Delivering Innovation and Intelligence in Product Design

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Abstract

Packaging designers must constantly inject innovations to attract consumers in a constantly evolving and highly competitive market. Keeping ahead of the competition by bringing new and exciting products to market faster whilst maintaining quality, presents a major engineering challenge. A new packaging development process is described, which introduces advanced automated simulation and optimization technology right from the concept development phase. Detailed predictions of primary, secondary and tertiary packaging performance are made possible through use of advanced simulation technology. Design optimization is then employed using the modelling as a virtual testing ground for design variants. The approach provides clear design direction, an opportunity for wider experimentation, helps to improve performance and reduces uncertainty in the development process.

Keywords: EPM, Packaging, Optimisation, Transportation Loading, Altair DataManager, Altair HyperWorks

1.0 Introduction

Unilever's 400 strong brand portfolio has brought leadership in every field of activity. It ranges from much-loved world favourites including Lipton, Knorr, Dove and Omo, to trusted local brands such as Blue Band and Suave.

Unilever constantly enhances the brand portfolio to deliver more intense, rewarding product experiences. Nearly €1 billion is invested every year in cutting edge research and development. Five laboratories around the world explore new thinking and techniques to help develop the product range.

The packaging design challenge remains a focused part of this innovation process. Packaging must fulfil many roles throughout the lifecycle of the product, roles that vary significantly depending on the target region, product and consumer driven requirements. Even if the primary packaging is well understood, there remains the need to optimize the performance of the secondary and tertiary systems. In addition to cost, sustainability is a big driver for reducing packaging material, and considering new recyclable options.

This paper describes an ongoing initiative at Unilever to define and reel out a new design approach driven by CAE. The technical challenges are many, ranging from capturing complex material response to capturing the process behind accessible user interfaces that can be deployed in a richly varied global business. Unilever is committed to yielding the greatest value from the design technology through employing it as early as possible in the product development cycle. To ensure accuracy of the predictions, materials need to be characterised at a level of detail previously reserved for detailed research activities. The simulation requirements have to be characterised and then tied down into robust repeatable processes to replace ad hoc studies. The resulting data needs to be recorded efficiently so that future projects can understand relative performance and avoid repeating work. Perhaps one of the biggest challenges has been to encapsulate all of this advanced simulation technology in such a way that it can be used to influence design decisions in one of the fastest and most reactive product development environments **[Figure 1]**.

