity of use is approaching recent growth levels. Lumber capacity grew by 13% between 1995 and 2000. The fastest growth occurred in some Canadian regions, while the least growth took place in the western parts of the United States and Canada. In 2001, capacity appears headed for a decline as at least 18 sawmills closed as a result of poor market conditions.

U.S. Timber Production, Trade, Consumption, and Price Statistics 1965-1999. 2001. James L. Howard. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-RP-595. 90p.

The report is part of an annual series that presents current and historical information on the production, trade, consumption, and prices of tim-ber products in the United States. The report focuses on national statistics, but includes some data for individual States and regions and for Canada. The data were collected from industry trade associations and government agencies. They are intended for use by forest land managers, forest industries, trade associations, forestry schools, renewable resource organizations, libraries, organizations, individuals in the major timber producing and consuming countries of the world, and the general public. A major use of the data presented is tracking technological change over time. One of the major technology shifts occurring in the wood-using industry is the substitu-tion of oriented strandboard (OSB) for plywood in the structural panel sector, as well as a shift in plywood production from the west to the south United States. Some data show these shifts. United States production of structural panels totaled 29.4 billion ft^2 in 1999. Production of OSB increased from less than 3 billion ft^2 in 1985 to 11.6 billion ft^2 in 1999. Plywood produc-tion was 20.1 billion ft^2 in 1985 before falling to 17.8 billion ft^2 in 1999. The decline in plywood production reflects the continued increase in the OSB share of the traditional plywood market.

Review of Wood-Based Panel Sector in United States and Canada. 1997. Henry Spelter, David B. McKeever, and Irene Durbak. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-GTR-99

Structural and nonstructural panels have been the fastest growing sector among wood products for the past two decades. The recent spate of plant construction and drop in product prices indicate slower growth and consolidation in the next 2 years. Growth in demand is unlikely to catch up with projected capacities until the next century, unless attrition of some existing capacity reduces industry growth. Among structural panels, costs of production are lowest for oriented strandboard, but there is a wide range among plants. Plywood costs are lowest in the U.S. South and highest in the West. Thus, the contraction of western plywood is likely to continue. Overcapacity also looms for nonstructural panels (particleboard and medium density fiberboard), but engineered structural wood products show opportunities for growth.

U.S. Forest Products Annual Market Review and Prospects, 2000-2003. 2002. James L. Howard. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL-RN-287. 5p.

This report provides general and statistical information on forests products markets in terms of production, trade, consumption, and prices. The current state of the United States economy is described. Market developments are described for sawn softwood, sawn hardwood, softwood log trade, wood-based panels, paper and paperboard, fuelwood, and forest product prices. Detailed information and projections for the year 2003 are presented.

Wood-Based Panel Plant Locations and Timber Availability in Selected U.S. States. 1998. Tim McKeever and Henry Spelter. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL–GTR–103, 53 p.

This report lists wood-based panel industry plant locations, production capacities, timber inventories, and wood costs for 24 U.S. states. Industry sectors covered include medium-density fiberboard, particleboard, softwood plywood, and oriented strandboard. Maps of major forest producing states show plant locations and the underlying density of timber stocking by county. The study relates physical measures of timber availability to market measures of timber scarcity and draws inferences about the potential of selected states to increase timber output at their present rate of forest productivity.

Value of Timber and Agricultural Products in the United States, 1991. 1996. David B. McKeever and James L. Howard. Forest Products Journal, VOL. 46, No. 10

In the United States, timber and agriculture are two important components of the Gross Domestic Product (GDP). The purpose of this study was to quantify the volume and value of timber in the U.S. economy in 1991 and compare the value of timber with that of agriculture. Combined, timber and agriculture accounted for 6.2 percent of total GDP in 1991, and 13.2 percent of the goods and structures portion of GDP. Primary timber products production totaled 17,889 million ft. in 1991 and was valued at $19,370 million. Primary agricultural products were valued at $156,094 million in 1991. Although timber was only 11 percent of combined timber and agricultural primary products production, it was the highest valued crop produced in two regions, the South and Pacific Coast, and fourth highest in two regions, the North and Rocky Mountain. Only the value of corn and soybeans produced in the North exceeded the value of timber produced in any region. Secondary timber-related products added $40,128 million of value; secondary agriculture-related products added $139,554 million. When primary and secondary products were combined, timber-related products accounted for 17 percent of all timber- and agriculture-related products in 1991.

Sawmill Closures, Openings, and Net Capacity Changes in the Softwood Lumber Sector, 1996–2003. 2002. Henry Spelter. USDA Forest Service, Forest Products Laboratory, Madison, WI. Res. Pap. FPL-RP-603. 12 p.

From a starting universe of approximately 1,300 Canadian and American sawmills, 149 were permanently closed between 1996 and 2003. This figure does not include small portable or part-time operations. These mills represented 17.6 million m 3 of capacity, nearly 12% of the 1995 industry total. On the other hand, 25 new mills brought on-line have offset 4.9 million m 3 of lost production potential. Further, upgrades to existing sawmills have added 31 million m 3 of capacity. The region most severely impacted by closures was the U.S. West, which accounted for over half of all the capacity lost. Other regions fared better, with the U.S. South and eastern Canada losing the least, the U.S. North and British Columbia taking somewhat higher losses. Overall, however, each major producing region gained capacity when all changes are accounted for.

Relationship Between Diameter and Gross Product Value for Small Trees. 1999. Barbour, J.R. In: Proceedings from Wood Technology Clinic and Show Conference, Portland, OR. Miller Freeman Publications, San Francisco, CA. 27: 40-46.

Abstract not available.

Very Small Log Processing Feasibility Study. 1998. State of Washington, Community, Trade, and Economic Development, Forest Products Program. Prepared by the The Beck Group. Portland, OR.

Examines lumber recovery from very small-diameter logs using state-of-the-art sawmill technology.

Small Log Sawmill Feasibility Study. 1991. Dubal, Beck, and Associates (The Beck Group). Project Rep. Portland, OR: State of Washington Department of Trade and Economic Development Forest Products Program. 118 p.

Abstract not available.

1994 U.S. Industrial Outlook. 1994. U.S. Dept. of Commerce, Industry and Trade Administration. Washington, DC: Superintendent of Documents.

Abstract not available.

Producing Hardwood Dimension Parts Directly From Logs: An Economic Feasibility Study. 1995. Lin, Wenie; Kline, D. Earl; Araman, Philip A.; Wiedenbeck, Janice K. Forest Products Journal. 45(6): 38-46.

The economic feasibility and profitability of a direct processing system for converting Factory Grades 2 and 3 red oak logs directly into rough dimension parts were evaluated. New present value (NPV) and internal rate of return (IRR) were used as the measurement of economic feasibility, and return on sales (ROS) was used as the measurement of profitability. NPV and IRR were estimated based on the predicted after-tax cash flow for a 10-year period. the results of this study indicate that converting Grade 2 and Grade 3 red oak logs directly into rough dimension parts is economically feasible. Under the given assumptions, an initial capital expenditure of $5.25 million to build a direct processing mill to process Grade 2 red oak logs can generate a $4.43 million NPV with an IRR of 27.5 percent. An initial investment of $4.42 million to build a direct processing mill to process Grade 3 red oak logs can generate a $3.93 million NPV with an IRR of 28.2 percent. It was found that the direct processing system is much more profitable than current sawmills and dimension mills. The predicted ROS values of the direct processing mills are 7 to 12 percent higher than the average upper quartile ROS values achieved by the hardwood sawmill industry and by the hardwood dimension and flooring industry from 1983 to 1992. A sensitivity analysis indicates that dimension part price, green cutting yield, and drying degrade and remanufacturing loss are the three most important factors affecting the economic feasibility and profitability of the direct processing systems. If the drying degrade and remanufacturing loss is too high, the proposed direct processing system may not be able to achieve its high profit potential.

