

Mathematical Modelling as a tool to inform packaging design

Eli Gray-Stuart, Massey University, School of Engineering and Advanced Technology

Twitter: @Eli_Gray-Stuart

Developing mathematical models is a great way to further our understanding of different systems and processes. At Massey University we use modelling to gain a better insight into packaging systems and how they can be improved. Mathematical modelling offers great flexibility and the potential to explore various permutations of a problem. This reduces the amount of time-intensive and costly experimental analysis required. Furthermore, a model allows us to visualise a range of parameters e.g. a temperature or moisture distribution in a food or packaging material, where experimentally it may only be feasible to take a limited number of physical measurements.

Our modelling work has covered many industrially relevant packaging applications; from the humble corrugated fibreboard box, which has been a main stay of packaging for decades, to work on “active packaging” which is still an emerging technology.

Modelling the thermal performance of corrugated fibreboard

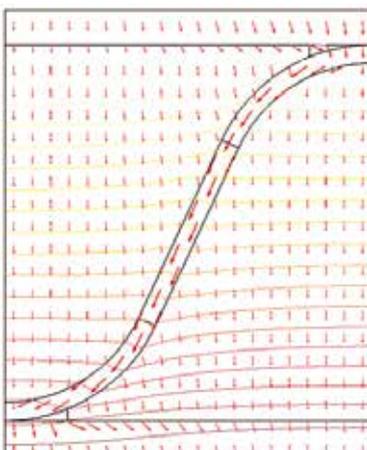
With corrugated fibreboard, we are interested in how its thermal performance can be optimised. A board with high thermal resistance can increase cooling and freezing times. On the flip side, this can be advantageous by slowing product warming during breakdowns in the cold chain. We developed a finite element model to predict the thermal resistance of corrugated board based on its geometry and the properties of the liners and medium paper. From this we were able to show how the majority of heat is transferred through the fluted medium. Such a model is useful from a design perspective as the thermal performance of new boards can be optimised to suit the application and give us a better indication of how a box will perform in the cold chain. This heat transfer model has evolved and been adapted to examine moisture transfer in corrugated board to tackle another



Eli Gray-Stuart



Finite element model simulation for heat transfer through corrugated board, (above) temperature profile and (below) heat fluxes, the arrow size represents relative heat flux



issue. In the supply chain the cyclical nature of the environment means the fibres in paper are in a continual state of flux as they absorb and desorb moisture. Over time this compromises the structural integrity of the box which can lead to failure and product losses. Modelling this mass transfer process is helping to increase our understanding of the phenomenon and is allowing us to explore ways to improve box performance through improvements to design and paper materials.

Active packaging is an area of increasing focus globally. Of particular interest is the use of packaging systems which release natural volatile compounds into the product head space. The efficacy of this hinges on the knowledge of the minimum inhibitory concentration (MIC) of the volatiles required to prevent microbial growth and quantification of the interactions of the active agents with food and packaging components. Through modelling we can design active packaging systems that match these different rates to maintain the MIC of the volatiles in the package head space through the distribution chain.

Limitations of modelling

As a concluding remark, it is important that we are aware of the limitations of our models. George Box famously said “all models are wrong, some are useful”. In the model development process, we endeavour to make sound assumptions and identify the variables which account for most of the variation in what we want to predict. By complementing modelling with comprehensive experimental validation we can advance our understanding and aid the improvement and development of packaging material and technologies.

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Cloud – A fresh approach to modernising your IT

Helen Masters, Infor South Asia – Pacific and ASEAN

Consumer tastes are continually evolving. Never before has there been a greater consciousness of what's in the products we eat, how they are processed and preserved, and the sources of their ingredients. Frankly, consumers are taking a fresh look at what they're eating, and it's the companies that can meet these expectations which are seeing results in the form of increased sales.

Catering to these new needs requires greater investments in R&D, as well as processing and packaging equipment. It also relies on improved communication with suppliers and customers, which ultimately places a greater demand on the data that food companies need to manage. Add this to constantly changing regulations, reporting requirements and on-going issues faced with planning, seasonality and promotion management, and the challenges keep mounting.

Balancing changing requirements with cash resources

But with so much on their plate, how do food companies balance the initiatives while operating within the reality of their cash flow?

For many companies, the idea of a major IT transitional investment such as a new enterprise resource planning (ERP) solution may seem too much to take on – with respect to both financial and time resources. Many of these costs are fundamentally driven by IT and data management, and so the temptation is quite simply to make do with existing software and supplement limited functionality with spread sheets and guestimates.

Any seasoned food and beverage executive who has previously experienced an ERP implementation which left them with sour memories would be unwilling to pursue the burden of another project, particularly if the business already feels swamped. This is true even if the business gained added value the first time around,

However as the world of ERP has changed significantly over the last few years, so too should one's perceptions.

ERP is no longer a one-size-fits-all solution

The traditional idea of a 'one-size-fits-all manufacturing' solution has developed into a specific 'food and beverage ERP solution' with optional modules to address unique requirements. This includes industry needs for traceability, new product introductions, complex scheduling and a myriad of other modern challenges. In order to increase profitability and maintain growth, modern businesses need to adopt these tools to help them rethink the way they operate and embark on bold new strategies.

Another barrier preventing food companies from moving to new solutions is the perceived high capital cost and the substantial disruption to their business. These have both been overcome with the introduction of industry-specific cloud solutions that have a purpose-built ERP functionality at their core. Cloud deployments are gaining momentum, and more food and beverage manufacturers are considering the benefits that can be derived from Software-as-a-Service (SaaS) rather than on-premise implementations.

Ask the right questions

Of course, with any substantial investment in IT, selecting the right vendor is often the most important factor to consider, and there are a number of questions you should be asking when evaluating a potential cloud solution.

1. What level of functionality is built in? Any cloud solution should offer flexible and industry-specific functionality that reduces the need for customisations. This includes built-in tools to address challenges such as short shelf life, attributes, yield and catch-weight.
2. Will it unify operations? It is important to avoid numerous separate applications. Rather, the solution should provide all the functionality that is critical to a business within a unified suite. These include capabilities for forecasting and demand planning, tracking and traceability, and recipe management. By having a comprehensive solution in the cloud, companies will enjoy enterprise-wide visibility that will help to streamline operations for greater efficiency.
3. Is it secure? To protect data, companies should always confirm that the solution follows industry best practices and protocols. Having a dedicated business unit that specialises in cloud implementation and deployment is a good indication of a vendor's commitment to security. Their consultants should also demonstrate extensive experience with SaaS-based implementations.
4. Are pricing options flexible? A major advantage of cloud solutions is subscription-based pricing that helps companies avoid upfront expenditure. It is even more valuable if the solution has the flexibility to add additional functionality and users to meet business growth and increased demand. Having a per-user-per-month pricing model increases transparency for cost projections and avoids rigid contracts that may become out-dated as the business evolves.

In summary, by moving critical applications to the cloud, food and beverage manufacturers may enjoy immediate savings and faster ROI, whilst at the same time enhancing their efficiency through industry-specific functionality. While operating with the very latest technology, manufacturers will also benefit from a flexible IT environment that offers scalability to meet business growth – while being well placed to successfully complete on a global stage.

With all these benefits in mind, organisations should be asking how, rather than why, they should move away from rigid on-premise solutions and embrace a more flexible, affordable and integrated cloud model.

Helen Masters, Vice President & Managing Director of Infor South Asia – Pacific and ASEAN

