United States
Department of
Agriculture

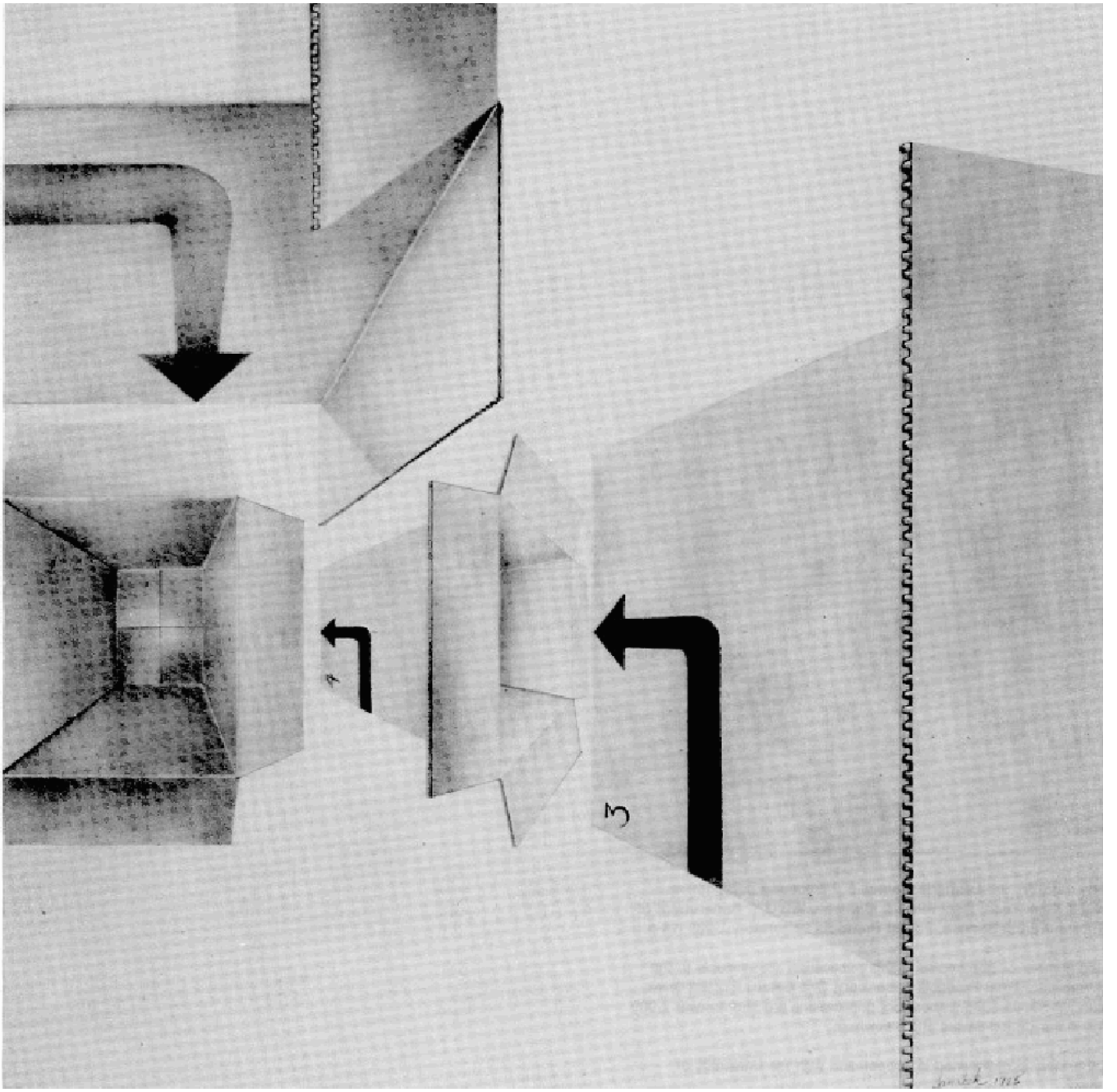
Forest Service

Forest
Products
Laboratory

General
Technical
Report
FPL-51

Packaging Perspective

1910-1985



Abstract

For 75 years the Forest Products Laboratory has been concerned for the wise use of wood. One of the major uses of wood is packaging. This report summarizes the research reports completed in packaging and relates the output in terms of forest management and return on the taxpayer's investment.

Keywords: Packaging, paperboard, pallets, corrugated fiberboard, crates, wood boxes, recycle, barrels, fasteners, cushioning, performance testing.

December 1985

Koning, John W., Jr.; Laundrie, James F. Packaging perspective: 1910-1985. Gen. Tech. Rep. FPL-51. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1985. 13 p.