Productivity in Natural Resource Industries. 1999. Simpson, Ralph D. Resources for the Future. 232p.

Several senior natural resource analysts study the role played by innovation, particularly technological innovation, in the pursuit of heightened productivity. Increasing the output of a given input improves a firms bottom line, makes it more competitive internationally, and reduces the potential for resource depletion and shortages, Thus, high productivity is a necessary ingredient of economic prosperity. This book illustrates the importance of technological innovation in achieving an acceptable level of output and efficiency. In this important new offering, a team of resource scholars describes and chronicles the development of recent innovations in selected natural resource industries. The authors also reveal the causes, sources, and net effect of such innovation on productivity. In all of these sectors productivity has increased considerably since the early 1980s, although the level of improvement varies across industries. To what degree did technological innovation contribute to that increase? Individual detailed case studies detail important innovations in America's coal, petroleum, copper, and forest industries. The primary focus is on extraction and production technologies, although the existence and importance of innovation in other areas such as management technique also enter the picture. For example, the combination of new technology with restructuring seems to have breathed new Life into a floundering U.S. copper industry. The authors describe the origin and diffusion of important innovation, and the concluding chapter quantifies the net effect of such innovation on productivity.

Cost Analysis in Wood Products Manufacture. Undated. Henry Huber and George Vasiliou. Cooperative Extension Service, Michigan State University. East Lansing, MI. 54p.

Abstract not available.

A Cost-Accounting System for Small Sawmills. 1965. James C. Whittaker. USDA Forest Service, Central State Forest Experiment Station. Columbus, OH. 23p.

Abstract not available.

Operations Management in the Forest Products Industry. 1984. Richard Baldwin. Miller Freeman Publications. San Francisco, CA. 264p.

With the manufacturing of forest products becoming ever more management- and capital-intensive, this book provides answers to questions such as how do successful firms grow and prosper? How does the industry at-large cope with the cyclic business environment? The answers lie more in attitudes and thought processes than in ready resources and markets. With time-tested management concepts in action, not just outlined in theory, this book presents 24 chapters organized into six sections: forest products enterprise: a study in change (overview); management heritage; management planning; production process; management and cost control techniques; and managing change. Topics examined within these sections cover everything from industry roots to financial planning and budgeting, mill scheduling and inventory control, energy management, and new technology and innovation. Addressing both technical as well as management concerns, this is a "must-have" reference for supervisors, operations managers, and executives involved in manufacturing softwood lumber, plywood, and reconstituted products.

The Best Possible Sawmill: a Guidebook for the High-Tech Journey Ahead. 1996. Bryan, Eugene L. Miller Freeman Publications, San Francisco, CA. 231p.

Part One presents insights and concepts, management tools, and the guidance systems companies need to understand in order to meet challenges and capture opportunities on the way to achieving BestPossible profits. Part Two outlines opportunity-based management principles and describes how companies can use optimization technology to produce departmental “roadmaps” to ensure that management efforts culminate in BestPossible profits. Included is a discussion on how to use internal benchmarking to track progress, minimize slippage, and document accomplishments. Part Three looks to the future and describes what a company must do to continually improve its BestPossible profit picture and thus have uninterrupted access to fresh opportunities. The entire forest products industry is on a high-tech journey into the future. Managers who are learning to use high-tech management tools to identify and manage complexity are leading this journey. This guidebook was written for such managers and others who wish to follow their lead.

Successful Sawmill Management. 1992. David Tooch. Northeastern Loggers’ Association, Inc. Old Forge, NY. 204 p.

This book is intended to provide sawmill managers with the basics for successful sawmill operations. It discusses technical and business issues and the intangibles essentials for good business planning and operation.

A Simple Profit Planning and Cost Management System for Small Sawmills. 1993. Robert E. Pajala. University of Minnesota Extension Service, St. Paul, MN. 19p.

This booklet is a guide to establishing a simple profit planning and cost management system for small sawmills. The booklet can be used to help you, the sawmill manager, custom design and implement a profit planning and cost management system for your sawmill business.

Business Management for Sawmill Operators. 1979. Vernon S. White. Proceedings of the Business Management Clinic for Sawmill Operators, Sawmill and Plywood Clinic, Portland, OR. Miller Freeman Publications. San Francisco, CA. 48p.

Abstract not available.

A Record Keeping System for Small Sawmills. 1985. George Niskala. USDA Forest Service, State & Private Forestry, Northeastern Area. Marketing Bulletin 74

Describes a record keeping system of expenditures for sawmill operators. This publication supersedes an earlier publication "A Cost Accounting System for Small Sawmills" 1965. James Whittaker. USDA Forest Service, Central States Forest Experiment Station.

The Logging Business Management Handbook. 1983. Ronald R. Macklin. Miller Freeman Publications. San Francisco, CA. 176p.

If you know what you are doing in the woods but get lost in the office, this book will give you the business tools you need. This handbook is for loggers—whether your business is successful or breakeven. Section I gives an outline of basic organizational structure. Section II covers operations management and control. Included are thirty-three cost analysis, personnel and equipment management forms.

An Updated Cost-Record System for a Logging Business. Undated. USDA Forest Service, Northeastern Area. NA-FR-29. 72p.

Describes a record keeping system of expenditures for logging contractors.

The Business Planning Guide: Creating a Plan for Success in Your Own Business. 1995. Bangs, David H. Jr. Upstart Publishing Company, Inc., a Division of Dearborn Publishing Group, Inc. Chicago, IL. 208p.

Abstract not available.

The Entrepreneur Magazine Small Business Advisor. 1995. Entrepreneur Magazine. John Wiley and Sons, Inc. New York. 664p.

This is a comphrensive guide providing the reader with the necessary information on starting, managing, and growing a small business.

The Entrepreneur and Small Business Marketing Problem Solver. 1991. William A. Cohen. Wiley Press. New York, New York. HF 5415.13 .C634

Abstract not available.

The Entrepreneur and Small Business Problem Solver: An Encyclopedic Reference and Guide (2nd edition). 1990. William A. Cohen. Wiley Press. New York, New York. HD 62.7 .C63

Abstract not available.

Small Business Sourcebook. (serial) 1970-1996. Gale Research Co. Detroit, Michigan. HD 2346 .U5 S65.

A guide to the information services and sources provided to 100 small businesses by associations, consultants, educational programs, franchisers, government agencies (federal, state, and local), reference works, statisticians, suppliers, trade shows, and venture capital firms.

A Planning Guide for Small and Medium Size Wood Products Companies: The Keys to Success. 1995. Jeff Howe and Steve Bratkovich. USDA Forest Service, Northeastern Area, S&PF, St. Paul. NA-TP-09-95

Guide for creating strategic, marketing and business plans for the forest products industry, primarily for medium to small operations. This guide is written with the objective of providing a tool to for creating: (1) strategic, (2) marketing, and (3) business plans for the forest products industry, primarily for medium to small operations. It is to provide a framework for organizing ideas, mobilizing skills, and formalizing plans to maximize the ability to implement, measure, and control business activities.

So You Want to Build a Sawmill? 2002. John “Mike” Higgs and Terry Mace. Paper presented at SmallWood 2002, Albuquerque, NM. 7p.

This paper outlines considerations in the form of questions in the establishment of viable sawmill businesses. Considerations include timber resource, market, facilities, regulatory, siting, workforce, sawmill design and layout, management, and operations aspects. Sawmilling is a more complicated business than first appears. Success begins by asking the right questions.

How to Write Business Plans for Forest Products Companies. 1993. Ed Pepke. USDA Forest Service, State & Private Forestry, Northeastern Area. NA-TP-17-93. 30p.

