"Forest Products Research"
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In the United States, forest products research carried on in scientific fashion got off to a slow start during the last decade of the nineteenth century. In 1887, the chief of the U.S. Division of Forestry, Bernhard E. Fernow, deplored the lack of knowledge about most American woods. "Crude experience has been our guide," he said, "and crude has remained our knowledge."

During the period from 1890 to 1910, small amounts of money were apportioned by the federal forestry establishment to universities for forest products research. Mechanical property studies were begun at the universities of Washington, Yale, Purdue, California, and Oregon. Preservation and dry kiln studies were undertaken at Yale. Naval stores research was started in the South. A small experimental pulp mill was erected in Boston, and wood chemistry and wood preservatives were also studied there in a small way.

Filibert Roth started his career by studying gross anatomy, shrinkage, and physical properties of pines at the University of Michigan in 1888. His publication, *Timber: An Elementary Discussion of the Characteristics and Properties of Wood* (Division of Forestry Bulletin No. 10, 1895), was a classic compilation of research-based knowledge about United States woods.

In 1907, McGarvey Cline, head of a section on wood uses in the U.S. FOREST SERVICE, proposed that improved efficiency and coordination in research could be obtained by bringing the far-flung federally sponsored products research scientists together in one laboratory. Accordingly, the Forest Products Laboratory (FPL) began operating in Madison, Wisconsin, on October 1, 1909. Scientists from various universities were moved to Madison and the cooperating University of Wisconsin provided a specially constructed laboratory building. Cline served as the first director of FPL, which formally opened on June 4, 1910.

There were a number of important early successes such as, for example, in the work of Harry D. Tiemann, who had been studying wood physics at Yale University since 1903. He was among the first of the university scientists to move to Madison in 1909. He brought the benefits of considerable research already done on the concept of the critical "fiber saturation point" in wood drying. Tiemann received the first of a number of patents on the humidity-regulated dry kiln in 1911. His kilns were rapidly accepted in lumber manufacture to speed up and control the long and expensive process of drying lumber. Subsequently, wood physics studies related to moisture have probably yielded more doctoral theses than all other forest products research subjects together.

Timber mechanics studies were also continued at FPL, with the objective of providing a full array of engineering data about American wood species. About 200,000 specimens were tested during the laboratory's first decade. Compilations of strength properties of American woods were published by J.A. Newlin, L.J. Markwardt, T.R.C. Wilson, and other research engineers. Most important was the characterization of "stress grades" of lumber on the basis of strength, a concept rapidly accepted by the industry.

The FPL's pulp and paper research group was soon equipped with an experimental fourdrinier paper machine and pulping equipment suitable for studying mechanical as well as chemical pulping. Pulp variables were also studied in mechanical pulping at a full-size experimental groundwood mill constructed for research at Wausau, Wisconsin, before World War I. Chemists at FPL studied the chemical composition of wood, wood distillation and extraction, and the manufacture of ethyl alcohol, glues, wood-preserving chemicals, and chemicals for stabilizing and moisture-proofing wood.

Forest products research boomed during the two world wars; the results were extremely important and useful for the war effort and far beyond. During World War I, the FPL staff rose from fewer than 100 employees to about 450. World War I caused many shortages. For example, paper requirements doubled. Scientists began planning research on a variety of tree species not then used for paper, notably the southern pines and hardwoods. FPL demonstrated a bleached sulfate pulping process in 1931, and nine years later a mill in Lufkin, Texas, began manufacturing newsprint from pulp produced by this process and mixed with groundwood pulp.

On May 18, 1928, Congress passed the McSweeney-McNary Act, which recognized research as an integral part of the nation's forestry program. It made special provision for continuation of products research at the FPL in Madison. FPL completed construction of a large, strikingly modern laboratory building in 1931. Over thirty years later, FPL added a large new pilot plant and two additional laboratory buildings.

During World War II, the FPL staff rose to about 700, in part to train wood processors, users, and inspectors, but mainly to conduct research and development work on the whole gamut of wartime uses, including airplanes, boats, structures, and containers; special papers were developed for greater wet-strength, durability, and stability for containers and maps, and for overlaying plywood. Adhesives for wood, permanently durable under all conditions of exposure, became commonplace.

During the two wars and the intervening period, the laboratory's reputation spread around the world, and it became the model for national laboratories in many industrialized as well as developing countries. Scientists from FPL accepted assignments abroad to assist in the establishment of these institutions, and young scientists from foreign laboratories spent lengthy training periods at FPL to prepare for research in their home countries. Through this long period from the beginning of World War I to the end of World War II, FPL was directed by Carlile P. "Cap" Winslow, a colorful, politically astute administrator.