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Packaging Perspective
1910-1985

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Introduction

Maybe the world's first package was a dry gourd used to carry water. This container was later supplemented by skin bags, earthen jars, alabaster vases, wooden casks, metal drums, glass bottles, plastic containers, and finally paper composites. Interestingly, most of these are still used somewhere in the world today.

Why do we think packaging important? Because its purpose is to distribute the essentials of life to the people of the world, safely, and efficiently.

To cover the field of packaging fully, we should discuss all the materials mentioned above; however, this paper is limited to consideration of wood and wood-based materials. We attempt, on the occasion of the 75th Anniversary of the Forest Products Laboratory (FPL), to summarize FPL research accomplished in this field.

We might have made our summary chronological, reciting the numerous accomplishments of successive historical periods from pre-World War I to post- World War II, or by decades, from the 1920's and 1930's through to the 1980's. Instead, we have decided to discuss packaging in terms of its impact on forest management and return on investment for the American taxpayer.

Forest Management

Packaging and packaging-related products make up one of the largest outlets for wood, and often utilize the poorest quality material from the forest. The latter point is significant because a key to good forest management is to find an economic outlet for poor-quality materials. As a direct result of packaging research, forest managers have been provided with a variety of options, as a few examples will show.

Most products in the United States used to be shipped in prime softwood, nailed, wood containers, until it was shown, largely by FPL research, that most hardwood species do just as well if properly used. The classification of wood according to its nailability and other properties, and the application of sound engineering principles are discussed in FPL Report 2129 entitled "Nailed and Lock-Corner Wood Boxes." Thus, a vast quantity of wood of hardwood species and lower quality became usable and acquired value because packaging provided outlets.

Major changes in packaging have been made for shipping fresh fruits and vegetables. Fifteen or twenty years ago, a large percentage of produce was shipped in wood boxes, baskets, or wirebound containers. With the advent of better adhesives, coatings, and container design, most produce marketed today, be it as small as grapes or as large as melons, is shipped in corrugated fiberboard containers.

Research changed crate design from an art to a science. New and efficient wood-crate fasteners and design principles are set forth in the "Wood Crate Design Manual" by Anderson and Heebink (1964). This manual is still the major source of information for crate design. Again, the emphasis is on the variety of wood species that may be used, thus providing economic outlets for a wide variety of wood species, which in turn makes good forest management possible.

Return on the Taxpayer's Investment

More low-grade hardwood is used in pallets than in any other single wood product. Pallets conveniently unitize products for efficient handling, shipment, and distribution from the manufacturer to the consumer, and thus are an integral part of packaging. They allow more efficient handling by mechanized equipment and reduce loss and damage resulting from the more severe manual handling. Recent research in this area is being summarized in a report on unitizing by Laundrie.

The impact panel is a creative idea developed by Stern. Damage to the leading edge deckboards of wood pallets is a common problem when using conventional equipment. The impact panel is a simple attachment for forklift trucks that significantly reduces such damage.

When an item to be shipped is sensitive to shock or impact, proper cushioning in transit is essential. Yet the packaging of such items in the past, and even sometimes today, has been left to chance. Wrapped in newspaper and packed in a box, the item many times may arrive safely; but many times it is damaged and the consumer suffers. Research by Stern and Jordan resulted in the development of cushioning design curves for various materials. Their results are incorporated in MIL HDBK 304, "Package Cushioning Design," and a series of reports, which form the basis for selecting the proper cushioning material to prevent shock damage.

Corrugated fiberboard, the single major packaging material, is used in over 90 percent of all packages shipped. Sometimes erroneously referred to as cardboard, corrugated fiberboard is a high stiffness-to-weight sandwich material, has low cost, and is recyclable. It has received much research emphasis, as indicated by the numerous FPL research reports listed at the end of this report as "75 Years of Dividends."

One of the most exciting developments in packaging in the last 75 years has been the development of ASTM D 41 69—Standard Practice for Performance Testing of Shipping Containers and Systems. With a knowledge of the shipping environment as reported in FPL 22 by Ostrem and Godshall and the development of TAPPI and ASTM test methods, we can now evaluate a product and package under simulated shipping conditions. This approach allows us to determine the minimum packaging required to ship the product successfully from manufacturer to consumer. By packaging all products efficiently, we are able to minimize the use of fiber and extend the timber supply.

In all these examples the overriding objectives have been: (1) To broaden the wood base that can be used in packaging, both in terms of species and quality, (2) to minimize the amount of fiber used, thus extending the timber supply, and (3) to optimize fiber use to provide proper protection to the product.

The research has been successful in terms of these objectives and, in turn, has created thousands of jobs and contributed to the high standard of living in the United States.