A business plan is an essential tool in starting and managing a new or expanding venture. It is not only a comprehensive gathering or ideas and information on the potential business and its feasibility, but it is also a way of monitoring that business, once established. Business plans are important sources of information for the organizers of a company as well as for their lenders, investors, potential partners, and business advisors. The author explains how to write business plans for forest products industries.

Wisconsin Forest Products Industry Siting Guide. 1989. Mater Engineering, LTD. North Twenty Joint RC&D Councils (Lumberjack RC&D and Pri-Ru-Ta RC&D Councils).

Guide and checklist for siting forest products industries (primary and secondary). Applicable Nation wide.

A Pulp Mill Siting Feasibility Study for Wisconsin. 1989. State of Wisconsin. Commissioned by Governor Tommy Thompson. State of Wisconsin, Madison, WI. 416 p.

Abstract not available.

Technology-Based Economic Development: A Study of State and Federal Technical Extension Services. 1990. Robert E. Chapman, Marianne K. Clark, and Eric Dobson. US Department of Commerce. US Government Printing Office, Washington, D.C. NIST Special Pub No. 786. 158p.

Abstract not available.

FOREST PRODUCTS MARKETING

Sources of Marketing Information for the Forest Products Industry, 2002. Ernesto Wagner David Fell, Eric Hansen and Christopher Gaston. Department of Wood Science and Engineering, College of Forestry, Oregon State University. Corvallis, OR. 85p.

We live in the information age and the success of your business depends largely on your ability to acquire relevant timely information. This is especially true when it comes to information that helps you market the products you produce. Because we live in the information age you are faced with a glut of information about a never-ending list of topics and markets. This publication is designed for several purposes. First it is a source of places to go to find market information. Second it provides guidance so that you can find your way to where you want to go without wasting valuable time searching in the wrong place. Whenever possible we list sources that summarize or consolidate data that may be of use to you. For example, there are many publications that consolidate U.S. Department of Commerce data into a readable format on an industry-by-industry basis, something that can save you literally hours of research time. Finally, no publication can list all the possible sources of information, but we hope that this can be a resource that you use on a regular basis to begin your search for the answers to your current questions. We hope this makes your job easier and makes you a more effective marketer.

Marketing Forest Products: Gaining the Competitive Edge. 1992. Dr. Jean Mater, M. Scott Mater and Catherine Mater. Forest Products Society, Madison, Wisconsin. Publication #MF-4120. 300p.

To stay profitable in today's economy, wood products must be marketed to specific markets, such as home center store sales, repairing, remodeling, the do-it-yourself market, factory-built homes, components, or export markets. Providing examples from the field and descriptions of marketing tactics and preparation checklists, this guide shows you how to: find your market niche; identify potential customers and target markets; develop the appropriate wood products; compete by using product differentiation; develop the most profitable distribution system; improve sales with packaging and point of purchase tags; promote the unique characteristics of each wood species; and hedge the risks of a new product venture. In addition, there are ideas for low-cost promotions; pricing and merchandizing strategies; a marketing glossary; and lists of trade journals, associations, and other references and resources. For marketing newcomers as well as experienced strategists, this book offers innovative ideas for increasing market share and capturing market segments throughout the wood products industry.

Forest Products Marketing. 1992. Steve A. Sinclair. McGraw-Hill, Inc. New York, New York 403p.

Discusses industrial markets, marketing, and marketing plans for lumber, panels, paper, and allied products.

Forest Products Marketing and Industrial Strategy Operating Guide. 1988. Jean Mater. Mater Engineering, Ltd. Corvallis, Oregon. 254 p.

Guide designed to serve as a source for marketing and strategic forest products infrastructure development produced under contract for S&PF NA utilization and marketing program.

Wood Product Demand and the Environment. 1992. Forest Products Research Society. In: Proceedings, International conference; 1991 November 13–15; Vancouver, British Columbia. Madison, WI: Forest Products Research Society. 288 p.

Abstract not available.

A Marketing Guide for Manufacturers and Entrepreneurs of Secondary-Processed Wood Products in the Northeastern United States. 1992. Ed Cesa. USDA Forest Service, Northeastern Area, S&PF, Morgantown, WV. NA-TP-09-92

Guide designed to serve as a source of marketing methods and strategies for manufacturers and entrepreneurs. Guide includes marketing concepts, quick marketing research methods, ways to locate customers, exporting, and financing.

Value-Added Wood Products: Manufacturing and Marketing Strategies. 1991. Williston, Ed M. Miller Freeman. San Francisco, California.

Abstract not available.

Practical Marketing Tips for Wood-Products Businesses: A Guide for Manufacturers, Craftspeople, Artisans & Designers. University of Vermont Extension.

Provides a number of marketing tips for wood products businesses and entrepreneurs.

Buying and Selling Softwood Lumber. 1998. Dave Leckey. Random Lengths Publications, Inc. Eugene, OR. 212p.

A guide to the North American softwood lumber market and marketing.

Domestic Market Activity in Solid Wood Products in the United States, 1950-1998. 2002. David B. McKeever. USDA Forest Service, Pacific Northwest Research Station. Portland, OR. PNW-GTR-524. 76p.

Solid wood is important to the construction, manufacturing, and shipping segments of the U.S. economy. Nearly all new houses are built with wood, and wood building products are used in the construction of nonresidential buildings, and in the upkeep and improvement of existing structures. Solid wood is used extensively to produce and transport manufactured products. It also provides a renewable energy source for industrial, commercial, and residential applications. In 1998, 19.6 billion cubic feet, roundwood equivalent, of all timber products were consumed in the United States, down slightly from 1996, but considerably greater than in 1962. About 87 percent of this was for industrial products, and 13 percent for fuelwood. Excluding fuelwood, solid wood timber products accounted for about 67 percent of the industrial roundwood consumed, and pulpwood products about 33 percent. Large amounts of residues are generated in the production of solid wood products, about 10 to 15 percent of total industrial roundwood consumption. Thus, solid wood products and pulpwood products each account for about half of the industrial roundwood consumed. This report examines solid wood timber products consumption in the United States over the past 40 to 45 years, relates changes in consumption to economic, social, and institutional factors during the period, and presents estimates of consumption in major end-use markets. Trends in timber products production, foreign trade, and domestic consumption over the past half century also are examined.

Recommended Lumber Terminology & Invoice Procedure (Revised). 1981. Compiled by Western Wood Products Association. Portland, OR. 25p.

Abstract not available.

Competitiveness of U.S. Wood Furniture Manufacturers - Lessons Learned from the Softwood Moulding Industry. 2001. Schuler, Al; Taylor, Russ; Araman, Phil. Forest Products Journal. 51(7/8): 14-20.

The furniture industry in the United States has been losing market share to imports for the past two decades. This article focuses on the market segment where most of the loss has occurred: the important wood household (non-upholstered) sector (SIC code 2511). In the upholstered furniture sector, exports are still larger than imports. But the wood household furniture sector is the largest sector in the furniture industry.

Match Your Hardwood Lumber to Current Market Needs (Part 1). 1990. Bush, Robert J.; Sinclair, Steven A.; Araman, Philip A. Southern Lumberman. 251(7): 24-25.

This article explains how hardwood lumber producers can best market their product. The study included four segments of the market for hardwood lumber. These segments were: furniture, cabinet, dimension and flooring, and molding/millwork manufacturers. The article explains how the study was conducted and the characteristics of companies (i.e., potential customers) that were included. It also discusses the hardwood lumber purchasing characteristics of companies in each of the market segments.

Matching Your Hardwood Lumber to Market Needs (Part 2). 1990. Bush, Bush, Robert J.; Sinclair, Steven A.; Araman, Philip A. Southern Lumberman. 251(8): 24-27.

