Technological Advances Making Plastic Pallets More Attractive

But Wood Will Continue to Dominate the Pallet Market, Says Pallet Lab Director

Technological advances are making plastic pallets more attractive, but their share of the market likely always will be less than wood, according to Dr. Marshall (Mark) White, director of the Virginia Tech pallet and container research laboratory.

Composites - hybrids between plastic and some other material, such as wood - may hold the most promise for pallet design and manufacturing in the future, he suggested.

Plastic pallets comprise a subject "near and dear to your hearts," Mark told members of the Canadian Wooden Pallet and Container Association earlier this year. They have received a lot of attention recently in the media, Mark noted. They are of interest to pallet supplier customers "and they should be of interest to you."

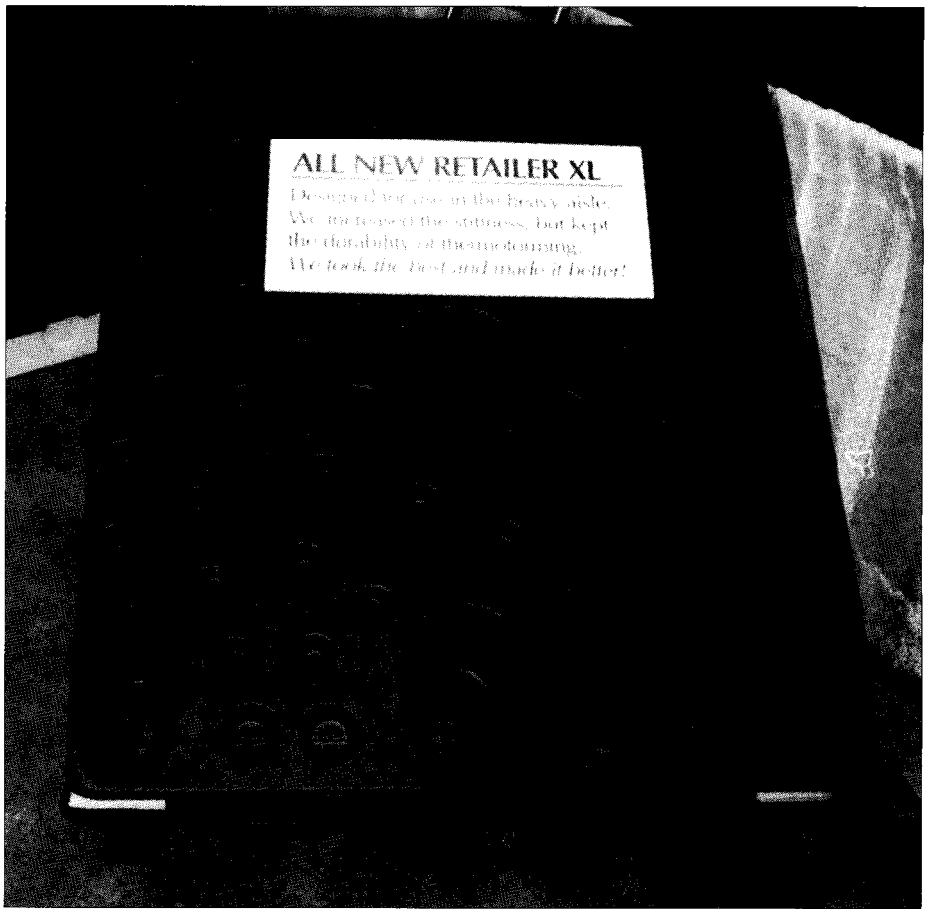
The purpose of his address to the CWPCA was to give the audience a better understanding of the current market for plastic pallets in North America, although the underlying data was based on market conditions in the U.S.

Pallet manufacturers should consider adding plastic pallets to their product line or mix, he suggested. "You should think about that." Whether you ultimately choose to sell plastic pallets or to market against them, it is "to your advantage to know more about them," he said.

Plastic pallets typically are used in managed pools or captive environments because they are priced much higher than wood. Tracking them is extremely important to prevent and reduce losses.

Plastic pallets have been in use since the 1960s. Historically they have been used in certain applications to ensure sanitation. Campbell Soup Co. was one of the first users of plastic pallets, which provided the shipping base for raw produce.

In the 1990s however, plastic pallets have moved beyond the niche for applications where sanitation is an important factor. The reason: users have recognized their economic and environmental benefits. "You and I have known this for years," noted Mark. "A more durable, reusable pallet in a managed program, such as the Canadian Pallet Council program and Chep's pool, are economically and environmentally sound."