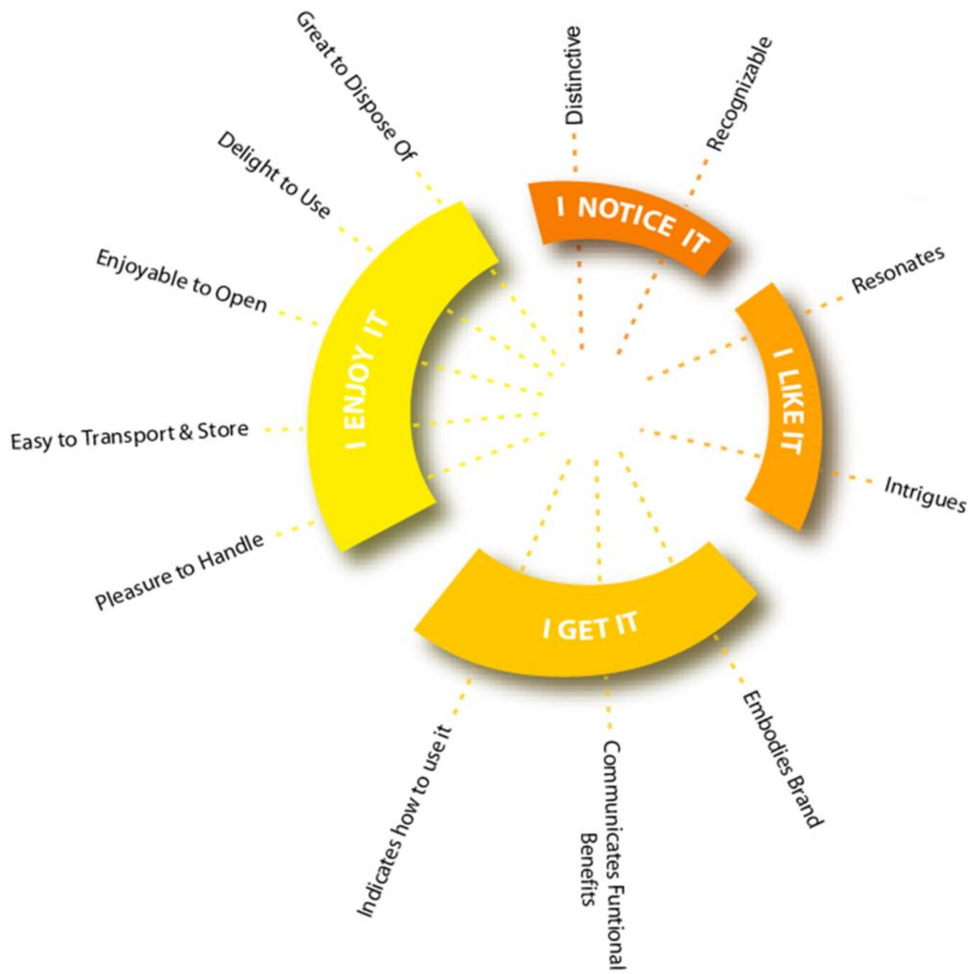

Figure 1: Unilever's Varied Product Goals

Unilever have partnered with Altair to utilise HyperWorks simulation, visualisation, systems automation and data management technologies to create a unique framework for enterprise level CAE driven product development. The "Atlas" system **[3]** developed by Altair in partnership with Unilever has reached a level of maturity to show significant benefits in product design in several categories and examples are presented along with an overview of the system.

2.0 Unilever's Virtual Design Process

The virtual design process must capture all of the packaging mix and "total environment" of the product life cycle. Virtual performance iterations must be efficient, accurate and repeatable facilitating and promoting optimization as part of the up-front process **[Figure 2]**. All of this contributes to the injection of innovation, reduction of cost and robustness in the final solution. Residual risks at the later stages of development are also reduced as is costly physical pack testing and prototyping.

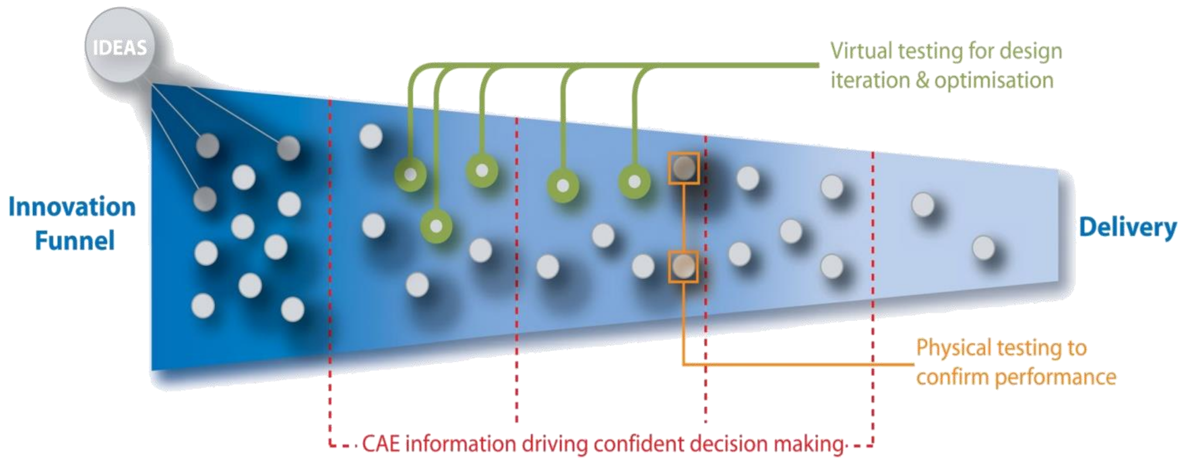

Figure 2: The Packaging Design Innovation Funnel

3.0 CAE Driven Design Case Studies

Two examples of virtual design applied to different product categories are presented. In the first example, a blow molded bottle for the household care category demonstrates the power of the technology for weight reduction. In the second example, an innovative injection molded cap mechanism is realised with help from HyperWorks optimization technology. Both products have been extremely successful in the market and exhibit strong shelf appeal.