This article discusses the reasons companies (buyers) are dissatisfied when purchasing hardwood lumber and the importance of various lumber and supplier characteristics.

Exploring Value-Added Options - Opportunities in Mouldings and Millwork. 1997. Smith, Bob; Araman, Phil. Southern Lumberman. July: 37-38, 41.

The millwork industry, which includes manufacture of doors, windows, stair parts, blinds, mouldings, picture frame material, and assorted trim, can be a lucrative value-added opportunity for sawmills. Those entering the value-added millwork market often find that it is a great opportunity to generate greater profits from upper grades and utility species, such as yellow poplar. In the past, approximately 75 percent of mouldings and millwork were made from softwoods, while the rest were made from hardwoods. However, this picture has been changing due to old-growth harvesting restrictions in the Pacific Northwest. More and more opportunities are being created for Eastern hardwoods.

Exploring Valued-Added Options - Edge-Glued Panels and Blanks Offer Value-Added Opportunities. 1997. Smith, Bob; Araman, Phil. Southern Lumberman. 258(4): 42-43.

As sawmills search for new opportunities to add value to rough sawn lumber, many consider producing dimension parts as one solution. Assembling dimension parts into edge-glued panels or standard blanks can add even further value. Blanks are defined as pieces of solid wood (which may be edge-glued) that are manufactured to a predetermined size. This article discusses the manufacturing of blanks and edge-glued panels as well as current markets.

A Comparison of Market Needs to the Species and Quality Composition of the U.S. Hardwood Resource. 1992. Bush, R.J.; Araman, P.A.; Muench, J., Jr. In: Wood product demand and the environment: Proceedings of an international conference; 1992 November 13–15; Vancouver, British Columbia. Madison, WI: Forest Products Research Society: 234–240.

The production and consumption of hardwood lumber increased during the 1980âs and is predicted to remain at high levels during the 1990's. In recent years, annual growth has exceeded annual removals on hardwood forests. However, much of the growth has been in species that are relatively underutilized in high value markets such as furniture and cabinets. Volumes of the most popular species, the oaks, experienced smaller increases. Sawtimber inventories of select species are skewed toward lower grade logs. The potential grade output from this material is skewed toward lower grade lumber (No. 2 Common and below). Potential differences between the demand and availability of the more popular species can be mitigated by species substitution. The relatively low quality of much of the resource and the growth in demand for higher quality lumber will necessitate continued markets for lower grade lumber and perhaps changes in consumer acceptance or technology.

Marketing Hardwoods to Furniture Producers. 1989. Sinclair, Steven A.; Bush, Robert J.; Araman, Philip A. Proceedings, 17th Annual Hardwood Symposium, Hardwood Research Council. pp. 113-119.

This paper discusses some of the many problems in developing marketing programs for small wood products manufacturers. It examines the problems of using price as a dominant means for getting and attracting customers. The marketing of hardwood lumber to furniture producers is then used as an example. Data from 36 furniture lumber buyers is presented to illustrate various product and service attributes of hardwood lumber which can be emphasized other than low price.

Furniture Marketing: from Product Development to Distribution. 1985. Richard R. Bennington. Fairchild Publications. New York, New York. HD 9773 .U5 B46

Abstract not available.

An Investigation of Hardwood Plywood Markets. Part 1. Architectural Woodworkers. 2001. Forbes, Craig L.; Jahn, Larry G.; Araman, Philip A. Forest Products Journal. 51(3): 17-24.

This is the first part of a two-part study investigating markets for hardwood plywood. North American architectural woodworkers were surveyed to better understand the structure and use of wood-based panels in the industry. A questionnaire was mailed to a sample of U.S. and Canadian architectural woodworkers. The sample consisted of members of the Architectural Woodwork Institute (AWI) and the Woodwork Institute of California (WIC). The response rate, adjusted for bad addresses, was 31 percent. The average architectural woodworker purchased $283,000 of panel materials in 1997, and $111,000 of hardwood plywood. Of total panel purchases, hardwood plywood (including all substrates covered with a hardwood veneer) represented 37 percent, followed by melamine-coated board (21%), raw particleboard (17%), and high-pressure laminate (8%). The Northeast region represented 38 percent of total hard-wood plywood purchases by architectural woodworkers followed by the Midwest (20.4%); the Southeast (14.9%); the West (9.1%); and the South Central (8.3%). Of the hardwood plywood purchased, 37 percent was particleboard core, 33 percent veneer core, and 24 percent medium density fiberboard core. Sixty-three percent of total hardwood plywood was premium grade, followed by custom (25%), and paint grade (7%). Red oak was the predominant face species used (31%), followed by maple (17%), cherry (16%), birch (10%), and mahogany (9%). Eighty-two percent of the faces were constructed of sliced veneer. Nearly 4 percent of total hardwood plywood purchases were of pre-finished plywood. This number was expected to increase to nearly 7 percent by the year 2000. The most important hardwood plywood attribute as perceived by architectural woodworkers was absence of delamination of veneers, followed by absence of defects showing through face, on-time delivery, absence of warp, and orders shipped correctly.

An Investigation of Hardwood Plywood Markets. Part 2. Fixture Manufacturers. 2001. Forbes, Craig L.; Jahn, Larry G.; Araman, Philip A. Forest Products Journal. 51(6): 25-31.

This is the second part of a two-part study investigating markets for hardwood plywood. Part 1 dealt with architectural woodworkers. North American fixture manufacturers were surveyed to better understand the structure and use of wood-based panels in the industry. A questionnaire was mailed to a sample of U.S. and Canadian fixture manufacturers. The sample consisted of members of the National Association of Store Fixture Manufacturers (NASFM). The response rate, adjusted for bad addresses, was 20 percent. The average fixture manufacturer purchased $1.2 million of panel materials in 1997, and $244,000 of hardwood plywood. Of total panel purchases, medium density fiberboard (MDF) represented 28 percent, hardwood plywood (including all substrates covered with a hardwood veneer) represented 20 percent, melamine-coated board was 20 percent, raw particleboard was 15 percent, and high-pres-sure laminate was 11 percent. Of the hardwood plywood purchased, 47 percent was MDF core, 34 percent was particleboard, and 14 percent was veneer core. Sixty-four percent of total hardwood plywood was premium grade, followed by custom (27%), and paint grade (5%). Red oak was the predominant face species used (31%), followed by maple (24%), cherry (11%), birch (10%), and white oak (5%). Fifty-two percent of the faces were constructed of sliced veneer. Over 6 percent of the total hardwood plywood purchases was of pre-finished plywood. This number was expected to increase to 12 percent by the year 2000. The most important hardwood plywood attribute as perceived by fixture manufacturers was absence of delamination of veneers, followed by on-time delivery, orders shipped correctly, and shipment arrives in good condition.

FOREST PRODUCTS EXPORTING & INTERNATIONAL TRADE

A Guide to Exporting Solid Wood Products. 2002. revised by Rachel Hodgetts, Justina Torry, and Lincoln Flake. USDA Foreign Agriculture Service. Forest Products Division. Washington, D.C. Ag Hdbk No. 662.

Guide designed to serve as a source for exporting wood products icluding sources of assistance. Topics include: Forest products economic aspects, tariff on wood products, export marketing, forest products marketing, overseas Private Investment Corporation.

A Basic Guide to Exporting. U.S. Department of Commerce. 1992. NTC Business Books. Lincolnwood, Illinois. HF 1009.6 .B38 1992

Abstract not available.

Wood Products International Trade and Foreign Markets. Annually. USDA Foreign Agriculture Service, Circular Series. (Annual Statistical Trade Issue, WP 1-93 and Annual Production, Consumption, and Trade Issue, WP 2-93. Forest Products Division, Room 4647, South Agriculture Building, Washington DC 20250-1000. (202) 720-0638. (202) 720-8461. This information is online and can be found in http://www.fas.usda.gov

Abstracts not available.