By the end of World War II, a growing realization that the high-quality timber that had helped to build a wealthy nation was becoming scarce caused a shift of the emphasis in research to the utilization of hitherto lesser-used species and to the more efficient use of existing supplies. At the same time, forest products research began to be of greater interest to wood-using industrialists. In 1943, the National Lumber Manufacturers Association (NLMA), through a subsidiary, the Timber Engineering Company (TECO), established a product development and research department with a laboratory in Washington, D.C., which studied a great variety of problems of interest to wood processors. In 1948, NLMA published a *Forest Products Research Guide*, listing 91 trade associations and 131 professional societies and commercial laboratories active in forest products research. The *Guide* also listed 209 forest products manufacturers and 507 processors, consumers, and material suppliers that participated in research.

Unfortunately, only a few industrial research groups were of any significant size, and the movement that developed at the time did not grow greatly, except at large forest products conglomerate companies and at firms that supplied chemicals, adhesives, and equipment to the industry. Even TECO's product development and research department was terminated in 1959. Furthermore, industry research was always of a proprietary and applied nature; very little of it was made public, although extensive and productive facilities were and have continued to be maintained by such firms as Weyerhaeuser, Potlatch, and Georgia-Pacific, among others.

Forest products research in universities before World War II was limited mainly to individual scientists at forestry schools. Notable exceptions were the Institute of Paper Chemistry established in 1929 at Lawrence College in Appleton, Wisconsin, where direction and financial support came from the pulp and paper industry, and the New York State College of Forestry at Syracuse, which early had strong faculties in wood technology, wood utilization, and pulp and paper.

Forest products research in state organizations dates from establishment of the Texas Forest Utilization Research Laboratory at Lufkin in 1937 and a similar laboratory at Corvallis, Oregon, in 1941. These and other such institutions, mostly at university locations, multiplied and grew in the decade after World War II. Graduate students at universities also contributed greatly to the research output at that time. However, after the postwar boom, difficulties in attracting students, high costs, and perhaps other problems caused some schools, notably Yale, Duke, and the University of Michigan, to withdraw from the forest products specialty. Nevertheless, there has been growth both in net numbers of research groups and in research output, and in the lat 1970s at least a dozen sizable state or university forest products research laboratories were active in the field.

Following the pattern established for agricultural research and extension under the Hatch Act of 1887, the U.S. Congress in 1962 passed the McIntire-Stennis Act which authorized federal support for forestry (including forest products) research at land grant colleges. Funds subsequently provided and administered by the U.S. Department of Agriculture's Science and Education Administration helped to create a more favorable and more stable situation for research at most of the forestry schools. At the same time, the Forest Service emphasized greater cooperation and support for university research. The universities have concentrated on basic research, which has not always flourished in the government's own programs.

The Forest Service has always had a concern for problems of dissemination and application of its research. Before World War II, forest products officers were stationed at offices in Missoula, San Francisco, and Portland to provide liaison with timber processors. After the war this service was enlarged into the "Forest Utilization Service" with representatives at each of the experiment stations. During 1964 and 1965, these liaison offices were replaced by forest products research projects at each experiment station. These projects have since concentrated on regional problems in cooperation with the central laboratory in Madison. At the same time, the Forest Service enlarged its liaison effort through its program of state and private forestry, adding product specialists to assist industry in improving its technology on the basis of the latest research findings. Perhaps the most successful such project was the sawmill improvement program, which in cooperation with state officials helped hundreds of small sawmills to increase lumber

yields. The Forest and Rangeland Renewable Resources Planning Act of 1974 and subsequent related legislation, especially in 1978, further promoted improvements in the Forest Service's long-range research planning process to increase the relevance of federal research to the overall forestry program of the country.

Recognition of research has come in part through the development of a profession of forest products science and technology and of publications specializing in this field. The professional organization of the forest products scientist and technologist is the Society of Wood Science and Technology founded in 1958 and numbering about 250 members in 1981. It publishes a quarterly journal and carries on other professional activities. The Forest Products Research Society, an information-disseminating organization formed in 1947 and dedicated to publicizing the results of research for the industrial practitioner, publishes two journals, conducts seminars, and otherwise stimulates the spread of new information about wood. In 1981, it claimed 5,000 members.

Further reading: Charles A. Nelson, History of the U.S. Forest Products Laboratory (1910-1963) *(1971). U.S. Forest Products Laboratory,* Wood Handbook: Wood as an Engineering material, *Agriculture Handbook No. 72 (rev. ed., 1974).*

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