3.1 Blow Molded Bottle Optimization [2]

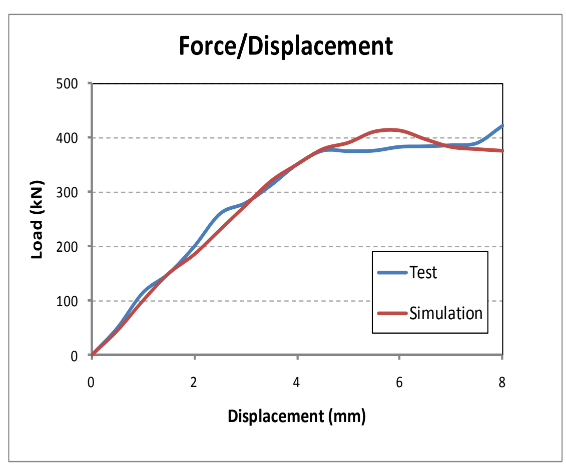

Figure 3: Blow Molded Bottle Packaging Solutions

Unilever pioneered the use of advanced simulation and optimization technology to light weight blow molded packaging **[1]**. The technology captures the manufacturing process and its effect on pack performance. Advanced simulation technology accurately predicts in-service loading performance and is verified by testing **[Figure 3]**. Once a single design is fully understood, an optimization loop can be constructed. Variables include wall thickness parameters and shape variations. The objective is usually to reduce the weight with constraints on topload capacity, drop performance and stiffness. The earlier comfort example and many more recent applications have demonstrated a weight saving of over 10% compared with traditional design methods.

3.2 Deodorant Cap Mechanism Design [3]

In the deodorant category, innovation is a very important part of creating new shelf appeal. Deodorant caps have to show a wide range of functionality to ensure reliability, usability and strong aesthetic appeal. The Axe / Lynx brand required a new packaging design and CAE took on a central role in developing the system **[Figure 4]**.

Topology optimization was used to develop a stiffening architecture for the key load carrying components. Design of experiments in HyperStudy was employed to understand sensitivity of the top load capacity and the locking mechanism. Heuristics were investigated through squeezing simulation of the sleeve and further topology optimization employed to improve stiffness.