Foreign Terminology and Trade Handbook for the Forest Products Industry. 1989. Mater Engineering. Oregon Department of Forestry, Mater Engineering, Ltd. Corvallis, OR.

Abstracts not available. Publication discusses terms and conversion factors for doing business in 10 major foreign markets.

International Forest Products Glossaries. Undated. Unauthored. Miller Freeman Inc., San Francisco, CA. 464 p.

Two multilingual dictionaries each containing the foreign translations for over 4,000 specialized terms used in all aspects of the forest products industry. These up-to-date references cover processing techniques, machines, systems, new timber species, and new wood-based materials. Invaluable references for forest industry traders, importers, exporters, wood converters, and furniture and paper manufacturers.

Strategic Marketing in the Global Forest Industries. 2002. Juslin, Heikki and Eric Hansen, Authors Academic Press. Corvallis, Oregon.

Abstract not available.

China: Changing Wood Products Markets. 1998. Zhang, Daowei; Liu, Junchang; Granskog, James; Gan, Jianbang. Forest Products Journal. 48(6): 14-20.

In the 1980's, China emerged as the world's second largest importer of forest products and the second largest importer of U.S. forest products. However, U.S. wood products exports to China declined nearly 93 percent from 1988 to 1996, from >/=448 million to >/=33 million. Little is known about the reasons that caused this decline. Less is probably known about the forestry and wood products market in China than most other U.S. trading partners. A consulting report by Ernst & Young for American Forest & Paper Association explored a strategy for expanding exports of U.S. forest products to China; however, its data and information are limited to 1993 to 1994. Other studies of the wood products market in China by DBC Associates, the National Forest Products Association, and Waggener are dated, and reports by the USDA

Foreign Agriculture Service are mostly anecdotal. This article describes recent trends of China's wood products imports and communicates the results of interviews with major wood products importers in China regarding the competitiveness of U.S. wood products in China.

What is Determining International Competitiveness in the Global Pulp and Paper Industry? 1994. Anon. In: Proceedings, third international symposium. Special Pap. 17; 1994; Seattle, WA. Seattle, WA: University of Washington, College of Forest Resources, Center for International Trade in Forest Products.

Abstract not available.

Log Export and Import Restrictions of the U.S. Pacific Northwest and British Columbia: Past and Present. 1998 Christine L. Lane. USDA Forest Service, Pacific Northwest Research Station. Portland, OR. GTR 436

Export constraints affecting North American west coast logs have existed intermittently since 1831. Recent developments have tended toward tighter restrictions. National, Provincial, and State rules are described.

The Effects of NAFTA and an FTAA on U.S. Exports of Hardwood Forest Products. 1998. Prestemon, J. P. Pages In: Meyers, D. A. National Hardwood Lumber Association. Memphis, TN. Proceedings of the Twenty-Sixth Annual Hardwood Symposium. 5/6/1998.

The North American Free Trade Agreement (NAFTA) took effect on January 1, 1994, beginning what might result in a restructuring of trade in the hemisphere, especially between the United States and Mexico. This restructuring and expected welfare gains are intended outcomes of the kind of freer trade among countries that has been sweeping the hemisphere for at least ten years. An ultimate outcome of hemispheric economic liberalization might be a regional free trade accord-a Free Trade Area of the Americas (FTAA). NAFTA and this possible descendant may affect forest products trade and the forest products sectors of some of these countries. Significantly, much change will occur for exports of United States hardwood products. It is important that hardwood product manufacturers in the United States understand the importance of Latin America relative to other trading partners and the possible effects of regional trade liberalization on United States trade in these and competing products. More information on the expected effects of NAFTA and a proposed FTAA will help current and potential future exporters to the region and investors in the region make better trade and investment decisions. In the following pages, we place Latin America in context with regard to forest products trade, particularly for hardwood solid wood products, and we report some predictions of the effects of NAFTA and an FTAA relevant to hardwood products manufacturers of the United States. We begin by describing the genesis of NAFTA and other regional accords, proceed to summarize current trade in key forest products among North American countries, and finish by providing some predictions and recommendations about opportunities for United States hardwood producers.

The Effects of NAFTA Expansion on US Forest Products Exports. 1997. Prestemon, Jeffrey P. Journal of Forestry. 95(7): 26-32.

When Mexico began liberalizing its domestic market and foreign trade a decade ago, the U.S. Government hoped U.S. exporters would gain easier access to the Nation's third most important foreign market, after Japan and Canada. Having just completed a free trade accord with Canada, U.S. trade officials sought to solidify changes in Mexico and encourage further economic reform by negotiating the North American Free Trade Agreement (NAFTA). Similar economic and political motivations are behind current U.S. Government interest in adding other countries to NAFTA or establishing an Americas-wide free trade area. Latin American leaders have themselves expressed a desire to create a regional free trade area by 2005. If new countries join NAFTA or if hemispheric free trade is accomplished in another way, among the new signatories might be relatively large producers and consumers of forest products Ca prospect that should draw the attention of U.S. forest products manufacturers and consumers. Some have suggested that growth in the forest sectors of Latin American countries might raise competitive pressures on North American forest products producers. Others have simply indicated the region's potential for substantially increased forest products output. No research, however, has been published on how NAFTA expansion to include other major forest products producers would affect competition. Given the current structure of trade in the Americas and the existing constraints to trade in forest products between the United States and the other countries, how would expansion of NAFTA change the situation?

SPECIAL FOREST PRODUCTS

Special Forest Products—Biodiversity Meets the Marketplace. 1997. Nan C. Vance and Jane Thomas (editors). Sustainable Forestry Seminar Series, Oregon State University, Corvallis, OR, October – November 1995. USDA Forest Service, Washington, D.C. WO-GTR-63.

> Although North American forests traditionally have been viewed as a source of wood and paper, a variety of profitable products are being discovered that come not only from trees, but from nonwoody plants, lichens, fungi, algae, and microorganisms. The northern temperate forests' abundant biotic resources are being transformed into medicinals, botanicals, decoratives, natural foods, and a host of other novel and useful products. These products are referred to as secondary, specialty, special, or nontimber forest products. Consumer forces, social climate, expanding global markets, and an increase in entrepreneurialism are contributing to a new interest in developing these products as a viable economic option. Species diversity, a biological attribute that contributes to the ecological stability of forests, takes on an economic value to those sourcing or "biodiversity prospecting" for natural products. Consideration should be given to how this diversity might contribute to stabilizing economies, particularly of communities that have a vital relationship with forests. A totally integrated model of ecosystem management or of sustainable forestry would include this kind of interaction. The Sustainable Forestry Partnership and the College of Forestry at Oregon State University along with the Pacific Northwest Research Station, and funded in part by the John D. and Catherine T. MacArthur Foundation, presented a seminar series at Oregon State University, Corvallis, Oregon, in the fall of 1995. The intent of the seminar series, "Special Forest Products—Biodiversity Meets the Marketplace," was to stimulate new and continuing dialogue concerning future sustainability of forest resources as they evolve along with other societal and economic trends into the 21st century. This proceedings is an .outcome of the seminars given by 11 experts who, with first-hand knowledge, offered new creative approaches for developing, managing, and conserving nontimber forest resources.

Income Opportunities in Special Forest Products. 1993. Margaret Thomas and David Schumann. USDA Forest Service, Washington, D.C. Ag.Info.Bul. 666.

