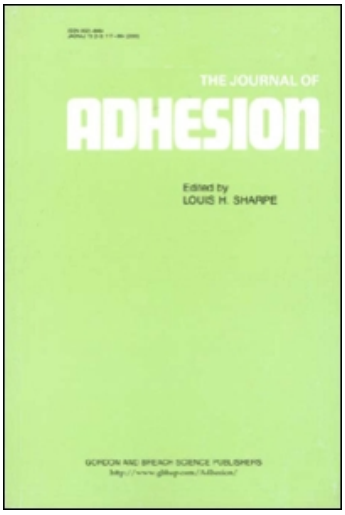

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The Role of Adhesives in the Improved Use of our Timber Resources

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The Role of Adhesives in the Improved Use of our Timber Resources

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Adhesives are extremely important to our wood products industry. Most of the wood products we use are reconstituted or bonded in some manner. Continual improvements in adhesives and adhesion science have led to an array of new wood products that have profoundly affected the management of our forest resources. A variety of particleboard products utilizes residues from the forest and primary processing plants, greatly extending our timber supply. Laminated structural members can be manufactured from smaller trees, thus permitting shorter rotations and better forest management. These are but a few examples of the technical advances in wood use made possible by adhesives. Future improvement in wood use will require a continued strong RD&A program in adhesives and bonding systems.

Key Words: Adhesives, Forest Resources, Timber Resources, Laminated Products, Research Needs, Wood Products.

INTRODUCTION

George Marra, in his keynote address at the "Wood Adhesives—Research Application, and Needs" Symposium held in Madison in 1980, noted that perhaps 70 percent or more of all wood materials

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in use today depend on adhesion. Because the wood-based industry represents 4 percent of the U.S. Gross National Product, providing 1 of 25 jobs, and because it supplies daily necessities for each of us, I find George Marra's statement a most appropriate beginning for this paper. Adhesives have promoted the efficient use of wood, improved forest resource management, and contributed greatly to industrial expansion. Here I would like to provide a perspective on 1) the importance of adhesives to good resource management, 2) possible areas for the expanded use in wood products, (3) important problems and opportunities involved in the increased use of adhesives and wood composites, 4) the research role of the Forest Service, universities, and industry, and (5) future research and development needs.

IMPORTANCE OF ADHESIVES TO GOOD RESOURCE MANAGEMENT

The modern age of wood bonding began around 1920 with the emerging need for reliable aircraft parts. Since then, theories of adhesion have been expanded, new adhesives developed, many new applications identified, and new industrial operations founded. The bonding of wood into composites such as plywood, particleboard, structural laminated beams, and fiberboard changed the patterns of wood use. Laminated beams replaced large solid wood timbers, plywood and particleboard replaced lumber for sheathing, and now structural flakeboard is supplementing plywood and other particleboard in a variety of applications. These changing use patterns have had tremendous impact on our wood resources and to some extent on how we manage our forests. Plywood production permits more complete use of each log and thus saves on the amount of wood harvested for housing and other construction. Laminated beams permit the use of smaller diameter logs for heavy construction applications. Medium-density fiberboard and industrial particleboard extend timber supplies by making more complete use of mill residues.

The developing sciences of adhesion and adhesives continue to be important factors in expanding the use of our wood base. For example, establishment and growth of the plywood industry in the South required development of bonding systems specifically for southern pines. Today about 40 percent of our softwood plywood

production comes from southern pine. The result has been many new options for managing our southern forest lands.

There is some uncertainty as to whether the plywood industry will continue to grow, but we are certain that the panel products industry will. The projected frontrunners in panel products are structural flakeboard and medium-density fiberboard. Structural flakeboard is particularly interesting in terms of exploring growth of an industry. The structural flakeboard industry started early in 1950 when a waferboard plant was built in Idaho.[1] It was not until the 1960's and 1970's that this industry began to expand with plants built in Canada. During the 70's, research efforts expanded in universities, Federal laboratories, and in industry to improve the forming and bonding of flakeboard. Results of much of this effort were summarized at the Structural Flakeboard Symposium in 1978.[2] The structural flakeboard industry is now growing rapidly. While there was only one flakeboard plant in the United States in 1978, there are 15 operating today and plans for 5 more have been announced.