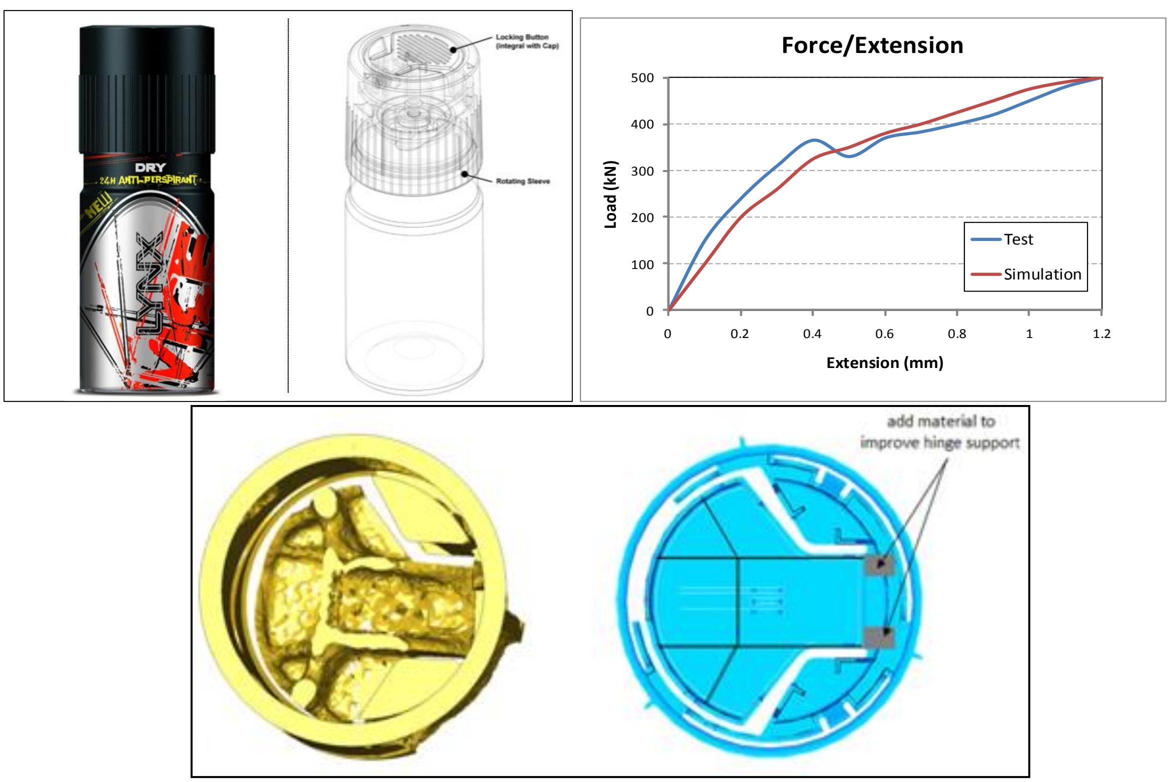

Figure 4: Axe/Lynx Deodorant System Design and Correlation

4.0 The Atlas System [1]

The Atlas System is a Hyperworks automation toolset designed specifically for FMCG (Fast Moving Consumer Goods) packaging design. The system encapsulates advanced analysis processes and presents them to the user in a clear GUI with minimal user input **[Figure 5]**.

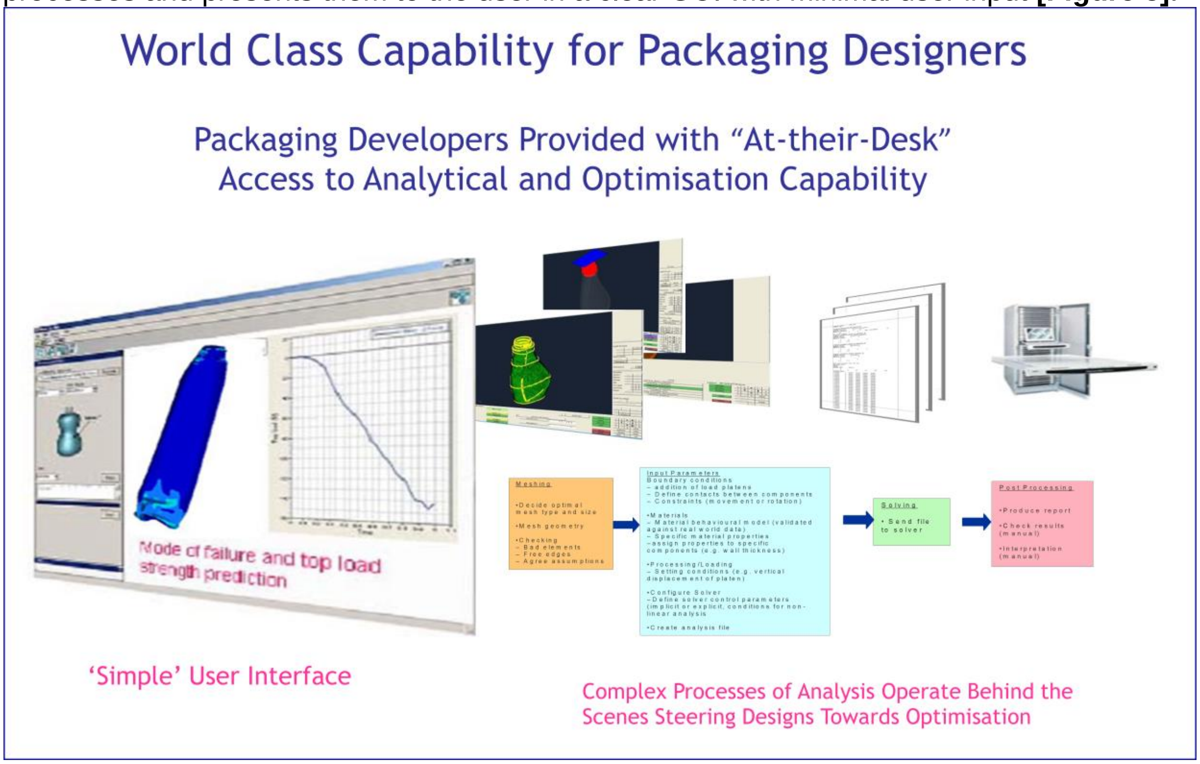

Figure 5: Unilever Atlas System Schematic

The system currently allows rapid development and design iteration for the following analysis types:

i) Blow moulding simulation **[Figure 6]**: to derive wall thickness distributions for a range of resins. The manufacturing results are transferred to the ongoing structural assessments.