> Discusses a wide range of special forest products that represent opportunities for rural entrepreneurs to supplement their incomes. For many rural areas, the path to sustainable economic development will include innovative approaches to natural resource conservation, management, and utilization. This publication describes special forest products that represent opportunities for rural entrepreneurs to supplement their incomes. The types of products discussed in this publication include aromatics, berries and wild fruits, cones and seeds, forest botanicals, honey, mushrooms, nuts, syrup, and weaving and dyeing materials. Each chapter describes market and competition considerations, distribution and packaging, equipment needs, and resource conservation considerations, and presents a profile of a rural business marketing the products. In general, products suitable for very small or part-time operations are described. A suggested role for each type of microenterprise within a broader rural economic development framework is also mentioned. Each chapter concludes with a list of contributors and additional resources.

Forest Communities in the Third Millennium: Linking Research, Business, and Policy Toward a Sustainable Non-Timber Forest Product Sector. 2001. Davidson-Hunt, Iain; Duchesne, Luc C.; Zasada, John C., eds. Gen. Tech. Rep. NC-217. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Research Station.

> Contains a wide variety of papers given at the first international conference on non-timber forest products (NTFP) in cold temperate and boreal forests. Focuses on many facets of NTFPs: economics, society, biology, resource management, business development, and others.

Opportunities for Conservation-Based Development of Nontimber Forest Products in the Pacific Northwest. 1999. B. von Hagen and R.D. Fight. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. PNW-GTR-473.

> The contribution of the nontimber forest products industry in the Pacific Northwest is described and analyzed from economic, social, and ecological perspectives. The promise of replacement for declining timber harvests has been largely unmet. On the other hand, nontimber forest products harvesting provides opportunities to people with the fewest options–recent immigrant groups and residents of economically distressed communities. In addition, the current economic contribution of nontimber forest products may be

considerably less than the future potential gain under management regimes that emphasize both timber and nontimber products.

Conservation and Development of Nontimber Forest Products in the Pacific Northwest: An Annotated Bibliography. 1996. B. von Hagen, J.F. Weigand, R. McLain, R. Fight, H.H. Christensen, (compilers). USDA Forest Service, Pacific Northwest Research Station, Portland, OR. PNW-GTR-375.

This bibliography encompasses literature on the historic and current scope of nontimber forest product industries in the Pacific Northwest and includes references on international markets and trade that bear on these industries. Key themes in the bibliography are biological and socioeconomic aspects of resource management for sustainable production; procedures for identifying, monitoring, and inventorying important resources; means for technical innovation and resource development; and public education about nontimber forest resources. Social policy issues address the role of nontimber forest products in rural development and the spectrum of ethical considerations required for socially acceptable policy formulation. Economics literature covers estimating the contribution of nontimber forest products to a whole ecosystem economy, analyzing and planning for joint production of agroforestry systems, and enhancing the performance of nontimber forest product sectors.

WOOD ENERGY

Primer on Wood Biomass for Energy. 2003. Richard Bergman and John Zerbe. USDA Forest Service, Technology Marketing Unit, Forest Products Laboratory. Madison, WI.

The purpose of this paper is to explain and describe the concepts of wood energy on a residential, commercial, and industrial scale in the United States so that the Forest Service can help meet the demands of communities involved in the forest products industry. In addition, the terminology associated with this field is for individuals to develop a basic understanding and familiarity with the technical terms that are common to bioenergy technology. Definitions specific to wood energy are given at the end of this report.

Biomass for Heat and Power. 2002. By Richard L. Bain and Ralph P. Overend. Forest Products Journal, Vol. 52 No. 2

Biopower is the production of electricity from renewable biomass resources. The production cycle has five key elements: biomass supply, transportation, handling, conversion, and electricity generation. Biopower is a proven commercial electricity generating option in the United States, and with about 11 GW of installed capacity, is the single largest source of non-hydro renewable electricity. There are many types of biomass feedstocks from diverse sources. This creates technical and economic challenges for biopower plant operators because each feedstock has different physical and thermo-chemical characteristics and delivered costs. Characteristics of biopower facilities, including feedstock flexibility and capacities that are typically much lower than fossil-fuel power plants, present opportunities for market penetrations in unconventional ways. Feedstock type and availability, proximity to users or transmission stations, and markets for potential by-products will influence which biomass con-version technology is selected and the scale of operation. Nationally, there appears to be a generous fuel supply; however, lack of infrastructure to obtain fuels currently prevent utilization of much of this supply. The nearest term low-cost option for the use of biomass is cofiring with coal in existing boilers. A potentially attractive biopower option is based on gasification. Gasification for power production involves the conversion of biomass to produce "biogas" for use in power generation. Direct-fired combustion technologies are options for retrofitting existing facilities to improve process efficiency.

United States Wood Biomass for Energy and Chemicals: Possible Changes in Supply, End Uses, and Environmental Impacts. Kenneth E. Skog and Howard Rosen. Forest Products Journal, Vol. 47, No. 2 63

As U.S. population and energy consumption increase, accompanied by growing concerns about global change and atmospheric pollution, there may be an opportunity for wood biomass to play a greater role in energy production if fossil fuel prices increase as projected by the U.S. Department of Energy. Forest biomass inventory is substantial in the United States and significant amounts of wood residue are generated from processing, construction, demolition, and municipal solid waste. Prospects for expanding the use of wood biomass for producing electrical power or ethanol will be enhanced by environmental needs and improvements in technology. Environmental needs include 1) reducing carbon emissions from fossil fuels and sequestering carbon; 2) removing wood from forests to improve forest health; 3) diverting urban waste streams from landfills; and 4) generating oxygenates, possibly from ethanol, for gasoline. Technology needs include improvement of short-rotation intensive culture techniques for plantations and improvement of electrical power and ethanol production processes. These efforts can help improve the comparative advantage of wood biomass feedstocks relative to fossil fuel feedstocks. Key environmental concerns will constrain the supply of wood biomass from forests and plantations; particularly concern for the effects of management for wood fuel on the diversity of plants and animals and on the depletion of soil and water resources. l increasing general demands for energy and chemicals; l abundance and availability of wood biomass sources; l the need to reduce fossil fuel consumption because of negative environ-mental impacts. Wood biomass is physically abundant in U.S. forests, and there are potential new and expanded sources from wood-waste production and short-rotation intensive culture (SRIC). A range of economic influences and environmental concerns will both promote and restrict the use of these sources. These include an increasing wood supply, new uses of biomass for energy, and certain environ-mental constraints.

Feasibility of Using Wood Wastes to Meet Local Heating Requirements of Communities in the Kenai Peninsula in Alaska. 2002. David L. Nicholls, Peter M. Crimp. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. PNW-GTR-533.

Wood energy can be important in meeting the energy needs of Alaska communities that have access to abundant biomass resources. In the Kenai Peninsula, a continuing spruce bark beetle (*Dendroctonus rufipennis* (Kirby)) infestation has created large volumes of standing dead spruce trees (Picea spp.). For this evaluation, a site in the Kenai-Soldotna area was chosen for a small, industrial-scale (4 million British thermal units (BTUs) per hour) wood-fired hot water heating system, which could be fueled by salvaged spruce timber and also by sawmilling residues. Thirty-six different scenarios were evaluated by using wood fuel costs ranging from $10 to $50 per delivered ton, alternative fuel costs from $1 to $2 per gallon, and fuel moisture contents of either 20 percent or 50 percent (green basis). In addition, two different capital costs were considered. Internal rates of return varied from less than 0 to about 31 percent, and project payback periods varied from 4 years to greater than 20 years. Potential barriers to the long-term sustainability of a wood energy system in the Kenai Peninsula include the availability of biomass material once current spruce salvage activities subside. The estimated wood fuel requirements of about 2,000 tons per year are expected to be easily met by spruce salvage operations over the short term and by sawmill residues after salvage inventories diminish. It is expected that a wood energy system this size would not significantly reduce overall fuel loads in the area, but instead would be a good demonstration of this type of system while providing other community benefits and energy savings.

