klöckner pentaplast

white paper

SUSTAINABILITY THROUGH DESIGN—Minimizing Total System Waste

It seems that the prevailing societal view of packaging is that of wasted resources. Corporate sustainability goals almost always include a focused effort to reduce packaging in general and packaging waste in particular. It should then be surprising to learn that substantially more damage can be done to the environment and to society's limited natural resources when the sole goal is to reduce waste through reductions in packaging. Intelligent use of innovative packaging films and modest increases in packaging weight can actually result in substantial environmental impact reductions for the total system.

Packaging has been referred to as the science, art, and technology of enclosing or protecting products for distribution, storage, sale, and use (Soroka 2002). This big-picture view belies the actual complexity of the many competing agendas that the packaging engineer must manage coherently. The packaging engineer is challenged with balancing the industry's complex and often diverging goals of

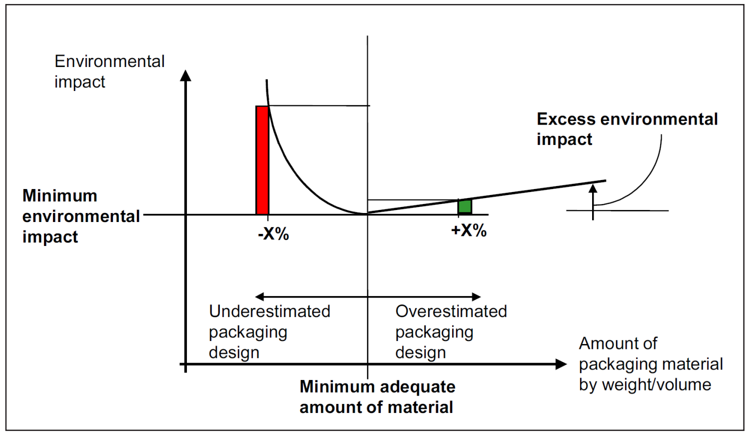
- Promoting consumer safety
- Promoting product protection
- Promoting quality assurance
- Promoting convenience features (easy open, portion sizing, tamper evident)
- Providing presentation and branding (marketability)
- Increasing processability
- Enabling efficient product distribution
- Providing environmental compatibility (achieving sustainability goals)

In essence, packaging engineers must design packaging systems in such a way as to deliver products to consumers and help to minimize total system waste.

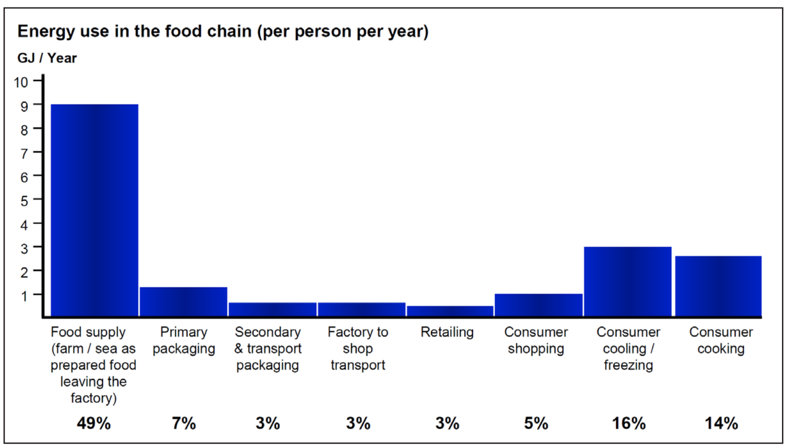
THE HOLISTIC APPROACH

Absent a holistic view, companies risk increasing total system waste by focusing solely on reducing packaging and packaging discards. Packaging plays a primary role in protecting goods during transit and maintaining adequate shelf life to survive the distribution channel. If packaging is underdesigned, it cannot fulfill this function, and damaged and spoiled goods must be discarded along with their packaging. (Advisory Committee on Packaging 2008, 13) The potential net effect of an underdesigned

packaging system is an exponential increase in pressure on natural resources. This concept is clearly demonstrated in the total system packaging model developed by Packforsk. "The model shows the extra environmental impact caused by excess use of packaging material as well as the one caused by an underestimated packaging design, which may result in waste of the packaged product. The growth at overestimated packaging design is linear, but the growth of the environmental impact at underestimated packaging design is exponential as one damaged package/product may waste an entire pallet load." (L. Erlöv 2000, 6)



