Professional Affairs

A NEW CONCEPT: WOOD AS AN INTEGRATED PART OF MATERIALS SCIENCE AND ENGINEERING[1]

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ABSTRACT

The study of wood technology at Washington State University has been integrated into a materials science and engineering curriculum that includes metallurgy and polymer chemistry. Previously, materials science concentrated on the study of materials amenable to manipulation of their engineering properties at the molecular level, such as metal and polymers. It has been shown that the properties of wood materials can also be manipulated, but not at the molecular level. The manipulation occurs at the level of fibers, or elements composed of many fibers. The new educational program is designed to provide wood-oriented students with a basic background in materials and engineering with emphasis on wood and polymers. The interrelationships of wood and various polymeric materials in the form of resins, adhesives, and overlays makes the coordinated study of wood and polymers a logical program for both industry and research oriented students.

Additional keywords: Education, materials science, wood technology, wood science.

INTRODUCTION

The study of wood, wood utilization, wood technology, and wood science traditionally has been almost exclusively under the jurisdiction of colleges of forestry or colleges of agriculture in United States universities. In contrast, the recently developed graduate program at Washington State University has been established in the College of Engineering under the Department of Materials Science and Engineering. Normally, such a department emphasizes metals, with some attention possibly being given to ceramics and polymers. In other words, "materials" has been used to cover man-made materials with little thought, or complete rejection, of materials of biological origin, such as wood. This approach is now gradually being altered to include wood, as wood technologists and scientists are beginning to participate in materials science programs.

The inclusion of wood as an integrated part of the Materials Science and Engineering curriculum at Washington State University has resulted from the conducive atmosphere established by a viable, industrial research organization of many years' standing in the College of Engineering. This research effort has been devoted to assisting the state of Washington, the region, the nation, and, indeed, the world in economic development, scientific advancement, and preservation of the environment. Faculty members working in the research areas of metallurgy, polymers, and wood technology were encouraged by the college dean to develop a new concept in materials engineering and to form a new department. From the outset the department chairman, the section heads of the various disciplines

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involved, and the associated faculty members were all willing to work together with open minds to bring into being this new educational concept. This paper will briefly review the historical development of this department and the concept of the educational endeavor.

GENESIS OF THE CONCEPT

In the late 1940s the legislature of the state of Washington established at Washington State University the Washington State Institute of Technology. The original organizational concept of the Institute of Technology was identical to that of many colleges of agriculture in which education, research, and extension are carried out in separate administrative units. In the case of the new Institute of Technology, these units were the College of Engineering, the Division of Industrial Research, and the Division of Industrial Services (Knight 1973). Faculty and staff of the Research Division were primarily involved in research and development. Some of them taught courses in their area of expertise when qualified instructors were not available on the regular teaching faculty. The primary emphasis of the program at first was to assist in the technical and economic development of the state of Washington. However, the economic community of this, as any other state, functions as a highly interdependent entity within a much larger sphere. Thus, this research and development program almost from the start provided services on a national and international scale and gained a world-wide reputation in the scientific disciplines involved.

A high percentage of the services rendered has been for industry, with the balance for various federal, state, and municipal government agencies. As a consequence of this close association, the scientists and engineers involved have been able to develop and maintain a strong sense of relevance to current problems.

The strength of the research and development program has been its ability to call upon many disciplines for solving a particular problem. Major departments are Mechanical Engineering, Electrical Engineering, Architecture, Civil and Environmental Engineering, Chemical Engineering, Agricultural Engineering, and Materials Science and Engineering. Within these departments are a number of research sections. Sections pertinent to materials science are as follows: metallurgy, polymers, wood technology, air pollution, radioisotopes, materials chemistry, structures, electronics, and design. As would be expected on any university campus, other departments, such as political science, economics, sociology, computer science, and business administration can be and have been involved in various research projects.

The Wood Technology Section, which was headed by George Marra for many years, developed strengths in several aspects of wood technology that have received international attention. These areas of specialization include particleboard and dry-process hardboard technology, adhesion, nondestructive testing, wood design engineering, and mechanical and physical properties of wood and wood composites.

During the same period of time, the materials chemistry, polymers, and metallurgy sections were also developing their programs and expertise as well as reputations in their particular disciplines. Thus, the time was right for an intermarrying of these various research groups into a new department that would continue the high level of research activity but would also develop a graduate program specifically designed to include, for the first time, a number of widely different materials in one curriculum. Emphasis was to be placed on establishing a common base within the department for all materials. The first discussions concerning this new development started in 1969.

DEPARTMENTAL PHILOSOPHY

As noted by Marra (1969, 1972a, b), the first problem that had to be solved was the definition of a "material." The general term, "materials science," had been established several decades ago in the eyes of metallurgists to cover metals or materials amen-

able to manipulation of their engineering properties at the molecular level. The problem in this discussion was that wood as a material has its molecular structure fixed by nature and therefore is presumably not amenable to such manipulation (Marra 1975).

While the properties of wood cannot be modified at the molecular level, the properties nevertheless have always been subject to some manipulation through such processing treatments as drying and impregnation. Surprisingly, nondestructive testing of lumber can be thought of as producing a "change" in the properties of wood in that its engineering values are changed from a generalized species average, to a precise value for each piece. Most importantly, whereas the properties of wood may not be manipulated, the properties of *wood materials* may be greatly changed through control of processing variables. In this respect, these wood materials are exactly comparable to other man-made materials such as metals, polymers, and concrete.