How To Estimate Recoverable Heat Energy in Wood or Bark Fuels. 1979. Peter J. Ince. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL-GTR-29.

A reference source is provided for estimating the amount of heat energy that may be recovered using wood or bark fuel in typical furnace and boiler or hot air combustion heat recovery systems. A survey of reported data on higher heating values for various species of wood and bark fuels is provided. A set of formulas of a type commonly used by combustion technologists is also provided for estimating combustion system losses and net recoverable heat energy per pound of fuel as-fired, based on fuel higher heating value, moisture content, and excess air stack gas temperature, and ambient temperature assumptions.

Harvesting Wood for Energy. 1981. Arola, Rodger A.; Miyata, Edwin W. Research Paper NC-200. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station.

Illustrates the potential of harvesting wood for industrial energy, based on the results of five harvesting studies. Presents information on harvesting operations, equipment costs, and productivity. Discusses mechanized thinning of hardwoods, clearcutting of low-value stands and recovery of hardwood tops and limbs. Also includes basic information on the physical and fuel properties of wood.

Biomass as Feed-Stocks for the Forest Products Industry. 1997. Hague, J.R.B. In: Biomass and Energy Crops. Proceedings, Association of Applied Biologists; 1997 April. Royal Agricultural College, Cirencester, UK. Aspects of Applied Biology. 49: 455–464.

Abstract not available.

URBAN WOOD UTILIZATION & RECYCLING

Utilizing Municipal Trees: Ideas from Across the County. 2001. Stephen M. Bratkovich. USDA Forest Service, Northeastern Area, State and Private Forestry. Newtown Square, PA. NA-TP-06-01.

> To show how municipal tree removals can be utilized for traditional wood products, this publication highlights 16 successful projects from around the country. These case studies are organized by the different types of participants: State and regional partnerships, municipalities, tree service firms, entrepreneurs, and sawmills. Contact information is provided for each case study.

Recycling Municipal Trees : A Guide for Marketing Sawlogs from Street Tree Removals in Municipalities. 1994. Ed Cesa, Ed Lempicki, and Howard Knotts. USDA Forest Service, Northeastern Area, S&PF, Morgantown, WV. NA-TP-02-94

> Provides an alternative strategy for using street trees removals; a recycling strategy that can potentially turn a cost-burden scenario into an income-generating opportunity.

Successful Approaches to Recycling Urban Wood Waste. 2002. Solid Waste Association of North America. USDA Forest Service, Forest Products Laboratory. Madison, WI. FPL–GTR–133. 20p.

> This report presents eight case studies of successful urban wood waste recycling projects and businesses. These studies document the success of recovered products such as lumber and lumber products, mulch, boiler fuel, and alternative cover for landfills. Overall, wood waste accounts for about 17% of the total waste received at municipal solid waste landfills in the United States. In 1998, the amount of urban wood waste generated was more than 160 million tons, with 29.6 million tons avail-able for recovery. Similarly, in 1998, new construction in the United States generated 8.7 million tons of wood waste, with 6.6 million tons available for recovery; demolition waste generated 26.4 million tons of wood waste, with 9 million tons available for recovery. The case studies were selected on the basis of the following criteria: an emphasis on partnerships among communities, businesses, governments, and non-governmental organizations; efficient use of funds; sustained creation of enterprise; and a high benefit/cost ratio.

Harvesting Urban Timber: A Complete Guide. 2003. Samuel B. Sherrill. Linden Publishing, Fresno, CA. 224p.

> Three to four billion board feet of lumber are being fed into landfills throughout the United States each year. Author Sherrill explains not only the importance of of harvesting urban trees, but also how to do it. He details how local businesses, woodworkers, and city governmnets can undertake their own urban timber harvesting programs. Explained in detail are felling, safety, timber conversion, and seasoning lumber from urban trees.

National Wood Recycling Directory. 1996. Cinda Hartman Jones, Editor. American Forest and Paper Association in cooperation with the UDSA Forest Service. AF&PA, Washington, DC. 99p.

> This directory lists by state and county the names and adresses of wood residue receivers nationwide. It is designed to be used by waste wood producers such as builders, remodelers, and demolition contractors to avoid costly landfill fees and better utilize previously discarded wood wastes.

What's Stopping the Recycling of Recovered CCA-Treated Lumber. 2002. Smith, R., D. Alderman, Jr. and P. Araman. Proceedings, Enhancing the Durability of Lumber and Engineered Wood Products. 47-50.

> The awareness and concerns regarding the environmental impacts and disposal of chromated copper arsenate (CCA) treated wood products are increasing. Several investigators predict that the quantities of CCA-treated lumber will increase significantly in the upcoming decades. Additionally, with the number of landfills decreasing, landfill tipping fees increasing, and limitations being placed on the types of materials which can be landfilled, it is vital that treated wood currently directed to landfills be recycled.

Urban Waste Wood Utilization: Proceedings of a Conference on Alternatives to Urban Waste Wood Disposal. 1979. Various. Included in: Conference Proceedings are five papers on the resource situation, nine papers on possibilities for utilization, and three papers on planning. USDA Forest Service, Southeastern Forest Experiment Station. Asheville, NC. GTR-SE-016. 127p.

Included in the Conference Proceedings are five papers on the resource situation, nine papers on possibilities for utilization, and three papers on planning.

MISCELLANEOUS PUBLICATIONS OF INTEREST

Exterior Wood in the South: Selection, Applications, and Finishes. Dan Cassens and Bill Feist. USDA Forest Service, Forest Products Laboratory, Madison, WI. FPL-GTR-69

Wood continues to play an important role as a structural material in today's high-tech society. As lumber and in reconstituted products, wood is commonly used for house siding, trim, decks, fences, and countless other exterior and interior applications. When wood is exposed to the elements, particularly sunlight and moisture, special precautions must be taken in structural design as well as in the selection and application of the finish. This is especially true in the South, where excessive moisture can quickly damage a structure and erode the finish.

This report describes the characteristics of wood finishes and their proper application to solid and reconstituted wood products. It describes how manufacturing and construction practices affect the surfaces of wood products, how various types of finishes interact with the surface, and how weathering affects the finished surfaces. Methods for selecting and applying various exterior wood finishes are presented. Finally, the failure and discoloration of wood finishes are discussed, and methods are described for preventing these problems. The information and advice given in this report provide a guide for obtaining maximum service life for finished exterior wood products in the South.

Wood-Frame House Construction. 1989. Sherwood, Gerald and Robert C. Stroh. USDA Forest Service, Forest Products Laboratory, Madison, WI. AG-HDBK-73

Presents sound principles for wood-frame house construction and suggestions for selecting suitable materials.

Changing Utilization of Hardwoods. 1962. Ed Locke. USDA Forest Service, Forest Products Laboratory, Madison, WI. Report No. 2244

Except for a few comments relating to markets, the FPL Director's comments state the current state of the hardwood resource as it relates to hardwood utilization - that of lower quality trees - an underutilized resource. Anyone working with small diameter or underutilized trees should read this.

Tropical Timbers of the World. 1984. Martin Chudnoff. USDA Forest Service, Forest Products Laboratory, Madison, WI. Washington, DC. Ag Hdbk 607. 464p.

Contains descriptions of 370 species or generic groupings of tropical trees and their timbers grouped by regional orgin: Tropical America, Africa, and Southeast Asia and Oceania. Standardized descriptions emphasize physical and mechanical properties, processing characteristics, and uses. Data have been compiled, evaluated, and synthesized from the world literature. Extensive tables of technical data are coded to permit easy comparison of species properties and to aid in the selection of woods most suitable for particular end uses.