Twin-sheet thermoform plastic pallets have been popular recently in the retail world. This Cadillac Retailer XL is used to ship downstream from grocery distribution centers to stores.

There also have been significant improvements in the material, design and manufacture of plastic pallets --- improvements that have lowered prices and made them more competitive. The result has been an opening up of new markets for plastic pallets.

U.S. industries that have used plastic pallets include automotive, dry grocery and produce, meat packing, beverage container, pharmaceuticals, and the U.S. Postal Service. They also have gained popularity as order-picking pallets and captive pallets.

Plastic pallets represent only about 3% or 4% of the overall pallet market. Estimates provided by Chep put plastic pallet production at about 3.5 million units in 1995 and 12 million in 1998, when the U.S. Forest Service estimated 420 million wood pallets were manufactured. Plastic pallet manufacturers are highly competitive and secretive about production figures. The Chep estimates are based in part on the known press capacity of large tools that make plastic pallets and information that leaks into the public domain about high volume contracts and sales.

The predominant plastic used to make pallets is a thermoplastic resin, which softens when energy is added. Thermoplastic resins include polyethylenes, polypropylenes, polyvinyls, polynylon,

polyesters, polycarbonate, and engineered themoplastics. The thermoplastic group of resins is less expensive, easier to process and to recycle, and is more resistant to shock and impact than thermosetting resins. In North America, the principal thermoplastic raw material in plastic pallets is polyethylene. (The dominant type in Europe is polypropylene.)

Of the various polyethylenes, high-density ones -whose properties may be changed dramatically by modifications - are most common in pallets. Some 11 billion pounds of polyethylene were produced in 1998 by petroleum companies. About 2% or 3% of the total polyethylene that was produced went into the production of plastic pallets.

Most plastics are extremely strong but are less stiff than wood. "Low stiffness may limit the load-carrying capacity of plastic," Mark noted. For that reason, they were usually not used in free-span racking. However, recently many plastic pallet manufacturers are turning to reinforcements to meet stiffness requirements. A Chep prototype, for example, has small I-beams imbedded in the polyethylene bottom deck; the I-beams are made of a different resin.

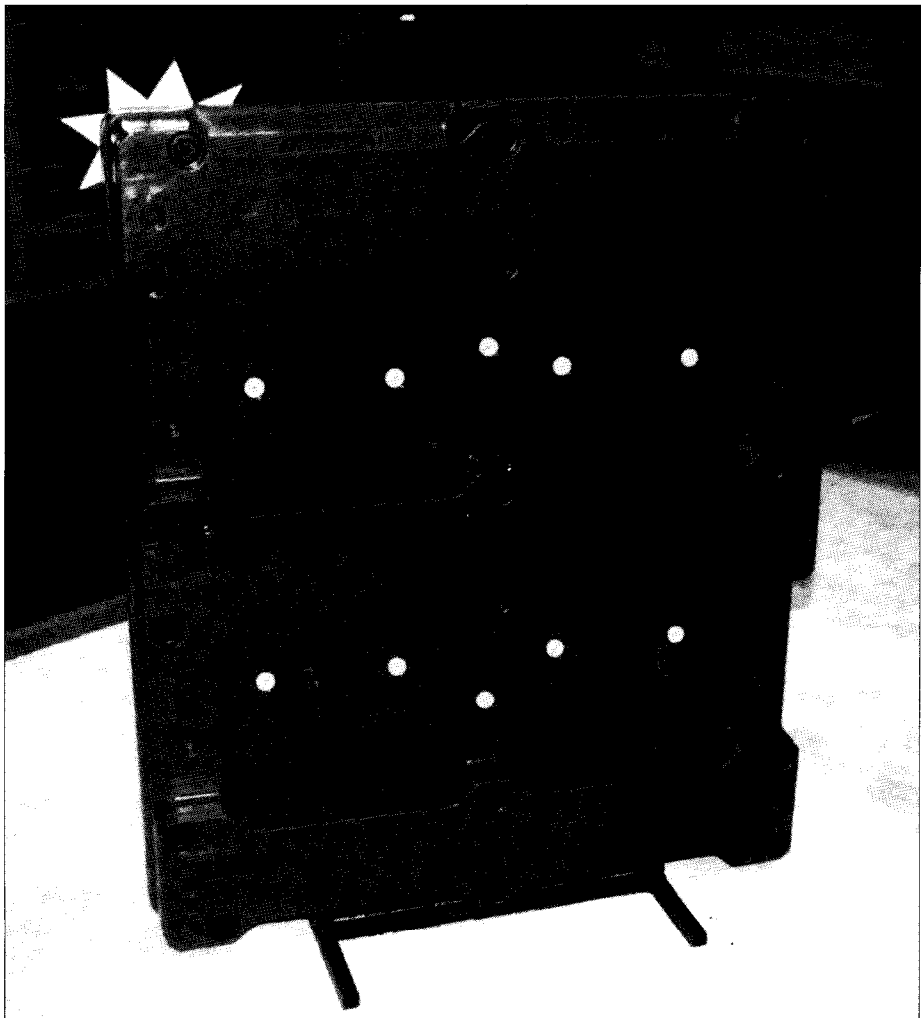
"Here's the problem," he explained. "In order for a plastic pallet, which costs more to purchase, to compete in the market place on a cost-per-use basis...it has to be more durable. To make something more durable, it has to resist shock and impact. But when you take a material and make it more impact resistant, you are going to sacrifice stiffness because those two properties are in opposition to one another. To make something more shock resistant, you make it less stiff. To make something stiffer, you're going to lose shock resistance. Plastic...is more shock resistant than wood, but it is less stiff."

