

# Brushing Up on Product Functionality

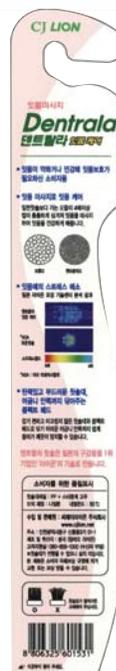
**Simulation and innovative product development go hand-in-hand at the Lion Corporation.**

by Nobuhito Nakagawa and Yoshiyasu Murata

Being in business for more than 100 years is a testament to a company's ability to understand customers' needs – as well as to deliver high-quality, reasonably priced products that meet those needs.

Lion Corporation, based in Tokyo, Japan, is one such company. Serving the needs of consumers since 1891, it provides a range of healthcare, household, chemical and pharmaceutical products.

Over the years, Lion has solidified its place as a market leader by applying innovative tools and techniques to its product development and sales efforts. In the recent evolution of one oral care product, for instance, the company employed state-of-the-art simulation techniques, leveraging the results to help promote product functionality to retail stores and consumers.



## Initial Simulation

In 1993, Lion introduced the Systema toothbrush. Originally targeted to older consumers with periodontal problems, the toothbrush featured ultra-super-thin bristles measuring 0.02 mm; that is one-tenth that of a traditional toothbrush.

These tapered bristles were designed to easily enter the periodontal pockets to remove decay-causing residue and plaque. What differentiated the bristles from those of other products was that they were soft, therefore minimizing stress and discomfort on already irritated gum lines. In addition, these soft bristles covered a greater surface area on and between the teeth, providing deeper penetration to better clean above and below the gum line to better prevent tooth decay.

**The Lion Corporation's Systema toothbrush, developed with simulation tools from Altair Engineering, is sold throughout Asia-Pacific.**

At the time, engineers at Lion used a general-purpose finite-element (FE) program to simulate the contact stress of the bristles against the teeth and gums. It took a full week to perform a simulation of two bristles against one tooth.

Lion leveraged the results of the simulation to run the first TV commercial using computer-aided engineering (CAE) to help prospective consumers visually understand the benefits of the Systema toothbrush design. In addition, the company utilized simulation results on the product package itself, to further illustrate the advantages of the Systema design over competitive products in retail stores.

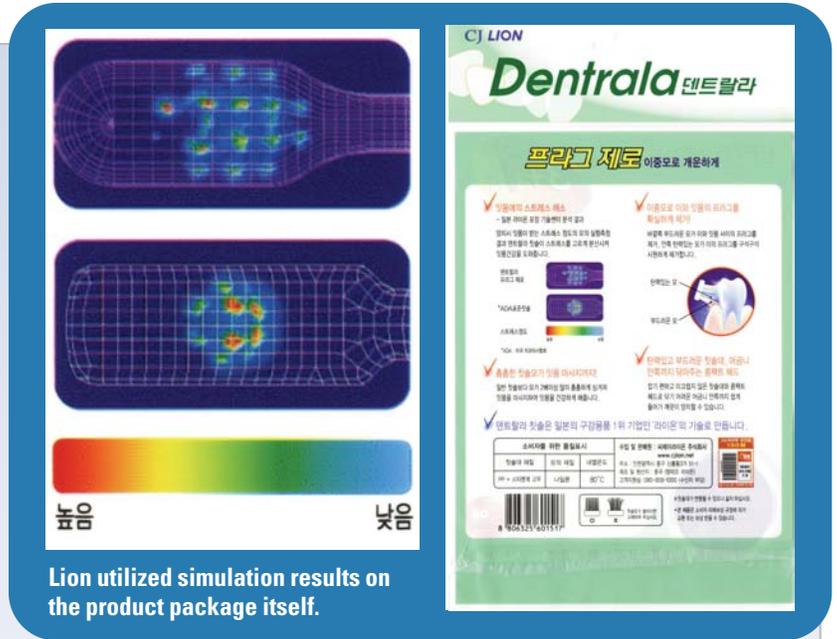
### Making the Most of CAE

Fast-forward to 2007, and you will find Lion undeterred in its efforts to innovatively apply simulation technology to enhance the lifestyles of customers. Engineers at Lion have applied more sophisticated simulation techniques to reposition the Systema toothbrush as a general-purpose product marketed to a broader audience.