A 2008 study on UK package recovery and recycling examined the total energy contained in each of eight distinct areas of the total food chain. It is evident in this study that packaging protects far more resources than it uses. (Advisory Committee on Packaging 2008, 4) In fact, when looking at the total energy required to get food from the farm to the consumer's plate, we see that approximately 50% of the energy requirement comes from food production and harvesting, with another 10% coming from transportation and retailing. Primary and secondary packaging average 10% of the energy used in the food chain, but protects the 60% already invested in the product. A 1% reduction in packaging could, therefore, generate a 7% increase in total system waste if the packaging reduction led to an under designed package. (Advisory Committee on Packaging 2008, 4) "When considering energy consumption the negative impact of product wastage due to inadequate packaging is substantially higher than the impact of using more packaging to protect the product. This represents a significant loss of resources to society, not to mention the implications of increased waste." (Monkhouse, Bowyer, and Farmer 2004, 12)



With the growing interest in climate change issues, the implication of increased food waste in landfills is gaining more attention. Landfills are responsible for approximately 22% of the manmade methane emissions, the second largest contributor in the U.S. Food waste placed in a landfill typically begins to anaerobically degrade and produce significant volumes of methane within one to two years of disposal and continues for 10 to 60 years or longer. (U.S. EPA 1) The methane gas generated has twenty-one times the climate change impact of carbon dioxide. (U.S. EPA 3) The long-lasting consequences of this

reality reinforce the need for packaging engineers to take a holistic view and consider total system waste when making package design decisions. This includes the opportunities to reduce product waste through extending product shelf life.

THINKING OUTSIDE THE BOX

Consider the case of a 16” fresh pizza currently packaged in a corrugated box. If not taking a systems approach to package design, one might assume that this is a preferred format because it is based on an annually renewable resource and is collected in a majority of municipal recycling programs. The holistic approach would challenge the packaging engineer and the material supplier to think outside the box and develop a solution that minimizes total system waste. When faced with this challenge, Klöckner Pentaplast responded by proposing a gas-flushed, thermoformed plastic tray and a barrier sealant web featuring high-impact graphics. The material selected for the thermoformed tray was Pentafood® kpbar™ SmartCycle® PET film which is made from 50% post-consumer plastic bottles.

The typical shelf life of a fresh pizza in the current corrugated format can be estimated to be 5 days. By moving to this new format, retailers and consumers see a product shelf life extension to 20 days or more; decreasing the risk that product will spoil rather than sell. This added shelf life also provides product suppliers the added benefit of potentially expanding the geographic reach of the product. Both benefits are supplemental to the reduced environmental burden associated with additional food production.

In addition to the shelf life improvement, substantial resource savings are also realized by the package redesign. By moving to this new format, packaging engineers are able to reduce the total weight of packaging materials used. The corrugated format carries with it a product to package ratio of 82:18, while the new format improves this to 94:6 by reducing 68% of the individual package weight. When applying these savings across five million annual units sold, it corresponds to a reduction of 918 tons of packaging materials. Given the post-consumer recycled content of the Pentafood® kpbar™ SmartCycle® PET film, it also equates to diverting 6.7 million 16-oz PET bottles from the landfill. The overall reduction in packaging material usage provides an annual energy savings of more than 45,000 GJ or enough energy to power 993 single family homes for a year. Green house gas (GHG) emissions also are reduced by nearly 1,800 metric tons CO_2 Eq., the equivalent amount generated by driving 343 cars for a year. (Boustead) (Franklin Associates)