The Role of Markets and Technology in Conservation of Timber Resources. 1995. Peter J. Ince, David B. McKeever and Richard W. Haynes. *In:* Proceedings of the 1995 International environmental conference; 1995 May 7--10; Atlanta, GA. Atlanta, GA: TAPPI PRESS: 315-325; 1995.

Technological options exist for timber conservation by using more recycled fiber, new composite or engineered wood products, and substitutes based on alternative materials or technologies. Given these technological options, conservation could occur as an economic response to market conditions. This is supported by historical trends, economic theory, and cost comparisons. In the long run, market conditions and technology development could lead to timber conservation in much the same way that constraints on energy resources recently led to energy conservation. In any case, markets and technology together play a significant role in timber conservation. Growing demand threatens the integrity of forest ecosystems, both in the United States and in countries that we import forest products from. Apart from policy intervention to reduce timber consumption or intensification of timber management to pro-vide greater timber supply, markets and technology can play a significant role in effectuating timber conservation. In this paper, we recognize that efficient pathways for evolution of technology in the future will be determined to a great extent by the influence of resource market conditions (i.e. market trends for timber, energy, etc.). Without policy intervention, timber consumption will be determined largely by input requirements of different production technologies and the evolution of those technologies as influenced by comparative economic advantages and market conditions. Changing market conditions can influence timber consumption via economic substitution and technological change. Thus, resource markets and technology of the forest product sector (including pulp and paper) are significantly intertwined with timber resource conservation.

Chunkwood: Production, Characterization, and Utilization. 1991. Arola, Rodger A. General Technical Report NC-145. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station.

Presents a collection of U.S. research papers about chunkwood, an alternative form of comminuted wood particles that range from finger size up to fairly large, blocky particles of wood. Discusses chunkwood`s characteristics, storage and drying, machinery, and use to build low-volume roads and as furnish for composite flake products.

Paper, Paperboard and Woodpulp—Production, Consumption and Trade. 2001. Peter Ince, Bernard Lomnard, and Eduard Akim. In: UN-ECE/FAO Forest Products Annual Market Review, 2000-2001. Geneva, Switzerland.

Since early 1999 and through the first half of 2000 both the European and North American pulp and paper sectors sustained a strong economic recovery. Recovery contrasted with relatively volatile markets from 1996 through 1998, and afforded producers the best market conditions since the previous market peak in 1995. The recovery is attributed to stable economic growth in North America and Europe, restrained growth in mill capacity, and an upturn in Asian and global markets.

Industrial Wood Productivity in the United States, 1900-1998. 2000. Peter Ince. USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. Res. Note FPL–RN–0272. 14 p.

The productivity of U.S. wood and paper product output in terms of wood input is computed and displayed in graphs. Background tables provide supporting data. The productivity trend parallels trends in the recovered paper utilization rate. Recycling and wood residue use are key factors in productivity gains.

Wood Decks:Materials, Construction, and Finishing. 1996. Kent McDonald, Bob Falk, Sam Williams, Jerrold Winandy. Forest Products Society, Madison, Wisconsin. Publication #7298. 94p.

This manual contains a wealth of important information on the design, construction, finishing, and maintenance of wood decks that is not available in other deck construction publications, including: Span tables for deck design. Unbiased technical information that clearly outlines the dos and the don'ts of wood deck design and construction. Information on the properties of various wood species used in deck construction and how these properties affect the quality and longevity of wood decks. Detailed discussion of proper materials and procedures for finishing wood decks. Proper procedures for inspecting and maintaining various deck components and finishes. *Wood Decks: Materials, Construction, and Finishing* is an invaluable resource for designers, home builders, remodelers, and do-it-yourselfers who are interested in wood decks.

Maximizing Forest Products Resources for the 21st Century. 2000. Richard F. Baldwin Forest Products Society, Madison, Wisconsin. Publication #MF-4670. 232p.

The forest industry is an essential global industry—yet it is an enigma. Some believe the Paul Bunyan heritage still lives: a heritage of big men, huge mills, and ancient trees. Others are not so sure: they know trees are the mainstay raw material for lumber, papers, and other products, but they don't know if the forest reemerges after harvest, and if it does will the land ever return to its preharvest condition. Somehow the industry has not escaped its cut-and-move-on reputation of the 19th century. The consumer and the industry have somehow each failed to recognize the change in each other. This book is a progress report to the industry participant, the consumer, the investor, and others who depend in some way on the forest and its products. Hands-on business activities, interviews, observations, and detailed research in the United States and 20 other countries covering five continents over the decades have provided material for the text. The 19 chapters are divided into five sections: an overview; the raw material base: globalization and re-engineering; the mills: adapting to changes; marketing and sales: meeting global demand; and moving ahead to the 21st century.

Issues Related to Handling the Influx of Small-Diameter Timber in Western North America. 2000. FPS. Forest Products Society, Madison, Wisconsin. Publication #7261. 98p.

Selective logging of a number of western species (e.g., ponderosa pine) and effective fire suppression methods have had a major impact on the health and composition of millions of acres of forests in the western United States. Many forest stands in the west are densely stocked, and the implementation of ecological restoration treatments in these stands will result in significant volumes of small diameter (20 to 38 cm d.b.h.) being available for processing. The papers in this 98-page proceedings were given at the 1999 Forest Products Society Annual Meeting in Boise, Idaho. The papers were selected for their focus on the management, characteristics, and quality of small-diameter softwood timber, and the challenges and opportunities involved in the processing and use of this timber in value-added products.

Wood: Influence of Moisture on Physical Properties. 1995. John Siau. Forest Products Society, Madison, Wisconsin. Publication #7282. 228p.

Nearly all physical properties of wood are influenced by its moisture content. This 228-page book, written by John F. Siau, provides information concerning the interactions between moisture, heat, and wood, probably the principle source of problems encountered in applications with wood. While this book can be used as a text and reference book for students and faculty in the wood technology field, it will also be helpful to engineers, architects, and designers who work with wood.

Finishes for Exterior Wood: Selection, Application, and Maintenance. 1996. Author. Forest Products Society, Madison, Wisconsin. Publication #7291. 128p.

This manual contains definitive, practical information on the proper selection, application, and maintenance of exterior wood finishes, including: How manufacturing, design, and construction practices affect the surfaces of exterior wood products. How various types of finishes interact with wood surfaces. How weathering affects the wood and finished surface. How to select and apply various exterior wood finishes. How degradation and discoloration of exterior wood finishes occur and what methods can be used to prevent these problems. *Finishes for Exterior Wood* is an invaluable resource not only for finish applicators, but also for designers of exterior wood structures interested in understanding the various mechanisms that affect the service life of finished exterior wood products.

Nondestructive Evaluation of Wood. 2002. compiled by Roy F. Pellerin and Robert J. Ross. Forest Products Society, Madison, Wisconsin. Publication #7250. 210p.

This book answers the request of our colleagues throughout the world who expressed the desire for a synthesized source of information on nondestructive evaluation of wood. Widely respected technical authorities were asked to prepare chapters dealing with their areas of expertise. Contents include: characteristics of wood, fundamental hypothesis, static bending nondestructive evaluation methods; transverse vibration and longitudinal stress wave nondestructive evaluation methods; acoustic emission and acousto-ultrasonics; proof loading; probing, drilling, and coring -- nondestructive evaluation methods; visual grading of softwood dimension lumber; mechanical grading of lumber; ultrasonic veneer grading; inspection of timber structures using stress wave timing nondestructive evaluation tools; and nondestructive evaluation of green materials -- recent research and development activities. Sections of the book originally appeared in technical journals, research reports, and various symposia proceedings. In addition more than 400 technical articles are cited in the chapters or listed in the Appendix.

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