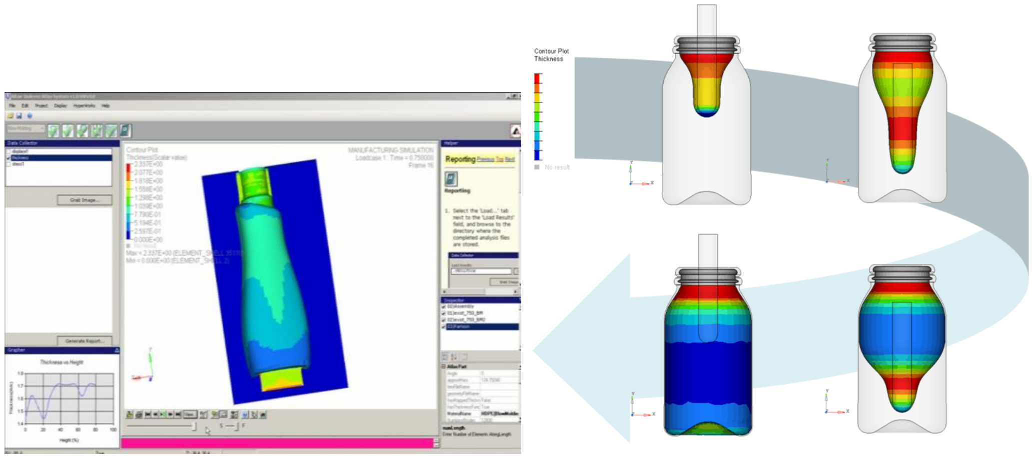

Figure 6: Typical Manufacturing Simulations

ii) Top load simulation **[Figure 7]**: to capture top load capacity and stiffness including non-linear collapse with non-linear material response. Multi-Part systems are supported, injection moulded or blow moulded.

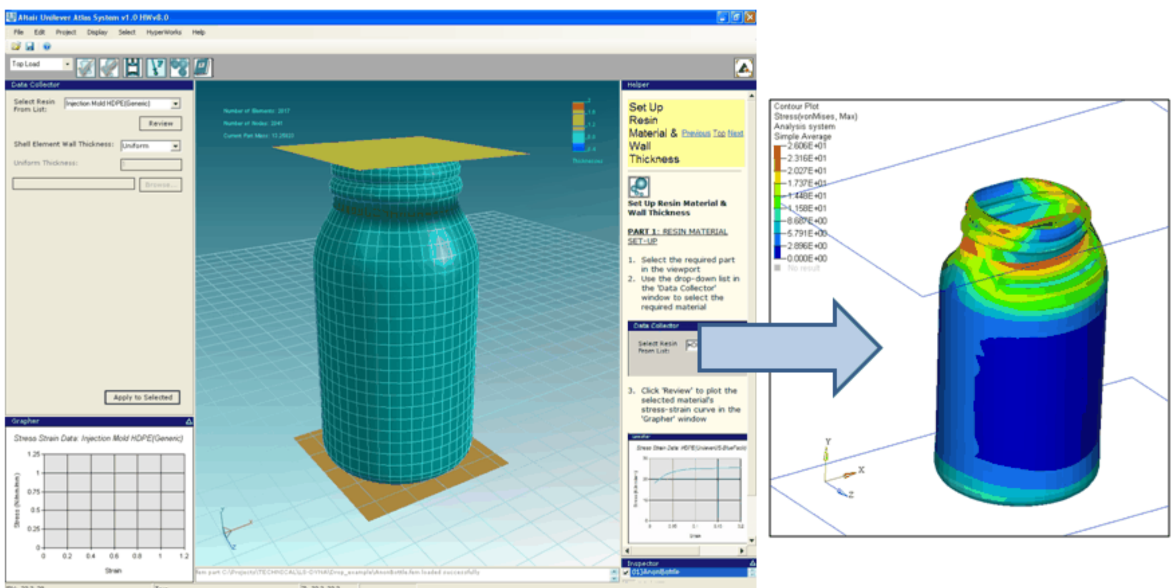

Figure 7: Typical Topload Simulation

iii) Drop Case simulation **[Figure 8]**: fluid structure interaction is captured together with strain rate effects and non-linear material response. Freedom of selection of impact attitudes is afforded through simple single parameters.