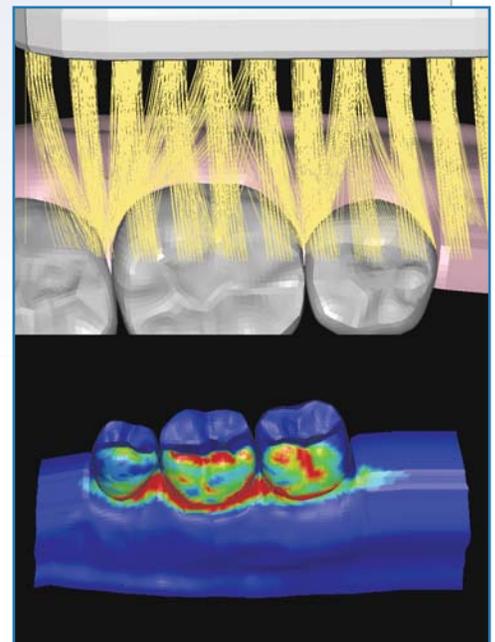
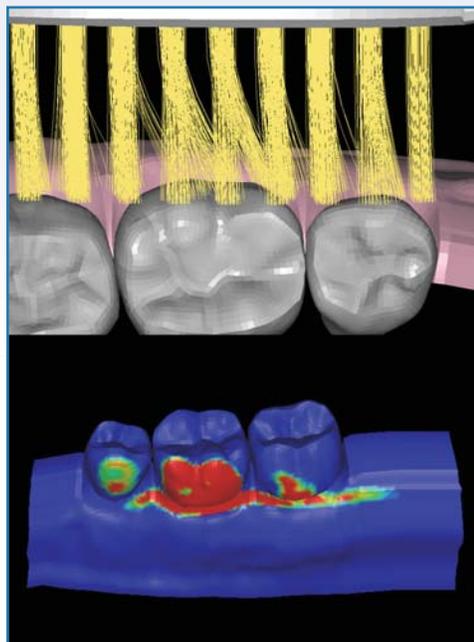
Thanks to advances in both simulation technology and computer hardware, engineers at Lion now can simulate multiple teeth in the jaw line in 3D – and do so more accurately – to gain a better understanding of the toothbrush’s performance. For example, Lion simulated the act of brushing teeth on an odonto-gnathic model and then performed a comparative analysis between the Systema toothbrush and a competitor’s product. These are very sophisticated problems.

Altair RADIOSS – a highly respected nonlinear solver solution that accurately solves today’s most complex contact problems – was applied to the project. To model the problem and visualize the results, Lion also used Altair HyperMesh and HyperView. All three solutions are part of the Altair HyperWorks enterprise simulation suite for rapid design exploration and decision-making.

Although engineers at Lion were familiar with HyperMesh and HyperView capabilities, RADIOSS was a new program to them. So, they invited Altair Engineering to consult on this project.



Lion utilized simulation results on the product package itself.



Altair engineers helped Lion use RADIOSS to set up the odonto-gnathic simulation. Engineers also analyzed the loads and displacements on the handles, whose functions are to absorb stress and minimize pressure on the teeth and gums. Then, engineers analyzed the contact friction energy of both brushes’ bristles to the teeth, comparing the same range of motion after two reciprocating movements.

The visualization compared the performance of both products and revealed that the “normal” toothbrush covered a smaller contact area with higher

Lion engineers compared the contact friction energy of a competitor’s product (left) with the Systema toothbrush (right). Analysis results showed that Systema bristles covered a broader contact area with lower stress levels, providing improved cleaning between the teeth and beneath the gum line.



**Lion's Systema product line now includes 14 types of toothbrushes, each with different head sizes, bristle hardness and handle shapes.**

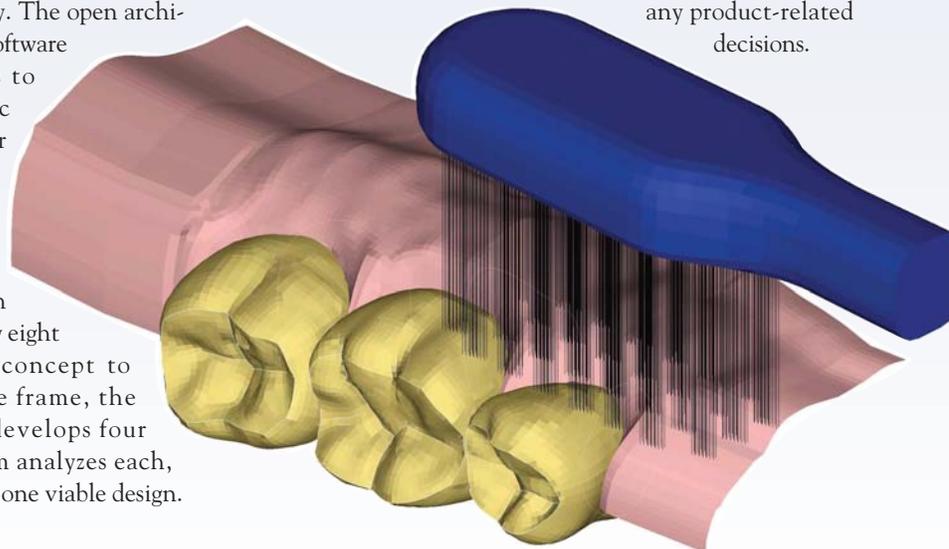
contact pressures. Overall, that combination resulted in poorer overall cleaning performance and increased stress on the teeth and gums. The Systema, on the other hand, had a broader contact area and lower stress levels, minimizing gum irritation while providing improved cleaning capabilities between the teeth and beneath the gum line.

The results allowed the company to reposition the Systema as an "automatic" toothbrush, one that can be used to brush all the teeth, even when consumers brush vigorously. To leverage the simulation, Lion shared the visualizations with retail outlets to demonstrate that the Systema product outperformed others on the market.