A number of years ago, Marra developed his nonperiodic table of wood elements in which he presents various elements such as cellulose fiber, fiber bundles, particles, flakes, veneer, lumber, and logs. By combining the basic wood elements he describes, it can be shown there are at least 3,000 reasonable ways to produce wood materials with widely differing properties. The development of particleboard and fiberboard is a case in point showing that indeed wood can be manipulated to yield products with varying properties. As Marra states, "This is manipulation of properties or synthesis, in every sense of the word except in the molecular sense, common to all other engineering materials. However, there are sufficient points of similarity to make the intellectual exercise practically identical in both cases" (1972a, b).

Another problem faced by wood in the context of materials science was the earlier abolition of processing as an area of concern for metallurgists in their own transformation to materials scientists. The wood people involved in developing this program were unwilling to yield in eliminating processing parameters from fundamental studies of properties in relation to composition. This particular viewpoint was later incorporated into the development of the curriculum in this new department.

It was recognized that there was a need to organize such a curriculum according to broad aspects rather than being based on narrow disciplines, as has been done many times previously. What is being developed is a coherent, all-embracing materials philosophy extending from the resource to processing, properties, environmental impacts, energy, consumption, recycling, and disposal. In other words, the entire picture is being looked at from an engineering viewpoint rather than just as small individual segments. Such an approach is felt to be the only one that can be taken in this modern age when all of the foregoing factors are becoming recognized by the world as important to survival. Materials must be used judiciously and must be conserved and used only where appropriate.

The COSMAT Committee of the National Academy of Science (1974) in its recent deliberations studied the educational needs of the country in the general field of materials. The Committee made two points in its opening statement: (1) Its scope would include materials of biological origin such as wood, and (2) processing is a part of materials science. These points agreed with the decision made in establishing the new department at Washington State University.

As noted by the National Commission on Materials Policy (1973), there is great concern about oil, coal, and ore reserves. They have been impressed with the easy inventory characteristics of our forests, comparatively speaking, and with its perpetual renewability. They have also been quick to appreciate that wood can substitute for many uses to which metals are now being put and that the latter should be conserved for the use of future generations in applications in which they are essential or uniquely superior. This statement is also in agreement with the new department's philosophy.

As Marra further stated, "Future com-

parisons with other materials will bring us a new source of pride in the fact that this biologically derived material is so versatile in its properties and uses. There are endless opportunities for research, both fundamental and applied, and endless challenges to synthesize new materials and develop new processes. All wood processes including particleboard, fiberboard, and plywood are begging for improvement and call for the best innovative talent available" (1972a, b).

THE EDUCATIONAL PROGRAM

The graduate program at Washington State University has been established to provide, first of all, basic backgrounds in materials and engineering. Students then concentrate on their chosen field of study which, for our discussion, would be the option established as Wood and Polymers. Polymers in the form of adhesives, resins, and overlays have long been associated with wood products. It is therefore logical that these two materials should be studied together in one curriculum because of their important interrelationships.

The graduate students are candidates for the degrees of Master of Science in Materials Science and Doctor of Philosophy in Engineering Science. Applicants are to have good undergraduate backgrounds in engineering sciences—mathematics, chemistry, physics—afforded by most engineering and wood science and technology undergraduate programs. Applicants admitted with engineering backgrounds may be required to complete some lower-level coursework in materials science to round out their backgrounds. Similarly, those coming from a wood science and technology program may need some lower-level engineering science courses, possibly in engineering mechanics and materials science.

Students work in conjunction with the faculty on research projects concerned with current scientific and industrial problems. These projects are in the aforementioned areas of particleboard and dry fiberboard technology, adhesion, nondestructive testing, wood design engineering, and mechanical ad physical properties research. Much of this research is designed for the purpose of relating fundamental science to applied needs in industry. This practical aspect is felt to be of benefit to the student, since there is great demand for individuals who have strong backgrounds in practical research and development, but have a good command of the latest innovations in the relevant sciences and technologies.

For those interested in wood and polymers, a number of courses of particular interest have been established, including polymeric materials, mechanics of solids, natural and synthetic polymeric materials, microstructure and properties of wood, basic principles of adhesion, reinforced polymer and wood-base composites, nondestructive testing of wood-based materials, parameters for synthesis of wood composition materials, and design of timber structures.

A number of graduate students attracted to this program are currently in residence. Several have come from developing countries. The enthusiastic response by those who have learned of this new concept in materials science and engineering, not only in the wood and polymers area but in the metallurgy area as well, has been a recognition of the fact that individuals possessing an excellent knowledge of many materials and how to use them efficiently are needed in the present engineering age.

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JOHN LAKE KEAYS (1913–1976)

Dr. Keays died suddenly on 29 March 1976. He was a Senior Scientist at the Western Forest Products Laboratory of the Canadian Forestry Service in Vancouver, BC, where he headed the active pulping group. As a well-traveled and well-read individual, he made many contributions not only to pulping of wood but also to complete tree utilization and economic aspects of forest utilization. His bibliography in these areas is extensive and valuable. He will long be remembered both locally and internationally for his interest in extending the frontiers of knowledge about fullest utilization of the total forest resource.

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