“Meeting Sustainability Goals and Environmental Mandates Using Thermoformed Packaging”

by Michael Brown

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Summary

Biography:
Michael Brown has 20 years experience in the thermoformed packaging industry as Vice President of Sales and Marketing for Ivex Packaging Corporation and Crystal Thermoplastics Inc. His company, Packaging 2.0, assembles strategic partners to provide front-end design services, manufacturing and global logistics for delivery of innovative packaging products including GeoSpring® thermoformed fragility packaging. As an established expert in innovative packaging and a member of the Sustainable Packaging Coalition, he has provided the leadership to take a number of visionary packaging concepts from planning to successful execution.
Abstract
Today's growing need for environmentally friendly packaging designs and materials is being driven by an increasing number of global packaging standards, mandates and take back fees. Increasingly, corporations are responding by meeting or exceeding these requirements through internal environmental stewardship and “design for environment“ policies. These external pressures, along with ongoing internal cost reduction efforts, have lead to the development of a number of next generation thermoformed packaging products and services for the consumer electronics industry. These developments have been applied to a variety of products at different points in the value chain, but they share some common environmental benefits:

- Decreased per unit packaging costs
- Reduced consumption of packaging materials
- Reduced freight and storage costs for inbound materials
- Increased pallet density for outbound product
- Environmentally friendly materials

This paper details current and future global environmental regulations, explores sustainability and highlights in detail examples of recent break-through developments in thermoformed plastic packaging.

Sustainability Defined
In the packaging industry the term sustainability is most often associated with some form of recycling or recycled material. However traditional recycling usually results in some form of degradation to the environment or the materials being recycled. In fact, most recycling is actually down-cycling as materials are reused in less valuable applications in each cycle. For a product and process to be sustainable the materials would have to be same-cycled into a product of equal value or up-cycled into a product of higher value; while the process would either have no impact on the environment or improve it.

A paper entitled Towards Sustainable Packaging presented recently by The Sustainable Packaging Alliance discusses the characterization and definition of sustainable packaging as follows:

The term “sustainable development” entered the public debate after the World Commission on Environment and Development published their landmark report, Our Common Future, in 1987. It was defined in this report (the Brundland Definition) as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” Our Common Future identified a series of social and ecological challenges that required a global response, including unsustainable patterns of industrial development. The report recommended:

In general, industries and industrial operations should be encouraged that are more efficient in terms of resource use, that generate less pollution and waste, that are based on the use of renewable rather than non-renewable resources, and that minimize irreversible adverse impacts on human health and the environment.  

The authors of Natural Capitalism identify four strategies to protect and enhance the earth’s natural capital (resources and living systems) on which the health and prosperity of humankind depends. They argue for a new industrial system that values natural capital as well as human, manufactured and financial capital. The four proposed strategies are:
• Radical resource productivity – using resources more efficiently to reduce depletion of resources, reduce pollution and lower costs.
• Biomimicry – redesigning industrial systems along biological lines, i.e. reducing the throughput of materials and eliminating the idea of waste by enabling the reuse of materials in closed cycles.
• Service and flow economy – changing the relationship between producers and consumers by focusing on the supply of services rather than products.
• Investing in natural capital – working towards restoration of the earth by investing in sustaining, restoring and expanding natural capital. 2

Sustainability Applied to Packaging
The authors of Cradle to Cradle; Remaking the Way We make Things challenge the traditional practice of designing to the lowest cost for a one way “cradle to grave” trip out of the factory3. Their vision is a world where we use more packaging, not less, a world where packaging cycles endlessly in either technical or biological nutrient streams; where eco-efficient packaging is designed to be an asset after use, not a liability; a world where packaging is made from simplified non toxic materials that are collected in closed loop recycling systems created by the packagers or biodegraded 4. Although their design concepts have been proven in the furniture, carpet and architectural industries they are as yet unproven in the packaging industry. Convinced that this vision is viable, they have assisted in founding The Sustainable Packaging Coalition, a non-profit organization of volunteer members companies. The mission of this group is to “advocate and communicate a positive and robust environmental vision for packaging; and leverage innovative, functional packaging materials and systems that support economic and environmental health”. 5