This "new" product, made possible by adhesives, is providing forest management options that foster wise use of our timber resources. Nearly all structural flakeboard is now made from low-density hardwoods—primarily aspen. However, research has been successful in producing structural flakeboard panels from mixed hardwoods. This development, made possible by a great deal of successful adhesives research, should be extremely important for future management of our hardwoods. Currently, we find use for less than one-half of our hardwood resource. Structural flakeboard or oriented strandboard can be made from the low-grade and smaller hardwoods that should be utilized in preparing for more intensive forest management.

Although the amount of lumber used for glued laminated timber is rather small in terms of total volume of wood used, the process has permitted the economic use of logs from smaller trees. Likewise, the current emphasis toward fabricated cross-sections such as glued and sawn panels, I-beams, and parallel-laminated timbers will reduce the demand for larger sized lumber and logs. As such, these products will have continued importance as the rotation age of our forests and average tree diameter decrease. For many of these products, we need to focus our research efforts on less expensive bonding systems including improved cold setting and RF cure adhesives.

The expanded use of wood composites offers one of the best options for more efficient use of our wood resource and improved manage-

ment of our forests. Such development, however, requires attention to several technical and economic issues.

EXPANDED USE OF WOOD COMPOSITES

As indicated earlier, we expect the use of structural flakeboard and other composite panels to expand in North America. The impetus is a growing population and related demands for housing. While non-panel wood composite products are extremely important to our economy, panels remain the primary composite products used in the housing industries.

The combined production of plywood and board products was 25.1 billion square feet (3/8-in. basis) in 1970, 32.5 in 1976, and is projected to be about 50 billion square feet in 1990.[3] Whether the projected production of these products will be reached depends on several factors. Certainly, a continued emphasis on research and development is essential if we are to avoid substitutes by other materials for these traditional products. We have to identify and address the problems and opportunities (challenges) surrounding the future use of adhesives in wood products.

Problems and Opportunities

Probably the most important problems we face are product quality and life-cycle performance. Because product and structural design is becoming more sophisticated, we must be able to compete more vigorously with other materials available to the marketplace.

There are many aspects to this problem that require the attention of researchers, manufacturers, and raw material suppliers. For example, we need to "incorporate" wood products into modern-day reliability-based design standards. These design procedures are commonly used by engineers and architects for steel and concrete. To date, the acceptable design technologies and material property input data have not been sufficiently developed for wood products. We see more activity in this area through the American Society for Civil Engineers Committee on Wood. Certainly reliable data on immediate and long-term performance on panel products are important considerations in this issue. It is in our collective interest to accelerate our efforts

to obtain these engineering and performance data for a variety of composite products.

Dimensional stability is another problem that should receive special attention. This is of particular concern for flakeboards used for exterior applications or in areas of high relative humidity. Approaches include improved adhesives, new methods for applying adhesives, or development of new adhesive-curing technology.

Another current and critical concern is formaldehyde emission from UF-bonded wood products. We must continue to evaluate potential and time-dependent limits of formaldehyde toxicity and identify control mechanisms or procedures. We need to learn more about the benefits of formaldehyde use and how to minimize any ill effects it may have. Considerable progress has been made by industry in reducing board emissions, and further improvements should result from on-going research. Certainly there will be continued public interest and pressure to evaluate the environmental consequences of our production processes and products. This is a legitimate public posture that researchers and manufacturers should respond to in quantitative terms.

In addition, a continued effort is needed to find new and even more effective adhesives. This includes adhesives more tolerant of mixed species and of difficult-to-glue hardwood such as oaks. We also have to improve the efficiency of resin use through the development of improved application methods and adhesive formulations.

Several approaches are underway to develop adhesives from renewable resources. The impetus for these efforts stems from the impending long-term shortages of petroleum. But also, it makes good sense to utilize more of the renewable resources such as bark, lignin, tannins, and agricultural residues and other byproducts which currently are produced in large volumes but find limited use—other than for fuel.