"The solution for this particular problem...will be composites or reinforcing techniques," Mark suggested. Experiments are underway on many composite materials. An ideal composite would contain material that is very resistant to impact and a second material for stiffness, Mark suggested; the latter may be provided by glass, carbon or wood fibers. "And now we have that beautiful marriage between two different materials to achieve an all-around, better pallet material with both characteristics." It will still be some time before a high-performance composite is developed, he indicated. Scientists have improved stiffness somewhat but not dramatically; in the future, technology may allow greater advances in stiffness.

Reinforcements make plastic pallets even more expensive. In addition, recycling of plastic pallets with reinforcements requires separating materials, which is somewhat difficult.

There are several plastic pallet manufacturing processes: thermoforming, injection molding, structural foam molding, blow molding, compression molding, rotational molding and profile extrusion.

In thermoforming, one or two sheets of polyethylene are heated and put into a mold under a vacuum or pressure to finish the molding process. The resulting pallets are very durable but not as stiff as other types of molded pallets without reinforcement. Another drawback is that they are hollow: forklift tines may pierce the pallet, allowing water or other contaminants to accumulate and perhaps create unsanitary conditions. Thermoform plastic pallets are used by the U.S. Postal Service and are popular with grocery dis-



Heavy-duty plastic pallets are addressing issues of concern. Breakaway fasteners allow the bottom boards to be replaced, and plastic grommets provide friction to keep the pallet from slipping on fork tines.

tributors for retail. A common thermoform plastic pallet is light-weight, neither rackable nor stackable, has no bottom deck, can handle light to moderate loads, and is fully nestable - an attractive feature for retailers.

Injection molding uses high pressure to produce a high quality pallet rapidly. However, there is a huge difference in the cost of tools. A machine used for thermoforming costs about $60,000 to $80,000; a high-pressure injection molding tool costs about $400,000 or more.

Structural foam molding, one of the most common types of manufacturing plastic pallets, is similar to injection molding except that a gas is added to the resin during the process. The gas expands in the mold, forcing the resin against the surfaces. The process requires less pressure and the tools are not as costly as injection molding. Structural foam molding produces a pallet that is lower in density, light-weight, stronger and stiffer.

Blow-molded pallets bear a resemblance to twin-sheet thermoform pallets although the process is different. A small amount of resin in a 'preform' essentially is blown up like bubble gum. The process is used to make such plastic products as milk bottles, but historically it has been difficult to harness the technology to make something large, like a pallet. Blow-molded pallets have properties similar to twin-sheet thermoform pallets but cost about 10% to 12% less.

In compression molding, a mold is filled with resin, and the male and female halves of the mold are pressed together. Unlike some of the other processes, compression molding will tolerate greater differences or impurities in resins.

Rotational molding makes use of centrifugal force. Tools are very inexpensive - some molds cost less than $1,000 - but the resulting pallets are crude in appearance and have rough surfaces. Cycle time also is long - 20 minutes or more. Few pallets are made with this process.

Profile extrusion is the method used to make so-called plastic lumber, which has enjoyed significant growth as an industry in recent years. The process is less sensitive to raw material purity than some other methods, and results in a product that has some of the same advantages of lumber: it can be cut to size, allowing manufacturers to switch rapidly from one pallet size to another, and can be assembled with a variety of fasteners.