THE MYTH OF UNPACKAGED FOOD

U.S. consumers are accustomed to the luxury of being able to purchase fresh fruits and vegetables in their local markets throughout the year. Many of these items can be purchased in bulk or loose without any primary packaging. "Consumers may assume, rightly or wrongly, that the loose product is a better environmental option, given that there is no packaging at the point of sale. Taking into account the fact that goods that are not pre-packed are more likely to be damaged or bruised, there may be as much or more waste from 'loose' goods as from packaged ones. This is not a result of globalization or long-distance trade in general – it applies even to produce from local growers." (Monkhouse, Bowyer and Farmer 2004, 27) The consequence of the absolute absence of packaging can clearly be seen in developing countries, where without access to the prepackaged technologies available in the U.S., food wastage "can be as high as 50%" of the total food in the supply chain. (Advisory Committee on Packaging, 23)

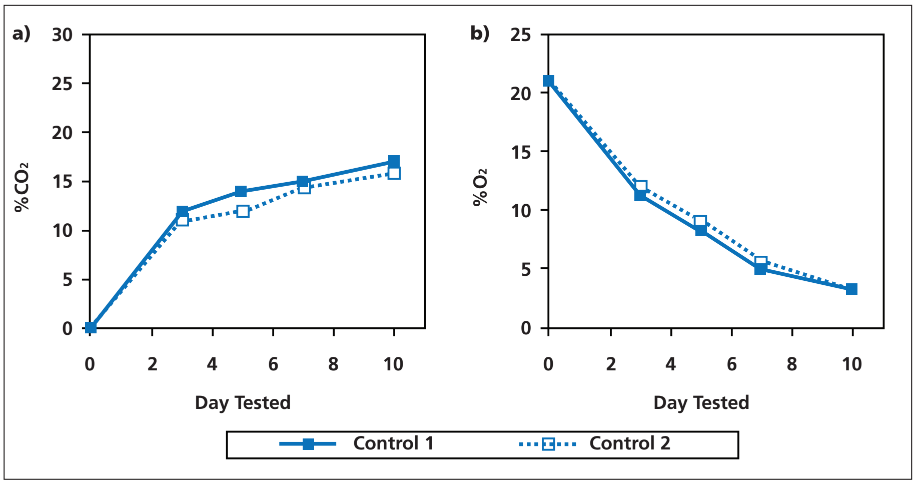
This impact is echoed in a 2003 Life Cycle Analysis (LCA) commissioned by Marks and Spencer to study different apple packaging systems. Results indicated that a net reduction in total system waste of 27% is possible with the use of a plastic tray as opposed to selling loose fruit at point-of-purchase. "Loose apples involve more waste at the packaging production, packaging plant and retail stages, and the waste arising on these business sites is far more significant than the small amount of packaging thrown away by the consumer." (Monkhouse, Bowyer, and Farmer 2004, 27)

To further illustrate the environmental burden associated with this type of food loss, let us examine the case of a regional strawberry producer that harvests approximately 3,640 metric tons of produce in a season. The energy required to grow, harvest, package and transport the strawberries to market is approximately 0.2 MJ per metric ton of fruit. The green house gas emissions associated with this same food chain is approximately 0.9 grams CO_2 Eq. per metric ton of fruit. For every one percent of fruit waste avoided through a leaner distribution system, better packaging or extended product shelf life, 689 GJ of energy are saved. This equates to enough energy to provide power to 14 single family homes for an entire year. Furthermore, that same one percent of avoided fruit waste yields a green house gas reduction of 32 metric tons CO_2 Eq., the equivalent of driving 6 cars for a year. (Williams n.d., 9, 10) With this level of environmental impact associated with each percent of food waste, the benefits of reducing food wastage through packaging technologies becomes even more apparent.

