industry focus

OPTIMIZATION AND CALIBRATION IN BIOMEDICAL ENGINEERING

Computational modeling of complex physiological systems and their interaction with medical devices has become an important area of bioengineering research worldwide. The attention on this field is growing to meet the market demand for an **acceleration in the development of safe, well-performing and reliable medical devices**.

Considering all clinical failure scenarios, their incidence in clinical practice, the investigation of undesired effects and their impact is fundamental. In the design process these elements should be taken into account, and **modeling and simulation** provides an **efficient and cost-effective solution**. A **complete and accurate exploration of interactions of design variables** is paramount to identify the best option from a large number of potentially good design alternatives of a medical device.

Therefore, **integrating different design disciplines, automating the simulation process** and enabling **design exploration with mathematical algorithms** play a key role. This **optimization and calibration** approach supports the execution of complex biomedical engineering design problems with remarkable **advantages in terms of time saving, efficiency and reliability**.

Advantages of ESTECO technologies

Great support for engineers facing these challenges comes from ESTECO technologies through their process automation, design exploration and data analysis platform.

- **Broaden the knowledge of the problem**, taking all variables and possible scenarios into account
- Enhance the **reliability of simulation** using **model calibration**
- Help **reduce the number of expensive prototypes** and pre-clinical experiments and **increase the safety of trials**
- **Reduce design times** by enabling **automation of complex simulation processes**
- Integrate **multiple design disciplines** for holistic design

modeFRONTIER

modeFRONTIER is a comprehensive solution for process automation and optimization of the engineering design process, enabling biomedical engineers to reduce experimental time and streamline data assessment.

OPTIMIZATION OF AN INCUBATOR

CHALLENGE
Find the best operational design of an incubator meeting specific temperature and humidity levels (target), air flow (velocity less than 0.35 m/s) and minimum heat loss to ensure the best health conditions for the infant.

SOLUTION
Given the input variables for velocity and angles of air flow, flow temperature and relative humidity at inlets, modeFRONTIER helped engineers choose between two designs. One design perfectly met the temperature (37 °C) and humidity (86%) requirements with only a 3% increase in the heat loss. The second design had a 6% reduction of heat loss with only 0.5% deviation from the target. Both designs kept air flow velocity under the critical limit. These results were provided in a short simulation time: just a few days compared to some weeks necessary without ESTECO technologies.

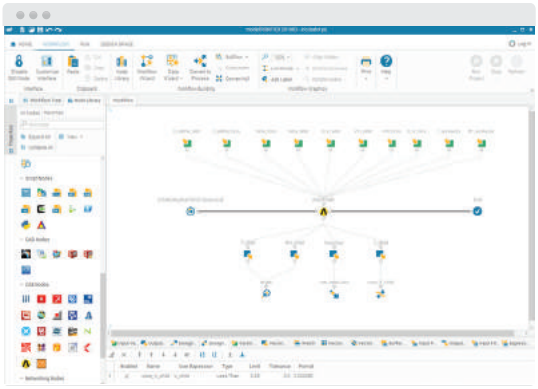
BENEFITS
Thanks to the integration and automation provided by modeFRONTIER, engineers could find the best balance between temperature and humidity values and heat loss reduction. The use of ESTECO technologies made it possible to choose among the best solutions in a short time, supporting the decision-making process.

FEMORAL PROSTHESIS

CHALLENGE
Investigate and find the best structural design of a femoral prosthesis considering strength, fatigue and part mass. Stress of the prosthesis should be minimized while still meeting fatigue certification.

SOLUTION
A standard static structural analysis and a fatigue test were performed to find the stress level of material properties for 5 million cycles, for the certification of femoral prostheses. With the Design of Experiments technology available with modeFRONTIER, engineers could explore the correlations of material properties (elasticity and resistance) with the maximum stress value and found that elasticity has a greater impact on it compared to resistance.

BENEFITS
Thanks to ESTECO technologies, it was possible to have a high number of reliable simulations, consider multiple design variables and have a complete view of their influence on the fatigue life of the prosthesis. As a further optimization step, engineers would be able to reduce the mass while ensuring the minimum stress levels.

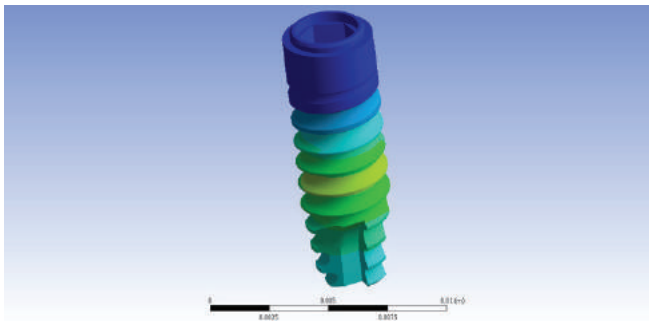


REMOVAL TECHNIQUE OF DENTAL IMPLANT

CHALLENGE
Optimize a new removal technique of osseointegrated dental implant based on a heating process, guaranteeing the extraction of the capsule while ensuring minimal necrosis of the surrounding area.

SOLUTION
modeFRONTIER integration with ANSYS software helped perform a two-step simulation process. The first step involved the calibration of a numerical model by setting up numerical parameters (heat transfer coefficient, material properties) to accurately simulate the heating process. The second step was the optimization of the removal technique by finding the best values for direction, duration, temperature and power of the heating instrument.

BENEFITS
Thanks to modeFRONTIER integration with ANSYS software, it was possible to set up a numerical model to simulate the removal process in the most realistic way. In this way engineers could optimize the same process in a safe and effective manner, avoiding the repetition of several tests on patients or test subjects.



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ESTECO is an independent software provider, highly specialized in numerical optimization and simulation data management with a sound scientific foundation and a flexible approach to customer needs.

With 20 years' experience, the company supports leading organizations in designing the products of the future, today.