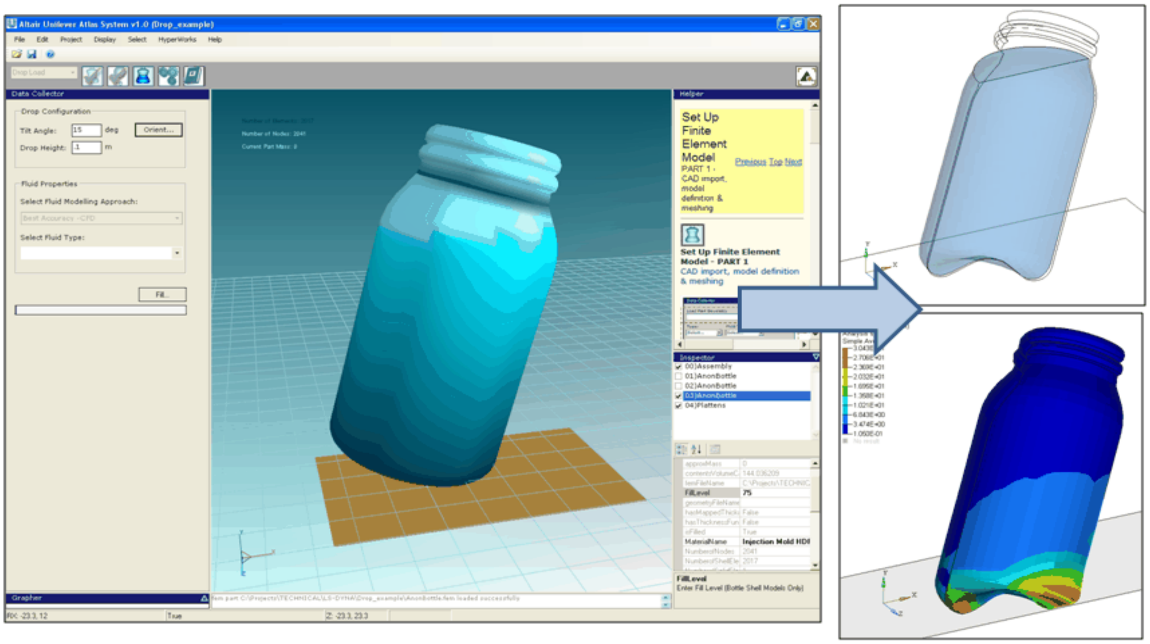

Figure 8: Typical Drop Simulation Including Detailed Fluid Structure Interaction

iv) Pallet Collation simulation **[Figure 9]**: representation of the entire primary, secondary and tertiary packaging system and simple selection of transportation excitation load cases. Rapid exploration of different pallet stack configurations is available with results ranging from whole stack stability to individual primary pack loads.

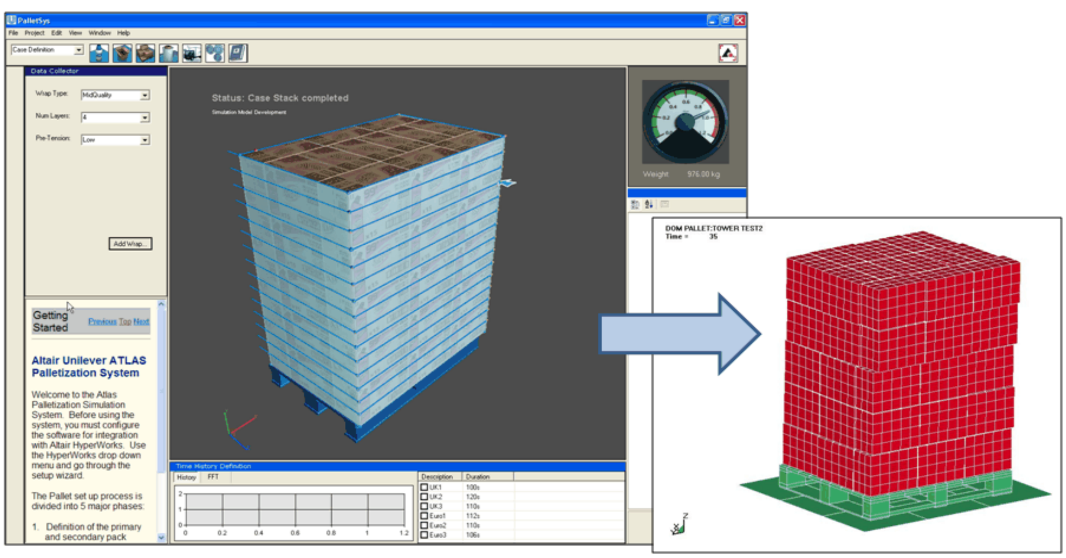

Figure 9: Typical Drop Simulation Including Detailed Fluid Structure Interaction

In-depth material and packaging response characterisation has been ongoing throughout development of the system and will continue as new materials become available. This information has been gathered through specifically designed physical testing programmes aiming to produce CAE specific data, not currently available from material suppliers. In addition, detailed road loading data has been captured and processed to provide the transportation acceleration signatures for pallet loading.