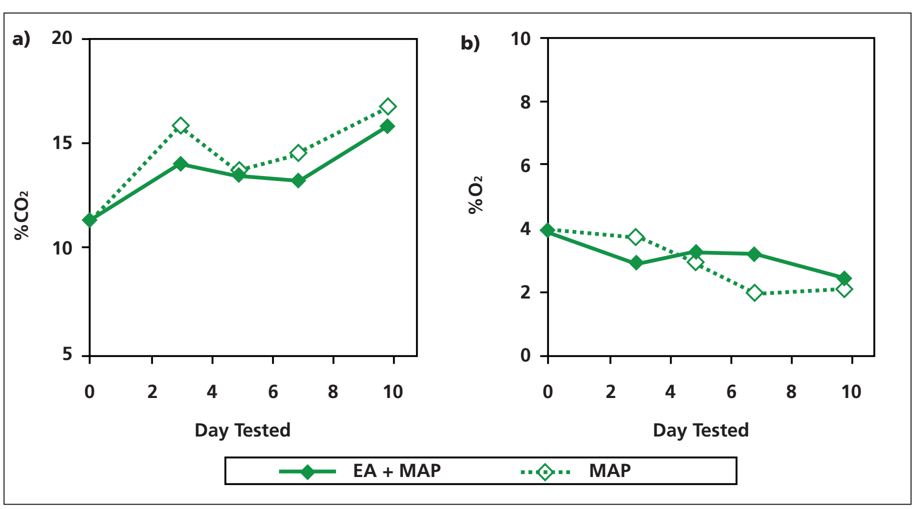
INNOVATION DELIVERED

Given the very short post-harvest shelf life of most fruits and vegetables, the ability to get fresh produce to consumers can be challenging. Some fruits, such as apples, avocados, bananas, kiwis, peaches, and tomatoes pose a special challenge because they increase their natural production of the phytohormone ethylene post-harvest, dramatically accelerating the fruit's ripening and spoiling process. In addition to losses resulting from transit damage or mishandling, this accelerated ripening process can be a significant contributor to unnecessary waste. Modern packaging technologies offer a solution to this challenge.

Klöckner Pentaplast has worked in collaboration with Carburos Metálicos (CM) a division of Air Products to better understand the ripening process and the specific advantages that may be offered through the combination of a modified atmospheric packaging (MAP) process and ethylene absorber (EA) technology. The graphs below represent the typical spoilage process of a kiwi fruit product in a standard overwrapped tray. The day to day increase in CO_2 levels (with no stabilization) along with the decrease in O_2 levels (with no stabilization) confirm microbial activity associated with ripening and spoilage.



Next, two modified atmospheric packaging (MAP) formats were compared to determine the optimal design for minimizing fruit spoilage due to oxidation. The first format consisted of a tray that was flushed with nitrogen gas; the second format utilized the same MAP system with Klöckner Pentaplast Pentafood® kpseal™ PET packaging film modified with ethylene absorbing (EA) capabilities, and a high oxygen transmission lidding film. The results showed that imploying a MAP process in combination with EA technology essentially doubled shelf life of the kiwi fruit. With MAP alone, shelf life was determined to be between 2 and 3 days, while the combination of MAP and EA extended the shelf life to 7 to 8 days. This can be seen in the graphs below as the difference in the reduction in CO_2 levels and the increase in O_2 levels over time.



These results confirm that microbial activity has been significantly delayed by both packaging technologies, relative to the control. The continued reduction in CO_2 levels observed in the combined MAP and EA system through day 7, relative to the increase in CO_2 levels observed in the stand alone MAP system starting with day 5 highlights the delayed onset of microbial activity offered by the combined MAP and EA packaging system. The net result of this optimized packaging technology is an increased shelf life for the consumer and a reduction in the amount of food waste destined for disposal.

THE JOURNEY TOWARDS SUSTAINABILITY

Society's view of sustainability is not likely to be transformed quickly from narrowly focused issues like packaging and packaging waste. Brand owners and packaging engineers are however beginning to expand their own views of sustainability and realize the benefits a broader approach provides. The road to sustainability is a journey that carries with it opportunities for new learning and incremental gains. Today's packaging technologies offer innovative ways to optimize package design and reduce environmental impacts. By employing a holistic approach to package design, engineers can begin to redefine the value that packaging brings to society and establishes a platform to communicate the essential role that packaging plays in safely delivering products and minimizing waste.

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