The first projects being tackled by this growing group are to create common definitions for sustainable materials and the creation of collaborative business to business closed loop intelligent materials pools. At a June 2004 meeting held in Seattle the group heard presentations and success stories based on both paper and plastic materials. At Pack Expo Nov. 9, 2004 the group held a well attended panel discussion: Sustainable Packaging Solutions: A Supply Chain Discussion. Work is ongoing on the definition and pooling projects funded by the U.S. EPA and membership dues from companies such as, Coca-Cola, Nike, Target, and Kraft. In this group’s working definition, sustainable packaging would:

• Meet the needs of the present without compromising the future
• Benefit individuals and communities throughout its life cycle
• Be harvested, manufactured, transported and recycled using renewable energy
• Productively circulate in biological or industrial cycles of production, use and recycling
• Provide a convenient, effective system for value recovery
• Be recovered or recycled at its highest value after use
• Be designed for safe, productive return to nature or industry
• Be safe for human and environmental health
• Be sourced from renewable or recycled materials

Currently, meeting this strict definition would be virtually impossible for the majority of transportation, protective and display packaging systems where commingled materials and global manufacturing complicate the cycling of materials through collection and reuse. So for now most companies are setting attainable environmental packaging goals that are less bad in practice when compared to their existing methods.
Plastic Packaging and the Environment


This paper offers the following background and statistics:

Even though plastic is an extremely efficient packaging material in terms of material used vs. product protection packaging comprises over 25% of total plastic resin sales, the largest category. Nationally plastics are the fastest growing component of municipal solid waste currently estimated at about 15% by volume, second only to paper.

Most recycled plastics are PET and HDPE containers, accounting for around one half of the plastics recycled nationally over the last few years. Exponential growth in new single serving beverage containers over the last 10 years has created a backslide in recycling percentages on a whole (71% for PET in 1994 in CA vs. 36% in 2003) while the number of containers recycled has increased dramatically (26.4 million containers predominately PET and HDPE in 1988 to 1.6 billion containers in 2001).

Nationwide plastic packaging resin sales have increased at a pace of 200 million pounds annually over the last 10 years while recycling has increased by about 50 million pounds. Plastic packing recycling has stagnated in the US to approximately 5 percent of the total amount sold.

The issue is the high cost of plastics recycling due primarily to their light weight and multiple resin types. Average collection costs exceed scrap values by as much as two-and-one half times. Plastic recycling therefore relies on subsidies provided by bottle bills, processing, and take back fees.
Domestic Packaging Mandates

To close this financial gap, a viable market for recycled plastics must be present. While the two top bottlers, Coca-Cola and Pepsi, have voluntarily committed to using recycled content in an effort to spur domestic markets for recycled PET, states like California and Oregon have enacted rigid plastic container laws encouraging manufacturers to utilize increasing amounts of recycled materials. California Senate Bill 235 (1991) requires that if industry did not meet a 25% aggregate recycling rate for rigid plastic packaging containers (RPPCs) by 1996 all RPPCs sold in CA going forward would have to meet one of three criteria:

- Contain 25% post consumer recycled material
- Have a recycling rate of 45%
- Be source reduced by 10%
- Be refillable or reusable

The definition of what constitutes an RPPC may vary, yet the consensus is that proposed amendments will include broader definitions and be more inclusive of thermoformed clamshells and blisters.

Examples:

<table>
<thead>
<tr>
<th>RPPCs</th>
<th>Not RPPCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• An 8 oz. or greater plastic bottle with a reclosable top (the top does not have to be plastic)</td>
<td>• Blister packaging that cannot be reclosed</td>
</tr>
<tr>
<td>• An 8 oz. or greater plastic jar with a reclosable top (the top does not have to be plastic)</td>
<td>• Clamshells that cannot be reclosed</td>
</tr>
<tr>
<td>• A reclosable clamshell pack that is capable of holding 8 fluid oz.</td>
<td>• A flexible tube</td>
</tr>
<tr>
<td>• A reclosable plastic blister package that is capable of holding 8 fluid oz.</td>
<td>• Service packaging that does not normally store a product for 7 days</td>
</tr>
<tr>
<td>• A plastic box that is capable of holding 8 fluid oz.</td>
<td>• A plastic box that has a least one side or an attached lid that is not made of plastic</td>
</tr>
<tr>
<td>• A plastic cylinder that is reclosable and capable of holding 8 fluid oz.</td>
<td>• A blister package that has at least one attached component not made of plastic.</td>
</tr>
<tr>
<td></td>
<td>• Any plastic container that can hold more than 5 U.S. gallons</td>
</tr>
<tr>
<td></td>
<td>• Any plastic container with a volume less than 8 fluid oz.</td>
</tr>
</tbody>
</table>

Financial Drivers for Change

Internationally packaging fees exist in over 30 countries with new programs in Canada, Asia and Eastern Europe. There are environmental design requirements in more that 25 countries covering empty space, source reduction, package prevention, recovery, reuse and recycled content.

E.U. Institutions have agreed to adopt CEN (the European Committee for Standardization) standard EN 13427:2000 on packaging which lays down essential requirements which all packaging marketed within the “European Economic Area” must comply. Packaging that does not comply with these essential requirements can legally be banned from EU markets!

Essential Requirements Summary:
• Packaging weight and volume should be minimized
• Noxious and hazardous contents of packaging should have minimum impact on the environment at the end of life
• Packaging should be suitable for material recycling, energy recovery, composting or for reuse

Ontario recently passed the Waste Diversion Act of 2002. Beginning June 2003, producers are responsible for 50% of the cost of collection and recycling of the packaging and printed paper material that they place on the market in Ontario.

South Korea sets limits on empty space and restricts the use of expanded polystyrene for use as buffers for electrical, office, Information technology and audio-visual appliances for specified packaging volumes of less than 20,000 cubic centimeters.

The National Peoples Congress in China, effective January 2003 has approved a design requirement that contains the language: “When products and packaging are designed their influence on mankind and natural environments during their life-cycle must be considered... enterprises should reduce the overuse of packaging and packaging wastes”.

It is clear that international recycling standards and fees are increasing and that companies designing rigid plastic packaging that will be marketed for more than one year should be sure that they address the following requirements:

• Contain 25% post consumer material
• Be reusable or refillable
• Be recycled at a rate of 25-45%
• Be reduced in size by 10% over the last 5 years

**Environmental Advantages of Thermoformed Plastic Packaging**

Thermoformed packages widely used in the retail and consumer electronics industries can be redesigned to comply with these requirements. Materials used can be standardized to feed recycling in both open and closed loop recycling streams and take advantage of the growing pool of recycled HDPE and PET from plastic bottles. Thermoformed plastic packaging presents an opportunity to innovate new packaging designs that will pull materials from recycling streams. New high end demand is needed for the economical collection of clean plastic streams. Recovered materials can be cleaned, extruded and thermoformed into new packages.
Corporate Environmental Packaging Program Example
HP has been a leader on environmental packaging issues since the early 90's. Their work in conjunction with the Institute of Packaging Professionals (IOPP) has lead to a broad understanding of environmental packaging issues in the consumer electronics industry. Their influence and leadership has lead the adoption of many corporate “Design for Environment” policies and driven new product innovation.

Hewlett Packard IPG Supplies - EcoVision
Excerpted from a presentation at Take It Back West 2004.
Many times it is difficult to determine which packaging design is the best solution for the environment. Meeting this challenge, HP developed a software tool called EcoVision that measures the environmental impact of any HP inkjet cartridge packaging concept. The EcoVision tool uses a scientifically based model -- a Life Cycle Assessment (LCA) model -- to calculate the many environmental impacts of the complete packaged solution. The Inkjet Supplies Business has used this tool to set environmental targets and limits for all new packaging designs. The EcoVision tool enables HP packaging engineers and managers to set and achieve environmental goals. It also gives them the ability to track and communicate progress towards these goals using scientifically based facts and data. The following graph of EcoVision scores clearly shows the relative merits of several candidate designs. Low EcoVision scores are good.