At the end of each of the processes automatic, customisable reporting is performed to provide summary design performance information **[Figure 10]**.

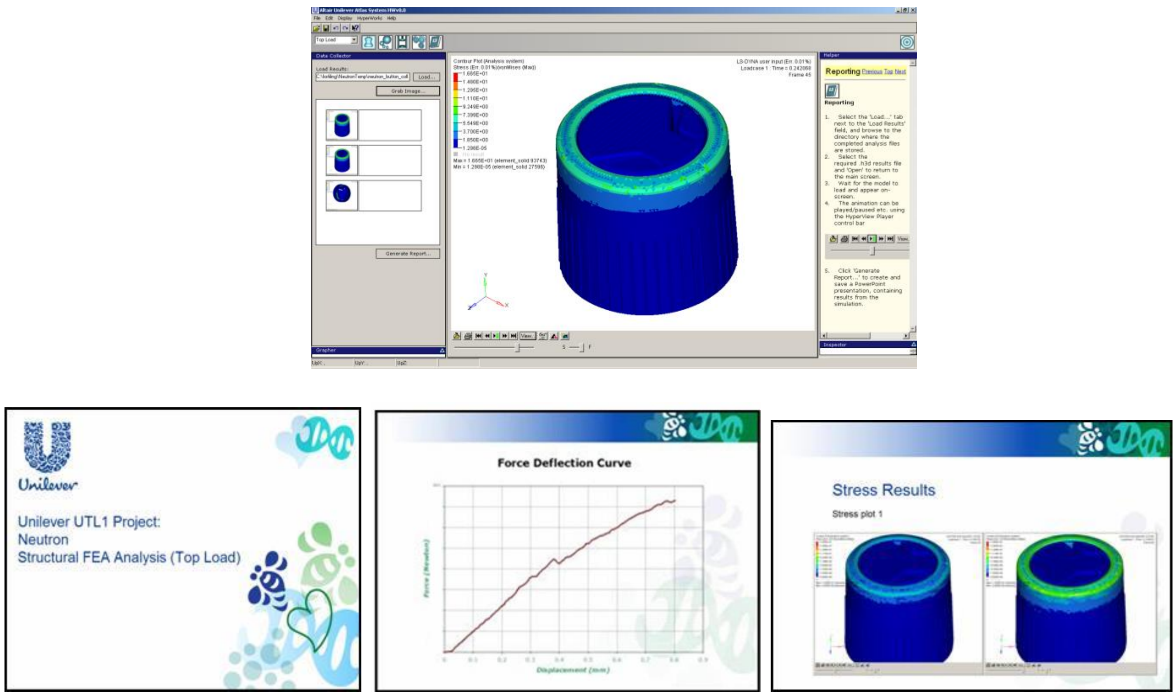

Figure 10: Atlas GUI Illustration Showing Lynx Cap Simulation and Automatic Reporting

The system provides a front end to a comprehensive CAE toolset (Altair HyperWorks) running on state of the art LINUX cluster hardware.

5.0 Conclusions

A packaging design process driven by CAE **[4]** has been developed and tested at Unilever. New product development has been enhanced on a number of projects across categories using the new approach. Significant weight savings have been realised as well as innovative new solutions. The simulations have proved to match reality closely and processes are in place for recording the method of application (Altair DataManager **[4]**). Material characterisation has proved to be a key component of the system underpinning the predictive accuracy.

The processes defined for CAE across the packaging design spectrum have been encapsulated in a HyperWorks **[4]** automation system (Atlas), which provides the user with a structured rapid design environment for experimentation and innovation. The system currently covers the main packaging design requirements including manufacturing top load, drop and transportation simulation. An accurate predictive capability is realised, which is repeatable and keeps pace with the rapid product development process.

Unilever continues to develop the system and is rolling out the solution to fit with the organisational structure and common design aims. Pressures will continue to grow in the general areas of sustainability, and waste reduction. Unilever sees CAE driven design and optimization as a means of ensuring the best technologies are adopted for meeting future challenges.

5.0 References

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