Another advantage of the extrusion process is that it can produce profiles of different shapes and designs that are more efficient from an engineering point of view - such as I-beam or rectangular. Different material designs and shapes can reduce pallet weight yet allow for a strong, stiff, pallet.

Extruded parts can be assembled with screws, nails and bolts. Ring-shank nails work best. They also may be glued or "welded" together. Parts can either be "welded" by high frequency vibration or heat, producing excellent joints and connections.

The cycle times of the various plastic pallet manufacturing methods range from a low of 2 minutes for injection molding and 2 to 3 minutes for compression molding to 6 or 7 minutes for twin-sheet thermoforming.

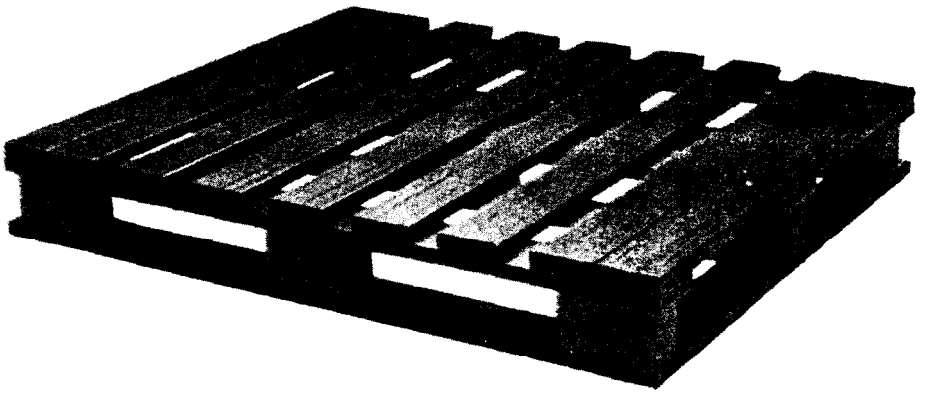
Most plastic pallets are made of virgin resins because the tools and manufacturing processes are sensitive to property variation. Profile extrusions are an exception; they can accommodate a high percentage of recycled plastic material - industrial grade or post-consumer grade.

An intrinsic advantage of molded pallets is that they have fewer components and joints. Since most pallets, plastic or wood, fail at joints, the fewer the better. At the same time, it is a disadvantage to repairing because a molded pallet contains fewer components. Rib structures can improve the performance and reduce the weight of molded pallets. Some plastic pallets have components that snap or lock together. Generally, however, the pallet will be weakest at the point of the snap fit.

Another problem with some plastics is that they can be slippery. "Let's face it," said Mark. "In material handling, when a

pallet slips on a fork tine, that's not good." The plastics industry has responded to this particular challenge, however, by developing techniques to make surfaces more slip resistant. For example, some companies emboss plastic lumber or sprinkle a denser plastic onto the surface to give it a roughness that improves slip resistance. Mechanically roughening the surface can increase the slip resistance of corrugated packaging on the pallet but may make the pallet more slippery with respect to the forklift tines. Rubber compounds melted and sprayed onto the surface also have proven successful in improving slip resistance, as well as the use of rubber grommets inserted into the deck.

Another issue for the plastics industry has been fire hazard. The U.S. has very specific regulations governing fire performance in warehouse environments, Mark observed. Plastic pallets are classified differently than wood pallets for insurance purposes, and their use may entail higher insurance premiums and additional investments in fire suppression systems. However, the plastics industry is beginning to address this issue, too, in order to achieve the same classification as wood. Some plastic pallets are being made with tire retardants, Mark noted - another instance where a challenge has been met successfully by technology.



One of many styles ofplastic lumber pallets. Different fastening styles include nails and various kinds of bolts. Plastic lumber can be extruded and can use recycled plastics.

Although plastic pallets are a "fantastic product," they are not going to replace wood pallets, Mark suggested. One reason is because they primarily compete in the reusable segment of the pallet market, which, in the U.S., represents only about half the market - the other half being expendable pallets. Another limiting factor, he said, is that plastic pallet production is at 100% of the capacity of the manufacturing presses and tools. Bringing a new tool on line takes about a year. he indicated.

Another limiting factor clearly has been cost. Wood is less expensive. In a finished pallet. the cost of material is about 15 cents per pound for wood and about $1 per pound for plastic, according to Mark.