Innovative Product Applications
Hot Plug Hard Drive - (Hewlett Packard Enterprise Systems Group)
Got milk? Well do you still have the jug it came in? If so, recycle it - as it might end up in HP’s Industry Standard Servers Hot Plug Hard Drives packaging. Beth Feldkamp took another look at the old disk drive design that initially was in fabricated urethane foam with corrugated paper inserts. She then developed a new solution that eliminated the need for this bulky foam material and replaced it with a thermoform plastic cushion. This new design concept nested nicely together which reduced inbound material transportation and storage (3 truckloads less a month). The new cushions are made up of about 80% recycled material - a combination of Post Consumer (predominantly milk jugs) and Industrial (post manufacturing PE waste) materials which can be easily recycled again. Better yet, this new design saves HP a little over a million dollars a year in material and transportation and warehousing costs.
This lightweight, patented GeoSpring® packaging system provides structures for a unitary spring system including flexible harmonic bellows. When a carton containing a product protected by this spring system is dropped from a height, the rapid deceleration caused by the impact engages the spring system and efficiently dissipates the shock and vibration. The system can be adapted to meet a wide range of shock/vibration dissipation requirements without using voluminous amounts of material.

Intel CPU Shipping Trays
Intel's Logistics Transport Materials Engineering (LTME) Team implemented a packaging design change for CPU shipping trays. The design optimized the number of CPU's in a box, replaced plastic foam cushioning with a 100% paper material and introduced an industry breakthrough by replacing the expensive standard tray with a lighter weight solution.

The new trays are 40% lighter which reduces overall packaging waste, is less expensive and requires no special handling to recycle. This innovative switch from injection-molded plastic to thermoformed (PET) plastic is yielding millions of dollars in annual savings and a reduction over 1.5 million pounds of plastic materials annually. The trays are designed to support product flow from initial delivery of substrates, through the multiple steps of fabrication, and then for delivery to customers. Intel is now working on the closed-loop processes that will enable the empty trays to be collected from customers, de-contaminated, and reused.
In addition to the tray redesign, Intel continued its tray recycling program, where CPU shipping trays are reused among Intel factories and Intel's OEM customers. In 1999 and 2000, over 4.6 million trays were reused, saving over 1.3 million lbs. of plastic waste.

These thermoformed trays are designed to interface with specific automation equipment and work in standard JEDEC (Joint Electron Device Engineering Council) tray handlers and processing equipment. This requires extremely tight tolerances of +/- .005” for form, trim and functional features on top and bottom sides of tray.

Top and bottom sides of tray are functional, with tightly-controlled cell dimensions

RSVP 3R System
(Presented by Jim Skinner and Tom Stevens at GPEC in 2002) Uses a global approach to manufacturing and return, built around minimum materials and light weight (the Reduce element), full recovery and remanufacturing (Reuse), nest-ability to reduce shipping bulk before and after use, plus bulk palletized shipment (Return). The system protects the U-Pad so effectively that few approach failure point. The full 3R cycle not only achieves environmental savings of raw material but also delivers bottom-line profit to Hard Disk Drive manufactures through packaging and shipping cost reduction, this is accomplished via a ‘total-cost-of-ownership’ approach.

3.5” HDD 20 Pack  2.5” HDD 20 Pack
In material choice, a low elastomeric coefficient was crucial, to yield excellent return, i.e. elasticity without plasticity to prevent permanent deformation. Second, the material had to hold its form under load in temperatures up to 140°F and resist cracking under load down to −40°F. Third, the material had to be curbside recyclable with enough feedstock for massive production quantities.

Only one material proved suitable: HDPE. But with post-consumer recycled resin, quality is vital. Care was taken to secure a narrow stream of closely inspected material. In subsequent testing, it was found that only highest grade RHDPE could deliver the necessary performance as the U-Pad must move up to 2.5”, deflect, and return to its original shape under load.