There is not only a need to formulate new adhesives but also to find new uses for all adhesives. In the Clarke Heritage teaching module on adhesives, Alan Marra[4] pointed out three general categories of adhesive use: 1) Bonding of initial wood elements (*e.g.* flakes, fiber), 2) bonding of primary products (*e.g.* panels, laminated beams, structural members), and 3) assembly of primary and/or secondary bonded products into structures. There are several opportunities for research and development in the last two categories. One example is in panelized or modular homes. This application is not new, but there appears to be considerable opportunity for expanded production

capacity in factory-built dwellings. It is also a market area where competition will develop from other countries. A recent article in Manufactured Housing discussed importation to the United States of factory built homes from Sweden.[5] Incidentally, 70 percent of the homes built in Sweden are now factory built. Another recent article in Automation in Housing and Manufactured Home Dealer, June 1984, gave warning that the Japanese factory home producers now are 8 to 10 years ahead of the United States in technology and marketing. This is truly a problem and opportunity that should be addressed.

THE ROLE OF FOREST SERVICE RESEARCH

Now I would like to briefly provide my view on the role that the Forest Service should play in the improved use of adhesives. My purpose is to identify, for future discussion with our research partners and users, those research boundaries that I feel the Forest Service should consider in its planning efforts.

First, we have two broad goals that are important: 1) Forest Service research should contribute to the improved management of our Nation's timber resource and 2) the results of the research should contribute to our Nation's economic and social needs. These broad goals apply for both in-house and extramurally funded research. Further, we have implied and directed guidelines not to duplicate or undertake research most appropriately performed by private industry. Generally, this implies that we should concentrate on basic research. However, it is appropriate, I believe, to conduct applied research to complete essential knowledge links between basic research and application. This is particularly important since we have a strong commitment to technology transfer.

We need to succeed in moving innovations from the laboratory to the marketplace. This requires interaction between Federal laboratories, universities, and industry. In the early stages of research we need to share knowledge and ideas. During the technology transfer phase, we need even stronger interaction—particularly with industry. We must continue to discuss research goals and identify RD&A needs.

A FRAMEWORK FOR THE FUTURE—RESEARCH NEEDS

The future direction of RD&A in adhesives has been identified in many workshops, meetings, seminars, and symposiums. We are all aware of the proposed direction, but a brief summary may be useful as we exchange information and viewpoint over the next few days:

1) We must continue our search for more effective and efficient adhesives—including those from renewable resources.
2) We must target applications for specific types and formulations of adhesives and evaluate their life cycle effectiveness.
3) We must aggressively identify potential environmental problems that might occur with the use of new adhesives systems, and we must provide environmentally acceptable processes.
4) We must undertake basic studies at the molecular level on bonding phenomena and durability.
5) We must develop accelerated procedures to determine the long-term performance of adhesives.
6) We must develop new methods and procedures to characterize the performance of primary, secondary, and tertiary bonded materials and structures.
7) We must obtain reliability based design criteria on composite wood products to make them more competitive with solid wood and other engineering materials.
8) We must more clearly employ a materials sciences approach to forming and using composite wood products.

These are a few of many areas of adhesives related work that we need to implement in the future.

CONCLUSIONS

Adhesives have played a major role in the development of the wood products industry. They have permitted the use of smaller diameter trees and residues from both the forest and mill. Currently, less than 5 percent of the logs delivered to the mill are left unused. Bonded composite products are one of the primary reasons for this high level of utilization.

As we look to the future, we must identify and work on the

most important problems and opportunities. We have to work together and determine our individual roles. For example, at the Federal level we may be limited in how far we carry our work in the RD&A continuum, yet we must assure technology transfer. When research results predict commercial opportunities, we need to accelerate industry's involvement.

I have outlined my views of the most important areas of research and development for our pursuit. They're important not only for improving economic opportunities, but also for increasing the level of wood utilization. Public concern over the management of our forest resources will increase in the future. As in the past, I expect that the continued improvements and new developments in bonded wood products will provide opportunities to meet this concern through improved forest management.

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