The success of the project hinged on Lion's ability to accurately represent the contact friction energy. This required close collaboration with Altair consulting engineers to characterize material models and customize HyperView's results reader to visualize the contact friction energy. The open architecture design of Altair's software simplified this process to present the odonto-gnathic visualization in the manner in which Lion required.

### **An Innovative Process**

A new toothbrush design takes approximately eight months from drawing concept to launching. In that time frame, the design team typically develops four concepts. The CAE team analyzes each, narrowing the concepts to one viable design.



## **The Test of Time**

In 1891, Tomijiro Kobayashi established T. Kobayashi & Co. in Kanda, Tokyo, to trade in the raw materials for soap and matches. The company grew, focusing on toothpaste and soap products. Eventually, T. Kobayashi & Co. specialized in toothpaste and later became the Lion Dentifrice Co. Ltd.

The soap business was spun off as Lion Soap Co., Ltd., which later became Lion Fat and Oil Co., Ltd. The two companies continued to expand their businesses independently. In 1980, however, the two merged into a single entity, the Lion Corporation.

Today, Lion employs more than 3,500 employees and offers oral care, beauty care, household, home, pharmaceutical and chemical products "to enhance the happiness and lifestyles" of customers. Net sales in 2006 were US\$2.6 billion.

from Good Morning to Good Night  
**More Dreams for Your Life**  
**LION**

Without CAE tools, engineers would need to make a number of physical prototypes and test them. Because of cost and time issues, it is not practical to do so. Instead, simulation tools enable engineers to evaluate several ideas and choose the best one.

Lion couples information on the product concept with in-depth market and demographic research on various segments of the consumer population. Company executives then weigh all the data before making any product-related decisions.

## Packaging with a Purpose

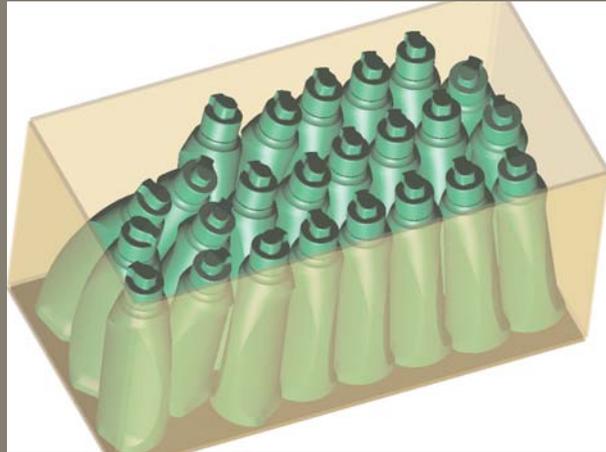
In addition to applying innovative tools and techniques to product development and sales, engineers from the Lion Corporation's Packaging Technology Department must ensure that bottled products, such as detergent, reach retailers' shelves intact for proper display. Simulation tools enable them to evaluate a range of shapes in the design stage – as well as the effects of motion and vibration on the bottles during transportation – to determine the best design solution.



In particular, Altair MotionView and MotionSolve, part of the Altair HyperWorks suite of CAE software, allowed engineers to conduct multi-body dynamics (MBD) analysis studies to predict the effects of shipping on the arrangement of the bottles within the shipping box. It is important to minimize disarray of the bottled products as the shipping box is commonly used as a display unit in retail stores. Corrugated cardboard dividers are commonly used to prevent disarray. However, this introduces additional cost and is not as environmentally friendly as using the bottle design and packing order to maintain the desired arrangement of the contents.

MBD analysis studies took into account the design (or shape) of the bottles, number of bottles, packing orders, dimensions of the corrugated cardboard boxes, presence of flaps on the bottom of the boxes, contact definitions between bottles and boxes, and typical loading scenarios experienced during shipping. The process was further accelerated by using the advanced model-morphing capabilities in Altair HyperMesh, which make it easy to modify the bottle shape.

Lion is also committed to developing durable, eco-friendly products. As such, Lion's Packaging Technology Department uses Altair RADIOSS nonlinear solver technology to simulate the



real-world effects on bottled products experienced during shipment and consumer use. The goal of these simulations is to minimize the amount of material used and to prevent product leakage when the bottle is dropped, compressed, decompressed and squeezed.

Lion designers focus on minimizing the amount of material used while ensuring that bottles can withstand various loads. Simulation tools enable them to run through a battery of tests efficiently without having to create physical prototypes or develop expensive injection-molding tools.

To receive more information about MotionView and MotionSolve, visit [www.altair.com/c2r](http://www.altair.com/c2r) or check 04 on the reply card.

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In addition to the Systema visualizations, Lion is applying innovative simulation techniques to other projects, including a rotating-head toothbrush, a design that combines multi-body dynamics (MBD) and nonlinear analysis. What's more, Lion is applying MBD techniques in other application areas, such as packaging (see *Packaging with a Purpose*).

The use of innovative techniques, such as simulation software, enables Lion to provide to customers superior products that are useful in daily life.

C2R

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To receive more information about RADIOSS, visit [www.altair.com/c2r](http://www.altair.com/c2r) or check 05 on the reply card.