Once the U-Pad is manufactured and used to initially ship components, it is collected locally at major end users in reused Gaylord bins. Users are motivated to collect: where they would have paid for packaging disposal, they can now call UPS instead. Through an established program, the product is picked up and shipped to Asian, European, or American extruders at no cost to users, made possible by the product’s nesting ability—92% more efficient than erected size.

**Motorola U-PAD Packaging System**  
*Excerpted from Motorola 2002 Ameristar Award Application*

High Density Polyethylene (HDPE) patented thermoformed U-PAD cushions for Digital Control Terminals (DCT) reduce packaging material, shipping volume, weight, and freight costs while generating over $3,000,000 per year in savings U-PAD cushions provides protection, built in rigidity, flexibility, and shock protection beginning at the supplier and continuing all the way to the point of installation by the cable operator. The HDPE material also provides excellent protection during several times of re-use. By incorporating shock absorbing crush depressions and selective cushioning along the bottom, sides and top, the DCT unit is surrounded to prevent breakage and cosmetic damage during shipment. In addition to protecting the product, steps were taken to improve ergonomics, simplify the manufacturing and packaging process, and improve cleanliness.
From an environmental standpoint the two U-PAD cushions replaced the need for four individual wrap around corrugated parts. This eliminated 8,960 pallet loads of packaging materials during the course of one year from the Nogales, Mexico and Taiwan facilities. This significant volume reduction of incoming material and wooden pallets also minimized truck delivery trips and forklift use translating into less Global Warming Potential (GWP). Every U-PAD has been designed for multiple reuses. When it no longer meets standards of protection, it is then recycled. The U-PAD is accepted worldwide and promoted by Motorola marketing and Environmental Health and Safety. Significant amounts of de-trashing have been reduced from the entire distribution system providing a positive impact on the landfill. Dust and fiber particles have been significantly reduced in the factory work environment. Special jigs and fixtures have been eliminated from packaging lines resulting in work simplification. The U-PAD Packaging System is a key player in Motorola’s goal to provide cost-effective, customer and environment friendly packaging.

Summary:
While strict definitions of the term sustainable packaging set the bar fairly high; the projects above prove that achieving incremental progress can pay big dividends in terms of meeting your company’s environmental objectives and cost reduction goals. The light weight nature of thermoformed plastic make it an ideal choice for meeting package “reduction” goals while the high strength to weight ratio of plastics make “reuse” feasible. Most collection systems are built around HDPE and PET so a focus on these materials makes “recycling” and the inclusion of recycled materials possible. HDPE has excellent impact strength where product protection is required and PET presents both good clarity for display packaging and stability for engineered structures. Combine these factors with low tool and engineering costs which make creative design exploration possible and thermoformed plastic packaging can be an excellent environmental choice.

Citations:
1) Towards Sustainable Packaging: Sustainable Packaging Alliance, April 2003
2) Natural Capitalism, Creating the Next Industrial Revolution: Paul Hawkin, Amory Lovins, L. Hunter Lovins 1999
3) “Cradle to Cradle: Remaking the Way We make Things” Bill Mc Donough, Michael Braungart
4) Cradle-To-Cradle: The next Packaging Paradigm? Packaging Digest, May 2003:
5) Sustainable Packaging Coalition Membership Terms and Benifits
6) Plastics White Paper: Optimizing Plastics use, recycling and disposal in California May 2003
7) Various Reports provided by: Environmental Packaging International
8) HP Environmental Packaging: Where We've Been, Where We're At, Where We're Going. Paul Grady Russell, CPP/Fellow, Packaging Process Manager

On-line References:
Packaging 2.0 LLC www.packaging2.com
Environmental Packaging International: www.environmentalpackaging.com
RSVP Operations LLC, thermoformed fragility packaging: www.rsvppkg.com
MDBC: http://www.cradletocradle.com
Precision Forming LLC: sales@precision-forming.com
Sustainable Packaging Alliance SPA: www.sustainablepack.org
Sustainable Packaging Coalition: www.sustainablepackaging.org
California Integrated Waste Management Board, Plastics Site: www.ciwmb.ca.gov/plastic