The total investment in FPL research, over a 75-year period, was about $250 million. Only a fraction of this went to packaging research, but the dividends from the packaging research alone are considered in this analysis.

It has been estimated that because of efficient packaging design developed at the Forest Products Laboratory, packaging volume was reduced both in World War I and in World War II to an extent equivalent to reducing from five to four the number of ships carrying the same amount of material across the ocean. The cost savings have been estimated at over $50 million, while the saving of lives by delivery of usable equipment at the front is incalculable.

The savings on crates during World War II were over 58 million board feet of lumber, estimated to be worth $14 million.

During the 1960's some of the FPL packaging research was integrated into a cost manual for the military. Using this cost manual, the military reported savings of over $100,000 in packaging costs in a single contract. Allowing for a modest average savings of no more than $1,000 per contract, the estimated overall savings for the thousands of military contracts exceeds $10 million per year.

The cost of raw material to the paper industry has been significantly reduced by the ability to substitute low-grade hardwoods for softwoods in the papermaking process. The resulting continued low cost for packaging materials is a return on investment for the taxpayer, helping to hold down the cost of food, clothing, and other essentials of life. The estimated savings achieved by adopting the results only of the press drying research with hardwoods exceed $360 million per year.

Potentially, the most dramatic return on investment comes from application of ASTM D 4169—Standard Practice for Performance Testing of Shipping Containers and Systems. Because company profits are involved, few figures have been published or can be expected. However, it is known that one company saved over $100,000 in its packing costs for a single item—and the company makes over 600 items. Another company reported a reduction of over 30 percent in damage to its products, and dollar savings exceeding $700,000 per year.

Thus, although we can give no exact dollar figure for return on taxpayer's investment, clearly the dividends from packaging research alone have far exceeded the total investment in the Forest Products Laboratory.

The information gained from all this reseach has been made available to the public. The list of publications at the end of this report represents "75 Years of Dividends."

Future

What can we say about the future of packaging with wood-based materials? We see a bright future, yet great challenges remain. For example, although we now have a performance standard for shipping containers, it is far from perfect.

Performance standards are required for the whole field of shipping hazardous wastes.

Although we have the means to produce sufficient food to feed the world, we lack the means to distribute it efficiently to the world. Packaging is one of the keys to the successful accomplishment of this major challenge.

Our testing and evaluation of packaging material has been limited to constant conditions of temperature and humidity, whereas in the real world conditions fluctuate. The importance of these fluctuations has recently been recognized and the consequences are now being studied. The results of current research will have to be integrated into the performance standard.

Although much has been written about stacking strength of corrugated containers, we still cannot satisfactorily relate the engineering properties of the paperboard components to the long-term stacking strength of the container in the warehouse, and so make optimal use of fiber.

Although we have a lot of information on packaging, we lack a model to integrate the information to provide the most efficient package to do the job.

The negative effect of scorelines on box compression is not fully quantified nor understood, and we are challenged either to eliminate the effect or to develop a new material that is not damaged by scoring.

We need to increase the use of recycled fiber, to remove contaminants from recycled fibers and to restore their bonding potential.

Corrugated fiberboard suffers deleterious effects from moisture. The sensitivity of paper to moisture has been successfully reduced by coatings and chemical treatments, but the effect is short term. We need an economical way to make paper rigid and dimensionally stable when wet and still able to be scored and folded when dry. The development of such a process is one of the greatest challenges we face.

Conclusion

The past 75 years have yielded many dividends but much remains to be done. With continued success we will extend our timber supply by more efficient use of wood and recycled fiber, provide outlets to use more underutilized wood species and thus give forest managers more options. The further use of fiber products with high performance per unit weight and cost is still the key to the future utilization of wood. The taxpayers have received a high dividend on their investment in packaging. The future is bright and the challenges are great. What is needed is a continued high level of support for continued fundamental and applied research in packaging.

75 Years of Dividends

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The Forest Products Laboratory (USDA Forest Service) has served as the national center for wood utilization research since 1910. The Laboratory, on the University of Wisconsin-Madison campus, has achieved worldwide recognition for its contribution to the knowledge and better use of wood.

Early research at the Laboratory helped establish U.S. industries that produce pulp and paper, lumber, structural beams, plywood, particleboard and wood furniture, and other wood products. Studies now in progress provide a basis for more effective management and use of our timber resource by answering critical questions on its basic characteristics and on its conversion for use in a variety of consumer applications.

Unanswered questions remain and new ones will arise because of changes in the timber resource and increased use of wood products. As we approach the 21st Century, scientists at the Forest Products Laboratory will continue to meet the challenge posed by these questions.